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FIFTY-EIGHTH

ANNUAL REPORT OF THE SECRETARY

OF THE

MASSACHUSETTS

STATE BOARD OF AGRICULTURE,

TOGETHER WITH THE

TWENTY-THIRD ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

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The State Board of Publication.

TABLE OF CONTENTS.

State Board of Agriculture, 1911.

Members ex Officio.

His Excellency EUGENE N. FOSS.
His Honor LOUIS A. FROTHINGHAM.
Hon. WM. M. OLIN, *Secretary of the Commonwealth.*
KENYON L. BUTTERFIELD, LL.D., *President Massachusetts Agricultural College.*
FREDERICK F. WALKER, *Chief of the Cattle Bureau.*
F. WM. RANE, B. Agr., M.S., *State Forester.*
J. LEWIS ELLSWORTH, *Secretary of the Board.*

Members appointed by the Governor and Council.

	Term expires
CHARLES E. WARD [1] of Buckland,	1911
HENRY M. HOWARD of West Newton,	1912
CHARLES M. GARDNER of Westfield,	1913

Members chosen by the Incorporated Societies.

Amesbury and Salisbury (Agricultural and Horticultural),	J. J. MASON of Amesbury,	1912
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Blackstone Valley,	JACOB A. WILLIAMS of Northbridge,	1912
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Hampshire,	HOWARD A. PARSONS of Amherst (P. O. North Amherst),	1913
Hampshire, Franklin and Hampden,	FRANK P. NEWKIRK of Easthampton,	1912
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Hillside,	HARRY A. FORD of Windsor,	1914
Hingham (Agricultural and Horticultural),	HENRY A. TURNER of Norwell,	1912
Hoosac Valley,	L. J. NORTHUP of Cheshire,	1912
Housatonic,	N. B. TURNER of Great Barrington (P. O. Housatonic),	1912
Lenox Horticultural,	ALFRED H. WINGETT of Lenox,	1914
Marshfield (Agricultural and Hort'l),	WALTER H. FAUNCE of Kingston,	1912
Martha's Vineyard,	JAMES F. ADAMS of West Tisbury,	1913
Massachusetts Horticultural,	WILFRID WHEELER of Concord,	1912
Massachusetts Society for Promoting Agriculture,	N. I. BOWDITCH of Framingham,	1912
Middlesex North,	GEO. W. TRULL of Tewksbury (P. O. Lowell, R. F. D.),	1914
Middlesex South,	JOHN J. ERWIN of Wayland,	1914
Nantucket,	JOHN S. APPLETON of Nantucket,	1912
Oxford,	WALTER A. LOVETT of Oxford,	1913
Plymouth County,	AUGUSTUS PRATT of Middleborough (P. O. North Middleborough),	1914
Spencer (Farmers' and Mech's Ass'n),	WALTER C. BEMIS of Spencer,	1913
Union (Agricultural and Hort'l),	SYLVESTER H. PEEBLES of Blandford,	1913
Weymouth (Agricultural and Ind'l),	THERON L. TIRRELL of Weymouth (P. O. South Weymouth),	1912
Worcester,	B. W. POTTER of Worcester,	1914
Worcester East,	GEO. F. MORSE of Lancaster,	1912
Worcester Northwest (Agricultural and Mechanical),	ALBERT ELLSWORTH of Athol,	1913
Worcester South,	WILLIAM E. PATRICK of Warren,	1913
Worcester County West,	JOHN L. SMITH of Barre,	1914

[1] Successor not yet appointed.

The Commonwealth of Massachusetts.

THE FIFTY-EIGHTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

STATE BOARD OF AGRICULTURE.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

During the past year there has been a remarkable development in relation to agriculture in the New England States, affecting that of Massachusetts probably more immediately and to a greater degree than that of the other States because of her superior markets and railroad facilities. I refer to the boom in agriculture and agricultural property in New England which has been fostered by the popular magazines and periodicals, and which has also engaged the attention of business men and capitalists. With the taking up of the free lands in the west, and the consequent cutting off of the supply of cheap lands in that part of the country, the attention of the public has been turned toward the east, and the lesson has been impressed upon it that here in New England, with the finest and most accessible markets in the country, there are greater opportunities for investment in agricultural property and for profitable development of farming operations than in the more newly settled regions. This has led to a great many inquiries as to farm property, to a close study of scientific farm methods, with a view to possible profitable operations, all of which has caused a general hardening in values of farm property. What the ultimate result will be cannot as yet be foretold, but it is my belief that we may reasonably look to a permanent increase in values, to an increased efficiency in our agriculture, and, because of these factors, to a more hopeful feeling and greater expectation of profit on the part of our farming population. That such an outlook is valuable cannot be gainsaid; in the world we are very apt to achieve, in a general way, what we expect to achieve, and one of the greatest handicaps under which agriculture in New England has suffered in the past twenty years has been the general pessimistic attitude of the majority of those engaged in it. This the present more hopeful feeling should, and undoubtedly will, do much to expel.

Another indication of this general upward movement in agricultural conditions in New England is the holding of expositions and fostering interest in certain crops and classes of crops, such as the New England Fruit Show of 1909 and the New England Corn Exposition of the past year. The former showed the public and the fruit growers of New England that we could produce as fine looking fruit as that of the west, the quality having long been admitted to be superior, and the latter that it was possible to establish world's records for yield of corn per acre in Massachusetts, in spite of the supposed superiority of western lands and methods for this crop. These expositions should be repeated in future years and others held covering other crops and products, so that we may know our own possibilities in as many lines as possible, and also demonstrate them to others.

From the standpoint of the business farmer the year has generally been very satisfactory. The effect of the third successive year of drought was more apparent upon wells, springs, streams and ponds than upon growing crops, as timely showers brought most crops through the season with surprisingly little damage. The rains of the early season, while not giving many inches of precipitation, nevertheless resulted in an excellent hay crop. The corn crop was remarkably good, both for grain and stover, and was secured without damage from frost, while other grain crops were at least average. For these reasons, together with generally satisfactory prices, the dairymen had a prosperous year, and came to the winter with well-filled barns and full stocks of cattle. Pastures suffered from drought, and many farmers fed both grain and hay at the barn during the summer months, thus reducing the profits of the business somewhat, as well as the stocks of hay for winter use. Grain and hay continue high in price, though grain has receded a trifle from its highest level, and dairymen should endeavor to raise as much as possible for their own use. The increasing difficulty in securing good cows leads to the suggestion that profit in dairying will soon come to depend on judicious breeding of dairy stock. Many dairymen could doubtless profitably cut down their total production and give more attention to the raising of their own stock and the production of their own feeds. A good profit on a small volume of product is to be preferred to a small or vanishing profit on a large volume.

The apple crop, though not heavy in yield, was one of the best of recent years in quality. More farmers sprayed their fruit trees than ever before and the result was an increased percentage of No. 1 fruit. Unsprayed fruit was also better than usual, but not to be compared with that secured where intelligent spraying was followed. The demand for New England fruit of good quality was greater than ever before, and it seems likely that the public is convinced of its superiority to a greater extent than we have commonly supposed. It remains for the farmers and fruit growers to hold and increase this demand by producing the grade of goods that is called for. The officials of the Boston & Maine Railroad report that many carloads of New England apples were sent to the middle west, where they competed successfully with those from the far west and commanded much higher prices than the native apples. This shows what may be done in the way of invading the markets of other sections, but for the present we would better bend our energies to recapturing and holding our home market, our most valuable possession and one too long neglected.

Market gardeners generally had a good year, though some crops, such as celery, were very short in many sections. Prices have been good as a rule and the demand well sustained. Onions were a light crop, but brought good prices. Tobacco was a very good crop, with prices, as far as known, about normal. Cranberries were a light to medium crop, with the berries small. Poultry and eggs brought good prices throughout the year, and the stock of poultry kept on farms and by small poultry keepers was generally increased.

Legislation of 1910.

The recommendations of this Board for legislation fared well at the last session, taken as a whole. As a result of the work of the year a law was enacted relieving the milk producer from prosecution when he innocently has below-standard milk in his possession, and giving him twenty days in which to bring his milk to the legal standard, thus protecting the consumer as well. With the standard law in force, so far as milk in the hands of dealers is concerned, the public is protected against possible fraud on their part and the farmer against the unfair competition resulting from such fraud. The law as at present relieves the innocent milk producer of the element of criminality that formed so strong an objection to the milk standard law as previously interpreted and enforced. It has accomplished all that was hoped for it, and seems to offer a reasonable solution of the problem which has proved so vexatious in recent years. Since its enactment no milk producer has been convicted of selling below-standard milk, and the interests of the public have not suffered, as the farmers have shown themselves ready to bring their milk to the standard in every case where they have been notified that it is below standard.

Other legislation relative to agricultural interests, recommended by this Board and enacted into law, includes the following: an act relative to wild deer, an act relative to State inspection of apiaries, an act providing for a special report on game birds, and an act making an appropriation for the encouragement of orcharding. These will be taken up under their proper headings and need no further comment at this time.

Milk Legislation.

Although the milk standard law would seem to be satisfactorily solved, for the present, at least, and further agitation in relation to it is to be ill timed, there remains one phase of the business on which legislation would seem to be in order at this session of the Legislature. As is well known, there is a determined effort in the making, backed by powerful interests, to have State-wide inspection of milk production, under the control and at the expense of the Commonwealth. Such inspection has some advantages from the standpoint of both the consumer and the producer, but in any form hitherto proposed is open to certain objections which more than nullify its good features. On the one hand, it must stop at the State line, and thus discriminates against the Massachusetts producer, placing burdens upon him to which his competitors in other States are not subjected, and at the same time inadequately protects the consumer, as it leaves by far the greater part of the milk supply of Boston, at least, uninspected as to conditions of production. On the other hand, it imposes an undue burden on the producer by obliging him to help defray the bills incurred in inspecting him. It is manifestly unfair to tax the town of Petersham, for instance, to help pay for inspection of milk for the protection of the people of Boston. Such a proposition catches the farmer coming and going, making it more expensive for him to produce milk and compelling him to pay for the work of making it more expensive. I do not wish to be understood as opposing proper inspection of milk production; I simply seek some method of inspection that shall be fair to all. To my mind the best solution for the producer and consumer alike lies along the line of legislation to allow the boards of health of cities and towns to inspect the dairies that produce the milk consumed in the said cities and towns, and to forbid its sale without such inspection. It may be objected that this is impossible of accomplishment in the metropolitan district, but it has been practically accomplished in some instances, certain dairies being already set aside to furnish the supply for certain towns. This step accomplished their inspection becomes a simple matter. Such a plan will afford the degree of protection desired by the several cities and towns, and also relieve the farming communities of any additional burden of taxation for the purpose. I would recommend, therefore, that the Board submit to the Legislature a bill authorizing boards of health of cities and towns to issue permits for all milk or cream received, held, kept, offered for sale or sold in said cities and towns, subject to such conditions as they may make, and to forbid the sale of any milk or cream produced, transported or kept under conditions not approved by the said boards of health.

Work of the Office.

During the year the work of the office has increased remarkably. We had many plans for work, such as rearranging and classifying the library, which we have been obliged to put over to some later time. This increase is due to a variety of causes, chief among them the wakening to the possibilities of New England agriculture, previously noticed, and the consequent demand for information, by publications or otherwise. In addition, our list of publications available for distribution has been increased, and we have taken considerable pains to acquaint the public with its contents. The policy of the office for the past year and more has been to answer every request, except those for a specified bulletin or publication, with a personal letter, and to go to all possible pains to obtain information for correspondents. That this policy is appreciated by the public we are well assured. Within a few days we have had on one mail no less than six letters thanking us for publications sent or information given. Careful work of this kind makes more work, as it encourages additional queries, but the citizens of Massachusetts are entitled to it at our hands, and we are glad to extend the same courtesy to those of other States.

The office library is in bad condition, containing many sets and parts of sets of bulletins and other publications which should be completed and bound, or otherwise disposed of. Many of the books and pamphlets are of no use to us, either because in foreign languages or for other reasons, and it is our purpose to send these to the Massachusetts Agricultural College, or to some other institution where they may be of service. The library should be rearranged and card catalogued, so that additions may be easily entered up. Also, the correspondence and other office work seems likely to grow beyond possible management by the present clerical force.

An interesting comparison is offered by the amounts expended for postage and for printing during the years 1905 and 1910. The former gauges the amount of correspondence and the amount of bulletins, leaflets, etc., sent out by mail. In 1905 the Board expended for this purpose the sum of $329, and in 1910 that of $617.43. The amount expended for printed matter gauges the demand for our publications and our effort to meet it. In 1905 the Board expended for this purpose the sum of $1,023.42, and in 1910 that of $1,605.94. In addition, we were obliged to carry over bills for this purpose amounting to between $400 and $500, which could not be paid out of the appropriations for 1910. We have been obliged, during the past year, to employ considerable help from time to time for addressing, mailing, stenographic work, typewriting and multigraph work. This has been paid for from the appropriations for other clerical assistance and lectures before the Board, for the expenses of the State Ornithologist and that of the Dairy Bureau. These matters could all be handled in this office if we had a stenographer permanently in employment, and the office work so lightened that the matters above referred to could be taken up and disposed of.

For these reasons I would recommend that the Board present to the Legislature a bill calling for an increase of the appropriation for extra clerical assistance and lectures before the Board from $800 to $1600 per annum, so that a stenographer can be regularly employed.

Wild Deer.

The nuisance caused by the presence of wild deer in the State, and the great menace they form to young orchards, market gardens, nurseries and farm crops, has been pointed out too often to need repetition at this time. The agitation for their regulation, begun by your secretary several years ago, resulted last year in a very satisfactory law, allowing the farmer to kill them in his orchards or crops, with any weapon at hand, and also allowing a short open season in the five western counties, when they could be hunted with shot guns. Something like 2,000 deer were killed during the year by farmers and hunters, without a single fatality to human beings. The Commissioners on Fisheries and Game last year estimated, at my request, the number of deer in the State at about 8,000, and their annual rate of increase at about 40 per cent, so it will be seen that those killed were less than the natural increase. Thus the relief secured is not as great as it would appear on first consideration. There will undoubtedly be a protest against another open season. Sentimentalists will urge that the deer form a pleasing feature of the landscape and should be protected at all times, but it is better for the community at large that they be kept within reasonable numbers, rather than that they be allowed to increase without check, and ravage our orchards and fields to the great detriment of agriculture. A business with an annual output of upwards of seventy millions of dollars deserves consideration before a mere sentiment. It will also be urged that it is cruel to allow them to be wounded with shot guns, in many instances to die in the woods, and this is to be regretted, but it is better that a few deer die in this manner rather than that one human being should be killed by the rifle in the hands of a deer hunter.

Changes in the Board.

The changes in the membership of the Board during the year came about entirely through the expirations of the terms of various members. Members retiring because of expiration of terms of service are: Dr. Austin Peters, formerly Chief of the Cattle Bureau, after eight years of service; Wm. B. Avery of the Deerfield Valley Agricultural Society, after three years of service; Henry S. Pease of the Highland Agricultural Society, after six years of service; W. A. Harlow of the Hillside Agricultural Society, after three years of service, and Isaac Damon of the Middlesex South Agricultural Society, after eighteen years of service.

Meetings of the Board.

The Board held its annual summer field meeting at the Massachusetts Agricultural College, Amherst, on June 23, 1910. The means and methods of spraying, grass culture and alfalfa growing, swine growing and management, and the making of certified milk, were demonstrated. Prof. L. A. Clinton of Connecticut gave an interesting lecture on corn growing. The attendance was large.

The second demonstration meeting was held at Ponkapoag Pond, in Canton, on August 18, 1910, with demonstrations of handling and hiving bees and combating foul brood in bees, also of budding, grafting and pruning fruit trees. The meeting was held for the people of the immediate section and was well attended.

The public winter meeting of the Board was held at Northampton, with the Hampshire, Franklin and Hampden Agricultural Society. The programme was a strong one, the attendance large, and the interest in the lectures unusually keen. The Northampton Board of Trade gave a reception to the Board at the Draper Hotel on the evening of Wednesday, December 7. The lectures delivered, and selections from the discussions, will be printed in the annual volume.

The annual business meeting of the Board was held at Boston, on Jan. 10 and 11, 1910, and special business meetings were held at Amherst and Northampton, in connection with the summer and winter meetings.

Agricultural Societies.

The agricultural societies generally held fine exhibitions and enjoyed a prosperous year. The attendance was good and only a few suffered from bad weather, most of these being able to make receipts equal expenses. The competition and interest in the agricultural exhibits at these fairs are certainly increasing. Attend any fair with which you were familiar in the past and you will find many more people looking over the stock and the hall exhibits, and a smaller proportion of the crowd gathered around the stage and other attractions. This increases the educational value of the fairs to a considerable degree, and makes them well worthy of support from the Commonwealth. The inspectors report that the societies are generally prosperous, with good grounds and buildings, and their criticisms are of details of management rather than of the general tendencies of the fairs. No objectionable features were noticed by the inspectors.

The societies generally responded to the request of the Board for assistance for the New England Corn Exposition, the greater part contributing sums ranging from $15 to $250. The Worcester Agricultural Society also gave the use of its grounds and buildings without charge. Altogether cash contributions to the amount of upwards of a thousand dollars were made by the societies. Without these contributions it would have been impossible for the exposition to have come out with all bills paid, and the societies are entitled to a great deal of credit for its success. I would recommend that the Board make the same request for assistance for the benefit of the New England Fruit Show, if it shall hold an exhibition during the current year.

Farmers' Institutes.

The institute work has been carried on along the usual lines and with the usual success. One hundred and forty meetings have been held during the year, with 198 sessions. All the societies held 3 or more meetings, except the Hoosac Valley and Oxford societies, which asked and received permission to hold but 2. Nine societies held 4 or more institutes, and 24 meetings were given to organizations other than incorporated agricultural societies. The attendance for the year shows a falling off, the average being but 110, as against 137 last year, 111 in 1908, 118 in 1907, 127 in 1906, 125 in 1905, and figures ranging from 94 in 1899 to 109 in 1904, for previous years. The falling off is accounted for in the main by bad weather at a time when a large number of institutes were held, rain and warm weather following the heavy snows of early winter and making the roads impassable for any distance. These accidents cannot be guarded against, but probably such a general condition will not occur again for several years to come.

A circuit has been arranged for Prof. R. M. Washburn of Vermont, for the week of February 27 to March 4. Dr. Geo. M. Twitchell will again make Boston his place of residence during February and the first two weeks of March, and will be available at any time during that period.

The list of speakers was carefully revised by the committee on institutes and public meetings and is now stronger than ever. We shall be glad to advise with institute managers in regard to speakers and subjects suited for their special needs. We consider the advertising of these meetings of special importance, and shall be glad to assist in any way.

Your secretary attended the annual meeting of the American Association of Farmers' Institute Workers, at Washington, D. C., early in November, and derived much profit from the meeting.

A new feature of the work was an institute for women, held at Lowell in December of this year, with women speakers. The meeting was a very interesting one, but I feel bound to say that I was disappointed in one respect, in that there were more men than women in the audience. It is my intention to continue this line of work to a certain extent, until it is demonstrated whether there is a demand for it in Massachusetts.

Owing to the demands on our appropriation for "the dissemination of useful information in agriculture," in the way of bulletins, we were obliged to carry over bills to be paid from the appropriation for 1911. This will necessitate a cutting down of the work, either in publication or in institutes, or both, during the coming year, unless an increase is granted by the Legislature. This being an appropriation where the sum is not fixed by statute I have included an increase of $1,000 in my estimates for the year. It will not be necessary to present a bill to the Legislature, but I would recommend that the Board instruct its committee on legislation to appear before the Legislature and urge the necessity of this increase.

Apiary Inspection.

The Legislature at the last session passed a special bill for the appointment of an apiary inspector by this Board, to serve until March 31, 1911, with an appropriation of $500. The declared purpose of the Legislature was to allow a trial of the work, to ascertain whether it was necessary and whether what was claimed for it could be accomplished. At the special business meeting, at Amherst, the Board elected Burton N. Gates, Ph.D., of Washington, D. C., and formerly of Worcester, as State Inspector of Apiaries. With the small sum at his command and the late date of beginning the work he could accomplish only a small part of what needed to be done. His investigations have established the presence of foul brood in all sections of the State, and have determined the fact that bees have been practically wiped out over large areas. The importance of this matter can be better understood when it is known that cucumber growers are absolutely dependent upon bees for the setting of the blossoms, and that in many cases the introduction of diseased colonies, unable to do the work, has led to heavy losses in the greenhouses. Further, fruit growers are in a large measure dependent upon bees for cross-fertilization of fruit blossoms, and experiments have shown that many partial failures of the crop have been due to their absence. The beekeepers appreciate the fact that this work is necessary for the preservation of their industry, and strongly favor its being made permanent. The details will be shown in the annual report of the Inspector of Apiaries, to be presented at this meeting, also plans for future work. I would recommend that this Board present a bill to the Legislature making this work permanent, and calling for an appropriation of $2,000 per annum. Careful estimates show that this sum is necessary for the next few years at least.

Nursery Inspection.

The State Nursery Inspector met with many difficulties in the carrying out of the work of the year, and was only able to do so through the aid of the United States government and the nursery owners. The threatened quarantine against our nursery stock by other States, from fear of the introduction of the gypsy and brown-tail moths, has put an entirely different face upon the future of the work. A greatly increased appropriation will be necessary if this industry, with an annual output of over a million dollars, is to be saved to the Commonwealth. The Massachusetts' Nurserymen's Association, composed of the owners of nurseries within the Commonwealth, proposes to ask for legislation to that end. Owing to their vital interest in the matter they are the proper ones to make the proposition, but I would recommend that you instruct your secretary and your committee on legislation to appear before the proper committees of the Legislature and urge the necessity for this legislation. Also, that you instruct your secretary to extend to Dr. L. O. Howard, Chief of the Bureau of Entomology of the United States Department of Agriculture, an expression of our cordial appreciation of the great assistance he rendered this industry and your Nursery Inspector during the past year.

The details of the work will be set forth in the annual report of the State Nursery Inspector, to be presented at this meeting. It is sufficient to say that the work was well done by Dr. Fernald and his assistants. The privilege of the law, by which private owners can call for an inspection of adjacent property for the San José scale, was availed of for the first time this year, several applications being received, and the nuisance abated under direction of the Nursery Inspector in each case. This feature of the work seems likely to have a wider application in the future.

Dairy Bureau.

The work of the Dairy Bureau has been characterized by thoroughness, judgment and moderation. The number of cases brought in court, the percentage of convictions secured, the disposition of technical violations of the law by warning without prosecution, and the educational work of the Bureau, all reflect credit upon its management. The members of the Bureau, with two others, appointed by the Governor, have been engaged in an investigation of the milk situation, with a view to preparing a plan for inspection of production. I am not, at this time, informed as to their findings, but can vouch for the thoroughness of their investigation. The details of the work proper of the Bureau are given in the annual report of its general agent, which will be presented at this meeting.

Cattle Bureau.

A new incumbent of the office of Chief of the Cattle Bureau will present his first report at this meeting. While entertaining the highest regard for the ability and the work of both the late and the present chiefs I would fail in my duty to the Board if I did not again point out the inconsistency of the law, which makes this Bureau a part of the Board and at the same time withholds from the Board any authority over it. The work of inspection of animals and prevention of animal diseases should be under the control of this Board; that of the inspection of meat and of slaughterhouses more properly falls under the State Board of Health. I would recommend that the Board present to the Legislature a bill providing for such a division of the work.

State Forester.

The State Forester will report to you verbally, giving a short statement of the more important features of his work. His formal report, too long to be read at this meeting, will be printed in the annual volume. That he has done a large amount of valuable work for the State I am thoroughly convinced, and I am equally certain that he deserves commendation and assistance. I would therefore recommend that this Board endorse the work of the State Forester, and instruct its secretary and its committee on legislation to render all the support to his recommendations for legislation that they shall deem proper and necessary.

State Ornithologist.

The State Ornithologist has been engaged during the year in the preparation of the report on game birds authorized by the last Legislature, along similar lines to the recent report on "Useful Birds and their Protection." Although this has taken the greater part of his time he has attended to his other duties as State Ornithologist, including a great deal of correspondence. The report on game birds will be issued some time during the year, and will be sold at not less than cost, the free list for the report being very small. Much of the stenographic work of the State Ornithologist can be taken over by the office stenographer if the proposed appropriation for that purpose is granted. Few people appreciate the wide field which his work covers, and the great demand for information along these lines. The sale of "Useful Birds and their Protection" has apparently reached a stable basis, about thirty copies a month being disposed of, and there is a sufficient number of the third edition on hand so that a reprint will not be needed in the immediate future. The details of the work of the State Ornithologist will be given in his report, which will be presented at this meeting.

Massachusetts Agricultural College.

The Legislature of 1910 dealt generously with the college and the work of the institution has been greatly increased and broadened. The numbers in attendance are growing, and it would seem as though the college was about to enter upon the most prosperous period of its history. No particular feature of the work presents itself for special comment, and the work of the institution as a whole is too varied and complex to be treated in this report. Continued generous support for this institution is asked at the hands of the Legislature.

The New England Corn Exposition.

This exposition was a great success. Launched a year ago, and held back one year to give right of way to the New England Fruit Show, the exposition showed the effects of the careful preparation in its exhibits and in the interest shown in them. The feature of the exposition which attracted the widest attention was the world's record for shelled corn per acre, made by a Massachusetts farmer, with New England flint corn. It showed that New England need ask no odds of the west, even in the latter's own specialty, and that it is still possible to grow this crop to perfection on our fields. The other exhibits in the halls of the Worcester Society amply showed that quality as well as quantity was to be found here. With a remarkable corn year and a splendid crop to draw from an artistic success was assured, but the financial success of the exposition was made possible by the generous donations of the agricultural societies. I make no question that this show will be repeated in future years, and there is nothing that gives a greater impetus to our agriculture than the holding of such expositions. By showing others what we can do we show ourselves, and set a mark to be aimed at in the future.

The New England Fruit Show of 1911.

The splendid fruit show held at Boston in 1909 will be repeated during the coming year, according to plans as now outlined. With the attention that is now being paid to apple growing, as well as other lines of fruit culture, and the general interest in the subject, it would be strange, indeed, if the record of a year ago were not surpassed. That this Board will co-operate is certain, that the societies will deal generously with the show I am convinced, and that the general public will respond as never before to an exposition of this sort I thoroughly believe.

The Farm Catalogue.

The Legislature of 1909 authorized the Board to collect all necessary information in regard to the opportunities for developing the agricultural resources of the Commonwealth by the reoccupancy of idle or partly improved farms and farm lands, and cause the facts so obtained and a statement of the advantages offered to be circulated where and in such manner as the said Board considered for the best interests of the Commonwealth, and appropriated $1,000 for the purpose. Your secretary investigated the subject carefully, and became convinced that the interests of the Commonwealth were best to be served by a publication on optimistic lines; that it was better to put the best foot foremost rather than to present a pessimistic picture of our agriculture, and presented an outline of his plan to the executive committee of the Board. The committee approved the plan and instructed the secretary to carry it out. The wording of the act allowed a certain amount of room for judgment in executing the project. Many delays were encountered in the work, owing to changes in office force, increasing work on other lines, delay of the boards of assessors and owners of farms in replying to our circulars, but the report was finally issued in November, 1910. You know how the plan was worked out and the instantaneous success of the publication. The edition was small, only 3,500 copies, owing to lack of funds, and in eleven office days these were entirely distributed.

The demand has continued unabated, and we have probably a thousand calls for a possible second edition on file at this time. These are by no means local, there being many from western States. It seems probable that an edition of 10,000 copies would not more than supply the demand for the present year. Such an edition, the printers estimate, would cost from $950 to $1,000. Money is also needed for postage for mailing the edition and other expenses connected with its distribution. If the work is to be continued other owners should be given an opportunity to list their farms, and a revised edition issued. There are many ways in which money could be expended which would, in my judgment, be of greater value to agriculture, but I doubt if there is any publication which we could offer that would be so much in demand by the people of the State, and of other States, as would this publication. As the general public pays the bills, both for this publication and others of more direct benefit to agriculture, its wishes should certainly be regarded when plainly expressed. I would therefore recommend that the Board ask the Legislature for an appropriation of $3,000, to publish a second edition of this catalogue, and to revise the material therein contained and publish a third edition.

The Encouragement of Orcharding.

A new line of work for the year was that under the appropriation for the encouragement of orcharding, made by the Legislature of 1910. A special committee, consisting of Messrs. Bursley and Wheeler and Professor Sears, pomologist to the Board, prepared a plan for the carrying out of the provisions of the act, which was accepted by the executive committee, acting for the Board. Under this plan prizes were offered for the greatest yield from any single apple tree; for the greatest yield from any acre of apple trees, trees to be in one solid block; for the best results from spraying, and for the best young orchard, of not less than two acres, trees not necessarily in one solid block, set in 1908 or 1909. The first three classes were awarded on sworn statements by the contestants, and the last class as the result of an inspection by Mr. Wilfrid Wheeler, acting as judge. The prizes were awarded as follows: Class 1, — first prize, $25, to Frederick A. Russell of Methuen, for a yield of 56 bushels from a Gravenstein tree; second prize, $15, to C. W. Mann of Methuen, for 44 bushels from a Baldwin tree; third prize, $10, to Rev. N. B. Fiske of Danvers, for 32 1-2 bushels from a Wealthy tree. Class 2,— first prize, $50, to the Drew-Munson Fruit Company of Littleton, for 227 barrels of Baldwin apples; second prize, $30, to Rev. N. B. Fiske of Danvers, for 115 barrels of Baldwin apples. Class 3,— first prize, $30, to Rev. N. B. Fiske of Danvers; second prize, $20, to the Drew-Munson Fruit Company of Littleton. Class 4,— first prize, $50, to Turner Hill Farm of Ipswich, with a score of 95; second prize, $30, to H. A. Hale of Colrain, with a score of 92; third prize, to E. Cyrus Miller of Haydenville, with a score of 91.

One demonstration meeting was held under this appropriation, at Medway, with very good results. It is planned to hold at least two meetings each year in future. Another feature to be developed during the current year is an exhibit of Massachusetts apples, in conspicuous places in Boston and other large cities. The fruit has been secured and plans are under way for its being shown.

A very interesting feature under this work was an exhibit of apples at the offices of the Board, the third week in November. No cash prizes were offered, but first and second prize ribbons for the best three specimens of the following varieties: Baldwin, Gravenstein, Hubbardston, McIntosh Red, Northern Spy, Rhode Island Greening, Roxbury Russet, Wealthy, King of Tompkins County, Sutton, Tolman Sweet, Yellow Bellflower, Red Canada, Westfield and Winter Banana. Ribbons were awarded as follows: Baldwin, — first, to H. M. Longley of Shirley; second, to B. L. Call of Colrain; honorable mention, to L. A. & C. J. Lahm of Carlisle. Roxbury Russet, — first, to Edw. A. Lunt of Newbury; second, to L. H. Bailey of West Newbury. Northern Spy, — first, to W. H. Campbell of Wayland; second, to L. A. & C. J. Lahm of Carlisle. Hubbardston, — first, to F. A. Russell of Methuen; second, to C. A. Campbell of Ipswich. King, — first, to Boston Consumptives Hospital; second, to C. A. Campbell of Ipswich. Rhode Island Greening, — first, to Samuel Leeds of Woburn. Sutton Beauty, — first, to Edward Farrar of Lincoln. McIntosh Red, — first, to Edward Farrar of Lincoln. Stark, — first, to F. A. Russell of Methuen. Palmer Greening, — first, to H. M. Longley of Shirley. Winter Banana, — first to E. D. Robinson of Vineyard Haven. Wagner, — first, to E. D. Robinson of Vineyard Haven. Yellow Bellflower, — first, to Boston Consumptives Hospital. Schiawassa Beauty, — second, to Boston Consumptives Hospital. Blue Pearmain, — second, to Wm. N. Davis of Hudson.

The exhibit attracted a great deal of attention, and the office was thronged with visitors during the four days that the apples were on exhibition, upwards of 1,000 persons, by conservative estimate, visiting the exhibition. The high quality of the fruit shown did much to convince the visitors, who were mainly residents of Boston and from the consuming class, that our home-grown fruit is the equal in appearance of any grown in the west, and all admit its superior quality. This exhibition is a feature which should be repeated every year in which there is not a fruit show of greater magnitude in Boston.

Bulletins of Massachusetts Agriculture.

The demand for these publications increased during the year, and the first edition of Nos. 1 and 2, on poultry and orcharding, were entirely exhausted. Calls for them accumulated to such an extent that a reprint was imperative, and they were issued during November in editions of 2,500 each. These editions were revised and new matter was added, which had appeared since the publication of the first edition. As they stand to-day they are fairly complete text-books on the subjects in question. New bulletins issued during the year were, No. 3, "Grasses and forage crops," and No. 4, "Small fruits and berries," the former in an edition of 2,000 copies and the latter in one of 2,500. Bulletin No. 4 covers fruits for the home garden, — peaches, pears, plums, quinces, grapes, strawberries and cranberries, — and there is a constant and increasing demand for it. Bulletins should be issued as soon as possible on vegetables and vegetable growing, dairying, animal husbandry and beekeeping. There is a demand for information on all these lines which we cannot, at present, satisfy. This demand and the need for these publications form an additional strong reason for the increase of the appropriation for the "dissemination of useful information in agriculture," previously referred to.

Crop Reports.

The monthly crop reports were issued from May to October, as usual. A new feature was the list of publications available for distribution, included in the report for August. A supplementary list, giving those issued subsequent to the printing of the previous crop report, has appeared in each of the succeeding issues, and will be made a regular feature. The issue for September contained a list of the annual reports available for free distribution, with the principal articles available in each. The special articles included in the various issues, in order of appearance, from May to October, were: "Corn selection for seed and for show," by Prof. Wm. D. Hurd; "Growing and marketing asparagus," by Frank Wheeler; "Alfalfa as a crop in Massachusetts," by Prof. Wm.

P. Brooks; "Celery growing, storing and marketing," by Henry M. Howard; "Quince culture," by Prof. F. C. Sears; and "Grape culture," by Edward R. Farrar. The editions were 6,090 for May, 6,300 for June, 6,500 for August, and 6,400 for the other months. The largest previous edition was 5,900 for September and October, 1909. A few copies are on hand for July and October, but the other months are entirely exhausted.

Publications.

The following publications were issued by this office in 1910, and, except those indicated, may be obtained on application: —

	Pages.	Number.
Agriculture of Massachusetts, 1909,	648[1]	15,000
Crop Report No. 1,[2]	37	6,090
Crop Report No. 2,[2]	37	6,300
Crop Report No. 3,	41	6,400
Crop Report No. 4,[2]	36	6,500
Crop Report No. 5,[2]	40	6,400
Crop Report No. 6,	38	6,400
Massachusetts Agriculture, Bulletin No. 1 (second edition, revised),	153	2,500
Massachusetts Agriculture, Bulletin No. 2 (second edition, revised),	165	2,500
Massachusetts Agriculture, Bulletin No. 3,	96	2,000
Massachusetts Agriculture, Bulletin No. 4,	113	2,500
Massachusetts: Her Agricultural Resources, Advantages and Opportunities, with a List of Farms for Sale.	160	3,500
Apiary Inspection, Bulletin No. 1,	12	3,500
Farmers' Institute Pamphlet,	15	900
Nature Leaflet No. 14 (reprint),	6	1,500
Nature Leaflet No. 28 (reprint),	5	1,500
Nature Leaflet No. 35 (reprint),	9	1,500
Nature Leaflet No. 36 (reprint),	5	1,500
Nature Leaflet No. 37 (reprint),	3	1,500
Nature Leaflet No. 38 (reprint),	9	1,500
Nature Leaflet No. 41 (reprint),	6	1,500
Nature Leaflet No. 43,	3	1,900
Nature Leaflet No. 44,	7	1,500

[1] Including twenty-second annual report of the Massachusetts Agricultural Experiment Station, 257 pages.

[2] Edition exhausted.

	Pages.	Number.
Nature Leaflet No. 45,	5	1,800
Nature Leaflet No. 46,	5	1,800
Annual Report of State Nursery Inspector,[1,2]	8	400
Annual Report of State Ornithologist,[1,2]	25	3,000
Annual Report of Chief of Cattle Bureau,[1,2]	63	500
The Farmer's Interest in Game Protection,[2]	7	300
The Culture of the Pear,[2]	10	300
Varieties of Apples for Massachusetts Orchards,[2]	28	500

[1] Edition exhausted.
[2] Excerpts from "Agriculture of Massachusetts," 1909, issued in pamphlet form.

Legislative Appropriations, Board of Agriculture.

Objects for which appropriated.	1910.		1911.
	Appropriated.	Used.	Appropriated.
Bounties to societies,	$18,000 00	$17,754 80	$18,000 00
Salaries of secretary and clerks,	6,200 00	6,200 00	6,200 00
Travelling and necessary expenses of Board,	1,300 00	1,165 10	1,300 00
Lectures before the Board, etc.,	800 00	762 43	1,600 00
Dissemination of useful information in agriculture,	4,000 00	3,998 98	5,000 00
Travelling and necessary expenses of the secretary,	500 00	366 80	500 00
Incidental and contingent expenses, including printing and furnishing extracts from the trespass laws.	1,100 00	1,099 99	1,100 00
Printing 15,000 copies of "Agriculture of Massachusetts."	6,000 00	5,740 15	6,000 00
Work of Dairy Bureau, including salaries,	9,800 00	9,690 00	9,800 00
State apiary inspection,	500 00	400 04	2,000 00
State nursery inspection,	2,000 00	1,999 95	10,000 00
State Ornithologist, salary and expenses,	1,000 00	999 92	1,000 00
Special report on game birds,	4,000 00	85 00	-
Collecting and circulating information relating to idle or partly improved farms or farm lands.	867 39[1]	867 39	1,500 00[2]
Poultry premium bounty,	1,000 00	600 00	1,000 00
For the encouragement of orcharding,	500 00	486 88	500 00
Totals,	$54,067 39	$52,217 43	$63,500 00

[1] Unexpended balance. [2] Reprint.

Extracts from Trespass Laws.

The distribution of printed extracts from the trespass laws has been continued during the year in accordance with the law on the subject. Each post-office in the State was furnished a copy on paper, for posting. The demand continues about as in former years, and there are no features in connection with the distribution worthy of special notice.

Better Farming Specials.

The Board and the Dairy Bureau co-operated with the Boston & Albany Railroad in the "better farming special" which it ran over its lines last spring. Your secretary accompanied the train throughout the trip, as did also the general agent of the Dairy Bureau, and speakers on fruit topics were furnished by the Board. The train made 18 stops, and upwards of 6,000 people availed themselves of its opportunities.

Your secretary also made one day's trip with the trolley "better farming special," run by the Springfield trolley lines. The attendance and interest in this special were good, though naturally not equal to those shown in the large and better advertised railroad special.

Seed Corn Distribution.

A new feature which I intend to introduce during the present year, if it meets the approval of the Board, is the distribution of seed corn to farmers. The plan, roughly speaking, is to secure seed of superior strains, mainly of Flint varieties, and to give small quantities to such farmers as will agree to plant and care for it properly, and to return double the amount received, for further distribution. Possibly they may also be required to exhibit a few ears in the office, in an exhibition similar in scope to our apple show of this year.

Respectfully submitted,

J. LEWIS ELLSWORTH,
Secretary.

Jan. 10, 1911.

Summary of Crop Conditions, 1910.

At the close of May vegetation and farm work were considerably in advance of the normal, while early crops were not beyond normal, owing to cold and unpleasant weather. Grass started early, and although it did not make as rapid growth as was expected, promised well. Fall seeding generally wintered well. The fruit bloom was generally heavy, except for peaches, and was not injured by frosts, except the early bloom of strawberries. Insects were about average in their development and numbers. Planting was well in hand at the close of the month. There was a fair supply of farm help to be had, with wages rather higher than for the past few years, day help commanding especially high prices. There was a marked increase in the acreage of corn, especially for grain, also in that of onions in the Connecticut valley. A considerable increase in interest in fruit growing was shown by the setting out of new orchards, greater attention to spraying and considerable areas of new cranberry bog.

Insects were not unusually numerous or injurious in June. The increase in the acreage of field corn was not as great as indicated in May, owing to failure of germination and delay in planting. The crop was very uneven, and in some cases poor in color. Haying was just beginning, with a good normal crop in prospect. The acreage of potatoes was decreased to a considerable degree, and the crop generally backward, but promising well. Yields of early market-garden crops were not above average and good prices were received. The supply of dairy products was fully up to the normal and prices were higher than ever before. Dairy cows were very scarce and high. Feed in pastures was in excellent condition. The strawberry crop suffered severely from rains and good prices were received. The set of fruit was not what was expected from the bloom. More farmers have sprayed than in any previous year.

Little damage was reported from insects in July. Corn came forward very rapidly, and at the close of the month was near the normal. The hay crop was one of the best for years and secured in good condition. Rowen did not start well, owing to lack of rain. The usual acreage of forage crops was put in, corn and millet being the favorites. Market-garden crops were uneven, some having suffered from drought, with prices lower than of late years. Apples dropped badly, and promised poorly; pears and plums light; peaches rather better than usual; quinces promised well; grapes average; cranberries not above average. Pastures were beginning to suffer from drought. Rye and oats were good crops in most sections. Barley looked well as a late forage crop. New orchards were not extensively planted in 1909 and 1910, but reports indicated that old orchards received much better care in pruning, spraying and fertilizing than ever before.

Corn was greatly benefited by the light rains of August and made good progress. There was little rowen in prospect on any but newly seeded fields. Early potatoes were much below the normal, but late potatoes looked well, with a few cases of rot reported. The acreage of tobacco in the Connecticut valley was about the same as formerly. The crop responded finely to the rains and promised to be very nearly normal. The returns indicated a light crop of apples, especially winter varieties; pears fair; peaches rather above the average; grapes average; quinces fairly good; cranberries somewhat below average. Pasturage improved with the rains of the month. Oats were an average crop for grain, but not quite as good as usual for hay and green feed. Celery suffered severely from drought; other late market-garden crops backward, but growing well.

September showed Indian corn matured well in almost all sections, and generally close to a normal crop, both for grain and stover. There was little rowen in most sections, except in southeastern Massachusetts, where it was in excess for the region. Feed in pastures was green, but light at the close of the month. Very much less than the usual amount of fall seeding was done, because of drought. Onions are generally a light crop in all sections. Late potatoes would have been an average crop, except for rot, which was most prevalent in the western counties. Root crops were generally in good condition; celery light; late market-garden crops in general much in need of rain. Apples were a light crop and small in size; pears good crop of good quality; peaches light in most sections; grapes not above the average; cranberries a light to medium crop, with the berries small. More spraying was practiced on apples than for many years. Several light frosts occurred, but with no appreciable damage to crops.

The final report of the season, at the close of the month of October, gave the value of the corn crop as considerably above the normal, a good crop of well-matured corn having been secured in almost all sections, and the acreage harvested being much in excess of the usual average. Ensilage went into the silo in good condition as regards maturity. Root crops were generally rather below the average, except on Cape Cod. Potatoes suffered from drought more than most crops, and rot was prevalent almost throughout the State, so that the crop was a disappointment. Light showers kept feed green and growing in pastures, but feed was nevertheless very short from midsummer on, and milk stock and many young cattle were fed at the barns, both hay and grain. Milking stock was generally in good condition, but young stock, where not fed supplementarily, came in thin in flesh. The large hay crop enabled farmers to feed at the barn without depleting their winter stock of hay as much as would ordinarily have been the case. Much less than the usual amount of fall seeding was done, owing to the drought keeping the land in poor condition for seeding. It was perhaps rather backward where put in, but generally looking well otherwise, owing to frequent light rains.

Prices for farm crops averaged higher than usual, despite the generally good crops, potatoes and cranberries being the only important crops where lower prices were reported. Forty correspondents considered prices to have been higher than usual, 67 average and 11 lower than usual. Milk, butter, eggs and meat brought high prices throughout the year. Apples generally brought better prices than usual, owing to short crop and better quality. Prices for tobacco were fully up to the normal.

Sixty correspondents, slightly under a majority, considered hay to have been among the most profitable crops; 41, corn; 24, apples; 11, potatoes; 7, tobacco; 5, cabbages; 4, sweet corn; and 4, oats; while 71 correspondents, more than a majority, and an unusually large leading number, considered potatoes to have been among the least profitable crops; 9, apples; 6, onions; 6, cabbages; 6, cranberries (an unusually large number for this crop); and 4, strawberries.

The season was generally considered to have been a profitable one by the correspondents, 80 stating that it had been profitable; 16, that it had been fairly profitable; 12, that it had been an average year for profit; while 3 held that it had not been very profitable, and 14 that it had been unprofitable for the farmers of their sections. The crops were generally good, despite the drought, and prices ruled high, which, with the good hay crop and well-filled barns, made it difficult to figure the year as anything but profitable, unless the view is adopted that no year is profitable for those engaged in farming.

Crops were shortened in some instances by drought, but there was surprisingly little damage from this source when the shortage of rainfall for the year was considered. The most serious effect of the drought was on the water supply, and in many sections farmers faced the prospect of drawing water from a distance throughout the winter, unless heavy rains came before the ground froze. Streams, springs and wells were reported as lower than for many years, and many of them as dry. One well which had not failed since it was dug, one hundred and fifty years ago, was reported to have dried up, and there were many instances of wells and springs which had never failed before, but which were entirely dry at the close of October.

PUBLIC WINTER MEETING

OF THE

BOARD OF AGRICULTURE

AT

NORTHAMPTON.

DECEMBER 6, 7 AND 8, 1910.

PUBLIC WINTER MEETING OF THE BOARD, AT NORTHAMPTON.

The annual public winter meeting of the Board, for lectures and discussions, was held at Carnegie Hall, Northampton, on Tuesday, Wednesday and Thursday, December 6, 7 and 8. The attendance was good, being above the average for all sessions and especially good on the second day, the lectures interesting and instructive, and the discussions well sustained and valuable.

The meeting was called to order at 10 A.M., on Tuesday, by Secretary Ellsworth. Second Vice-President Avery presided, and introduced His Honor Calvin Coolidge, mayor of Northampton, who delivered the address of welcome.

ADDRESS OF WELCOME, BY HIS HONOR MAYOR CALVIN COOLIDGE.

We are having an election here today and I assure you that it is a relief to leave for a few minutes and extend to your Board a most hearty welcome to our city. Northampton is known throughout the United States as an educational center, and for that reason it is the more fitting that you should meet here, as agriculture is becoming each year more and more the pursuit of the educated man. Also, we have recently started a school here which is devoted to the teaching of agriculture to our young men and women, Smith's Agricultural School and the Northampton School of Industries. This school is, I believe, destined to prove of great benefit to this section in agricultural and domestic lines. We are, moreover, in the heart of a farming district, and dependent upon the products of the soil for our prosperity. To the north and east lie the meadows of the Connecticut valley, the most fertile section in the Commonwealth; great land for raising tobacco, onions and corn, — land that has been noted for generations as especially fitted for agricultural pursuits. To the west of us the fruit-growing industry is developing rapidly. One man paid this year $20,000 for apples in the towns of Williamsburg, Conway, Goshen and Cummington, and he did not touch the best orchards in the section, those at Haydenville, at all. It is estimated that in that region this year $45,000 has been paid for apples alone, and it was not a particularly good apple year.

The organization known as the People's Institute, which occupies this building and two others near by, is open to every one, especially to those who work in the mills, and is doing a great deal of educational work. It can provide a teacher for almost any line one may wish to study, including the domestic sciences, such as cooking, dressmaking and millinery. It is made use of to a large extent by our Polish people, who are coming in here and taking up land, and who are thrifty and industrious and generally good citizens. They are taking up land and doing much in an agricultural way, particularly in raising tobacco and onions, and I see in them a good deal of promise for the future agricultural development of this region.

Agriculture is becoming, like all other pursuits, the pursuit of the specialist. We have in this region the Massachusetts Agricultural College, — an institution which has done a great deal in developing the agricultural resources, not alone of Massachusetts, but of the other States of the Union, and foreign countries as well. I hope that before you leave us you will visit Smith's Agricultural School, an institution of which we are especially proud. We want you to make yourselves at home in our city; visit our institutions; and we hope that you will go away feeling that you have had a pleasant and instructive gathering here, and feeling that as soon as you can you will visit us again.

The chairman then introduced Secretary Ellsworth, who made the following response, on behalf of the Board, to the address of welcome: —

RESPONSE FOR THE BOARD, BY SECRETARY ELLSWORTH.

Much to my regret, Vice-President Bursley is unable to be here and take this part in the programme, but I want to thank the mayor, on behalf of the Board, for his cordial welcome. Among the many duties and undertakings of the Board, which include its publications, its institute work and its large correspondence, are these annual meetings, which are held in various parts of the State. This is the third such meeting to be held in Northampton. The first was held in 1882, when Hon. John E. Russell was secretary of the Board, and at that meeting, among other subjects discussed, were those of milk and tobacco. The tobacco question was discussed then for the first time, and since then we have always recognized that industry when we have met anywhere in the Connecticut valley. I believe that the milk question has been discussed, in some form, at every meeting we have held, as the dairy industry is our great industry, and the product the one indispensable article of food. The second meeting held here at Northampton was in 1891, when Mr. Stockwell, my immediate predecessor, was secretary of the Board. At that time Booker Washington was one of the speakers, and the attendance at the session which he addressed set a record for these meetings.

This beautiful valley, to which Mayor Coolidge referred, is, without doubt, the most fertile section of Massachusetts. While we have several other valleys in Massachusetts, there are none quite equal to the Connecticut valley in extent, in fertility or in the beautiful farms which it contains. Your farms here are wonderful for tobacco, onions, corn, apples, and, in fact, anything that will grow outdoors in this climate. I do not want to get started on the apple question, but few people have realized what we can do in apple raising here in New England, in Massachusetts especially. One of our members, Mr. Frederick A. Russell of Methuen, in the orchard contest under the auspices of this Board, reported a Gravenstein tree on which he grew $56 worth of apples. If you had 40 such trees to the acre you could very easily figure out something big in apple raising.

These meetings are of immense value to those who attend them, and, furthermore, the lectures and discussions appear in our annual report, together with much other matter of interest. Sometimes I believe that if they were not so printed we should have larger attendances at these meetings, but we certainly look forward to this meeting as likely to be one of the best which we have ever held.

The Chairman. The next item on the programme is a lecture on "New England pastures," by Mr. J. S. Cotton, M.S., of the United States Department of Agriculture, Washington, D. C. Mr. Cotton has traveled all over the United States, looking into this question, and it gives me pleasure to present him to you.

NEW ENGLAND PASTURES.

BY J. S. COTTON, ASSISTANT AGRICULTURIST, UNITED STATES DEPARTMENT OF AGRICULTURE.

One of the most important problems confronting the New England farmer to-day is the improvement of his pasture lands. These pastures have deteriorated greatly, and many of them have now reached a point where they are not producing sufficient feed to pay the taxes and the cost of maintaining the fences. As a result of their extremely low yield it is necessary to devote a considerable area of the cultivated lands in the growing of forage to supplement the pastures. In view of the present high price of grain it is important that these pastures be made to produce more feed than they are doing at the present time, and thus relieve the tillable land from growing so much forage, in order that the farmer can raise some of the high-priced grain on his own land.

These pastures were cleared of timber some forty to one hundred years ago, and were allowed for the most part to sod over by a natural process. Since that time they have been grazed from early spring until late fall at practically their highest carrying capacity. During this time very little improvement in the way of reseeding or fertilization has been practiced. At first the deterioration of these pastures was very gradual, but during the past twenty years they have declined much more rapidly. One of the reasons for the more rapid decline during the past few years is that, because of the enormous increase in the growth of the cities of this country, and because of better transportation facilities, the majority of farmers in this region have been specializing in the production of dairy products, and have been increasing the amount of stock that is being run on these pastures without reference to their carrying capacity, and without endeavoring to build them up in any way to sustain the increased number of cattle.

It is noticeable that in the country at large nearly all of the dairy pastures have become much poorer than formerly, while pastures on which beef cattle are run are fully as good as they ever were, if they have not actually improved. There are pastures in Kentucky, Tennessee and Virginia, fully as old as any in New England, that are carrying as much stock as they ever did, and are worth a hundred or more dollars per acre. In the northwestern part of Middlesex County, Ontario, there are some three hundred thousand acres that farmers, owing to the scarcity of labor, have abandoned for farming purposes, and have seeded down to pastures, renting the land to cattle graziers. After twenty years' use these pastures are producing more feed than ever, and the land is in better shape to grow crops than it was at the time cultivation ceased. This land is also valued at a hundred or more dollars per acre.

In the corn belt men buy land that has been worn out as a result of a one-crop system, and, by putting it into grass and feeding on it, are able in about ten years' time to build that land up to a point where it can produce large crops. Much of the land that has been built up in this manner is now selling at $200 per acre. This comparison is made in order to show that it is not only unnecessary for pastures to decline, but, on the other hand, that land, through proper methods of management, can be built up to a high degree of productivity by the pasture method.

At first glance it would seem that the difference between the worn-out eastern dairy pastures and the beef pastures of the other States mentioned was one of soil conditions. However, we find just as poor pastures adjoining these beef pastures as are found in New England, while a couple of pastures have been found in the heart of the dairy section that, through careful management, have been maintained at as high a point as any beef pasture that has been seen, and that are remarkably productive. The investigations that have been carried on by the Department of Agriculture show

A pasture that has been protected from overgrazing, and has been carefully fertilized. White clover and Kentucky blue grass June grass, are very abundant.

that while soil types and climatic conditions greatly modify the carrying capacity of a given pasture, nevertheless the great difference between the dairy pastures and the beef pastures is one of management. The dairy farmer usually tries to get all the feed that he can from the pasture, without reference to the condition in which it is left. If the pasture is grazed a little too closely he supplements it with feed grown on the tillable land, in order to help the cows, but still continues the overgrazing. The beef cattleman cannot do this. The beef steer must have an abundance of feed close at hand, so that if he is to make good gains he can get all he wants to eat without much effort. As the profits are directly dependent on the number of pounds of gain that the steer puts on, the beef cattlemen have learned by experience that there must be a luxuriant growth of grass for their steers or else they will lose money. Consequently they are very careful never to overgraze their pastures, and if they see that a pasture is being overstocked they immediately cut down the number of stock.

There are a number of causes why these dairy pastures have deteriorated. One of the principal causes is the practice of turning stock on the pasture too early in the year. Unless the grass plants are allowed to get a sufficient start to have a good green leaf surface they are greatly handicapped in making much growth. A study of the structure and life history of plants shows us that there are numerous small green bodies, which by the way give the color to the leaves, that are known to botanists as chlorophyl bodies. It is necessary that certain kinds of the plant food absorbed by the plant go to these small green bodies and thereby manufacture substances which the plant can use in growing. If these leaves are kept grazed so close that there is not an abundance of these small green bodies the plant has very little chance to make much growth, or, in other words, produce much forage. If such a plant is kept grazed too close it will eventually become enfeebled and will disappear.

Again, on many soils, where there is a considerable amount of clay, if stock is turned out while the ground is still wet and "punchy," the ground becomes so compacted by constant tramping that it is impossible for the roots of the plants to penetrate among the soil particles and get the necessary plant food. I have had occasion during the past year to see one pasture that has been absolutely ruined because the stock was turned in it while the ground was still too wet. The soil has been badly compacted, until it has now reached a point where there is absolutely no remedy, and the land is not worth paying taxes on.

Another reason, and undoubtedly the most important one, is that of overgrazing. Not only must a plant have sufficient green leaf surface with which to manufacture food for its further growth, but in case it is a perennial plant it must be allowed to store up food to be used the following spring in starting a sufficient growth to enable it to begin manufacturing its own food again. If a perennial plant is not allowed to store up this surplus food it becomes weakened and eventually dies. In the case of annual plants, which form only a small portion of the vegetation in eastern pastures, it is absolutely necessary that they be given a chance to mature a crop of seed or else they soon become extinct. In both cases, as these plants disappear through misuse, their places are taken by weeds or plants that stock will not graze.

Many dairymen consider that cows do not do as well where the grass is allowed to get too tall. This is true if the grass is allowed to head out and go to seed. The best stockmen have learned by experience that their cattle do better when the grass is allowed to grow two or three inches high, and, as they express it, "get strong." They have also learned that when a pasture gets ahead of their cattle it is an easy matter to mow the tall grass, letting it lie on the ground as a mulch.

Many farmers believe that unless they keep their pastures closely grazed the weeds will take possession. In some instances this seems to be true. Pastures have been seen where, if the stock was kept off for two weeks, the weeds, especially daisies and yarrow, would take such complete possession and make so rank a growth that there would be nothing for the cattle to eat. The men using such pastures are actually losing money. If such areas cannot be reclaimed through cultivation or other practical methods the quicker they are abandoned as

A pasture that, through years of overgrazing, has deteriorated to a point where it is producing very little feed, and brush is taking possession

pastures and converted into timber lots the better. In that way they can eventually be made to pay dividends.

All of the feed obtained by the cow is turned into milk, flesh or into the energy necessary for carrying on her natural functions. If that cow is required to use the greater part of her energy in traveling many miles over the pasture in securing her daily feed, that very act is going to result in a greatly decreased supply of milk. If such a cow were kept in the stable or barnyard all of the time, and given only the feeds that are used to supplement that pasture, she would produce more milk than she does after running over that field all day, and would thus become more profitable. A very concrete instance of this came to notice near North Adams, Mass. In carrying on investigations in this region two pastures were studied that adjoined each other on a hillside where the conditions were absolutely identical. One of these was badly overgrazed. At midday, when the cows should naturally be lying down and ruminating, all of the animals on this field were actively engaged in trying to get enough to eat. In the adjoining pasture, just on the other side of the stone fence, there was an abundance of feed, some of it actually going to waste. In this area the cows were lying down taking life easy. There is no doubt but that the cows in the latter pasture were giving more milk than the others, simply because they were enabled to convert the greater part of their feed into milk.

While it sometimes seems as though close grazing is necessary in order to keep down the weeds, nevertheless the fundamental cause of those weeds taking possession was that of overgrazing. A striking illustration of the fact that overgrazing is a cause of the weeds taking possession has been shown in California. Originally on the greater part of the ranges of that State there was a good covering of natural grasses that were relished by live stock. As these grasses were destroyed by overgrazing their places were taken by plants that were not relished by stock, the fact that they were not readily eaten giving them the opportunity to thrive. As the better plants disappear the live stock learn to eat the poorer quality of vegetation. As a result, this in turn was destroyed, and its place was taken by plants even more inferior in character. This has resulted in the carrying capacity of the California ranges being very greatly lowered.

The constant close cropping of the vegetation on such a pasture means the robbing of the soil of its fertility, the loss of vegetable matter or humus being especially great. This loss of fertility will of course not be nearly as rapid as where hay is cut from a meadow and nothing replaced. Nevertheless, it is going on all the time, and is one of the important factors in pasture deterioration.

Again, where a pasture is badly overgrazed the evaporation of moisture from the soil is much more rapid. The best graziers of the country have learned by experience that if their pastures are to do well there must be a good grass covering or vegetable mulch in order to tide them through the periods of dry weather. There seem to be two reasons for this: first, where the grass is kept very closely cropped the sun's rays get a more direct action on the bare ground and thus dry it out much more quickly; second, the humus, which is so necessary in the soil in order to allow plant growth, helps greatly to retain the moisture. Where this humus has been used up, the ground will naturally dry out much more quickly.

There are numerous pastures throughout the New England States that are situated on areas of thin, poor soil and that are on steep hillsides, where the danger of erosion is very great, which should never have been cleared of timber. Such areas, if not already allowed to revert to forests, should be replanted to timber at the earliest opportunity. Again, there are numerous pastures that are very rough and full of large boulders, in which weeds and brush have gotten nearly complete possession. In many instances it would cost altogether too much to attempt to clear such land. The best method of making it pay dividends is to put it into forests. It has been definitely proved that, with the present prices of lumber, the setting out of such areas to good marketable timber will be the best sort of an investment. Information as to the best methods of planting forests can be obtained from State Forester of the Massachusetts State Board of Agriculture, or from the Forest Service of the United States Department of Agriculture.

The great majority of New England pastures can, however, be built up to a point where they will produce much more feed than at the present time. There are six general methods by which such pastures can be built up, at least one of which can be used on nearly every New England pasture.

First. — Prevent overgrazing. The reasons for this have already been given.

Second. — Do not graze too early in the spring. In many instances if the cattle were kept off the pasture for two weeks longer than is the prevailing practice the pasture would produce far more feed and would carry a great deal more stock.

Third. — The investigations that have been carried on during the last few years show that one of the most essential points in pasture improvement is that of fertilization. Nearly all of the New England pastures show a striking lack of vegetable matter. The best method for replacing this is to top-dress with barnyard manure. Experiments that have been carried on in top-dressing land show that a light coating applied for two or three years in succession will give much better results than if a large quantity is used in any one year. With many of the farmers the question of where the barnyard manure is to come from is a very serious problem. It is probable that in many instances the farmer could profitably use commercial fertilizer on some of his meadow land for a time, and use the barnyard manure that ordinarily goes on that area on his pastures. If the barnyard manure is not available, or if the land is too rough to permit of getting it on the ground readily, it is possible that commercial fertilizers may be of value in this restoration process. While there seems to be considerable difference of opinion as to the value of commercial fertilizers in the improvement of pastures, there is evidence at hand which indicates that this method can be used to advantage. At the present time a series of experiments in pasture improvement are being carried on in the State of Maine and in Broome County, N. Y., these experiments being co-operative between the agricultural colleges and departments of those States. In these experiments the use of commercial fertilizers is being quite extensively tried. It is hoped that in the course of two or three years more definite information can be given on this subject. Any farmer in this State desiring to try commercial fertilizers in the improvement of his pasture can readily obtain information from the State Agricultural Experiment Station at Amherst as to the best mixture to use and how to use it.

Many of these pastures also show a great improvement where lime is used. This is especially true of pastures in New York State. It is noticeable that our forefathers used lime in considerable quantities and for a time obtained excellent results. After a while they ceased to get any benefit from the lime and stopped using it. To-day we find many men who are not using lime because their forefathers found that they got no results. They do not realize that after a period of years this lime has been used up, and that it can again be used to advantage.

Cultivation. — Wherever a badly depleted pasture is smooth enough and free enough from stones to allow plowing, it should be broken up and put under cultivation for a period of two or more years, and then seeded down again. A number of instances have been found where men have done this but have failed in getting a good stand, oftentimes the pasture being taken over quickly by weeds. In each instance that has been brought to notice the trouble has been in the work not being properly carried out. In a number of cases the farmers plowed the land and put it in crops for a couple of years without fertilizing, then seeded it down. Naturally, such a pasture is in worse condition at the time of seeding down than when broken. If such an area had been properly fertilized this trouble would have been prevented. Again, the average farmer in seeding down such an area uses a mixture of grass seeds that are suitable for meadows, instead of using a pasture mixture. This means that after the grasses that are naturally adapted for meadow uses have disappeared there are no permanent pasture grasses to take their places, and weeds of necessity come in. During the past season not less than twenty pastures have been observed that have failed from this one cause alone. Had the owners, with the work that they put in, used a proper mixture, they would have obtained excellent results.

Where the land is too rough to permit of plowing some form of a harrow can be used to excellent advantage. The harrow will tend to break up the clods of manure and scatter them over the ground better, thus making them more available. It will also cover whatever seed may have matured. Again, it will have a tendency to tear up the sod where the grass has become root-bound, and will help to form a dust mulch with which to prevent too great an evaporation.

In many instances reseeding will greatly hasten the process of restoration. During the past two or three years many of the New England pastures, owing to periods of drought, have been badly burned out. A great many of these could be improved by broadcasting seed, and wherever possible, working it in with some form of a harrow. In reseeding such an area, timothy should be used in order to get quick results. In addition, a little redtop, some bluegrass, and red, white and alsike clovers should also be tried. A small amount of orchard grass and meadow fescue would be of great advantage in this mixture. At the present time seed of orchard grass and meadow fescue is rather expensive, and consequently a very large amount of them cannot be recommended. These two grasses have the advantage, in such a pasture mixture, of starting earlier in the year, thus furnishing grazing before the blue grass and white clover, which are the predominating pasture grasses, get started.

Another point in the improvement of pastures is that of the eradication of weeds. No general method can be given for this. Where the pasture is badly infested about the only practicable method is that of plowing. If this cannot be done, it is possible to get rid of the weeds by mowing just before they go to seed. The managers of the most successful pastures in this country all make a practice of mowing their pastures at least once a year, in order to keep down the weeds, and find that it pays them well to do so.

Mr. H. M. Porter. I see a great many pastures full of little hummocks of moss; how should such a pasture be treated?

Mr. Cotton. I believe that this condition shows the need of lime, and should use it myself. I should also put on a disk harrow to tear up the moss and put in seed.

Mr. A. M. Lyman. I have been trying to get land into pasture as fast as I can, by taking small lots and fertilizing and seeding them, and then fencing them in, and have found rye very useful, both to seed in and for spring feeding. Sometimes we feed it in the fall, if it comes along better than we expected. It serves a double purpose, giving early spring feed and serving as a protection to the grass. I have also found clover an excellent thing to use in a pasture mixture. It is always wise not to depend entirely on the pastures, but to have something that can be fed at the barn, to help out if the pasture feed gets short.

Mr. C. P. Aldrich. Does moss mean reduced fertility?

Mr. Cotton. Ordinarily it does, but sometimes it comes in abundantly after land is cleared of timber, and there it cannot be due to depleted fertility. I am not sure that the moss comes to stay, in such cases, but think that certain species of ferns and brakes would come up through it in time.

Prof. F. W. Rane. I have been greatly interested in the way Mr. Cotton has brought this question before us. I was especially pleased with the way in which he brought out the question as to where the line should be drawn between lands that should be kept for pasture and those which should be allowed to grow up to wood. Just where it is to be drawn is always a question, as some pastures that seem to be worth very little will be found, on investigation, to be producing a good deal of feed. While I am a forester, I cannot agree that everything but lands that ought to be kept in general agriculture should be put into forests; but there are many lands which are much more valuable for forest growth than for any other purpose. White pine is a tree crop that will grow all over the State, and will average 800 feet per acre per year from the beginning. We will not get it at first, but the increase in growth after the twentieth year will make up for it, and it will surely average 40,000 feet in fifty years. White pine is to-day worth on the stump from $7 to $12, according to its distance from market. We can all afford to study this subject carefully, and make up our minds whether our particular lands are most valuable for pasture, fruit, cultivated ground or forests. It is a simple matter to get them back into forests, if desired.

Mr. Ethan Brooks. Do you think the effect of lime on the pasture is the same as when used on cultivated land?

Mr. Cotton. I am not much of an expert on the use of lime. Most of my time has been spent in the west, where it is not so much needed; but in a rough way I should say the effect is the same. I would refer you to your agricultural department.

Mr. Brooks. I have tried lime on a plowed field and on a pasture, applied the same day and in the same way. In the first case there was a marked effect, and in the second none that I could see. This was explained to me by a chemist, on the ground that the plowed field was a clay soil, where the lime cut the soft stones and set potash free; and in the pasture the stones were granite pebbles, on which the lime had no effect. At one time I sent my young stock to the hills to pasture; but later I tried putting the same money into cleaning up the pastures and fertilizing them, also seeding with a mixture containing a good deal of orchard grass and clover, and I found that it paid very well. The seeding was done in a wet time, in August, and the orchard grass is there yet, although that was twenty years ago. We only treated the run-out portions of the pasture; a good deal of it needed no treatment.

Mr. H. A. Turner. In the section of the State from which I come, the South Shore, the pastures are not as valuable as in most sections. Part of mine I have cut over every year, and part I have let come up to wood, and it is a question whether that portion has not paid the best. What I want to ask is, what is the best way to get rid of bushes, where the pastures are stony and rocky?

Mr. Cotton. I know of no good method, except hard work. If that costs too much, the only thing is timber. That is something each one must figure out for his own particular pasture.

Professor Rane. How about sheep?

Mr. Cotton. I am recommending them very highly. I find that sheep have played a very important part in the building up of pastures. On these hillside areas it seems to me there should be more sheep. I have seen pastures in Vermont where the dairy herd had no place, — they are too steep, and make too much work for the cow and the man. The sheep kill out a great many weeds, and will keep back a good many kinds of bushes, but upon the coarser bushes they have no effect. Perhaps they might be used to keep the sprouts down after the bushes are mowed, thus saving the trouble of further mowing.

Mr. J. F. Adams. I have kept sheep for some years, and my experience is that they will kill out some kinds of weeds, such as golden rod, very well, but that they will starve to death before they will feed on bushes.

Mr. Turner. The bayberry bush and the blueberry bush trouble us the most. Would the sheep eat these?

Mr. Cotton. I don't think so. I am inclined to think that the blueberry bush is an indication that the land needs lime, and that liming would help the condition.

Mr. P. M. Harwood. The lecturer has covered the ground in a very comprehensive way as to the building up of our New England pastures. There are certain portions of our pastures that should go back into timber. I remember a certain hilltop in my native town, where the timber was cut off years ago, the ground burned over and rye raised for several years, that has been absolutely good for nothing for pasture. It now has seeded to white pine, and the pines are growing well. On the other side of the wall on that same hill, where the humus was not burned off, there has been good pasture all the time. Many of us have been over-cropping our pastures. The farmer in Massachusetts is helped immensely if he has some woodland coming into market, so that he can sell some timber about once in five years. He should have his waste lands set out to timber, and the timber growing while he sleeps. I have in mind one little parcel of land of about 12 acres, that was taxed for $120 in 1876, and which was sold the other day for $2,500. In another case a man who had other resources bought a farm in the town of Petersham, some forty or fifty years ago, for $3,800. He did little real farming, but let it grow up to wood and timber, and within a year it was sold for $35,000. I do not wish to be understood as advocating the policy of doing nothing and letting your farm grow up to wood, — there is reason in everything, — these are simply rather extreme illustrations of what can be got out of lands that are of little or no value, even for pasture, when they are seeded to the proper wood growths; and that it is not wise to have all your eggs in one basket, — even the dairy basket. The lecturer has pointed out the fallacy of trying to get something for nothing out of our pastures, and we old dairymen must, most of us, plead guilty. Take a tract of a few acres in the pasture, that is level, where the cows have been resting, and let the farmer plow it and plant corn or potatoes, later turning it back into the pasture. That soil is rich, and he gets a good crop, and thinks it is still as good as ever for pasture. Perhaps it is, but he has been robbing the land.

Mrs. J. F. Adams. I would like to ask Mr. Cotton how much lime it would pay us to use on our pastures on Martha's Vineyard, when we have to pay $25 freight on $30 worth of lime? Also, I would like to ask Professor Rane how we can make white pine grow?

Mr. Cotton. The person owning the land will have to figure out whether he or she can afford to go to the necessary expense to carry out any recommendations I may make. In your case I would try it in an experimental way at first; but you seem to be solving your problems pretty well as they arise.

Professor Rane. It is certainly a problem whether white pine will grow on Martha's Vineyard. On the Vineyard and Nantucket the winds are so severe that when the trees get to a certain height they seem to be warped to a certain extent. Nevertheless, I have seen a plantation of Scotch pine that made trees of very fair size. The conditions are different on Cape Cod than in other parts of the State; but we find there large white pine stumps, showing that white pine once grew there. I think one reason that so little white pine is seen in that section is because it is so valuable that the owners are cutting it off as fast as it gets of salable size. Then, too, the fires, which are so prevalent down there, kill out the white pines by running over the ground, whereas they do not hurt the pitch pine so much. The poplar springs up very readily after fire, and might be valuable on the Cape. We have instances where it has grown twenty-three inches in eighteen years; and one cabinet maker tells me that it is as valuable as white pine.

Prof. W. D. Hurd. This pasture question is a fundamental problem, of special importance in the dairy business. These are two kinds of pastures: those of the west, to which what Mr. Cotton has said fully applies; and those of New England, which are usually rather rough, rocky and bushy, and I have been unable to work out his suggestions on these lands. The mixture he advocated for seeding seems to me excellent for hay land; but timothy and red and alsike clovers are not, in my experience, adapted to our rough New England pastures. Kentucky blue grass, redtop and meadow grass are primarily pasture grasses. I want to ask whether he has had any experience with Russian brome grass, and whether that is not a grass that should do very well on these rough hillsides?

Mr. Cotton. I do not know about the Russian brome grass, but have doubts whether it would grow well here. We have experiments going on now in Maine and Vermont, from which we hope to work out the best pasture mixture for New England. The mixture I have given to-day is based on general knowledge, and may very well need modification for certain regions.

Mr. Geo. W. Trull. I would like to ask Professor Rane whether he would advise the setting out of old pastures to forests, with the gypsy and brown-tail moths so prevalent, to say nothing of other pests and forest fires?

Professor Rane. The gypsy and brown-tail moth are certainly a great menace in the eastern part of the State. So far as white pine is concerned, we need not worry so much. The brown-tails will not touch them at all, and in a clear stand of white pine the little gypsy moth caterpillars will die before they get strong enough to feed on the needles. It is in mixed stands that these insects do the greatest damage, and they are certainly serious enough there. With such a stand I should advise cutting it as soon as infested, and using the money to set out a clear stand of white pine and to keep that free from deciduous trees, thus protecting it from infestation.

Mr. H. O. Daniels. We have few pastures in Connecticut, and these we like to get into tillable land as rapidly as we can. I am now plowing some of my pasture with dynamite, and hope to grow alfalfa on it after we get it fitted. I do not want the young men to get the idea that they can get more by sitting still than they can by hustling, — that is not good doctrine. Let them look into these old pastures, rip out the rocks, and cut the bushes and burn them. We are just beginning to realize the possibilities of agriculture, and in a few years they will be better known; to-day the opportunities in that line are the best in our history.

Question. What are the possibilities of the continuous use of commercial fertilizers on pastures, without stable manure; and what do you think of putting the land in clover for a time?

Mr. Cotton. I think where the pasture is badly run down, much can be accomplished by using a green manure crop; and I would rather depend on that plan than on the continuous use of commercial fertilizers. They are more of a stimulant than a plant food, in my judgment.

Mr. Wm. E. Patrick. I have been troubled about my pastures, for, while people say that I have good pastures, I can see, when going over them, that they are not as good as they used to be. These dry seasons have played havoc with them. I would like to ask whether it would pay to sow a grass mixture over these pastures that cannot be plowed or harrowed as they stand? Also, I have not been stocked very heavy this year, and some grasses have gone to seed;

and I want to ask if I am going to receive some benefit from that? Some people say that the bushes grow so much faster when the pastures are not stocked fully that you lose more than you gain; but I have never found that the cattle kept the bushes down very much.

Mr. Cotton. There is no question but that you receive benefit from the grass that has gone to seed. Our experience shows that resting is one of the best methods of restoration. As to reseeding, I think that if you could use a brush harrow, as you can on nearly any piece of land, you could work the seed in and give it a better start. Give the soil a good combing when the frost goes out. If you have a dense sod, a worthless foundation, your grass seed will not catch. If the ground is comparatively bare, I believe you can reseed very successfully. In the ranges of the mountain regions — in Washington, California and Montana — we have had excellent success by reseeding right on top of the ground. We shall have more data on this question later on, through our experiment work in Maine and New York.

Secretary Ellsworth. Seeding in rye is one of the best ways of seeding a pasture, furnishing spring feed for the cows and protecting the young grass plants. Sometimes the milkman will complain of the quality of the milk, if the cows are allowed to eat too heavily of the rye at first; but that can be avoided by bringing them onto it gradually, allowing them to feed on it but an hour or two at first, and gradually increasing the time. I know of no way in which spring feed can be obtained more cheaply than on rye, or of making milk more cheaply at that season of the year.

Afternoon Session.

Secretary Ellsworth. I will introduce to you Mr. Frederick A. Russell of Methuen, who represents the Essex Agricultural Society on the State Board of Agriculture, and who will preside at this session.

The Chairman. It is a great pleasure to preside at this meeting. I am very much interested in the production of milk, and have need to be interested. We have in the rear of the hall a show of corn, and it seems to me that no farmer in Massachusetts can afford to raise corn unless he can turn it into milk, or some dairy product. The subject of the afternoon is one that has many phases, and we expect to get a good deal of light on some of them. I take pleasure in introducing Mr. A. J. Pierpont of Waterbury, Conn.

THE PRODUCTION OF MARKET MILK.

BY MR. A. J. PIERPONT, WATERBURY, CONN.

The New England cow was formerly kept by the New England farmer to transform the grass of summer, and the hay and stalks of winter, into milk, cream, butter and cheese for the family. The butter and cheese were made in June, when the succulent feed caused the milk to flow freely; and the cow was dried off in the fall, to save the labor of milking and caring for the product through the winter. O generation of ease and simplicity, why could I not have lived and labored with you!

The rapid growth of our manufacturing cities has created a great demand for dairy products. Butter and cheese are supplied by the fertile west, but the God of the Pilgrims so constituted milk that it could not stand shipment from the west, and left the business of supplying fresh milk, for New England's increasing population, to the New England farmer.

It used not to matter how much milk the cow gave; so long as she milked easy, did not kick and was not unruly, she was a good cow. When the opportunity came to sell a few quarts of milk, the returns were clear profit. Feed cost nothing, for they raised that. Labor cost nothing, for the farmer would not be earning anything elsewhere during the time he spent in milking and caring for his cows. As the population increased, he sold more and more; it was demanded throughout the winter. Therefore, the silo was built to supply succulent feed throughout the winter. The crop-growing capacity of the farms was taxed, and western grain had to be purchased; and gradually this grain has become a necessity, and gradually soared in price. Outside labor had to be employed, first at farmers' wages; but gradually the laborer found that work on the dairy farm means long hours, hard, constant work, no Sundays or holidays, — and he steered clear of these farms. Boards of health have passed rules, necessary to insure clean, healthful milk, that have added to the cost of production.

At last the milk producer has awakened to his conditions. What seemed a profit and a road to success proved a snare. The increased cost of feed, labor and cows, the rapid depreciation of cows and implements, the cost of delivery, and the proper cleansing of utensils, etc., — made the milk really cost more than it brought. This fact is evidenced by the frequent auction sale of herds by those who cannot make both ends meet; by the shabby-looking homes and farm buildings that we see in many sections; by depleted soils (a farm often grows poorer year by year, even when everything grown is fed out on the farm); and by the number of farmers' wives in insane asylums, or worked to such a state that life has no pleasure. Young men are leaving the farms of their birth for easier and more remunerative employment. The President appointed a commission to find out what is the matter with the farmer.

The trouble with the dairy industry is, that it has changed so gradually from the selling of the surplus products from the family herd into a gigantic commercial business, requiring good business methods and close study of the details. The time is here when the master dairyman cannot do his day's work of physical labor, and then rest with untroubled brow. He must study feeds and feeding, breeds and breeding; weigh the feed given and the milk taken from each cow; determine the profit from each individual, breeding from those showing a good profit, and eradicating the boarders; on the same principle as factories, by improved methods of bookkeeping, determine the profit on every machine and on every man's work, and know to a fraction of a mill what every article he puts on the market costs him. You know how the railroad officials figure the profit or loss on each road and on each train; and wherever there is a loss, a train is taken off or the fare raised. Arrange the barns, and plan operations so that the best results may be obtained by a minimum amount of labor.

Do you know that Massachusetts has 192,000 milch cows, averaging about 4,000 pounds per cow? Do you know that the product of more than one-half of these cows does not pay market price for the food they consume, and the labor of caring for them day after day is performed for nothing? And do you know that there are herds in this State where the net profits from the sale of milk and the sale of stock are $10,000 a year, — more than $100 per cow? What an opportunity for improvement, and what a need of a great awakening of dairy farmers and the dissemination of dairy education! We must learn what it costs to feed and care for our cows, and then see that every day we get at least a little profit from every cow we keep.

In studying this problem, there are four factors which we must consider: man, cow, feed, market.

Man. — Without the man who loves his animals, sees to their constant comfort, and feeds them all they need without overfeeding, success is impossible. The trained feeder cannot tell his man how to feed; it must be done by the master's eye and the master's hand.

Hired Labor. — The dairy hand must be a high-class laborer. A small proportion of laborers are fit to work about live stock and market milk. He must be a strong, active worker. for the work is heavy and constant. He must have good health, for human diseases are transmitted to cattle, and the milk is a ready conveyer of diseases to city customers. He must be naturally clean in all his habits, for no number of rules from the boss will force a filthy man to produce clean milk. Even smoking, which is a universal habit among all classes, is almost prohibited in the dairy. I have employed a good many men, and have had but a very few smokers. I am not a tobacco crank, but experience has taught me that the employee who wears a pipe is usually too careless to care for cows and dairy utensils. He must also be a man of quiet, gentle disposition, to get along well with dairy stock or dairy customers. He must have both science and natural skill, whether he is to feed, milk and care for cattle, or care for dairy utensils and dairy products. What other business, trade or profession demands so many requisites in one man as dairying? He must also be punctual and steady, and report for work early every morning, including Sundays and holidays;

for feeding, milking, peddling and the details of washing and bottling cannot be intrusted to a substitute for a single day, no, nor an hour, without costly "breaking in" or chancing serious loss. I have recently been repairing some buildings, and had occasion to employ at the same time a mason, a carpenter, a plumber and a painter. My regular men worked three hours in the morning, before these skilled artisans appeared; worked with them through the day, doing the harder parts of the work, such as digging, lugging stones and cement, and the plain work that was beneath the dignity of the mechanics; and worked at chores two hours after the skilled men had departed. After paying the workmen what they considered their due, I was almost ashamed to pay my month men, — their wages looked like such a small pittance for their long hours of steady, faithful, hard work.

Costly plants, expensive operations, Golden Lad cows and a side of the barn covered with rules cannot make good one wrong act of an ignorant, careless, filthy or vicious milker; for, after all our preparation, we are entirely dependent on the milker's skill and good will.

I have in mind a certain dairy in Connecticut, fitted up for the production of certified milk, at a cost of nearly $50,000. The owner hired cheap men, and tried, by enforcing rules of many wipings, washings and disinfectings, and by unobserved watching, to produce 12-cent milk. The milk was frequently bad, and the farm never paid expenses. A year ago the farm changed management. Young, healthy American men, some of whom were Agricultural College graduates, did all of the work, for which they were well paid. Rules and watching were discarded, the only check being an arrangement made with one of the customers, whereby an occasional bottle of milk was sent to the State laboratory for analysis. Of course these samples were taken when none of the force knew about it, but results were reported to the men. Only once this past summer did the bacteria count reach 5,000 per cc. The New York standard for certified milk is 30,000. The 5,000 count occurred in July, when, by delay in transit, the milk reached the laboratory late and without ice. The latest report was 1,000 per cc. The trade increased rapidly, the price had to be raised to 15 cents a quart, and the farm has paid all expenses, besides increasing its stock and equipment from its earnings.

The man who can manipulate his fingers so as to rapidly extract the milk from a cow's udder can certainly learn to wipe a lead joint or wield a mason's trowel. The man who can successfully manage a pair of horses, can develop executive ability enough to build a railroad. The man who has patience enough to drive an ox team or milk an Ayrshire heifer, could learn to spend a day in building a staging in preparation for driving one hundred nails ten feet from the ground, and so be a carpenter; and has staying qualities enough to become a life insurance agent, who talks and waits for business. The man who can fix a broken mower so that it will cut grass, with the horses hitched to it, in fly time, out in the blistering sun, or can repair a manure spreader in the field, while lying under it in the snow in zero weather, could probably, after four years of apprenticeship, become a machinist. And he who is willing to double himself up under the battering end of ten to fifteen cows, by the light of a lantern, twice a day, and endure with patience the possible battering from hoofs in front and hoofs behind, and the certainty of having his face lashed with not less than two tails, dry or wet, and is supposed to have no thought but that of keeping the visible and the invisible dust from his pail, and giving no vent to his pain except an occasional "So, boss, so," or "Careful, now," is certainly courageous enough to be a soldier, and has grit and insensibility of feeling enough to become a great lawyer.

And the licensed druggist problems are simple compared with the complex problem of feeding and preserving the health of the dairy animal; extracting the milk which is created near the floor of a cow stable and near the dirty end of the animal, without letting it come in contact with the human hand or become contaminated with dust, laden with the harmful bacteria with which the stable is filled; putting it into a sterilized pail, and immediately cooling it where the air is pure; placing it in clean bottles or cans; and delivering it to the precious baby, whose very life sometimes depends on the cow and the care and skill of the dairymen more than on its own mother. Thousands have gone to untimely infant graves, and have been mourned by relatives and by mothers who would not be comforted, for their babes were not, leaving parents bereft forever and their days saddened and shortened, and perhaps the family name extinguished, — because of milk improperly cared for, through ignorance or negligence. Is this responsible work to be intrusted to the cheap laborer?

Is it a wonder that there is a scarcity of farm labor on dairy farms, — where eleven or twelve hours of careful work are required daily, and at least one-half that amount Sundays, for $20 or $25 a month and board, less than 15 cents an hour, while the crudest kind of foreign labor gets that or more, and artisans, with no more intelligence or skill than we need in our dairy business, command 30 to 40 cents an hour. Very true, the proprietor pays all that he can afford, and perhaps more than he himself receives, after allowing for interest on his investment, and figuring pay by the hour for himself and family.

Oh, no, I am not a pessimist; I love farm life, and I love the dairy cow; and I believe that there is abundant opportunity for thousands of New England farmers to make a success that will entitle them to as good a living and all the comforts enjoyed by city residents by furnishing our prosperous and growing manufacturing cities with a pure, wholesome milk, produced and handled under sanitary conditions, at a fair price.

The dairyman is not avaricious; he is satisfied to work hard, attend faithfully to his business, and give clean, honest goods every day in the year, if he can receive enough to pay his help proper wages, pay for grain, tools, etc., and receive 5 per cent on his investment and 25 cents an hour for his labor, — and what other business man of equal capacity asks less? This we should get, and must get, to be fair to ourselves and to our families. But, mind you, this is not for the investor, who leaves the management of his dairy to hired help, — God never intended the dairy business to make the rich lover of ease richer; nor for the slothful man, who gives his herd little care and study; nor for the keeper of cows giving less than 6,000 pounds of milk a year; nor for him who will not keep records, or study the cost of feed and compute the profit on individual cows; nor for him who allows careless milking by men with dirty hands, sends milk to the market from tuberculous cows with inflamed udders, or milk containing excrement or dust, or which has or has had hair in it (straining the hairs out does not remove the pollution they have caused, — one hair may carry 10,000 bacteria), or which has been put in unclean pails or cans, — but for the business dairyman, who conducts the dairy business as a business, studies details and investigates sources of profit and sources of loss as carefully as the manufacturer or city business man, employs help fitted for the work, and pays them their due.

Physical labor is easier and cheaper than brain labor. The proprietor or manager of a large dairy cannot afford to do too much physical labor, though he may enjoy it, and the temptation to lead his men is strong. A mistake in planning operations, or poor judgment in some of the many decisions he has to make daily, resulting from a tired brain, will lose for him much more than he has earned with his hands.

Cow. — The dairyman, to be successful, must have the dairy cow. The dairy cow is a highly developed machine, capable of converting hay, silage and grain into large quantities of milk, rich in butter fat. The more food she will transform, the greater her value. There is a wonderful chance to improve our dairy cows. While the average production of this State is about 4,000 pounds per cow, and that of your best dairies about 8,000 pounds, there are individual cows in this State that have produced over 20,000 pounds, and there are cows that have given 27,000 pounds of milk, making 1,200 pounds of butter, in a year. Of the cows with which we are working, why is the great mass so far below the few phenomenal cows? What folly, and waste of time and feed, to breed and raise the scrub, which will never sell for what it cost to raise, and which is a loss to the keeper as long as he keeps it, regardless of the price paid! I care not what breed one chooses, but if you start out to breed a dairy cow, take advantage of ages of breeding, and breed better. It is not necessary or advisable for the milk producer to buy or breed registered cows; but by all means breed to a registered bull of some breed, and stick to that breed. In selecting a bull to breed from, see to it that his dam is the pattern from which you wish your future herd to be made. You may feel sure that her defects will be transmitted to many of his daughters. I recall an instance of a noted bull whose daughters were great producers, holding world's records. I noticed that many of these daughters had high forward udders; and when afterwards I saw this bull's dam, I noted that she had the same high udder as her granddaughters. See that his dam's dam, and sire's dam also, have the characteristics that you want in your herd, and that he is a good individual. Raise your heifer calves, and if they are from cows of mixed blood they are quite sure to take on the characteristics of the sire's family; and often the first cross of native cows and a pure-bred bull of established breeding will throw a herd of as great producing powers and better constitution than a herd of pure breds. If the females are pure bred of another breed, there is a balance of forces, a clash, and the chances are less for getting valuable offspring. Families of different characteristics of the same breed may clash, and beget offspring inferior to either parent.

Feeding the Calves. — I feed six pounds of new milk twice a day for three months, and give them grain of a mixture of bran, oil meal and whole oats as soon as they will eat it, and rowen hay, all they will eat; and do not neglect fresh water every day after they are a month old. They need a little grain for a year; their stomachs are not sufficiently adapted to grass and hay to enable them to do their best. The second year, do not feed much grain, thereby forcing them to eat quantities of roughage, to develop capacity and make them hardy. Too much grain at that age will make them delicate feeders later, and cause them to fall off when put on roughage. Do not let them freshen until they are thirty months old. Feed grain liberally the last four months, so as to develop the udder.

Cost of a Dairy Cow.

August, calf,		$10 00
Three months, milk, 12 pounds, at 2 cents,		21 60
Hay, 6 pounds,	$0 05	
Grain, 3 pounds,	05	
Turnips, 1 peck,	02	
6 months × 30 = 180 days ×	$0 12 =	21 60
6 months, pasture,		5 00
6 months, barn, at 17 cents per day,		30 60
6 months, pasture,		6 00
3 months, barn, at 22 cents per day,		19 80
2½ years labor,		?
		$114 60

For various reasons, three of which I will mention, cows are usually sold for much less than the actual cost of raising: —

1. Because there is something wrong with them.

2. Because the one who raised them does not know the cost of raising them.

3. Because the owner had to sell, on account of poverty.

Those of the first case are as useless to the buyer as to the seller. In the second place, probably no attention was paid to the quality of the sire. The country is full of scrub service bulls, and it is very doubtful if many of this class would show any profit in the dairy. In the third case they will probably soon be on the market again, for the same cause.

Breeding dairy cows for the market is losing business. Breeding them for one's own dairy is indispensable. But the demand for dairy cows is rapidly increasing, and the market price this fall approximates the cost of raising.

Value of a Cow.

Pounds,	Quarts.	3½ Cents per Quart.	Feed.	Labor.	Profit.	Value.[1]
16,000	7,441	$260 43	$110 00	$50 00	$100 43	$326 29
14,000	6,511	227 88	100 00	45 00	82 88	273 64
12,000	5,581	195 33	90 00	40 00	65 33	220 99
10,000	4,651	162 78	80 00	35 00	47 78	168 34
8,000	3,721	130 23	70 00	30 00	30 23	115 69
6,000	2,790	97 65	60 00	25 00	12 65	62 95
4,000	1,860	65 10	50 00	20 00	—4 90	10 30
3,000	1,395	48 82	45 00	17 00	—13 18	—14 54

[1] Three times yearly profit, plus $25 for carcass.

Feed. — No matter how good the dairyman and how good the cow, she must have sufficient feed, — palatable, nourishing feed, — in order to be profitable. It does not pay to be stingy with the feed. It requires considerable feed to maintain life; a little more makes a little milk, and a little more makes a little profit, and if the cow will utilize a little more, there will be a greater profit. We must raise all of our roughage, and buy concentrates, rich in protein. With plenty of well-matured ensilage and early cut clover or alfalfa hay nicely cured we have a balanced ration, and need not use much grain for the cows of large digestive capacity.

Ensilage is indispensable for the New England milk producer. Fifteen to thirty tons can be grown on an acre. It is easy to grow; never fails; takes more than ninety per cent of its weight from the sun and water; is conveniently harvested; takes up but little storage space; is easy to feed; is valuable not alone for its carbohydrates and fat, which furnish fuel for the body, but for its palatability and succulence, keeping the bowels regulated, and making the winter months equal June for milk production. In fact, I can make milk cheaper in winter with it than in summer without it. Some progressive dairymen are filling their silos the first of June with rye and clover for summer feeding. It has the advantage of allowing one to use the same silo for two crops. But I am of the opinion that corn ensilage is the cheapest feed, and also the best feed; and that the dairyman does well who puts up enough in the fall to feed every day in the year. I believe it is the cheapest feed on earth, keeps the cows in splendid condition, is conducive to good health, and keeps them yielding a steady flow of milk. Corn does the best on turf ground. I plant by hand three feet apart each way, four kernels in a hill.

Last week I rode twice across Indiana, and saw thousands of acres of corn standing. Stock of all kinds were running through it, and the appearance of buildings indicated that much stock would be left exposed to the weather all winter, and help themselves to corn in the field and wheat straw from the stack. Such shiftless, wasteful farming would not be tolerated in New England. The small growth of corn, the scrubby-looking stock, and the untidy, desolate-looking buildings and homes, prove the folly of such a system of agriculture.

I also believe in feeding good hay every day in the year that a cow will eat it. Where the pastures are good, there are a few weeks that a cow does not care for hay; but if she is hungry enough to eat it, she should certainly have it. I believe a cow's health is better and that she will last longer if she consumes ten pounds of hay a day, though she may produce the same amount of milk cheaper from other feeds.

Clover is a valuable feed, but it seems to be a crop to talk about and write about more than for every-day use by the dairyman. The seed is expensive, runs out quickly, gives small yields to the acre unless heavily fed, and is very difficult to cure in New England weather, where we have to make hay with a fork in one hand and an umbrella in the other. In a limestone region, where there is a guarantee of no rain during summer, it may be grown to better advantage. However, what clover we are able to get cured nicely is valuable feed, and the sod is valuable for growing a crop of corn.

The heavy applications of manure on a dairy farm, or on such dairy farms as save all the manure, tend to make the land acid, and the clover plant will not flourish on an acid soil. This condition may be corrected by applications of lime, wood ashes or Thomas slag. I have used all these, and wood ashes have proved the most successful on my farm, though I cannot tell why.

Alfalfa is like clover, only more so, — its advocates write longer and "holler" louder. The agricultural papers have been booming alfalfa for Connecticut and Massachusetts for twenty years, and possibly twenty years before that, — I don't remember. We hear wonderful stories from new enthusiasts every year. Some of the earlier ones have quieted down, possibly, after having sold their farms by the ton, to inoculate the soil of new converts. But I am not personally acquainted with very many in Connecticut or in Massachusetts who have laid by any great amount of wealth accumulated from raising alfalfa. Undoubtedly it is a valuable crop, and will be more extensively grown for dairy stock; but it has not yet solved the old-time problem of getting something for nothing.

If one has but a few acres of tillable land, and wants to get a large amount of roughage to feed with ensilage, he can disc some corn stubble in early spring, sow oats and marrowfat peas, make them into hay, disc again, and sow millet. Two large crops of hay may be secured, and corn be grown on the millet sod the following year. The practice of alternating corn with oats, peas and millet may be continued by applying a heavy coat of manure every year. When corn is to follow corn, I sow rye on the corn stubble, and harrow in. This protects the ground from washing by heavy rains; utilizes the available portions of winter-applied manure in early spring, holding them until the corn crop is ready to use them; furnishes early pasture, a soiling crop or poor hay, before plowing time; when turned under, adds humus to the soil and makes the soil looser; and, slowly decomposing, furnishes food for the corn during the growing season. Perhaps a better disposition of the rye field in the spring is to harrow in clover seed and roll, then cut a crop of rye hay and a crop of clover hay that season, two or three crops of clover hay the following season, and corn again the third. I have been perplexed for many years to know what kind of a rotation to practice, having but little land, and not wishing to grow anything except stock feed. I have about settled on this: (1) corn; (2) rye hay and clover hay; (3) three crops of clover; (4) corn again on clover sod. I am not satisfied with this method, for I do not like rye hay, but am at a loss to know what better to do.

Manure spread daily on the land, except during the muddy season and on deep snow, does the land much more good than manure that has been piled around the barns; and the absence of the old-time manure pile has no bad effect on the quality of the milk, the spring work, or the appearance of the place. The spreader should be regulated so as to cover all the land every year. Top-dress the meadows first up to January or February, then apply the fresh manure to the corn ground. I have noted that the portions of the corn field having the freshest manure had the heaviest corn.

Grain. — I feed a pound of grain for every three pounds of milk a cow gives, as a standard, feeding more or less, according to age of cow, condition, pressure of milk market, etc. Four or five kinds of grain mixed together give the best results, and, for convenience and safety, mix so that a quart weighs a pound. Give a cow three ounces of good dairy salt daily, — not bitter hay salt; or, to save time in feeding, mix two pounds of salt with every hundred pounds of grain. Union grains and Unicorn are both safe and good feed. Possibly the same analysis can be made by home-mixing large quantities, — one to three dollars a ton cheaper; but it is questionable if the small dairyman, or he who intrusts the mixing and feeding to hired help, can do better than to use them. A cow will not eat enough of either to hurt her.

Market. — The last and perhaps the most important part of my subject, from a financial point of view, deals with the milk after it has been produced. The expert stockman, with his highly developed dairy herd and the best of feeds, does not always make a profit. Sad, but true, it is too often the case. The first step necessary is to know the cost of the product. Figure insurance, interest, depreciation, taxes, your own time, etc.; and, if your market conditions are such that you cannot make a profit, stop before you have lost that which you have, and sold yourself into slavery. Milk, safeguarded as it must be in certified plants, cannot be put on the market for less than 15 cents a quart, and many have lost money at that figure. Since writing the above I have received notice from the proprietor of Fairlea farm, announcing that his price after December 1 is 18 cents per quart. Business men of such courage in the dairy business are having a tremendous influence on the price of all milk, and we should do all in our power to support their position. The actual cost of production may not be more than 1 cent a quart more than that of ordinary milk, but the interest on the plant and the cost of selling is enormous. Certified milk routes are scattered. People of wealth will buy certified milk when their babies are sick, and change to cheaper milk of unknown history as soon as the baby is better. There is a great agitation for clean milk, and the large cities will take a good many quarts a day at 15 cents to 20 cents a quart; but the great volume of milk must continue to be sold at a price close to the cost of production.

As dairymen, we are not sneaking criminals, trying to evade the law, civil or moral. We are the last class of people in the world to knowingly place a food on the market that could possibly injure man or babe. The proper care of milk requires knowledge and skill, which must be exercised every day in the year. We are willing to acquire this, if the consumer will pay the cost, and not compel us to compete with ignorance and filth. We welcome inspection, investigations, and the rigid enforcement of all the laws necessary to insure cleanliness and safety. *Clean* and *cold* is the whole secret of good milk.

Some of the Details in producing High-class Milk. — The cows and attendants must be clean and healthy. It is estimated that from 150,000 to 200,000 people die of tuberculosis in the United States every year, — as many as were lost during the whole civil war; and it is thought that the disease is carried to a great many, especially children, in cows' milk. Probably the germs are not contained in the milk when drawn, except in cases of tuberculosis of the udder, which is not very frequent, but suspected if there are any lumps in the udder, or if the cow is subject to garget or inflammation. But it more often comes from the fine particles of excrement of a tuberculous cow, or the sputum of a tuberculous attendant, dried into dust, and finding its way into the pail.

You have all probably seen, some time in your life, a ray of bright sunlight shining through a crack or knothole in a barn, revealing the thousands of particles of dust in every cubic inch of space, moving rapidly about; and, if you think of every one of these particles of dust carrying a thousand bacteria, many of which may be the specific germs of a fatal disease when taken into the stomach of a delicate babe, and consider that in warm milk each germ may multiply by 100 every minute, you can appreciate the importance of allaying some of the dust, and removing the milk from the stable and cooling it as soon as practicable.

The ceilings, walls and floors of the stable should be tight; cobwebs and dust thoroughly swept down. The stable should be whitewashed twice a year. Whitewash is a disinfectant, — seals up the cracks and makes the stable sweeter and lighter. Wiping the udders and flanks with a clean, damp towel, just before placing the pail under the cow, will do more good than any other simple, inexpensive operation. The towel should be wrung out after every two or three cows, and the milker's hands wiped dry.

The cow's tail is a terrible source of infection, generally dirty, with the most dangerous kind of dirt. Constantly switching, it keeps the dust of the region in motion, and it is not infrequently thrust into the face of the milker or into a pail of milk; and when milk is scarce, I am afraid it is not always thrown away after such a pollution. The tail should be docked, clipped or daily washed, and held securely while milking.

Bedding of shavings or sawdust creates less dust, and dust of a less harmful nature, than hay or straw; and if care is taken not to have any dry feed moved in the stable for an hour before milking, and the floor is sprayed just before milking, the amount of dust will be kept down preceptibly.

A pail with as small an opening as can be conveniently milked into will help a great deal. Strainers over the opening do not do much good, except to keep out hairs and particles of dirt, which, if the cow has been properly groomed, will not be present.

Milk commissions recommend that the milk room be located at least fifty feet from the stable. I do not approve of this, as it makes so much extra walking. I like a clean, well-lighted little room, adjacent to the stable, with a tight wall between, where the milk can be poured through a wall-funnel and run into a cooler, without the milker or stable air entering the milk room. The milk room should be sprinkled with clean water or flooded with steam prior to milking. The milk should be immediately cooled with ice water, and kept in ice water or packed with chopped ice until consumed. Every utensil coming in contact with milk should be rinsed until all the milk is off, then scrubbed with hot water containing an approved washing powder, again rinsed with clean water, and last steamed in a steam closet or over a steam spout, or scalded with boiling water.

Flies should be kept away from milk at all times, for after coming from the barnyard they are likely to have dirty feet, and they have been proved to be ready carriers of disease.

With these simple and inexpensive precautions, milk may be kept sweet for two weeks, and certainly at the ordinary age of delivery should be a safe and wholesome food for any one. At 10 or 12 cents a quart, it is about as economical a food as can be purchased.

In certified barns there are many more things that must be done, such as rejecting the first two streams from each teat; washing the hands in antiseptic water before milking each cow; milking through absorbent cotton; carrying into a room one hundred feet from the stable, and straining and straining; all attendants wearing laundered suits; cows tuberculin tested, and groomed and scrubbed until they are sore; watchman to carry all droppings from the barn as soon as dropped; tiled milk room, marble wash basins and expensive stables. These things are nice, may add a little to the safety, but are not so important as the simple operations previously mentioned. They are what makes the milk cost, and probably must be done to make the customers, paying a long price, feel that they are getting their money's worth.

Now, remember the four essentials of producing market milk: the man must be a dairyman; the cow, a dairy cow; the feed, sufficient and adapted to dairy feeding; and the market price, a little above the cost of production.

Question. Why does it cost more to take care of a cow giving 16,000 pounds of milk than of one giving 4,000?

Mr. Pierpont. A cow giving 16,000 pounds of milk would consume nearly $110 worth of food, while the poorer cow might be maintained for $45. Then there is the slightly increased expense of caring for the good cow, caused by the extra time taken in milking and feeding. I have tried to be wholly fair to the poor cow, and think that if anything there is more difference between her and the good cow than I have indicated. These figures are approximations; I have no 16,000-pound cows, so cannot speak from actual experience.

Mr. Burton W. Potter. Why is it that you haven't them? Isn't it because there are not many of them to be had?

Mr. Pierpont. There are not many because there is not the demand for them; the milk producers are not willing to pay those prices.

Mr. Potter. What is the average of your herd?

Mr. Pierpont. Last year the average was 7,432 pounds, the highest giving 11,539 pounds and the lowest 5,340 pounds. In the thirteen years I have kept records the highest cow average is 9,316 and the poorest 3,500 pounds. In the one case there is a yearly profit of $61, on the basis of my figures, and in the other a yearly profit of 6 cents.

The Chairman. The speaker has called attention to four points, the man, the cow, the feed and the market. We can buy the feed, and perhaps can get the market, if we cater to it, though there seems to be very little market for milk at the higher prices. Most of us are producing milk for a trade that will not pay over 8 or 10 cents a quart, and many of us are not getting enough to pay expenses. As much depends on the market price as anything, although the cow and the man are difficult to secure. The feed we can buy, if we have the other necessities.

Mr. Potter. I agree with most of what the lecturer has said, but I wish to call a few of his statements in question. I do not believe that we have been given the milk market for New England producers. In fact, the Boston contractors are now bringing in milk from northern New York and from Canada, and I am informed that cream is shipped in from Prince Edward Island. Certified milk will keep two weeks with icing, and sterilized milk two weeks without ice, so that I see no reason why milk cannot be shipped into Boston from a thousand miles away; and under our present freight rates it will cost no more to ship it that distance than from the Connecticut valley. The railroads do not always know just what they are doing, any more than the farmers. At a recent meeting the general counsel of the Boston & Maine Railroad made the statement that they had been carrying milk at a loss for thirty years. A witness before the Interstate Commerce Commission has recently stated that the railroads of the country could save a million dollars a day by the application of scientific principles. The lecturer asks an impossibility when he asks us to know just what it costs to produce milk. No two men in this audience would agree as to the exact cost. I compiled some figures at one time and made it cost 5 cents a quart, but Dr. J. B. Lindsey said that it cost more than 5 cents, and I am satisfied that he is nearer right than I. I think that a heifer costs just about what the lecturer has indicated, perhaps a few dollars less, say $100, but not less than that. I agree fully with the lecturer that we should all keep good cows, but there are not many 16,000-pound cows to be had at any price. I have a heifer with her first calf that has given 12,000 pounds of milk in nine months, and another heifer, that looks just as good, and has given but 8,000 pounds. Perhaps next year these same heifers will reverse their milk yields. All these things must be taken into account, and all you can do is to keep and breed good cows and keep them in good condition. The consumers have to pay a fair price for everything they buy, except milk, and that they expect to get for just what it costs the farmer, with the freight charged back.

Mr. P. M. Harwood. I want to emphasize the courage of the man who goes out and asks a decent price for his milk. The chairman of this meeting and the secretary of this Board are taking that stand and doing it successfully. Everything depends on the last point the speaker made, — the market and successful marketing. With decent prices and decent profits you will see enthusiasm in the dairy business. One reason why our milk producers do not get along better is that they have to compete with too many sections. To-day much of the milk sold in the Boston market is pasteurized, or partially cooked, before it is shipped, so that it may be brought in from New York and Canada. Milkmen and milk producers do not hang together closely enough. Let the milkmen of any town get together and agree to raise prices, and it is probable that not more than one of them will stick it out until the end of the season, and he will be very likely to lose most of his customers.

Mr. John Bursley. I would like to ask the lecturer to give us some points on raising the standard of the average dairy herd.

Mr. Pierpont. First, get a pure-bred sire, whose dam and whose sire's dam was a good milk producer, of the pattern you want your future herd made from, and you can feel pretty sure that your herd will begin to improve. Use some breed that suits your fancy and stick to that breed. If you have skim milk, and give your cows enough other feed, you can raise just as good heifers on that as on whole milk. The reason I use whole milk is because I have no skim milk to use.

Mr. H. O. Daniels. The question has been asked as to where we were going to get the man and get the cow. I say, raise them both. I believe the man who is raising an American citizen to-day, and raising him so he will wish to become an American farmer, occupies the highest position a man can have. I believe the man who is trying to build up his stock, and who puts his best effort and ability into the work, will have a herd that he will be proud of. Start with a pure-bred sire and I doubt if there is a man in this audience who will not then go and get a pure-bred heifer to work with him. That was the way we started, and we have 40 pure-bred cattle to-day where we had not 1 five years ago. Pure-bred cows are the best associates a man can have, and I believe our New England boys can make out as well in life in dairying as in any other business. The price of milk is low because we have so many small producers, because we have to keep so many of them to make a living. Cut off half the herd, keep the better half, raise cows to reproduce it, and save the money that goes into other States to keep the herd going. The problem can be solved, and we can solve it just as well as the other fellows.

Dr. J. B. Lindsey. I think that the lecturer has shown a fine grasp of the dairy subject, though we may not agree with him on every point. The question of cost of milk production is a vital one to the average producer, and in the past milk has sold for altogether too low a price, — less than it cost to produce it under satisfactory conditions. I believe that this is because the average farmer has not known what it costs him to produce milk. He has given his labor and that of his family, and said that it did not cost anything, with the result that the public at large has come to believe that milk can be had for 5 or 6 cents a quart. They are gradually realizing that they must pay more. As soon as the producer and consumer realize what it costs to produce milk, and that the producer cannot sell it for less than cost, I believe that the whole problem will work itself out. At the experiment station we have simply figured the feed cost of raising a dairy cow, and find it to be, for Jerseys and Jersey grades, from $50 to $65. We feed no new milk after the first three weeks, but have depended solely on skim milk and hay. We have not tried to figure the labor cost, as we are carrying on experiments, and our labor cost is necessarily high.

Mr. N. B. Turner. In Berkshire County we have a good deal of good pasture land, though rough and rocky. My plan is to take cows that are milking, and are going to freshen in the fall, get them to own a calf each, and turn into an out pasture. In the fall I have a big yearling and a cow worth more than when she went to pasture. The calf will work the cow harder than we would if we milked her, but she will stand it without scouring. For the next two years I should not reckon my hay and pasture as high as does the lecturer. I should be glad to take in yearlings at 15 cents a week. I should have them freshen before they are two and a half years old. I think you get a better cow that way, by letting the udder grow and expand with the cow, before her body is done growing.

Dr. Lindsey. The opinion among practical dairymen in the past seems to have been that it pays to buy rather than to raise dairy cows. Many of our dairymen depend entirely upon cows that they buy. That is one reason that cows are so high, because so many of them have been brought in and kept a year or less, and then turned into beef. I would ask the lecturer if he finds it to his advantage to raise his own animals.

Mr. Pierpont. I find it so, for the reason that I cannot find cows that I can buy for less than $100 that will make a profit.

Mr. E. H. Forristall. How much grain is it advisable to feed a large yearling heifer? Is it not better to feed more heavily on grain after she has had her first calf, and get a good growth at that time?

Mr. Pierpont. I believe in feeding heavily the first year, beginning with 1 pound a day, and increasing to 3 pounds the latter part of the winter. I want all the size I can get the first year, as I think that is the cheapest time to get the size; and the second year I want them to eat all the roughage they can, giving them but little grain, as my theory is that that will make a cow of large digestive capacity. Then the last three months before freshening, at two and a half years of age, I begin to increase the grain, so as to develop the udder.

Mr. W. A. Harlow. What do you think about the milking machine?

Mr. Pierpont. I think that the milking machine may become practical, but that as yet it is not.

The Chairman. I will ask Mr. Jewett to tell us something about that.

Mr. W. C. Jewett. I believe thoroughly in milking machines, but my plant is a little out of date, and I did not care to put the necessary money into fixing it up, so I am temporarily not using them. If I had a herd of heifers started on the milking machine they would never give a bit of trouble, but old cows will sometimes hold up their milk, just as when milked by hand, and for no apparent reason. If you weigh the milk, strip the cows that do not give what they should at any milking, and keep your power regular you will have no trouble with the milking machine. I used steam, and had a great deal of trouble in keeping the power regular.

Mr. Turner. What do you think best, to pasture stock, or soil them and keep them in the barn?

Mr. Pierpont. If I had a pasture I should turn the cow out to get whatever it had to offer. I do not think we can afford to bring green crops to the cow, but I do think it is economical to feed ensilage and hay nearly every day in the year.

Mr. W. C. Burt. I do not want any young man here to think it costs $114 to raise calves. My experience is that it never costs over $50 to raise a good heifer.

Mr. Bridgman. I figure that the cost of raising a heifer is about $45, with skim milk at 33 cents a hundred pounds, and labor. You cannot get more than $5 for a good grade calf, so why charge yourself more than that for one. I have two heifers now, two and two and a half years old, that will give a good 7,000 pounds of milk the first year, and they would not sell for $100. If it really costs $100 to raise them, it is better to buy, as you can pay from $60 to $75 and get 7,000 pounds of milk the first year. I usually keep cows two years, and get considerably more milk the second year than the first.

Mr. Bowman. I was looking over the dairy farms in Rhode Island the other day, and I find they are feeding beet pulp, costing $24 a ton. Is beet pulp a good thing to buy at that price, or is it better to buy ensilage?

Dr. Lindsey. Dried pulp is worth more than ensilage, but it is not worth $24 a ton, — not over $16 or $17. Beets are exhausting to the soil, and unless you have plenty of room to raise all your feed I should raise corn for ensilage, raise what hay I could and then buy the rest of the hay and grain needed to make a balanced ration, in the form of cotton-seed meal, wheat bran, etc.

Evening Session.

An evening session was held at 8 o'clock, at which Charles W. Bosworth, Esq., of Springfield, Mass., delivered an interesting and eloquent address on "The horse on Massachusetts farms." By request the lecture is not included in this volume.

Second Day.

Secretary Ellsworth. It is my pleasure to introduce as the presiding officer for this session the First Vice-President of the State Board of Agriculture, Mr. John Bursley of West Barnstable.

Mr. Bursley. Mr. Secretary, ladies and gentlemen, I feel that an introduction is hardly needful with many of you, because I have met you on these occasions for so many years.

The subject that is before us this morning is one that has interested our people throughout the State, and one in which the consumer as well as the producer is vitally interested. I am glad so many of you have gathered for instruction on the subject of clean milk, which will be presented in a very able manner by Prof. R. M. Washburn of the Vermont Agricultural Experiment Station, Burlington, Vt.

THE FOOD VALUE OF CLEAN MILK. THE DEMAND FOR CLEAN MILK: THE REASONABLENESS OF IT.

BY PROF. R. M. WASHBURN, DEPARTMENT OF DAIRY HUSBANDRY, VERMONT AGRICULTURAL EXPERIMENT STATION, BURLINGTON, VT.

A situation exists to-day in New England and New York, and, to a lesser extent, westward to the opposite ocean. It is more than local, though we are the first to feel it keenly. It is more than a dairyman's problem; in fact, it is more than an agriculturist's question. It is an economic condition based upon tradition, poor memory, personal greed, and an inability and unwillingness of the average individual to read or reason.

Dean Davenport of Illinois calculates that by the end of the present century there will be about twelve hundred million people in this country.

President J. J. Hill of the Great Northern Railroad, when discussing the food supply of the future, predicts that by the middle of the present century there will be a wheat shortage of 400,000,000 bushels.

Lord Macaulay is quoted as saying: "The day will come when the multitudes of people, none of whom has had more than half a breakfast or expects to have more than half a dinner, will choose a Legislature. It is possible to doubt what sort of a Legislature will be chosen. . . . There will be, I fear, spoliation. The spoliation will increase the distress; the distress will produce fresh spoliation. . . . Either civilization or liberty will perish."

There remains very little new land to be taken up; our "out west" is past, so far as extension is concerned. The nation faces a situation which is none the less real because distant a few years from us.

Even if we question the accuracy of these estimates in rate of human increase and shortage of food, the fact still remains that we are coming soon to a condition where it will be imperative that all possible of the organic-energy-carrying material about us be converted into human food in the most unwasteful fashion.

Around about us there are hundreds of thousands of acres of hill and meadow lands, producing vegetable growth which is absolutely valueless as food for man direct; and in addition to this we find that 60 per cent of the energy-carrying material of our field crops is likewise in such form as to require first being consumed by some food-producing animal before it has any food value for man.

In practice, the consumption of this otherwise waste stuff limits itself down to the beef steer and the dairy cow, and close study has shown that the cow will produce about seven times as much human food per unit of feed consumed as will the steer. In fact, the corn stalks, leaves and cobs produced on one acre of good corn, if fed to a steer will provide material for about 50 pounds edible dry matter in the form of flesh, while if fed to a dairy cow about 330 pounds edible dry matter will be produced. National economy, then, would demand that our hill pastures and lowland meadows, as well as the coarse fodders of cultivated fields, be employed in the production of milk.

Our New England farmers are now engaged in milk production more largely than in any other branch of agriculture; or, in other words, they are working along the lines of greater public good in food production. Yet it is a painful fact that for some reason, or many, the business can scarcely be said to be a paying one. There is now a living in it, but little more.

On top of the present condition another is climbing, which is tending strongly to make it yet more difficult to so handle this most honorable of human callings as to make it profitable for those engaged in it. I have reference to the great popular demand for better milk without a corresponding better price, and the fact that our milk producers already receive such poor pay for their product that at best the enterprise holds out small inducement, indeed, to those who have capital seeking employment.

The demand for clean milk is growing; it is growing rapidly. The health authorities, aided by many of the best-informed consumers of our cities, are active throughout the land in establishing laws and rules to govern the quality of milk sold in their respective cities. Whereas formerly the milk inspectors had to do principally with the retailer of the milk, the actual producer is now becoming more and more involved, so that the health regulations of Boston and New York, and of other cities, are very materially affecting the routine work on the dairy farms throughout New England and New York. That this demand is increasing is evident to every one at all conversant with the situation. Our first question is, "Is this demand a well-founded and an intelligent one?"

Amount of Milk used. — According to the latest obtainable figures there are produced in the United States about 7,266,400,000 gallons of milk per year, of which practically 30 per cent, or 2,180,000,000 gallons, are used as milk. Though this figure looks large it even then amounts to only six-tenths of a pint per day per person, which, viewed in that light, appears small. If accurate figures could be obtained up to the present time, they would undoubtedly be larger than those named, for milk is being more and more consumed as its real value becomes better known. At present "milk and cream together furnish about 16 per cent of the total food of the average American family."

Number of Dependent Infants. — There are in the United States approximately one and one-half million babies under one year of age at the present time, about one million of whom are dependent entirely or largely upon cow's milk for their nourishment, and the per cent of bottle-fed babies is increasing. Although adults consume considerable quantities of milk, infants and young children furnish the principal market for milk. What relation is there between cow's milk and the well-being of these babies? Statistics in this country are largely wanting on the subject, but we have reason to believe that the figures obtained from Berlin, Germany, are accurate for their conditions, and approximately so for ours. In the following table we note the death rate per thousand of infants fed on different foods: —

TABLE 1. — *German Statistics, showing the Death Rate per Thousand fed on Various Foods.*

Fed on mother's milk, ...	7.4
Fed on mother's and cow's milk, ...	21.4
Fed on cow's milk, ...	42.1
Fed on milk substitutes, ...	67.7
Fed on cow's milk and substitutes, ...	125.7

From the above we note that where 1 child dies which is being breast fed, there are nearly 6 when fed on cow's milk. In some places, most notably in our large cities, the death rate among bottle-fed babies is ten times that among breast-fed. This in itself would indicate either that the cow's milk is not adapted to the human infant, or that there is a great fault somewhere in the handling of the cow's milk. In comparing the composition of human versus cow's milk, we notice that they differ principally in the following points: the fat in the cow's milk is about 30 to 40 per cent higher than in human; sugar in human milk is nearly twice as high as that in cow's; the protein content of cow's milk is more than three times that of human; the nutritive ratio in the case of the cow is approximately 1:4, and approximately 1:8 in the human, with an acid reaction in the cow's milk and an alkaline reaction in the human, as indicated in the following table: —

TABLE 2. — *A Comparison of the Two Milks, showing their Average Relative Component Parts on a Chemical Basis (Per Cent).*

	Water.	Fat.	Sugar.	Protein.	Ash.	Nutritive Ratio.	Reaction.
Cow's milk, . . .	87.0	4.0	4.5	3.75	.75	1:3.9	Acid.
Human milk, . . .	88.4	3.3	6.9	1.50	.20	1:7.8	Alkaline.

The differences as indicated above are quite readily overcome by a method known as modification, which is simply the addition of water, milk sugar and lime water in such quantities as to establish in the modified cow's milk approximately the conditions present in the human.

Fat v. Cleanliness. — A study of the methods of modification shows us that it is customary to start a child with a milk in which there is about 2 per cent fat, and that gradually the fat content is increased until the child, at five or six months of age, is receiving milk containing about 4 per cent fat. Undoubtedly this fact is largely due to the popular notion that fat is the most valuable ingredient of milk, and that milk has value in proportion to its fat content, without any particular reference to the other features. That this is a mistaken belief is becoming known slowly, as we study more and more closely the value of the other constituents of the milk and the value of cleanliness. Experiments have been conducted to show the value of rich milk versus half-skimmed milk as animal food. These experiments bear out thoroughly the experience of our dairy stock breeders, namely, that rich milk, that is, milk containing around 5 per cent fat, is not conducive to highest bodily vigor; that milk containing practically only half that amount will develop stronger, more robust and thrifty animals, whether they be pigs or calves, than will milk containing 5 per cent or more of fat; and we have no reason to doubt but that it is the same with children. In fact, we have many reasons for feeling that it is the same with children. Not infrequently in these tests have the pigs and calves fed on rich milk died outright from acute indigestion, diarrhœa or constipation, whereas their mates, on a less fat milk, have grown vigorously and without internal troubles.

The statement just made is not a "boost" for the Holsteins nor a "slam" on the Jerseys. It is a statement of fact which every housewife and every physician should remember. Moreover, the stand taken by many of our city authorities in regard to the fat content of milk, namely, that, whether a cow gives a 5 per cent milk or a 3 per cent milk, it must not be changed in any particular, is unwarranted, unjust and unscientific. If a city or a State adopts a fat standard for milk, it should certainly allow all who wish to standardize their milk to that standard. If that is not to be permitted, then every retailer of milk should be allowed and compelled to set his own standard, and be held accountable only to the living up to that self-imposed standard.

Jersey milk standardized to 3 per cent fat is more valuable as a food than the milk of a Holstein which tests only 3 per cent naturally, because there will be an equal amount of fat and a greater amount of sugar and protein in such milk; and to forbid such standardization, and prosecute those who practice it, smacks more of a desire to make a large and showy annual report than a wish to safeguard the health or the purse of the consumer.

The absence of dirt in milk is of greater value than the presence of fat over 3 per cent.

The cause of bad milk is something which every producer, handler and consumer of milk should understand. That there is a very vital connection between the cleanliness of milk and the health of our children, no one who is informed can deny. For convenience in study, the causes of poor milk may be grouped under three heads: the cow; the air; bacteria.

Under the first we must recognize that when the cow is out of condition her milk is also out of condition; that to a very considerable degree milk is not dead matter, but portions of the living mother. It is well known to producers of high-class infant-feeding milk that when cows have, for instance, been injudiciously fed on something like green corn, their bowels become excessively loose, which effect is transmitted through the milk to infants consuming such milk. Any condition in the food which would cause the opposite condition in the foster mother would cause a similar opposite condition in the child. Again, though a cow herself be thoroughly healthy, if the food consumed is ill flavored, like rye or wheat pasture, or silage not properly made, the pungent and disagreeable characters will be transmitted to the milk, and cause the sensitive child, who soon becomes an expert judge, to refuse the food it so much needs. It is highly unjust and improper, however, to prohibit the feeding of silage to dairy cows altogether, for there is practically no other food which can be fed in winter which will so closely resemble summer food, and which will keep the cow in such thoroughly good physical condition, to say nothing of the producers' right of say in the matter, — that of economical production.

Silage made from mature corn, preserved in properly constructed silos, and fed in quantities not greater than 25 to 30 pounds per day, will, by keeping the cows' general system in better condition, cause a better milk to be produced than those same cows could produce under like sanitary conditions were they fed solely on some dry food.

The air of the stable is too frequently close and filled with dust and disagreeable odors. That the milk, or rather the fat of it, will absorb odors, is known to all of us. The rate at which such odors are absorbed, however, has frequently been overestimated. The milk should, however, be removed from the stable atmosphere as soon as it can conveniently be done; and in storage, too, it should be under clean environment. Independent, then, of the possibility of bacterial contamination, there is a reason for an early removal of milk from ill-flavored places.

Bacteria, though tiny things, are now receiving an immense amount of attention, and justly so, for great is their ability to do good or ill. The dairyman, too, must remember that every particle of dust is a tiny raft or airship, each carrying upon it a dozen to a hundred living things which have the power of growing and filling large space. The dandruff and hair from the cow carry with them particles of manure which introduce the organisms which are frequently the cause of the "summer complaint," colic, etc., in infants. The dust in the air also introduces molds and bacteria from dusty hay, fodder and bedding, which injure or destroy the feeding value of such milk.

I say, brother dairyman, did you ever see a farmer get up in the morning, and, without washing, take two pails of swill from the house to the hog house, handle the tools contained in the hog house; then go to the horse stable, spank the horses over, feed them their grain, curry them and possibly harness them; then go to the cow stable, and, after catching and tying up a calf, sit down to milk *without* washing his hands? I say, did you ever see him do all this *without* washing his hands? I have, we all have; and we all know that to milk absolutely dry handed is extremely difficult on many cows, and that not infrequently the lower portion of the hands becomes well washed during the milking process. Where does that dirt go? Into solution in the milk, and, being in solution, it cannot be strained out through any amount of cheese cloth or even absorbent cotton.

Imagine with me for a moment that the good housewife beats eggs, mixes cake, kneads bread or does any other similar piece of food work regularly in so dusty and ill-flavored a place as the ordinary cow stable. How many of us, young men, would be willing to marry into that family? Would you, Mr. Reader? As a matter of fact, however, the detrimental effects which could possibly result from such work, which we would immediately pronounce fearfully dirty, would be nothing of consequence, for the reason that all those foods are thoroughly baked, and thereby sterilized before being consumed, whereas milk is consumed raw, and that by our tenderest specimens of humanity. These are not pleasant thoughts, but they are fact thoughts, and this is not a one-sided story.

Milk as a Disease Carrier. — That epidemics of contagious diseases have been brought about through the medium of milk as a carrier of the specific organisms causing the disease has been thoroughly well shown many times. In fact, there are on record authentic instances of 500 epidemics which have occurred within the past thirty-five years, — 317 of typhoid, which is now almost exclusively a country disease, brought about by poor sanitation and flies; 125 of scarlet fever and 58 of diphtheria, all of which were traceable definitely to milk, not as a cause but as a carrier of the organisms introduced carelessly or accidentally, either from close contact with a person having the disease, or from the fact that the dairy utensils have been rinsed in water carrying the disease germ. Again I repeat, that with milk the absence of dirt is of greater value than the presence of fat over 3 per cent.

Why has Cleanliness such Value? — Because milk is a good food for many forms of trouble-making bacteria; because it is consumed in a raw state, which permits of introduction into the child of any organism which may be in the milk; because it is the principal if not the sole diet of such infant or child; because of the tender age of the consumer, — all of which emphasize the necessity for great care in the production and handling of this article.

Clean and cold are the two qualities which enabled our distinguished dairy friend, Mr. Gurler, to ship milk from DeKalb, Ill., to Paris, France, where, after twenty-one days, it was still sweet and wholesome, though carrying no preservative whatsoever other than mere cold; the same qualities which enabled a few dairymen who exhibited milk at the 1906 National Dairy Show at Chicago to exhibit a milk of such high quality that "some of the samples remained perfectly sweet after being shipped 1,000 miles across the country, put in storage at a temperature of about 32° F. for two weeks, and then reshipped a distance of 900 miles to Washington, D. C., where they were stored in an ordinary ice box several weeks longer, some of the certified samples being still sweet after five weeks. A part of a box of cream entered in this contest was placed in cold storage in Chicago at a temperature of 33° F. and remained sweet and palatable for a period of seven weeks!"[1] When such records can be made by a few men, it opens the eyes of all of us to the possibilities of the industry, and should at least make us all thoroughly ashamed of ourselves for producing a milk so dirty and keeping it so carelessly that it becomes sour in one or two days.

In conclusion, then, we must admit that the demand that milk shall, at least, be as clean as other foods is a reasonable and just demand.

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[1] Bureau of Animal Industry, Bulletin 87, p. 20.

The Reasonableness of Clean Milk.

To lay aside all sentiment, for love can neither be measured nor weighed, the naked truth remains that our children are the highest priced domestic stock we have, and that their quality and often their lives are continually threatened by the poor quality of milk fed them; and that it is cheaper in dollars and cents to keep them well on clean food than to try to make them well on drug-store dope.

The cost of producing such clean milk is considerable, as will immediately be argued. Just how much more cost is added because of the extra labor involved in producing a clean rather than a common article will always be very variable, and is hard to state with any high degree of accuracy, but that such added cost is more than the present profits in the industry is painfully certain. It requires a greater expenditure for equipment, and a constant and much greater expenditure for labor, besides a considerably more thorough education in the business, which may cost more dollars to acquire. I maintain, however, that the extra cost of producing clean milk, when added to the present cost of producing plain milk, does not cause the resulting product to be as expensive a food, even for the adult, as other foods of similar value; and too, when our people come to a full understanding of this matter, and will cease demanding a milk rich in fat regardless of how rich it may also be in dirt, and will demand cleanliness instead, the extra cost of such cleanly production may be partly compensated by a lessened fat content, and thereby work a double benefit, for the milk as food for children will be more valuable because of the absence of both some fat and much dirt.

Adults. — Too often milk is thought of as a drink, as a mere beverage, although we know, when we stop to think of it, that such vegetables as the carrot, parsnip, cabbage and pumpkin all carry a higher percentage of water than does ordinary milk; or, in other words, 100 pounds of milk has more dry matter and much more actual food in it than 100 pounds of carrots and parsnips.

To make direct comparison between foods, however, is difficult, for several factors must be taken into account. To compare foods directly upon the basis of the amount of dry matter contained in them is improper, for the reason that the character of such material varies greatly in value; to make direct comparisons upon the basis of the amount of protein (muscle-making foods) that they carry is equivalent to stating that the heat and energy carrying portions are of no value, which is, of course, not true, they being required in seven to ten times as great quantities as the former; to make comparisons directly upon the number of units of energy liberated is likewise improper, being equivalent to saying that the protein is of no value, which again is untrue. So then, in order to compare one food against another, it is necessary to compare those foods which have similar proportions of digestible protein and energy-bearing nutrients; or, in other words, to compare foods which have similar nutritive ratios, and are either both of animal or both of vegetable origin, for the digestibility of milk and meat products is very materially greater than that of cereals and garden vegetables. In the following tables the foods are grouped so that those of approximately like nutritive ratios are compared against each other.

TABLE 3. — *Comparison of Foods, showing Waste Matter and Digestible Nutrient.*[1]

KIND OF FOOD.	Nutritive Ratio.	Refuse (Per Cent).	Water (Per Cent).	Digestible Dry Matter (Per Cent).
Fat porter house steak,	1:2.1	12.7	52.4	38.5
Round steak,	1:1.5	7.2	60.7	31.4
Hamburg steak,[2]	1:1.5	–	66.0	31.0
Eggs,	1:1.7	11.2	65.5	22.2
Skim milk,	1:1.8	–	90.5	9.2
Whole milk,	1:4.3	–	87.0	12.5
Smoked ham,	1:4.2	10.7	48.0	38.3
Cream,	1:18.2	–	74.0	25.0
Bacon,	1:15.1	7.7	17.4	71.0

[1] Adapted from Farmer's Bulletin 142, United States Department of Agriculture.
[2] Average of 12 fair samples collected in Burlington, Vt.

From the above table we are impressed by several facts. First, by the high percentage of waste matter in many forms of our common foods, there being nearly 13 per cent bone and gristle, actual waste, in porter house steak. Then that the bone-free portion is composed of more than one-half water, and that, of the dry matter, another portion is not digestible, giving only 38.5 per cent digestible nutrients in porter house steak, with a nutritive ratio of 1:2.1. Let us study these foodstuffs at their ordinary market prices, and see what the actual digestible food nutrients cost per pound, comparing them against others of similar character.

TABLE 4. — *Showing Cost of Digestible Nutrients per pound in Various Food Stuffs.*

KIND OF FOOD.	Nutritive Ratio.	Ordinary Price.	Cost per Pound Digestible Dry Matter.
Porter house steak,	1:2.1	30 cents pound.	$0 80
Round steak,	1:1.5	20 cents pound.	64
Hamburg steak,	1:1.5	20 cents pound.	60
Eggs (1 dozen = 1½ pounds),	1:1.7	36 cents dozen.	1 03
Skim milk,	1:1.8	2½ cents quart.	14
Plain milk,	1:4.3	7 cents quart.	28
Ham,	1:4.2	25 cents pound.	65
Certified milk,	1:4.3	15 cents quart.	60
Clean milk,	1:4.3	12 cents quart.	48
Cream,	1:18.0	40 cents quart.	80
Bacon,	1:15.0	25 cents pound.	35

The above table is striking in that it shows us that skim milk, with a nutritive ratio comparable with that of porter house steak, when sold at 2½ cents a quart, or 1¼ cents per pound, does not cost one-fifth as much per pound of actual food as does porter house steak, and that eggs at 36 cents a dozen (1 dozen eggs equaling 1½ pounds), because of the waste of shell, and the very high water content of the contents of the shell, costs us a little more than $1 per pound of digestible dry matter, as against 14 cents in the case of skim milk. Even Hamburg steak, that most humble of all meats bearing the name steak, when sold at the usual price, 20 cents per pound, costs 60 cents per pound of actual food, or more than four times that of skim milk, even at $2\frac{1}{2}$ cents per quart.

Comparing the second group of whole milk against smoked ham, we find that whole milk at 7 cents a quart costs us only 28 cents per pound digestible dry matter, whereas ham, because of the bone, skin and water, costs us 65 cents per pound; and that certified milk, even at the "awful" price of 15 cents a quart, costs us only 60 cents a pound; or, in other words, *certified milk* at 15 cents *a quart is cheaper food, even for the adult, than smoked ham at 25 cents a pound,* and as cheap as Hamburg steak. In fact, if the prices of milk to the consumer were exactly doubled, and nine-tenths (instead of one-fourth) of the increase given to the producer of the milk, the farmer would then not be greatly overpaid, and the consumer would still be getting food *more* cheaply per pound of actual digestible material in milk than in any other animal food of similar food value. As a matter of fact, the selling price of milk should be increased about 4 cents a quart, and $3\frac{1}{2}$ cents of this raise given to the producer, in order that a cleaner milk may be made possible, and still have a market value in proportion to the increased cost of cow feeds, labor, building material and land values, which have advanced from 50 per cent to 100 per cent since 1895. Truly, good milk at 12 cents per quart is cheap food, while dirty milk is dear at half the price.

Coming to the next group, and comparing cream against bacon, we find that 18 per cent cream at 40 cents a quart costs us about 80 cents per pound digestible dry matter, whereas bacon, with approximately the same food-giving power at 25 cents a pound costs us only 35 cents per pound. Cream has the price attached largely because of the flavor and the name, not because of its real food value.

"The idea that only whole milk is fit to use, which is rather erroneously held by housewives, is perhaps ascribable to the esteem in which cream is held as an ingredient of 'rich food,' and may lead to quite needless waste or expenditure. For growing children, who need large quantities of protein and carbohydrates, 2 quarts of skim milk would supply more of these constituents and more ash than 1 quart of whole milk. . . . Many families who are in the habit of drinking whole milk and buying cream would doubtless be quite as well off if the top of the milk, say two or three inches in a quart bottle, were poured into the cream instead of the milk pitcher; the milk ought still to be far from thin and blue, and there would be a marked saving in the cost of cream."

"The commonly accepted standard for a man at moderately active muscular work calls for .28 pounds of protein and a fuel value of 3,500 calories per day, so that a lunch of 1 pint skim milk and ½ pound of bread furnishes very nearly one-third of a day's nutriment, and at a cost of but 5 cents. If whole milk were used instead of skim milk, the cost would be about 7 cents, and the fuel value 1,080 calories, while the protein would remain the same in amount;" and added to this is the further fact that the presence of milk in human diet increases the digestibility and food value of all other food consumed by about 5 per cent.

Reviewing the situation, then, we see that milk as a food for infants and young children is almost indispensable, and in reasonable quantities is an economical food for adults; that the consumers are demanding something that they are not yet willing to pay for; and that the producers are commanded to do something which they cannot do and stay in the business.

By co-operation last winter you did some good work, and the whole country, the consumers not excepted, respect you the more for it. Is the time not now ripe for a broader co-operation, one which shall reach all producers, contractors, health officials and milk consumers in New England and New York? Is it not time for the dairy associations of these States to join hands, first with each other, then with those of contractors and others, for the purpose of placing before the consumers of milk the facts regarding the true value of milk; to keep placing it before them until the opposition to an increase in price shall have been broken, and milk put upon the basis that it has so long deserved; until, in fact, the occupation of producing this most vital of American food necessities shall become an attractive one both to capital and to men?

There is right and justice in the demand of the consumer for a cleaner, purer milk, and there is equal right and justice in the demand of the producer that he be repaid the extra cost of producing this extra quality, and no amount of inspection or legislation will really avail much until the producers are adequately repaid.

Mr. Wm. E. Patrick. How do you account for dairy men being such fools as to sell their product at the price they do, and pay double for what they buy?

Professor Washburn. I shall not call the farmer a fool, for when we go into the cities we find men from the farms in every walk of life, and managing great businesses with skill and intelligence. Of all the business enterprises in the world farming is the most complex. To be a scientific farmer requires more training, and more careful training, than to be an equally good scientist in any other line. A scientific agriculturist must know chemistry, physics, botany and physiology, and all the other allied branches, and then cement the whole proposition together by experience, and have common sense, business sagacity and diplomacy enough to handle hired men. Answering more particularly, I would say that farmers have sold for less than the true cost because they did not know what that cost was. The true cost of a quart of milk is a thing which it is extremely difficult to get down to exact figures.

There is a viewpoint I would like to impress upon every man in the world who is interested in agriculture. I recently spoke before a gathering of farmers, and a lady asked to know the subject. I told her. "Well," she said, "the State is doing a lot for the farmer these days." Is it for the farmer? If so, is the State pauperizing the farmer by helping him? In this country there are, roughly speaking, twice as many people altogether as there are on the farms. There are about as many homes in the cities as on the farms. In other words, there are two homes for every farm, one family on the farm and one family in town. The family on the farm has the first rights in the stuff they produce, and the man in town is dependent for his board upon the surplus. In the case of shortage, who goes hungry? The man depending on the surplus. Who, then, is most affected by improved agriculture? The farmer gets the first good, but the city man gets greatest good, in the study of agriculture. All this is beside the question, but it is a thought I always like to bring out.

Mr. S. H. Reed. Can you give the death rate per thousand in the country, where children are raised on the cow's milk, and in the city, after the handlers have handled that milk?

Professor Washburn. I cannot. I doubt if the figures are obtainable; certainly I have never been able to get them. A comparison conducted between cow-fed and breast-fed babies is not an entirely fair one. The dairyman might keep his milk entirely clean until it was delivered to the mother, and then the mother might do something to the milk that would injure it. It is ignorance and neglect and selfishness in the home, nearly as much as outside the home, that cause death. There would not be nearly as many deaths as there are if the milk were carefully kept after it reaches the home.

Mr. Reed. Is the producer to blame, or the consumer either, any more than those who take the milk from the farm and carry it to the city?

Professor Washburn. By all means, no. The uses to which milk bottles are subjected in the city homes are something awful, in many cases. It is a problem not for the dairyman alone, nor the agriculturist alone; it is an economic condition based upon many things, including tradition and greed.

Afternoon Session.

Secretary Ellsworth. I will introduce as the presiding officer for this session, Mr. John L. Smith of Barre, representing the Worcester West Agricultural Society. Some of the best farm management in the State is found right there in Barre, as perhaps you will pardon me for saying when you learn that I was born there.

Mr. Smith. This subject has not been discussed as much as some others at our public meetings, but it is, I sometimes think, the most important of all, for no matter how good a product we produce we are not successful if we fail to manage our business properly. I now have the pleasure of introducing the speaker of the afternoon, Hon. N. P. Hull, Deputy State Dairy and Food Commissioner, Dimondale, Mich.

FARM MANAGEMENT.

BY HON. N. P. HULL, STATE DAIRY AND FOOD COMMISSIONER, DIMONDALE, MICH.

First, I want to take you into my confidence by telling you that I did not come to Massachusetts to tell you all about the details of running your farm, for I know, as well as you, that the only way I could successfully handle the details of a farm in Massachusetts would be to leave my farm in Michigan, move here, settle upon this land, and study conditions of soil, market and climate for a few years; then I might be able to understand fairly well the details of farm management in Massachusetts; but I maintain that there are certain basic principles of farm management that are just as true here in Massachusetts as they are in Michigan.

Let me here give an illustration of farm management. Upon one side of the road there is a man who does a fairly good day's work, day in and day out for a year. At the end of the year he has made a profit; he has something to show for his labor; he has been able to surround himself and his family with the comforts of life, educate his children and lay aside something for the day of sickness, calamity and death. Beside him, or perhaps across the road, there is another man, who works harder than the first-mentioned man; his wife works harder than any one ought to have to work, and his children work hard, but at the end of the year he is no better off than at the beginning. After a decade has gone by this man has nothing to show for his labor except the bare fact of having existed. The one man has managed his farm, his business, correctly; the other man has not. The result is one man succeeded; the other did not.

Let me here ask you a question. How many of you who have been farming for ten years can tell which crop grown upon your farm, or which line of live stock handled, has paid you the most net profit? Some of you can. I dare say most of you cannot. If you know nothing about where you have gotten your profits, wherein has your experience of ten years upon a farm profited you in being able to more intelligently direct your efforts for the next ten years? I am a farmer, the same as you, and I did not come here to run down the farmer, nor to separate my lot from yours; but I want to maintain here that our good Creator knew what he was doing when he made the farmer. He gave him good, strong hands and arms because there was work to do in the world, and the farmer has his fair share of this world's work to do, but he also knew what he was doing when he put a part of the farmer's anatomy above his ears, and put brains therein. I presume he thought the farmer would use those brains to more intelligently and more cunningly direct the efforts of his hands, so that the work of those hands would avail him more. Let me illustrate this. A young man from the fruit section of Michigan was sent by his father to our agricultural college to take a course in horticulture. After completing the course the young man returned to his father's farm. The father had 10 acres of apple orchard on his 80-acre farm. The boy said, "Father, let me take this orchard, prune it, fertilize it and spray it, as I have been taught to do." The father was a hard-headed old farmer, and, looking the boy over, he said, "Humph, you have been down to that college and got the big head, have you? I want you to understand that I grew apples before you were born." The boy was a chip off the old block. Looking his father in the face he said, "Dad, it looks to me as though you have made a mistake." "Why?" asked the father. The son replied, "Either you made a mistake when you furnished the money to send me to college to learn what I now know, or else you are making a mistake when you will not let me use that knowledge." This was a hard nut for the old gentleman to crack. Finally he said to the boy, "Take the orchard and try it one year; I guess you cannot spoil it in that time." The boy took the orchard, pruned it, sprayed it and cared for it as he had been taught to do, and he made more profit off that 10 acres of apple orchard that year than his father had made off the whole farm in the past ten years. The boy's hands or arms were no stronger, neither did he work harder than his father had worked, but he won because he more intelligently guided the labor of those hands. In farm management, whether the farmer lives east or west, north or south, there are two things that he should ever keep before him: first, that he should sell as many dollars' worth of product off his farm each year as he can, which shall carry with it the largest per cent of profit possible; second, that he shall maintain or increase the fertility of his farm so that he may go on selling more dollars' worth of product, which shall carry with it a larger per cent of profit.

As to my first statement, the truth is almost self-evident. If we are to progress in the world and have better things, and to make better communities, we must do it largely from the profits in our business. In fact, the profit that we make in a year measures, in a commercial way, the value of that year of our life, and surely we ought to feel that our life is of sufficient value to urge us on to get as much for it as we can.

As to the second proposition. A man having a warranty deed for an 80-acre farm has a legal right to mine it; or, in other words, to blight it so that those who come after him shall not be able to make a living from it. I do not believe that he has a moral right to do this. He owes it to his children, to his community, to his State and to his nation to so handle his farm that a fair share of the great unborn armies of the future shall be able to make a living from it.

Again, as to my first proposition. One source of income or profit to the farmer is crop production. We owe it to ourselves to know which crop is best fitted to our land, our climate and our conditions, and then strive to so handle this crop that we shall make the largest possible profit from it. I have learned that in producing a crop, after one gets a sufficiently large crop to pay for the cost of production, it requires but a little larger crop to furnish us 6 per cent profit; and it requires but just a little larger crop than this to double the profit, and just a little more will triple the profit. Let me illustrate that by the corn crop. I do not care to have you remember the figures I give you; they would be of no value to you, as they would not approximate your conditions, but I must give some figures to illustrate the principle. Upon my farm for the last ten years, taken as an average, 55 baskets of ears of corn per acre, together with the resulting corn stover, will just about pay the cost of production. If I grow 4 baskets more, or 59 baskets per acre, I make 6 per cent upon my investment. If I can grow 4 baskets more, or 63 baskets per acre, I will make 12 per cent upon my investment. That is, under my conditions, a 63-basket crop of corn is as good again as a 59-basket crop. Let me illustrate this. My friend Mr. Smith here is husking corn on one side of the fence, I on the other. You come along and ask Mr. Smith how his corn is turning out. He says, "63 baskets per acre." You ask me. I say "59." Most of you would say there is not much difference in those two crops of corn, but if my figures are true there is quite a difference, for I must plow my land again, plant it again, care for the crop and harvest it, and get another 59 baskets, then I will have 8 baskets of corn profit in those two years; but my friend Smith gained 8 baskets of profit in one year. I put in two years to accomplish what my neighbor accomplished in one year, which means that by simply growing 4 baskets more corn per acre than I grew he has doubled the value of his time compared to mine. What is true in principle regarding the corn crop is true of every crop we grow. When we put in part of our lives growing crops, we should strive to produce such crops in such a way as will return to us the largest value for the time we expend.

I am reminded of a farmer in northern Michigan, who, when asked to attend a farmers' institute, said, "If I have good land, and the good Lord sends us the rain and sunshine, I will get a crop; if He does not send the rain and sunshine, I cannot; and there is no use attending an institute." I suppose the good Lord will send the same amount of rain upon our fields whether we know the business of farming or not, but whether the surface of our fields are so crusty that the rain will run off to the hollows, or whether the surface will permit the percolating downward of the rain into the great storehouse where it can be drawn upon in time of need, depends upon the intelligent handling of the field. So many sumbeams will strike our fields each year, whether we study to know or not, but whether they shall be refracted backward or shall be absorbed to quicken our land depends upon the intelligence we use in feeding that land. I am constrained to believe that if we, as farmers, do our part as well as the Lord does His, we might, most of us, be better off.

As to maintaining fertility, there are two methods we may successfully follow. First, that of green manuring and commercial fertilizers; second, that of adopting some line or lines of live stock husbandry, feeding out as much upon the farm of that which the farm produces as is possible, and returning the resulting fertility to the farm. While in a limited way a man may undoubtedly succeed by the first method, my judgment and practice would lead me to believe that for the great majority of farmers, both east and west, the second method is the better and more practical. It is not enough, however, that we feed out the stuff we raise upon the farm and convert it into a finished product and fertilizer, but we must see to it that this fertilizer is cared for and goes back upon the land. The Secretary of Agriculture estimates that about one-half of our farm-made fertilizers are wasted, and he also estimates that this waste equals or exceeds a billion dollars a year. How long can we go on wasting our natural ability to grow crops, depleting our fertility and wasting our resources, and still be able to feed the great number of people that there will be for us to feed in the future?

In adopting some line of live stock husbandry, we should keep in mind the first principle of success which I mentioned. We want to feed out our product to the animal that will return to us the most for it, with the largest per cent of profit. To do this, my judgment and experience permit me to recommend the dairy cow. In proof of this let me compare the cow as an economical producer to the steer. Suppose we have here a unit of feed. This unit represents enough feed that if fed to the steer will make him dress one pound more. That is, the steer will take this feed and convert it into a pound of dressed beef. Now, if instead of feeding this unit to the steer we fed it to a good dairy cow, she would convert it into a pound of butter or two pounds of cheese. A pound of dressed beef by the side would be worth from 5 to 10 cents. A pound of butter would be worth from 20 to 40 cents. But, some one says, the cost of producing the pound of butter, aside from the feed, is more than that of producing the pound of beef. This is true, but the difference in cost of production is no way commensurate with the difference in the value of the product. Now, if I recommended the cow to you, and stopped there, it would not be quite fair, for it is true that many men are keeping cows that do not return to their owners the first cost of the feed they consume. This, however, is not the fault of dairying, but the fault of the man keeping the cows. He is not using enough intelligence and painstaking care to know the essentials for success of the business that he is in, and then adopting these essentials. There are just three essentials in profitable dairying. These are, first a good cow; second, good feeding; third, good care. There are some cows that have the natural ability to take feed and profitably convert it into milk. There are other cows that have not this natural ability to take feed and profitably convert it into milk. I have said that in Michigan there are three kinds of cows. This, I think, is also true in Massachusetts. One kind of cow takes her feed, digests and assimilates it, and because of her inborn tendency, predisposition, temperament, or call it the law of nature, if you will, she converts this digested feed into beef. This is a beef cow. Another cow, because of her temperament, converts her digested feed into milk. This is a dairy cow, and I care not what her breeding or color may be. I just want to know that her temperament prompts her to convert that feed into milk. I would advise the farmers to tie to this sort of cow, for, in my judgment, she will do the farmers of Massachusetts more good than any other animal that walks on four legs on the farms of Massachusetts. Then there is another kind of cow, that takes her feed, digests and assimilates it, and God only knows what she does with it. She neither makes milk nor beef of it, and she is of no value to any one anywhere and should be gotten rid of.

Time and space will not permit me giving a talk here upon feeding and the care of cows, but successful farm and dairy management necessitates a man knowing how to do these things and then doing them. Let me give an illustration of farm management. One man whom I knew bought a farm, and ran in debt for one-half the purchase price and for teams and tools to stock it. His neighbor said, "It was too bad, for he would lose all his hard-earned money invested in the farm." When he moved to the farm his neighbors watched him. He first made a small barnyard. His cows were kept there nights, and the first thing in the morning, with a shovel, he gathered the droppings and put them on the compost heap. His neighbors said, "Well, that is all we want to see. If he is to pay for that farm he must grow crops and sell them, and not bother around in that way." It was a bother to this man to collect those droppings; then he must bother to take them to the field and scatter them; and his bother did not cease there, for, other things being equal, from the first year that man moved upon the farm he has been bothered with harvesting a larger corn crop, a larger wheat crop and a larger bean crop; and to-day he is bothered with a first-class farm, has educated his children and has money in the bank. He succeeded.

Another man, not far away, has his farm given to him. He did not believe in bothering. No manure was ever collected unless it had to be to get it out of the way. At one time it looked to him to be cheaper to move the barn than to move the manure, so he moved the barn. He did not believe in being bothered. Nature helped him. Other things being equal, he was bothered a little less each year, and his crops were light, and he did not have to bother so much to harvest them. To-day he is not bothered at all with a farm. The mortgage took it and he moved away. There were two systems of farm management. The one system led to success; the other to failure.

Some of you will argue that I have told you nothing new, and I think this is true. I did not come to Massachusetts with the idea of telling you a lot of new things, but I did hope that from our reasoning together we might all return to our homes and farms with a little renewed incentive and inspiration to do our farm work better. It is not so necessary for farmers to know a lot of new things, but to do as well as they already know. I asked a minister once if he called his congregation together every Sunday morning to tell them a new story about the Christ child, born in a manger, who lived to be an example to men, and who died upon the place of skulls. He replied, "Oh, no, they have heard that story until it is an old story; but did I not call them together, and from that personal contact and interchange of thought did they not get something of an incentive and inspiration to follow the example of that Man who died that we all might live, His influence would drop backward and backward in their lives, and He would have died in vain." What all men need is more encouragement to do, and do well.

Let me advise you here to diligently study to know best how to do, and then to determine to do your best. Do this, and then stick to your farm and to your farm work, for, as the poet said, —

'Tis a coward who quits a misfortune,
'Tis the knave who changes each day.
'Tis the fool who wins half the battle
Then throws all his chances away.

The time to succeed is when others,
Discouraged, show traces of tire.
The battle is won in the home stretch,
And won 'twixt the flag and the wire.

Mr. Wilfrid Wheeler. I would like to ask if the speaker puts his manure onto the land as soon as it is made?

Mr. Hull. We have a covered barnyard, with a cement floor, and two or three times a week the manure is hauled out to the fields. Sometimes in the winter, when the weather is bad, the manure may remain in the barnyard for two weeks or more, but practically it is carried to the fields as soon as it is made. It will never be any more valuable than it is then, and that is the time to apply it.

Mr. E. W. Payne. Suppose the ground is frozen, and you have a side hill, with a brook flowing below it.

Mr. Hull. In that case I should not put the manure there. You will not lose as much as you would think, but still you will lose something. Put it on your more level land, where there is something growing. A covered barnyard is a fine thing. You can use it for exercising your young stock, which will be perfectly comfortable there, and nothing will be lost, on account of the cement floor.

Mr. H. M. Burt. What about the barn cellar? Many of us have barns built on side hills, with good cellars underneath, and with cement bottoms, and the manure stays there all winter.

Mr. Hull. In keeping cows and producing milk I should not want the manure under the barn until spring, as some gases must certainly rise, and it cannot make a healthful place for cows to dwell. It is just as cheap to have a covered manure pit outside, and everything sweet and clean underneath. If you have a good basement to your barn I should advise you to use it for something else, and put your manure somewhere else.

Secretary Ellsworth. I would say for the benefit of the speaker that these barns were built a number of years ago, on what was then thought to be the best principle. The manure cellars are almost invariably open on one side, and are used for storage for farm machinery, and for many purposes besides the storage of manure. They are almost all ventilated. It costs a great deal to build here in New England. Lumber and labor are both high. The people who have these barns are keeping healthful herds and making good milk, and should not be compelled to discard their buildings and build anew, even though they are not according to the latest ideas of the doctors and scientists. We cannot be sure just what their ideas will be after we have made the change.

Mr. Hull. Yes, I have seen that; I have seen farmers keeping their hogs in such a basement; and though perhaps they had a right to keep their barns in that way they certainly could not afford to keep hogs in that way. They were losing the interest on their investments. A man who has such a basement can do very well by closing it up, putting in windows, a cement floor and the King system of ventilation, and using it for a cow stable. He can then take out the old stable and use all above the basement for storage. One reason why we do not have more progress in these matters is that city boards of health have spasms of inspection, and send men out to inspect who are totally unqualified to pass upon what they see. These men make all kinds of foolish suggestions and requirements, and ask too much at a time, — more than the farmer can reasonably be expected to do. If they would ask him to take one step at a time, and send out men who knew what they were talking about, I believe that our farmers would be ready to take hold and work with them to better conditions. The city man has his side of it, too, and is certainly entitled to have good clean milk for his children.

The CHAIRMAN. I am a milk producer, and many of us think that there is another side to this question, that the consumers do not take the care of the milk they should after receiving it, but are always willing to throw the blame on the producer.

Mr. GEORGE W. TRULL. I would like to ask the morning speaker how large a quantity of milk is a cubic centimeter, and how the bacteriologists manage to count as high a number of bacteria in that quantity as they tell us about.

Professor WASHBURN. A cubic centimeter is about 15 drops, say half a teaspoonful. The bacteriologist mixes the milk very carefully, so that every portion is like every other portion, draws out one cubic centimeter, and puts it into a thousand times that quantity of pure water, which has previously been boiled, to make it sterile. Then he mixes that thoroughly, takes one measure of it, and puts it into a thousand times more pure water. This he mixes thoroughly again, takes out one measure of it, and places that in a beaker dish, in which there is a jelly-like substance, in which the germs can grow. In forty-eight hours there will be some spots on the jelly, each one being a cluster of bacteria, which grew from a single bacteria in the mixture. Count these spots with the naked eye and multiply that by the times diluted, and you can approximate it. We cannot get it exactly right, but we can tell the difference between 1,000 and 20,000 and between 20,000 and 50,000.

Mr. TRULL. Is any milk produced absolutely without bacteria?

Professor WASHBURN. It is practically impossible to draw milk that will not have germs in it, because there are germs living in the udder and staying there from day to day.

In the evening a reception was tendered to the State Board of Agriculture and others attending the meeting by the Northampton Board of Trade, at The Draper. There was informal speaking by members of the Northampton Board of Trade, the State Board of Agriculture and others, singing by the quartette of the Massachusetts Agricultural Glee Club, and Mr. W. A. Harlow rendered an interesting selection in praise of the Morgan horse. The occasion was thoroughly enjoyed by all participating.

Third Day.

Secretary Ellsworth. It is my pleasure to introduce to you Mr. W. A. Harlow of the Hillside Agricultural Society, who will preside this morning.

Mr. Harlow. While the audience is materially reduced this morning, the attendances which we have had have been a source of great pleasure to the Board, and have spoken much for the loyalty of the people of this vicinity to the Board and to Secretary Ellsworth, as well as for the work of Mr. Newkirk in preparation for the meetings. The subject this morning does not interest many of us who come from other sections of the State, but I can well understand that it is vital to most of those who are here, even more so than the subject of cows is to the dairyman. I take pleasure in introducing Dr. W. W. Garner, physiologist in charge of tobacco investigations, Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

HARVESTING AND CURING CIGAR WRAPPER TOBACCO.

BY DR. W. W. GARNER, BUREAU OF PLANT INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE.

Tobacco affords one of the rare instances among our important farm crops where yield is usually secondary to quality, and there are few, if any, other crops the values of which are so dependent on the painstaking care, skill and good judgment of the producer. Of the various factors entering into the successful production of a superior quality of tobacco, none is more important than the proper management of the curing process; but, unfortunately, this process is also the feature which is least understood, either from the scientific or the practical standpoint.

Because of the increasing interest in the method of harvesting tobacco by picking the leaves, which introduces new problems in curing, it would seem that this subject is worthy of special study, both by the scientific investigator and by the practical grower, and I shall endeavor briefly to outline some of the important factors in successful curing, and to draw some comparisons between the methods of curing on the stalk and curing the picked leaves.

What is Curing?

We have to consider at the outset the question of what curing really means. The leaf at the time of harvesting contains a large amount of water, but it is evident that the curing is something more than mere drying, for a leaf dried out rapidly by heat has few of the desirable properties of a well-cured leaf. Again, a leaf dried under the right conditions for curing weighs much less than would the same leaf if dried out quickly. Curing, therefore, means the development of certain properties or qualities which the green leaf does not possess, and also a loss in weight in the dry leaf in addition to the loss of water.

In order to understand something of the changes which take place in curing, it is necessary to consider for a moment the plant as it matures and ripens in the field. The leaf may be considered the factory in which is manufactured from the raw materials absorbed from the air and soil the food supply which enables the plant to grow, to "ripen," as we say, and to produce seed. The energy to operate this factory, so to speak, comes from the sunlight, and during the day, especially on sunshiny days, the food supply accumulates in the leaf. During the night, however, the building up of food stops, and the accumulated food supply, excepting of course such as is required for the leaf itself, is carried away to other parts of the plant, such as the very young parts and the seed head. This explains why topping and suckering cause the leaf to spread and to take on more body, for, the seed head and suckers being removed, the food materials collect in the leaf in greater quantity. One important feature of ripening, therefore, is the accumulation in the leaf of certain food materials which it has built up. These materials are chiefly of a starchy nature, and tend to make the leaf brittle and more or less woody or strawy. We must remember, moreover, that plants must breathe or respire the same as do animals, and this breathing or respiration process also uses up a large portion of the food supply. The two uses of the food supply built up by the leaf are, accordingly, to promote growth and to maintain the breathing or vital processes of the plant.

We have seen that the leaves of the plant when ready for harvesting have accumulated an excess or reserve food supply, chiefly of a starchy nature, which gives to the ripe leaf its characteristic properties. We are now in a position to consider what happens in the curing barn. It has already been stated that a leaf quickly dried out does not show the properties of cured tobacco, and it is impossible to cure such a leaf. Again, if a green leaf be exposed to chloroform vapors for a short while, which quickly kills it, the leaf can never be cured successfully. The same is true of a bruised leaf, and we are brought at once to the very important fact that *curing is a living or vital process, and that leaves prematurely killed cannot be successfully cured.* The changes taking place in the leaf in the barn are strictly analogous to those occurring in the growing plant in the field. The leaves, of course, cease to grow, but the breathing or respiration process continues until they die from starvation or lack of water. Cut off from their supply of raw material, they cannot continue to manufacture additional food to maintain the vital processes. They use up the reserve supply stored up during the ripening period in precisely the same manner as an animal may live for many days without food, though losing in weight, because the reserve food supply in the tissues it utilized in maintaining life. In brief, therefore, curing is a vital or living process, whereby certain constituents of the leaf, such as starch, which tend to make it brittle and chaffy, are broken up, and certain other desirable constituents, such as the so-called "gum," are correspondingly increased in amount. Along with these changes in composition the color changes from green to yellow, and this shows that the leaf has reached the dying stage. As soon as the leaf is dead, the brown color quickly appears, and though there are some further changes after the leaf dies, these can take place at almost any stage while the tobacco is in bulk or during the sweating and aging.

The Most Favorable Conditions for Curing.

The important fact to keep in mind here is that the leaf must be kept alive till the first stage of the curing is completed, *i.e.*, until the yellowing begins, and this brings us to the question of the most favorable conditions for curing. The first change to be noticed in the leaf is wilting, caused by the loss of water. This wilting hastens the curing, and is desirable, provided it does not go too far. Rapid drying kills the leaf before there is time for the changes already discussed to take place, and the result is that the tobacco "hays down." Gradual and not rapid drying is, therefore, one of the favorable conditions for curing. The leaf is also killed by extremes of temperature, so that artificial heat, if used at all, must be applied with caution, and the temperature should not be allowed to exceed 110° F. at most. The green leaf is killed at freezing temperatures and the curing process is practically stopped at temperatures below 50° F. The proper conditions of temperature and moisture are the principal requirements for good curing. All growers in this section know how injurious the cold northwest winds are to tobacco in the curing barn, and this is because the temperature drops too low for good curing, and, also, the water is evaporated from the tobacco too rapidly. The leaf dries out but does not cure.

Pole Sweat.

The importance of not allowing tobacco to dry out too rapidly during the yellowing period has been emphasized, but, on the other hand, growers well know what happens in prolonged periods of warm wet weather if the tobacco has already yellowed. The disease known as pole sweat is merely a decay of the dead leaf, and is caused by lower organisms, so-called "germs," which find in the leaf their food supply. Like the tobacco plant itself, these organisms, which are really minute plants, must have an abundance of moisture to grow rapidly, and they flourish only within certain limits of temperature. Our experiments have shown that pole sweat becomes serious when the relative humidity of the air between the curing leaves reaches 90 per cent or more, causing them to become soggy, and when the temperature lies between 60° and 100° F. After the disease has gained a foothold, a much lower humidity or greater extremes of temperature are required to check it promptly. It is important to remember, however, that pole sweat does not set in till the first and principal stage of the curing has been completed, which is ordinarily indicated by the yellowing of the leaf, for only the dead portions of the leaf are attacked. One of the common forerunners of pole sweat is the so-called " strut " of the leaf, which is a stiffening of the veins and midrib, caused by the excessive moisture in the air having checked the evaporation from the leaf. The strut or stiffening indicates danger from sweat, but really does not play any part in the development of the disease, although it does injure the tobacco. It is simply a sign of too much moisture.

Successful curing requires certain conditions of temperature and moisture to enable the leaf to actually cure instead of simply drying out, on the one hand, and to prevent loss by pole sweat, on the other hand. The practical question is as to how these conditions can be maintained in the barn independently of the outside weather.

Use of Artificial Heat.

The natural temperatures prevailing during the curing season are never too high for good curing, and of course they are never so high as to prevent pole sweat. On the other hand, it often happens that it is too cold for satisfactory curing, especially at nights and when the crop is harvested late, so that even if the pole sweat is temporarily checked the tobacco may be spoiled by haying down. Artificial heat is, therefore, the only means of securing at all times the right temperature. The moisture required for good curing is contained in the tobacco itself, and if the outside weather is favorable, the rate of drying can usually be controlled by ventilation. If the temperature is favorable but the air too dry, the remedy is to close the barn tightly, so as to hold the right amount of moisture in the air within. In case of long periods of rain, fog or muggy weather, ventilation alone cannot be of any benefit. The tobacco will rot if it has reached the critical stage, whether the barn be kept open or closed. The only means of reducing the moisture in the barn is by using artificial heat combined with ventilation. In the first stage of the curing, before the leaf begins to yellow, there is no danger from pole sweat, but if the outside temperature is below 50°, sufficient heat is needed to prevent the tobacco from becoming chilled; otherwise it will hay down. Unless the outside weather is very damp, little or no ventilation is needed. The tobacco in this stage will not give off its moisture any faster than it is removed from the surrounding air. After the leaf has yellowed, however, the moisture comes to the surface, whether or not it is taken up by the air, so that the tobacco soon becomes soggy. The only practical means of drying the air in the barn is by heating it, and the only way of keeping it dry is to replace it by freshly heated air from the outside as soon as it becomes too moist. In other words, the air must be heated before it comes in contact with the tobacco, and it must be removed as soon as it becomes moist.

If we raise the temperature 20°, we double the capacity for holding moisture, and if the temperature in the barn can be kept 15° to 20° higher than that of the outside air, with a reasonable amount of ventilation, there is no danger of pole sweat, no matter how wet the outside weather may be. Warm air is, of course, lighter than cold air, and, surprising as it may seem, moist air is lighter than dry air at the same temperature. For these reasons the natural course is to admit the outside air at the bottom of the barn, heat it to the proper temperature and allow it to move upward through the tobacco. Sufficient heat must be applied to drive the air through the tobacco fast enough to prevent its becoming chilled, otherwise it will stagnate before reaching the top of the barn. Too little heat is worse than none, for it simply drives the moisture from the lower into the upper portions of the tobacco. It is also necessary to provide some means of escape for the warm moist air when it reaches the top of the barn. If the roof is not tight there may be sufficient natural ventilation, but with a very tight roof, a ventilator is needed along the peak of the building.

The next question is as to the best means of applying the heat. Open charcoal fires have been used to some extent and with success, but the method is laborious and expensive. For best results the heat must be well distributed, so that a large number of small fires is better than a few larger ones. The charcoal burns out rapidly, so that the fires require close attention. We have been endeavoring for the past three or four years to work out a simple and cheap method of heating based on the use of flues and heaters or furnaces, using wood as fuel, and I feel confident that we will soon be able to announce a satisfactory process. A system of this kind will insure a more even distribution of the heat, and the amount of heat can be more easily controlled. I believe that artificial heat will be used more and more as its advantages are more fully recognized, especially in curing picked tobacco.

Harvesting by Cutting the Plant versus Picking the Leaves.

This brings us to the last topic for discussion, a comparison of the methods of harvesting and curing by cutting the plant and by picking the leaves. We will not attempt to discuss at this time the economic phases of the question, such as the relative cost of the two methods and the labor supply, but will consider briefly the merits of the two processes as regards yield and the quality of the cured leaf. There is no doubt that it costs more to harvest by picking the leaves, and the important question is whether the increased value of the crop is sufficient to justify the use of the method.

We have found by careful tests that a leaf cured by picking will weigh 10 to 15 per cent more than when cured on the stalk. There is no doubt of this fact, and the reason is easily explained. It has already been pointed out that while the plant is growing in the field a portion of the food supply manufactured in the leaf is carried into the stalk to feed other portions of the plant, and exactly the same thing happens in the curing barn. Every grower knows that while the leaves of the cut plant soon die and cure down, the stalk remains green for weeks and even months. It is also a familiar fact that the young suckers on the plant may grow considerably in the barn. The stalk and suckers continue to live because they draw food from the dying leaves. I have often heard expressed the opinion that the leaf draws from the stalk, but this would be a case of the dead feeding on the living, which is not nature's way of proceeding. It has also been found that if suckers are allowed to remain on the stalk when harvested, the cured leaf will be lighter than when they are removed, and this is because the suckers draw food from the mature leaves through the stalk. We see, then, that there is a clear gain of 10 or 15 per cent in cured weight when tobacco is picked, and this means, of course, that the leaf has more body. This may or may not be desirable, depending on the condition of the tobacco when harvested; and, in my opinion, picking will give better results with what may be called a wet-weather crop than one grown during a dry season. If tobacco grown in a dry year is picked, it may be too heavy when cured. This is one reason why picking gives good results with shade-grown tobacco, for the leaf is naturally thin, and curing on the stalk might give a product without sufficient body.

As regards quality, there is no doubt but that picked tobacco cures down with different properties from that cured on the stalk, and it is for the trade to say whether the leaf is better suited to their needs. In general appearance the picked tobacco as it comes from the barn is less attractive than when stalk cured. It undoubtedly has more of the so-called "gum," giving it greater elasticity, while the grain is generally not so prominent. The most important remaining difference is in the colors obtained. These are usually of a duller cast, containing a greater proportion of green thus somewhat resembling Cuban tobacco. The value of a tobacco crop depends not only on the total weight obtained and the quality of the different grades, but also on the percentage of first-class wrappers, and there is no doubt but that picking yields a larger percentage of wrappers than stalk curing. Again, the actual number of cured leaves obtained by picking is increased in addition to the increase in body, and, in fact, our experiments with broadleaf during the past season indicate that the total increase in cured weight under practical working conditions amounts to about 20 per cent.

As to the curing of picked tobacco, the process is of course much more rapid than is stalk curing, and, consequently, less complete. The leaf proper cures quickly, though the stem remains green for a considerably longer time. If picked tobacco is to be valued more highly by the trade, it will probably be due to the increased amount of gum and elasticity and to the colors obtained. The question of the effect of artificial heat on the colors of picked tobacco is one of great importance, and I am of the opinion that heat properly applied will give more desirable colors. As regards pole sweat, while the period of danger is shorter, we have found that picked tobacco will sweat more readily than that cured on the stalk, so that it must be closely watched, even if the weather does not indicate danger from this cause. Judging from our experience this past season, it is doubtful whether picked broadleaf can be cured successfully without artificial heat. However, the whole subject of curing picked tobacco (except shade grown) is still largely in the experimental stage, and much yet remains to be done before final conclusions can be drawn.

Summary.

Now, to summarize very briefly, I would divide the curing process into two stages; the first, which is by far the more important, including those changes occurring before the leaf dies; the second, the further changes taking place after the leaf is dead.

In the first stage, under favorable conditions, the leaf undergoes a slow process of starvation, which is absolutely necessary for good curing. Care should be taken that the leaf is not killed by too rapid drying before the process is complete. The tobacco should be allowed to dry out gradually, and the rate of drying can be controlled by regulating the ventilation, except in very wet weather, when artificial heat is also required. Again, the temperature in the barn should not go much below 50° F., for under these conditions the tobacco simply dries out without curing. The use of artificial heat is the only means of keeping the right temperature in the barn in cold weather. If the leaf is prematurely killed in the first stage by haying down, no amount of sweating or fermenting can fully correct the damage.

The change from the first to the second stage of curing, which is the point at which the leaf dies, is indicated by the yellowing of the leaf. There is less danger from too rapid drying of the tobacco in the second stage. On the other hand, the principal danger after the yellowing of the tobacco is from pole sweat, caused by too much moisture. The only means of controlling pole sweat is by the use of artificial heat combined with ventilation.

Comparing the methods of harvesting by picking the leaves and by cutting the stalk, the picked leaves after curing are 10 to 15 per cent heavier than when cured on the stalk. They have more body and more of the so-called "gum" and elasticity. The colors of the picked leaves are usually not so clear as when cured on the stalk, and they show more of a greenish cast.

Mr. George P. Smith. Would you apply heat during the first stage of the curing?

Dr. Garner. The matter of applying artificial heat is not entirely settled, and should be tried out very carefully, but in the first stage there is no danger from pole sweat, as there is no danger of the leaves not drying out fast enough, and there is, therefore, not much use for heat, unless the weather is cold. In the first stage it is the temperature that is important, and in the second stage the humidity; and as excessive humidity is the cause of pole sweat, artificial heat is, therefore, the remedy for that trouble. If there should be a cold night during the first stage of curing it would be well to have just enough heat in the barn to keep the chill from the tobacco, to prevent the temperature falling much below 50° F. Do not allow the curing to be checked by too rapid drying or by too low a temperature. If the weather is wet we need both heat and ventilation in the first stage. In the second stage the important point is to dry the leaf, and it cannot well be dried too rapidly. This is contrary to the views held by many, but if the first stage is passed through successfully, you can make good any shortage in the second stage by regulating the fermentation. Take a leaf of green tobacco, put it in a hot oven and leave it for five minutes and it will never cure, but will be in exactly the same condition after it has been hanging six months.

Mr. Smith. About how long does the first stage take?

Dr. Garner. That depends a good deal on conditions, because curing is regulated a good deal by the rate at which the drying proceeds, and more especially by the temperature. Tobacco will cure very rapidly if the temperature is 80° F. or above, but if it remains between 50° and 60° F. the curing is very slow. Under favorable conditions the essential changes in the first stage can take place in from three to five days. After that period no injury is done by too rapid drying.

Mr. Thaddeus Graves. The ordinary practice has been to cut off all ventilation and apply artificial heat for the purpose of drying the air, the feeling being that it was an endless task to dry all the air that could come in from outside. Do I understand that you advise ventilation as well as heat in moist weather?

Dr. GARNER. Yes, for the reason that the object is not to dry the air but to increase its capacity to take up moisture from the tobacco. Suppose the temperature is 60° F., and it is raining outside. The atmosphere will take up no more moisture, as it is saturated. But if we heat the air in the barn to 80° F. it will take up twice the moisture that it will at 60°, because each increase of 20° in temperature doubles the capacity of the air for holding moisture. Then, if you let in damp air from outside it becomes heated and takes up more moisture. On the other hand, there is danger in applying heat and keeping the barn closed if the weather is wet outside, as you simply stimulate the tobacco to give off more moisture in the barn and do not remove the moisture. You must make a distinction between drying and curing tobacco. It must not dry too rapidly, but let it cure as rapidly as it will.

Mr. H. J. SEARLE. I would like to inquire what apparatus there is that gives any promise of being of advantage to the ordinary tobacco grower. We understand that open charcoal fires in the ground are undesirable, also steam heat.

Dr. GARNER. We are experimenting with a system of flues and furnaces which we hope to be able to announce definitely, in a short time, as a successful method. The furnace is very simple, a home-made furnace, simply a hole in the ground, with an ordinary cover and a flue leading out from it. We use wood as fuel. We are using a double vent once across the barn and return. Each pipe runs out doors, and we have a furnace for each vent. It may be that after further experiment we will find that we can get along with a single vent, or can run several of them into a central exit flue. There are a good many things about this system of which we are not certain as yet.

Mr. GRAVES. If the roof has no ventilator and you put heat in the bottom of the barn that will drive the damp air to the top, is it possible to heat that damp air?

Dr. GARNER. With a loosely shingled roof there will be a good many crevices through which the air can escape, thus making natural ventilation, but if you have a very tight roof, such as a tarred paper roof, you must have a ventilator at the top. Heat alone is of no benefit in moist weather, because the moist air must be allowed to escape. While the increase in temperature enables the air to take up more moisture it cannot continue to do that forever, but soon becomes saturated at the higher temperature.

Mr. Searle. Does not any kind of heat, open or closed, help when tobacco is puffing and preparing to sweat? I have used large stoves open at the top, with drafts on each side at the bottom, and a large sheet-iron cover to prevent the direct heat coming in contact with the tobacco over the stove. If the heat is too strong I dig a hole and let the stove down as low as I want it.

Dr. Garner. I should recommend the use of heat when pole sweat is threatened. The man who sits down and allows his tobacco to rot under such conditions is doing exactly the same thing as if he allowed his crop to spoil in the field. Until we develop a better system use charcoal.

Mr. Searle. How would coke do?

Dr. Garner. I cannot recommend coke because it has a great deal of sulphur in it. While burning, the sulphuric acid will be given off and will be likely to bleach the tobacco and ruin it, when an open fireplace on the floor is used. If used in a furnace, so that the gas will be carried off, this objection will not apply.

Mr. Lyman Crafts. I would like to ask if there are not conditions possible in the second stage of curing when the application of heat would do more harm than good? Suppose the air outside is thoroughly saturated with water for a considerable period, and the temperature is down to 40° or 50° F., would not the application of heat without ventilation cause the tobacco to throw off much more moisture than it would without heat, and would not that do more harm than good?

Dr. Garner. You have brought out an excellent point. We must guard against low temperature, as I have said, in the first stage of curing, but we know that low temperature will stop pole sweat, and if the temperature in the second stage is anywhere from 40° F. down to freezing, I think it would be wiser not to apply heat. By applying heat then you will simply favor the pole sweating.

Mr. Graves. Do I understand that a leaf taken from the stalk cures with more weight than where cured on the stalk; and if so, how do you account for it?

Dr. Garner. It unquestionably does have more weight, as has been proved by repeated experiments. In the field tobacco takes up its raw food material from the soil and the air, and this raw material is worked over for the use of the plant in the leaf. This goes on only when the sun shines, and at night the food material is carried out of the leaf and into the stalk and the roots, to feed the other parts of the plant. When a green tobacco plant is hung in the shed there are always young suckers on the plant. Exactly the same process goes on in curing in the barn as in the field; the food material is carried away from the leaf into the stalk to feed these suckers. You have noticed that they grow in the barn and that is where they have gotten their food. Consequently, the leaf weighs less when cured than if not subjected to this drain. Many have the idea that the course is just the opposite, — that the leaf draws from the stalk, — but that would be contrary to nature, as it would be a case of a dead thing feeding on a living thing, which cannot happen. The leaf dies very quickly, but the stalk will remain green for two months, and during that time is drawing its food supply from the leaf, or it would also die. In Virginia they sometimes pick the leaf from the stalk and sometimes harvest by cutting the stalk. When they follow the latter method they split the entire stalk open, leaving only two or three inches at the lower end to set astride a stick, and the stalk lives only a very little longer than the leaf.

Mr. Graves. I know by observation and experience that your position is correct. If it increases the weight 10 or 15 per cent, and the picked tobacco is worth something like 50 or 60 cents a pound, would not the difference in weight pay for the extra cost of harvesting?

Dr. Garner. It is entirely possible that you would get the same price for the picked tobacco that you did for that cured on the stalk. Whether the increased weight would pay for the increased cost of harvesting would depend largely on the price received. The increased weight might not mean better tobacco. If we have a thick, heavy tobacco, a dry-weather crop, I do not think curing by picking would be a good thing, as we would be likely to get a leaf that would be too heavy.

Mr. Graves. As the tobacco plant commences to ripen from the bottom up, and as the bottom leaves, which are very good if picked at the proper time, have deteriorated a great deal by the time the rest of the plant is ripe, is that not an additional reason for picking?

Dr. Garner. Yes, we get more leaves in picking, as well as an increase of from 10 to 15 per cent in weight in the particular leaves. In our experiments last year we probably got a total increase of 20 per cent in the weight of the crop picked, for these reasons.

Mr. Parmenter. Is not the process of spearing tobacco and hanging it on laths to be preferred to hanging it with twine?

Dr. Garner. It is a step in the right direction, but whether it is important from a practical standpoint I cannot say. The best plan is to split the stalk, according to the Virginia method, but that you cannot do here, because you have too many leaves on the stalk. There they have only eight or ten leaves, and the experienced workers split the stalk very rapidly and rarely injure a leaf. That would not be possible with your plants.

Mr. Searle. How are we to know when the leaves are ready to pick?

Dr. Garner. That is something for which no hard and fast rule can be laid down, but it must be determined by each grower for each particular crop. It is something that will come with experience. In picking we pick the particular leaves at just the time when they are most valuable, and it is necessary to make several pickings. We are carrying on experiments as to the proper time of picking, but cannot as yet make any definite statement.

Mr. Smith. To what extent would it be practical to introduce irrigation to get over the trouble of the dry-weather crop curing darker and being of less value than that of a normal season?

Dr. GARNER. It is true that the dry-weather crop is less valuable than that grown in a comparatively wet season. All plants grow thicker leaves when the season is dry than when it is normal or wetter than usual. It is easy, therefore, to get a tobacco leaf that is too thick and too heavy. Something can be done in curing to correct this, but the trouble cannot be entirely overcome in that way. I think that the cost of irrigation would be too great a burden on the value of the crop. If a plant were needed every year you could afford it, but you might have wet seasons for three years after installing the plant, and it would be lying idle and undergoing deterioration, without being of use.

Mr. PARMENTER. Taking into consideration the increase in weight, the saving of the bottom leaves and the decreased liability to pole sweat, is it not settled that the correct way to harvest tobacco is to pick it?

Dr. GARNER. Theoretically, I should not hesitate to say that tobacco should be picked; practically, it would depend on labor supply and those things that come into the question of the increased cost.

Mr. GRAVES. The common theory is that the lower leaves should be picked the day after topping, but I have seen the lower leaves double in size after the tops have been broken off.

Dr. GARNER. It does not necessarily follow that they should be doubled in size. If we are going to gain in weight at expense of quality, it is a doubtful proposition. I am not so sure but that sometimes the first picking should be made before the plants are topped; at other times it might properly wait for some days. In shade-grown tobacco not topping at all has been extensively practiced, and with success.

Mr. CRAFTS. I have seen tobacco where the lower leaves were well matured at the time of topping, and at other times they have been hardly large enough to be of any use. With favorable weather after topping they increased in size and also made leaves of a very desirable quality. In the first case they had not the size that would appeal to the buyer, and I doubt very much whether they had the quality before they had the growth.

Dr. Garner. As in curing, there is always room for a great deal of judgment. In curing, you cannot say that just so much heat must be applied every year and just so much ventilation. The best we can do is to deal with the implements used, and each one must make such use of them as to get the best results possible from his particular crop.

Mr. Arthur Hubbard. Would you advise top suckering?

Dr. Garner. Theoretically it is desirable to leave the top suckers. These suckers are not large enough to in any way injure the bottom leaves, which are picked before the suckers reach any considerable size. As a rule the top leaves are too thick. The suckers tend to give a thinner leaf; smaller, lighter and nearer being ripe. I have seen some striking illustrations where the suckers were removed from each alternate row. Where they were removed the top leaves were probably half as large again as where the suckers were not removed. I do not think there is any gain in that. There is no use growing a large filler leaf when you can grow a smaller wrapper leaf.

The Chairman. We would like to hear from Mr. Whitmore.

Mr. F. L. Whitmore. I have been thinking how very confusing this must all be to a man who has never raised tobacco. In thirty years I have never had trouble with pole sweat except once. In the last two years we have had a deficiency of 24 inches in the rainfall, and I suffer more from that cause than from too much water. I have been conducting some experiments under the direction of the United States Department of Agriculture. Some of the tobacco in these experiments is picked and some harvested in the plant; some is cured by the old process and some by artificial heat. It is a very fussy business, but it has also been extremely interesting and instructive. I hope that the government will eventually have some important results from these experiments. However, there are so many climatic and other conditions to contend with which we cannot control, that what is good management one year may not be the next. Finally, when we get the crop grown it may not suit the buyers. This year they all want 26 inches of dark, leather-like substance, and I cannot supply that for them.

The CHAIRMAN. We would like to hear from Mr. Russell.

Mr. H. C. RUSSELL. We have had more or less trouble lately with white mold on the stems when the tobacco was going through fermentation. I would like to ask the speaker if he can account for this trouble.

Dr. GARNER. There are two points worth considering. One is that these molds flourish only in the presence of considerable moisture. If the stem is apparently moist there is danger from mold. Molds cannot go above a certain temperature. Our experience is that if the tobacco heats up properly there is not much danger from mold, but that if it refuses to heat up the molds will develop, because there is not sufficient heat generated to kill them. If the tobacco is high cased, with special reference to the stems, there is danger from molds. On the other hand, even with a reasonable amount of moisture there remains some danger of molds if the temperature is not high enough.

Mr. RUSSELL. Is it possible to ferment a crop of tobacco successfully that grew in a dry season, and has a thick leaf that lacks life or quality?

Dr. GARNER. I do not think so. We can do something in the curing, but of course we cannot make a wet-weather crop out of a dry-weather crop by any means of curing or fermenting. The curing is the more important in correcting these difficulties. The trouble in the sweating is that the tobacco has not the proper material in it to ferment. The conditions under which it has been produced are not right, and therefore the material that induces fermentation and produces heat, bringing about the changes we desire, is deficient in the leaf.

Mr. RUSSELL. The whole question of these fads and fancies about the leaf of tobacco is brought about more by the whimsical notions of cigar smokers than anything else. Fifty years ago the buyers would pay about 6 cents a pound for the tobacco, and did not care much whether it was dark or light. We sold our crops easily enough, though we did not get a very big price for them. We had no trouble then about mold, or any of these questions that have come up recently. Now, we tobacco growers want a better price for our crops, and the smokers want just what they fancy in the wrapper, and will take the cigar that suits them in color and appearance, regardless of what is inside it. So we must keep on studying and trying to find something that the trade wants.

Mr. Whitmore. I am having trouble with root rot for the first time. I have been advised to sterilize the seed beds. Is it a safe proposition to depend on the old seed beds when sterilized, or should I seek a new location?

Dr. Garner. The trouble can be controlled for the time being by sterilization, without changing the seed beds. Whether they should be sterilized every year we do not know. It would certainly be safer to sterilize every year. The work must be done thoroughly. Use plenty of time and plenty of steam. The little organisms that cause root rot are simply little plants which can be killed by heat the same as a tobacco plant would be. If we take a fresh potato and bury it from three to six inches deep in the seed bed, and after sterilization find that the potato is cooked, we are pretty safe in saying that the minute organisms have been killed also. Perhaps more heat is required to kill the minute organisms than to cook the potato, because we must kill the spores which reproduce these organisms as well as the organisms themselves. You must use steam under high pressure, and give plenty of time for the soil to be heated deep enough to reach them. The apparatus used is very simple; an inverted metal pan, made the width of the seed bed and the other dimensions regulated by the size of the boiler you have to work with. The sharp edges of the pan are driven into the soil to a reasonable depth to hold the steam in, the steam turned on under high pressure, at least 90 pounds, and the heating continued for not less than thirty minutes, preferably an hour. It is also a good plan to have burlap or some other covering to lay over the portion that has been heated when the pan is removed to the next portion, to hold the heat in the ground as long as possible.

Mr. Searle. I have sterilized my seed bed for two years and have done considerable work for my neighbors. It is very simple if you have the steam. I use a wooden box, 6 by 10 feet, and find that it is just as satisfactory as a metal one, though of course it is more difficult to handle. An additional advantage in sterilization is that it kills the weed seeds. One of my neighbors had a fine seed bed which he had neglected, so that it had become so weedy that it was practically ruined. We sterilized it for him, and where he had had no plants for the two previous years, this year he had oceans of plants and no weeds, and sold enough plants to pay for the sterilization twice over.

Mr. Wm. B. Avery. Before the meeting closes I wish to move a formal vote of thanks to the Hampshire, Franklin and Hampden Agricultural Society, to the People's Institute of Northampton and to our associate on the Board, Mr. F. P. Newkirk, for what has been done to make our stay here so pleasant and profitable.

Secretary Ellsworth. I am glad to second the motion, and wish to express particularly our appreciation for what Mr. Newkirk has done for the success of the meeting. He has been untiring in his activities to make this meeting a success, and has watched over us every moment. I would also add to the motion our thanks to the Board of Trade of Northampton, and to the quartette from the Massachusetts Agricultural College Glee Club, who have entertained us so pleasantly with their songs on the two evenings of our stay.

Mr. Whitmore. On behalf of those not members of the Board I would like to express our thanks to all who have been instrumental in giving us such an interesting and valuable series of lectures and discussions.

Carried unanimously. Meeting adjourned.

SUMMER FIELD MEETING

OF THE

BOARD OF AGRICULTURE

AT

AMHERST.

JUNE 23, 1910.

SUMMER FIELD MEETING OF THE BOARD, AT AMHERST.

The summer field meeting of the Board was held at the Massachusetts Agricultural College, at Amherst, on June 23, 1910. There was a good attendance at the meeting and a very interesting programme was carried out. In the morning the following demonstrations were given: demonstration of means and methods of spraying, by Prof. F. C. Sears, professor of pomology, Massachusetts Agricultural College; explanation of experiments in grass culture and alfalfa growing upon the experiment plots of the Massachusetts Agricultural Experiment Station, by Prof. Wm. P. Brooks, director of the station; demonstration of swine growing and management, by Prof. R. L. Gribben of the Division of Agriculture, Massachusetts Agricultural College.

Lunch was served in the college dining hall.

In the afternoon Prof. L. A. Clinton of the Connecticut Agricultural College delivered an address on corn growing and management, which appears on the pages immediately following.

At 4 o'clock P.M. a demonstration of the making of certified milk, as practiced on the college farm, under the direction of Farm Superintendent E. H. Forristall, concluded a programme which was at once one of the most interesting and one of the most instructive ever given at a summer field meeting of the Board.

CORN GROWING IN NEW ENGLAND.

BY PROF. L. A. CLINTON, DIRECTOR STORRS AGRICULTURAL EXPERIMENT STATION, EAGLEVILLE, CONN.

At the present time the corn crop in America leads all others, not only in its total value, but in the general interest and popular enthusiasm with reference to its growth. Nearly every experiment station has some line of work under way in connection with corn breeding or corn feeding, and boys' and girls' corn-growing clubs have become numerous. In the teaching of agriculture in the public schools, corn is one of the most valuable crops which can be studied. The reason for this general interest in the corn crop is not difficult to discern. There is no other crop which comes so near to being a general-purpose crop as corn. No other crop, over such a wide section of the country, can furnish the amount of food product per acre, few crops are so free from disease or insect pests, and but few crops are grown which are so generally successful as the corn crop.

While the total yield of corn for the United States is enormous, far exceeding in value that of any other one crop, yet the average yield of corn per acre for the United States and for every section of the United States is ridiculously small. To be sure, Connecticut leads in corn growing, as she does in most other things, — her yield of corn per acre in 1909 being greater than the yield in any other State, the enormous amount being 41 bushels per acre! Massachusetts was not far behind, but with the average yield per acre of 38 bushels, she has nothing to boast of. We desire, however, that those well-meaning public citizens who have become interested in agriculture, and are telling about the decadence of agriculture in New England, and her worn-out soils, shall take notice that New England raises more corn per acre than is raised by any other section of the United States. To be sure, the acreage is not so great in the New England States as in the great corn-growing States of the west, yet last year Connecticut raised 60,000 acres of corn; Massachusetts 47,000; and Connecticut, with her so-called worn-out soils, raised more corn per acre by 10 bushels than did Iowa; by 5 bushels than did Illinois; and by 1 bushel than did Indiana. I wish to call especial attention to this fact, for while we may have used more commercial fertilizer, and the cost of raising our corn crop was without doubt somewhat greater than the cost of raising corn in the middle west, yet New England agriculture is not a thing of the past, and we have never yet realized the full possibilities of the fertile New England hills. Averages are always low. When one man in Connecticut can raise 133⅓ bushels of shelled corn to the acre, and our average production for the State is only 41 bushels per acre, it means that the farmers of Connecticut are not fully awake to the possibilities of corn growing. Without any considerable increase in expenses, but with more attention to details, to adaptation of the crop to the soil, to the use of proper fertilizers and proper seed corn, the average yield per acre of corn in New England could be increased from 10 to 30 bushels; and this increase will come, not because the railroads of the country are going into farming, but because of the painstaking work of the individual farmer, and because in every community there will develop some farmer who will lead the way and show to the others how this increase can be brought about.

We all are interested in the practical means by which the average yield of corn may be increased. The subject of corn breeding has come to be almost a science during the past ten years, and yet in spite of all the agitation we have only held our own in the average yield per acre. For the past five years there has been a slight increase in the production per acre. We may possibly feel satisfied that we have been able to maintain the production of previous years, in spite of the fact that the agricultural lands have been depleted somewhat of their fertility, and yet it is rather disappointing to know that we have not made much progress in the matter of corn growing. Not every farmer can become an expert breeder of seed corn. This is the work for the specialist, the same as improving varieties of stock; but there is a place in every community for some man who will make a study of the needs of that community, of the type of corn which is best adapted to the locality, and who will produce the seed corn required by all the farmers in that locality.

We have learned that we can do with corn almost anything that we choose to do with it. By careful selection and breeding we may increase its percentage of oil, we may increase its percentage of protein or we may increase the starch content. If we desire a type of corn which will produce the ears high upon the stalk, it is possible, by selection, to secure this type. If we wish a type of corn free from suckers, we can, by selection, secure this type. One reason why corn breeding has not appealed more to the average farmer is the fact that in the market no distinction in price is made between corn of high or low protein content, but corn is sold simply as *corn*, at a certain price per bushel. So long as this is true, we cannot expect the general farmer to pay much attention to the development of corn in any certain direction. What he desires is a high yield of corn per acre, and upon this point should center the work of corn breeding. So long as the dairyman must sell his milk simply as milk, without any distinction being made as to the fat content or to the sanitary conditions under which the milk is produced, we must not expect great advancement in the dairy business. The case is somewhat different, however, with corn. The greatest market for the corn product is right at home on the farm where the corn is produced. Only about 20 per cent of the total yield of corn in the country is shipped out of the county in which it is grown. With the wheat crop nearly 60 per cent is shipped out of the county where grown. This means that the corn crop is the general crop for home consumption; that it is fed to the live stock on the farm, and that any increase in the percentage of protein or any valuable constituent which is found in corn will serve to reward the producer for his skill and care exercised in its production.

To what extent should the general farmer become a breeder of corn? We doubt very much whether it is wise for him to do much in the way of corn breeding. What he should do is to make such a careful study of corn and its conditions of growth that he shall be able to select that type of corn which most fully meets his needs. Having found out what this type is, he should then be able to recognize good seed corn, and to purchase that type of seed which will most fully meet his requirements. To become an expert corn breeder requires a greater amount of care, of skill and of attention to small details than the usual farmer is willing to give to the subject. If the farmer has a type of corn which seems well adapted to his needs, and he wishes to perpetuate and improve that type of corn, the most practical method of procedure for him lies in the selection of high-producing ears, which shall serve for the production of seed for his general crop. It is impossible to tell with certainty by the looks of an ear, by the perfection of the rows of kernels on the cob, by the space between rows and by the other fancy points which are used in corn judging, which ears possess the highest producing power. If, however, a man is a good judge of corn, he might select a ten-ear sample out of 100 bushels of ears which would win first prize at a corn show, and yet in producing power these ten ears might be far inferior to other exhibits which might be present. The breeder of dairy cattle has shown us a way of improving corn, and that is by what is known as the "advanced registry tests." A high price is not paid for the dairy cow because of her color, the length of her tail, the curve of her horns or the size of her milk well, but because of what she can do and what her ancestors have done. In other words, production or performance is the only and true test of actual merit, whether with dairy cows or with corn.

Prof. C. G. Williams of Ohio Agricultural Experiment Station has worked out the most reasonable and practical test of production, and his plan briefly is as follows: certain ears of corn will be selected and numbered, one-half of each ear will be shelled and carefully preserved, while the other half of each ear will be planted in test rows of one-half ear to the row. From these test rows records will be secured as to the individual merits of the ears tested. The shelled corn which was saved from the four or five best producing ears is then planted on an isolated area, and in this way seed is produced for the crop or the multiplying area of the succeeding year. Thus the seed corn will be produced from the highest yielding four ears of the test area. This system of corn breeding, known as the "remnant system," requires three distinct corn-breeding areas each year. The first is what is known as the ear-to-the-row test, where one-half of each ear is planted and one-half is saved for future use of the four or five best ears. The second is a small breeding plat from the remnant of the four or five best ears of the year before. In this second plat all the corn may be detasseled except that from the one ear which gave the highest production. This will insure that the male parent in this breeding plat shall be from the highest producing ear of the test of the year before. Seed is saved only from the detasseled rows, thus insuring cross fertilization. The third area is known as the multiplying plat, and this should be planted on a part of the farm isolated from all other corn. The seed produced on this plat should be kept for planting the whole crop of the succeeding year, and for supplying all the neighbors who may wish to pay the price for the same with improved seed corn. It will require three years from the time the first selection is made until the general crop of corn is planted from this selected seed. While this work of selecting and breeding is not difficult, and not beyond the ability of an average farmer or farmer's boy, yet where one has already overburdened themselves with farm work, it will usually be found impracticable as well as impossible to go into corn breeding even to the extent I have here outlined. To add this to the work of the already overburdened farmer would not be unlike the adding of teaching agriculture to the already overburdened teacher of a country school. There is a place and an opportunity for some bright boy in every community to go into this matter of corn breeding and to furnish the entire seed corn for the community. Corn thus produced will be worth considerable more than that which is purchased in the general market, raised in some distant section of the country, no one knows where, and which may not be adapted to the special local needs of the community where it is to be used as seed.

At the present time a larger part of the corn which is grown in New England is grown from seed which is purchased at the local seed store, possibly a local hardware or grocery store, without any special reference to corn breeding or selection. Even with this rather haphazard way of buying seed corn there is an opportunity for the exercise of discretion and skill in the purchasing of seed. One should first determine what type of corn will most fully meet the requirements. The mistake which is most usually made is in the selection of the type of corn, simply because it is a large growing variety. This is especially true in this section, where corn is grown almost entirely for the purpose of ensilage. In selecting corn which is to be grown for the silo, it is well to select one of the largest growing varieties which will come to full maturity, or which will at least approach maturity, in the usual season of the locality where it is grown. This would mean for southern New England the selection of such varieties of dent corn as Leaming, Pride of the North and Early Mastodon, and for northern New England the growth of such varieties as Pride of the North and possibly Leaming or Longfellow. It is only in rare and individual cases that it is wise to grow in New England such varieties as Eureka, Cuban Giant and other large growing varieties which will come nowhere near maturity in our usual season, and yet there are cases where it may be wise to select the largest growing type of corn which can be secured. If one has but 5 or 6 acres on which to grow corn, and a 200-ton silo which must be filled, then the largest growing variety of corn should be planted, without regard to whether it comes to maturity or not. The purpose here, of course, is to secure the largest amount of roughage and succulent food which can be grown to the acre. But on most farms it is wiser to grow a larger acreage of corn of some variety which will mature the grain, and in this way secure quality in food as well as quantity. Most of the seed corn offered for sale in the local markets is shelled corn, and the farmer never has an opportunity to see what type of ear produced this corn. If shelled corn is to be purchased, a careful examination should be made to determine the quality of the corn; the kernels should be clear and bright in color, full and plump in outline, not shrivelled and shrunken, indicating immaturity. The germ should be large, and not discolored or black, and a germination test should be made in every case to determine if the corn will grow. For, after all the discussion with reference to corn breeding and selecting, the most important quality which must be possessed by the seed corn is the power of growth. Good looking corn which may possess nearly all of the admirable qualities which are desired in seed corn can be found lacking in that most essential of all qualities, the ability to grow. Unless seed corn possesses this quality in a high degree, and with vigor and strength, corn had better be fed to the chickens, and replaced by other corn which will grow, whether or not it comes from quite as aristocratic a family.

While the selection of good seed is fundamental and vital in the growth of corn, yet it is only one of the elements which make for success. The best seed corn ever produced, if planted and cared for as is some of the corn grown in New England, would fail to give satisfactory results. It is just as important that we give serious attention to the matters of rotation of crops, adaptation of the crop to the soil, proper soil fitting and fertilization, tillage, harvesting and curing. All of these matters are of equal importance with corn breeding.

The proper place for corn in rotation is the first year after sod. No other farm crop seems so well able to thrive upon the undecomposed turf as corn. If the turf which is plowed for corn is in part made up of clover, this is all the better for the corn, as the clover will have brought to the soil a large portion of nitrogen which will be needed by the corn. Some growers have found it necessary to raise corn year after year on the same land, depending upon the liberal use of stable manure and commercial fertilizer and cover crops for maintaining the soil. While this can be done and a high average yield of corn maintained, yet it is not a practice which should be universally adopted, and can only be used to advantage where for special reasons it is found necessary. That treatment of the land which shall cause a cultivated crop like corn or potatoes to alternate with a sowed crop like oats or grass and clover tends to keep the soil free from weeds, to prevent the waste of plant food, to increase the soil humus and to bring about generally those conditions which are found favorable for crop production. Whether farm manure shall be plowed under for corn, or whether it shall be applied as a surface dressing after plowing, must be determined by the local conditions. If that method of plowing is practiced which leaves a furrow on edge rather than completely inverting it, the manure may be applied before plowing, and then harrowed in with the disc harrow. By thorough incorporation with the soil it will not only furnish plant food for the crop, but will serve to improve the physical condition of the soil. To leave the manure in the yard until after the corn ground is plowed, and then to haul it over the plowed land in distributing it, greatly adds to the labor without producing marked increase of the crop over that method of applying the manure before plowing. Where farm manure and commercial fertilizer are both used upon the same land for corn, if the manure is plowed under and the commercial fertilizer applied as a surface dressing they will supplement each other, the commercial fertilizer starting the corn off vigorously and the farm manure serving later in growth. It is impossible to lay down any definite rules which will apply in all cases, but the practice must vary according to the type of soil, according to the condition of the manure and according to the previous treatment of the land.

In planting corn a system of check-row planting has many advantages over drilling or rowing but one way. Where the soil is infested with weeds and grass it is a great advantage to be able to cultivate the corn in two directions. This can only be brought about by the planting in the check-row system. Two row horse planters can now be purchased which will plant corn in check rows, providing the land is fairly level. On much of our hill lands it will be found that these check-row planters are not a complete success. We have one field at the Connecticut Agricultural College planted this year by one of these machines. Corn is rowed in one direction, but it would require the skill of an acrobat to cultivate it in the other direction. On another field, which is fairly level, the planter has done most excellent work, the corn being well rowed in two directions. Many farmers still hold to the practice of planting with a hand planter. In this case it is possible to check row the corn with absolute uniformity. With the land marked off in advance, two men with hand planters will have no difficulty in planting from 8 to 10 acres per day. In growing the dent corn for the silo these rows may be 3½ feet apart in one direction and 3 feet apart in the other direction. In growing the smaller types of flint corn the rows may be 3 feet apart both ways, and abundance of room will be furnished for each hill of corn.

Directly after the corn is planted cultivation should begin. This cultivation should not be delayed until the corn is up, but may oftentimes be given to advantage on the same day on which the corn is planted. Especially is this true where the corn is likely to be dug up by crows. The use of a smoothing harrow or weeder directly after planting has in many cases served to protect the seed from damage by the crows. It is even more effective than treating the corn with tar or other substances. After the corn is up, the first cultivation should be given with an implement with narrow teeth, which may be run close to the rows of corn, which are set fairly deep; this will not roll the earth and bury the hills of corn. The first cultivation should be as deep as any cultivation you expect to give during the season, for if any of the surface roots are to be pruned, that pruning should be done at the first cultivation, for at that time the plant has relatively a much larger growth of root system compared with top than it will have again during the season. During the growing season the corn should be given cultivation at frequent intervals, the number of cultivations being determined somewhat by the season and soil conditions. During a dry season the surface should at all times be kept loose, open and porous; and during a wet season, as soon as possible after the rain the surface should be stirred to a depth of from two to three inches, and this surface layer made as dry as it is possible, for the drier we can keep the surface of the soil on any cultivated field the more completely do we hold the moisture beneath the surface, where it is needed by the growing plants.

The practice of hilling corn is one which is advisable only on lands which are naturally too wet for the growth of corn, or in a wet season, when it is desired to establish surface drains in which the surplus of rainfall may be carried quickly from the field. During recent years we have not been seriously troubled with a surplus of rainfall, and consequently those fields which have been given level tillage through the entire season have given best results. Corn is a valuable crop for New England because it gives a splendid opportunity for the growth of cover crops, which may be used to advantage for green manuring purposes. This cover crop can be sown to advantage at the last cultivation of the corn, but it is often better to wait until the corn is harvested, especially where this corn is to be put into the silo; then harrow the field over thoroughly before sowing the seed for the cover crop. Of all cover crops which have been tested in New England, none have proved of greater value than rye, or a mixture of rye and winter vetch, or rye and clover. If the seed can be put into the soil during the month of September a good growth will be made in the fall, and it will serve to prevent erosion, to hold the soluble plant food and prevent waste in the drainage waters.

The most economical way of storing the corn crop after it is raised is to put it into a silo, and of all the types of silos so far recommended the round, wooden stave silo is, for the general farm, the best type. Concrete, brick and stone silos have all been tried and all have their advocates. It is claimed for them that, once constructed, they are a permanent improvement, and yet no one seems to know of a stave silo which has ever been worn out. For twenty or more years stave silos have been in use, and so far as can be learned they are, where properly constructed, just as good to-day as when they were built. If a stave silo is good for twenty-five or thirty years, even though it must then be replaced, it is more economical than a concrete or brick silo. The money representing the difference in cost between the two types of silos, if placed in a bank at 4 per cent interest, would at the end of twenty years have won enough dividends to more than pay for the construction of a new stave silo. I make this statement with reference to silos in spite of the fact that the Massachusetts Agricultural College has two concrete silos, and is apparently well satisfied with the results. Recently, in discussing the matter of silo construction, and advising that the base of the silo be on the level with the feeding floor, and that it is not usually advisable to dig a hole in which to set the silo, I was informed that this pit in the ground was necessary in order to hold the juices of the silage and prevent their waste. If the corn is allowed to come to that degree of maturity to which it should come, there will be no visible juice to be preserved, for it will all be mixed with the silage. As a better quality of hay is secured where the grass is not allowed to come to full maturity before being cut, it was supposed that corn would also make a better quality of silage if it were harvested before it came to maturity, and it is difficult to overcome the practice established during the early years of ensilaging corn. It is rather unfortunate that our local fairs and State fairs all over New England are held during the month of corn harvest. Of course the farmer and his sons and all the hired men must go to the fair, and this frequently means that the corn is harvested and silos filled in order that this work shall not come along to interfere with the attendance at the fairs. Better take the risk of a slight frost and let the corn come to maturity than put it away when it is green and lacking in its fullest development. While corn and corn products alone do not make a perfect ration for farm animals, nor the stalk nor the grain contain that degree of protein which is necessary for the dairy cow, yet as a source of carbohydrates, of roughage, of material to mix with purchased concentrates, there is no crop which can take its place.

Much has been done to improve the crop as a result of breeding and selection, and this work will go on until every man who plants corn will plant pedigreed seed corn, which he knows possesses high producing qualities. But I wish to emphasize the fact that the selection of good seed is only one of the elements which makes for success with this crop. It is probable that without the slightest change in our practice and use of seed corn we could, by better cultivation, better fertilizing and better rotation, increase the yield of corn in Massachusetts at least 10 bushels per acre, and this would mean an increase in the crop for the entire State of 470,000 bushels. Ten bushels more per acre would mean an increase in the corn crop in Connecticut of 600,000 bushels. For those who have no faith, or but little faith, in the modern principles of corn breeding this matter of better tillage and better care may appeal. While the work of corn breeding is peculiarly work for the specialist, and will probably be taken up by not more than one or two men in every community, yet every man who grows corn should endeavor to make the land grow not a meager 38 to 40 bushels of corn per acre, but should make it realize the full possibilities of what was intended for corn, 50 to 75 or even 100 bushels per acre.

The salvation of the dairy business in New England will not be secured when satisfactory arrangements have been made with the milk contractors, but the final success in the dairy business will depend in part upon lowering the cost of production, and this will mean the production of more and better corn, the use of ensilage for summer and winter feeding of the dairy herd, and the contemplation and mastery of every detail which makes for the growing of a successful crop of corn.

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CORN SELECTION FOR SEED AND FOR SHOW.

BY PROF. WILLIAM D. HURD, MASSACHUSETTS AGRICULTURAL COLLEGE.

The renewed interest in corn growing is a significant thing in New England agriculture. When corn could be laid down "on track" in the east for 30 cents a bushel there may have been some excuse for the New England farmer depending on the "corn belt" for this important product. For the past ten years, however, the price in the eastern States has ranged from 70 to 90 cents a bushel. Careful calculations show that corn can be raised on New England farms at a cost of from 30 to 45 cents per bushel (shelled), hence it is a profitable crop to raise. That corn is adapted to almost any rotation, that silage is indispensable in feeding a dairy herd, that this crop is extensively used in the arts and manufactures, always finding a ready market, and its being a native of New England are further reasons why this most important crop in this country should be more extensively grown here.

The average yield of corn throughout the United States, according to 1908 statistics, was 26.2 bushels per acre. The average yield over the six New England States for the same year was 40.5 bushels to the acre. This same year several growers in New England obtained yields of from 100 to 133 bushels of shelled corn to the acre (calculated when taken from the field). What accounts for this wide difference between the average yield and that secured by careful growers? No doubt favorable soil, proper manuring, cultivation, etc., played important parts, but probably the most important factor was strong, virile, productive, properly selected seed. The need of more attention on the part of farmers to seed selection, and the fact that this year there is to be held in New England a great corn exposition, where selection and preparation of samples for show will count, are sufficient reasons for the emphasizing of these points in this paper. An attempt only has been made to take up such points as would aid New England farmers to improve their corn, and get ready for the exposition.

The main object from the standpoint of the farmer in all breeding of plants and animals is to improve the plant or the breed of animals with which he is working. Practical men have realized for generations that it was a profitable thing to use the best individuals in a herd to breed from. The fact that there is as much individuality in plants, that ears of corn, for example, differ as much in their productive power and breeding characteristics as do animals, has not seemed to be generally recognized, or, if recognized, the knowledge has not been made good use of. Seed corn has been generally planted without respect to the region in which it grew, its productive ability or even its germinating power.

A simple problem in mathematics will show how important it is that in any attempt to improve corn a good individual kernel should be used to start with. One kernel of corn produces an ear. An ear of corn, according to type and variety, will contain from 400 to 1,200 kernels. Taking 800 kernels as an average for an ear, these 800 kernels may reasonably be expected to produce 800 stalks, which, counting 1 ear to a stalk, gives 800 ears in the second generation. Each of these 800 ears, if properly handled, may be expected to produce 800 ears in the third generation. Then in three years there would be produced from the one kernel 640,000 ears, or approximately 8,000 bushels. A farmer, then, can modify to a great extent the quality, yield and all-round general characteristics of his crop by beginning right, with good seed.

It is not expected, or even wise to advocate, that every farmer shall be a corn breeder, but there is need of developing in New England strains of corn which will be adapted to the soil, length of season and the demands of our New England agriculture. No doubt a considerable number of farmers will attempt to improve strains of corn in the future, and these simple directions are given for their benefit. Improving corn does not involve a knowledge of plant breeding. Great advancement can be made by simple selection. Any man with a keen eye, a desire to improve the corn and an ideal to work toward may expect to be well repaid for his time and labor.

The writer would not overlook the fact that proper soil, climatic conditions, manuring, fertilizing and proper methods of culture are all extremely important, but the limits of this paper prevent a discussion of these at this time.

As has already been stated, good seed is the first and fundamental step in corn improvement. Uniform ears, straight rows, large size of ear, high percentage of corn to the cob and other points, considered on a score card at a show, may all be valueless when productive power is considered, and the whole purpose of corn improvement is more ears or more fodder to the acre.

Before any attempt is made to improve a plant some knowledge of the character and habits of the plant should be acquired. With corn one should understand a few of the botanical characteristics of the plant, the way the ears are formed, the root system, etc. The corn plant varies in height, according to type and the geographical region in which it grows, from 1½ feet to perhaps 25 feet. On the stalk are to be found joints or nodes, and if the stalk is cut crosswise above one of these joints there will probably be found an embryonic ear, which would seem to show that the original habit of the plant was to produce a small ear at every joint. The silk is the female organ of reproduction, the tassel, the male organ of reproduction, containing the pollen, which is shaken and blown about, falling on the silks (pistils) and fertilizing them. The fact that there is so much pollen produced by the tassels and this is blown about by the wind, or carried over considerable distances by other agencies, accounts for corn "mixing" so badly. It is not safe to plant two distinct types nearer than 20 rods of each other, and even at this distance considerable cross-fertilization may take place. To avoid "inbreeding" and to cause cross-fertilization somtimes every other row in a breeding plot is detasseled.

Corn plants have two root systems, one consisting of coarse strong roots, coming off at a little distance above the ground, which act as braces for the plant. The other is the fibrous root system, which grows underneath the soil, taking nourishment for the plant. A knowledge of how this last root system places itself in the soil will aid in deciding the kind of cultivation to employ. Deep cultivation after the plants are started destroys this feeding root system, lessening the growth of the plant, as well as allowing great loss of soil moisture.

Another point which must not be overlooked, but which will not be discussed at length, is uniform stand. It is an easy thing, by careless planting or by using poor seed, to lose 10 per cent or even 20 per cent of the hills or bearing stalks in the hills. This loss may mean the net profit which might have been obtained with the same amount of land, labor, fertilizer and cost of growing the crop. Care should be taken to have no vacancies in the field or barren stalks in the hills. Without a uniform stand a good yield cannot be expected.

Corn may be selected to increase strength of plant, yield, early maturity, size of ear, content of starch or protein, position of ear on the stalk, amount of leaf, if for silage, and for other desirable characteristics. It is not possible to select for many of these characteristics at the same time.

For New England it is probably best not to go too far from home for a type with which to begin. The mistake is too often made of sending for seed to regions where entirely different climatic conditions prevail than those under which the crop is to be afterwards grown. Care should be taken to select a type that will be worthy of improvement. Get as pure a strain as possible; one adapted to your region, and one that will mature in an average season. Oftentimes seed can be secured from some one who has already spent several years in doing the preliminary work necessary to establish a strain and fix a type. Secure seed from such whenever possible. It will save years of your own time.

This may seem like a paradoxical statement, but the time to begin to grow corn is in the late summer or early fall. Seed corn should also be selected in the field. By so doing the character and strength of the plant, the position of the ear on the stalk, the way it hangs, early maturity, and all the other desirable characteristics which make the ear a desirable one, under growing conditions, may be taken into consideration. When corn is selected from the crib none of the factors which enter into the growth under field conditions are known. One must be guided by external characteristics, and these are not sufficient. Never buy seed corn shelled which you expect to improve. In this condition even the kind of ear that produced the corn is not known. Let the corn become perfectly mature in the field before harvesting.

Much of what might otherwise have been good seed corn is ruined in storing and curing. When taken from the field ear corn contains 25 per cent to 35 per cent moisture. If allowed to freeze while containing this amount of moisture the vitality will be greatly lessened, if not entirely ruined. Therefore the corn must be thoroughly dried before freezing.

After it is properly dried it should be stored in a dry place, and no natural temperature will harm it. It should be either placed in racks or hung up in small traces. Do not shell or place in boxes or barrels. Considerable more corn should be saved early in the fall than will be needed, in order that more careful selection may be made later.

While the external characteristics of an ear may be used for the preliminary work of selection, these are not sufficient to determine whether corn is fit for planting or not. In other words, the first prize ear in a corn show may be no better and often not so good as some other good ear. An ear of corn to be used for seed should be required to answer for itself the following questions: Will it grow? Will it mature? Has it constitution? Has it breeding characteristics? None of these important questions can be answered without at least testing the ear in two ways.

First, the simple germination test may be applied. Where quite a number of ears are to be tested a box 20 inches by 20 inches and 3 inches deep can conveniently be used. Mark off the box, with strings, into squares 2 inches on a side. Fill the box level full of sawdust or sand. Number each ear and each square of the germinating box. Place five or six kernels from ear No. 1 in space No. 1, and a similiar number of kernels from the other ears in corresponding spaces. Place the germinating box in a temperature of about 70° to 75° F. Keep the sand or sawdust moist. As germination takes place you will no doubt find many ears showing weakness or poor germinating power, and they should be discarded at once.

Sometimes corn that will germinate will not grow well under field conditions. So in any effort to improve corn the desirable ears retained from the germination test should be tested in the field. The most convenient method is by what is called the "ear row test." This consists in planting row No. 1 with corn taken from ear No. 1, row No. 2 with corn from ear No. 2, etc. Plots of any desired size may be arranged, and while much more elaborate systems of plot tests have been recommended, for the average farmer the above will be sufficient. The plot used for this purpose should be given the best of preparation, fertilization and care throughout the season, giving the corn every possible chance. Before the pollen begins to scatter, all weak and barren stalks should be removed. Half of each row may also be detasseled before the fertilization of the silk takes place, to prevent inbreeding. Seed ears for another years' crop may be selected from this plot and cared for as before described, and marked improvement should be the result.

The operations described are simple, the work is extremely interesting, there is need of such work, and those who carry it on will find ready sale for their product at prices far in advance of those usually secured.

Selection and Preparation of Corn for Show.

For purposes of exhibition corn is now usually shown in single-ear, ten-ear or eighty-ear (approximately a bushel) lots. The ten-ear sample, the one most commonly used, is of convenient size to be easily judged, and is of sufficient size to show a fair sample of what the crop really is.

Numerous score cards have been devised for corn judging. Necessarily each varies with the ideas of the different persons who compile them. A score card, however, aids the judge in keeping all the important points in mind. It establishes a uniform basis for study and comparison, and prevents laying undue stress on certain points to the exclusion of others. The use of a corn score card requires judgment, the same as for fruit, live stock, milk or other products. Score cards differ for different sections. Obviously, the same score card should not be used on corn of the type grown in New England as for that grown in Iowa or Missouri. In order to formulate a score card for New England corn the officers of the New England Corn Exposition appointed a committee to consider this matter. After consulting about twenty authorities on types of corn the following score cards for dent and flint corns have been decided upon. These will be used in judging the corn at the exposition this fall.

Score Card, Flint Corn.

Points.	Perfect Score.
1. Maturity and seed condition,	20
2. Uniformity,	15
3. Kernels,	15
4. Weight of ear,	10
5. Length and proportion,	10
6. Butts,	10
7. Tips,	5
8. Space between rows,	10
9. Color,	5
Total,	100

Score Card, Dent Corn.

Points.	Perfect Score.
1. Maturity and seed condition,	25
2. Uniformity,	15
3. Kernels,	15
4. Weight of ear,	15
5. Length and proportion,	10
6. Butts,	5
7. Tips.	5
8. Space between rows,	5
9. Color,	5
Total,	100

Explanation of Score Cards.

Of course some difference must be made in judging dent and flint corn. The following explanation of the points are made to guide the growers in selecting their corn for exhibition purposes this fall: —

1. Maturity and Seed Condition. — This is perhaps the most important point on the score card. Corn is worthless, economically speaking, if it will not grow. The ears should be firm (try twisting in the hands) and free from mold. They should have a bright luster. There should be no chaff or silks adhering. The germs should not be shrunken or blistered, and the sample should show an all-round healthy, vigorous appearance.

2. Uniformity. — Uniformity and trueness to type are usually considered together. Few types are recognized in the west. It is hard to determine what a "type" of New England corn is. The ears should be similar in length, shape, size and color, indentation of kernels, etc. Uniformity in an exhibit would go to show that the corn was sufficiently developed so that the type had become somewhat fixed and stable.

3. Kernels. — Of course here again an entirely different basis must be used for dent and flint corns. The kernels should be uniform and slightly wedge shaped. (Judges remove a few kernels from different parts of the ear to determine this.) The shape of the kernel determines to a great extent the amount of corn on the cob, lost space between rows, also chemical composition. Kernels with much starch are rich in carbohydrates; those having a larger germ are rich in oil. The kernels should possess germs of good size. Kernels of uneven size do not work through corn planters with uniformity. The edges of the kernels should be straight and fit closely together; they should be of uniform thickness. The rows should also be straight.

4. Weight of Ear. — In this score card this item takes the place of "proportion of corn to cob" in other score cards. Dry cobs do not vary much in weight, and it is much easier for a judge to weigh the ears than to have two or three out of ten shelled and the proportion of corn to cob determined in this way. The weight of shelled corn per acre is the important point. Here again there is a wide difference between dent and flint corns. Dent ears may weigh 16 ounces or more, and are usually produced one on a stalk. Flint ears weigh 8 ounces to 10 ounces, and more than one ear is commonly produced on a stalk.

5. Length of Ear and its Proportion. — The size of ears of corn vary considerably with the locality, soil, etc., so it is hard to fix a standard of length. Dent varieties should be $9\frac{1}{2}$ inches to 10 inches long. Flint varieties may be 11 inches to 12 inches long. Some varieties of both types may be smaller. In dent corn the circumference of the ears taken 2 inches above the butt should be about two-thirds the length. Ears with too large a circumference for their length are slow to mature. Ears should not be too tapering. Nearly cylindrical ears are desirable. Ears should be full and strong in the central portion.

6. Butts. — Large yield to the acre depends on having the butts and tips well filled out. The kernels should be uniform in size and well arranged around the butt, surrounding a cup-shaped cavity. The butt of the ear should not be too large, neither should it be so small as not to support the ear well when it is hanging on the stalk. Butts should be somewhat expanded but not too large.

7. Tips. — Should be well covered with kernels of uniform size and in rows which are a continuation of those on the ears. Poor tips may be caused by an unfavorable season. Tips well filled out show good breeding and a larger amount of shelled corn to the acre.

8. Space between the Rows. — Much space between the rows reduces the proportion of shelled corn. The shape of the kernels, the straightness of the rows, both at the base end of the kernel and on the exterior, should be very slight.

9. Color. — The color of the kernels should be uniform and of a bright luster, showing good condition. White or black kernels in yellow corn should be severely cut and *vice versa.* Too many mixed kernels may disqualify the exhibit. Missing kernels may be taken to mean that those originally occupying the vacant spaces were off color. The cobs should all be of the same color. Usually white corn has white cobs. Red cobs in yellow corn are preferred. Variation in color of cobs shows mixture and poor breeding.

Preparation of the Corn for Exhibition Purposes.

After the corn has been carefully selected, according to the points given in the foregoing score cards, it should be carefully stored, so that the ears will not become broken or otherwise injured. Keep it in a place where the luster will be maintained. It is just as allowable to "groom" an exhibit of corn and otherwise make it look well for exhibition purposes as it is to place animals in "show condition." All silks, chaff, etc., should be carefully removed. The butts may be trimmed to give them as neat an appearance as possible. Any attempt to improve a sample by removing kernels and inserting others should meet with a disqualification of the exhibit. In shipping, each ear should be wrapped separately, and should also be plainly marked with a small tag fastened into the butt with a tack or small nail.

The whole exhibit should be properly labeled in accordance with the regulations which are laid down by the officers in charge of the corn exposition to which the corn is sent.

GROWING AND MARKETING ASPARAGUS.

BY MR. FRANK WHEELER, CONCORD, MASS.

Since the asparagus rust has established itself in this country it is well known by the most experienced asparagus growers that the variety introduced from France, known as *Argenteuil*, or *Palmetto*, as it has been renamed since its introduction here, is much more resistant to rust than are other varieties, and is the more desirable kind to grow. One-year roots are much to be preferred to older ones, as they will not be so much mutilated in transplanting to the field from the seed plot, and will suffer less check; neither are they so likely to be stunted in the seed bed if dug as one-year roots as if allowed to grow three years; also, the one-year roots will get to the producing stage as soon as the older ones.

Procure seed that you know is true to name, preferably from some selected strain, known to be resistant to the rust, and of good market qualities. Sow the seed as early in the spring as the land can be made ready, on an early, moderately heavy, sandy loam, thoroughly enriched for two or more years with stable manure and chemicals, in drills 1 inch deep, 16 or 18 inches apart, thinly, or 1 to 2 inches in the row. This prevents crowding, and it is not necessary to thin the plants, which is desirable, as they are difficult plants to pull up so as to get all the root and prevent that plant coming up again. Keep this seed bed free from weeds by frequent wheel or scuffle hoeing and hand weeding. If troubled by the asparagus beetles or slugs protect the plants by dusting with Paris green, put on with a powder gun when the plants are wet with dew, or dusting slaked lime on the plants and slugs. The lime will stick to the slugs and kill them by contact. It is well to cover the plants in the seed bed through the winter with coarse, strawy manure or old hay, to protect the roots, as strawberries are covered or mulched for the winter.

The soil most favorable to the production of asparagus is a sandy loam, of a smooth texture, free from coarse grit, gravel or stones, 8 to 12 inches deep, underlaid with a smooth, yellow, loamy subsoil, changing to a close sand at a depth of 3 feet or more. It is better to prepare the field for the permanent bed one or two years before setting the roots, by growing some crop that requires high fertilization and thorough cultivation. The soil should, during this one or two years before setting, be well filled with manure to a depth of 9 inches or more, to stock the soil with humus, as all applications after the roots are set will have to be on or near the surface. A soil well stocked with humus will stand drought much better than one that is deficient in humus. The year previous to setting the roots the land should receive a heavy dressing of lime, nearly 1 ton to the acre, or an even heavier dressing of wood ashes, unless the land has received frequent applications of either or both of these materials in recent years, in which case a smaller quantity will be sufficient. Asparagus is very sensitive to an acid soil and will not do well on it.

The autumn previous to setting, plow the ground to a depth of 9 inches or more, if such a depth does not bring up too much of the poor subsoil. During the winter or spring spread 10 to 20 tons of manure broadcast, and in the spring, when preparing the ground, apply broadcast what chemicals are to be used. Thoroughly wheel harrow two or three times and smooth. Mark out the rows 4 feet apart and get them straight, — the field is to be planted for twelve years or more, — as much better work can be done in the care of the field with straight rows than with crooked ones. Open the furrows first with a swivel plow with two horses abreast, turning the furrows all one way. Then follow with a large two-horse landside plow, with the horses tandem in the furrow, throwing the earth the first time the same way as the swivel plow threw it, and then coming back in the same furrow, throwing the earth to the opposite side of the trench, where no earth has been thrown. In this way the trench can be made quite clean to a depth of 7 inches below the settled level surface without any shoveling by hand.

The roots are dug from the seed bed by plowing out with a large two-horse plow, shaken out with forks, and taken to some building where they can be separated and sorted, discarding all small and poor plants. The plants are set in the bottom of the trench 2 feet apart in the row, and covered with 2 inches of soil. The field is taken care of during the first season by hand hoeing in the line of the trench, working in soil a little at a time, so as not to have the trench filled full before the middle of August or first of September, and cultivating on the ridges between the rows with some cultivator that will not work the earth into the trenches too fast. If it is thought worth while to take care of the field by hand for a part crop, a row of beets, carrots, parsnips, bush beans or some similar crop can be planted on the top of the ridge any time after the asparagus is set.

The beetles and slugs must be taken care of by the same or similar means as those used on the seed bed, or if hens and chickens can be kept on the field they will be a help.

At some convenient time during the winter or spring following the setting in the field, and each succeeding year, spread from 10 to 20 spreader loads of manure per acre, and at the spring preparation of the land apply chemicals supplementary to the manure, in such quantities that the land will receive each year from 125 to 150 pounds of nitrogen, from 250 to 300 pounds of potash and from 100 to 125 pounds of phosphoric acid per acre. The chemicals used should be nitrate of soda and high-grade tankage for the nitrogen, and ashes and muriate of potash for the potash. Probably the tankage will carry enough phosphoric acid to make the required quantity, with that from the manure, but if not, use Thomas slag, bone meal or acid phosphate. If ashes are hard to procure use more muriate of potash to make up the deficiency of potash, and use one-third ton of lime per acre each year to keep the soil alkaline.

The second and each succeeding year the land is prepared by the use of wheel and smoothing harrows, no plow being used. The tops or brush of the plants are not removed, but are broken down and cut up by first using a cutaway harrow, driven with the driver riding. Next, a whole disk harrow is used crossways of the former course of the cutaway harrow, riding or not, as the texture of the soil lets the harrow into it. The harrows should not at any time be weighted so as to crowd them on to the crowns of the plants. Either before or after the second harrowing apply the chemicals, and harrow them in with the wheel harrow, not riding it the third time. Then smooth off with a smoothing harrow, but do not drag with a plank smoother or roll with a roller. If, however, it is desired, for any reason, to plank or roll the field, this should be followed, at as late a time as possible to do it without injuring the new shoots, by another application of the smoothing harrow, to kill all weeds that have started, and to leave the surface of the field rough, to prevent the soil from drifting in high winds and making the shoots crooked. The small pieces of brush and other material should be left on the field.

The field during the second year is taken care of with cultivators and horse hoes, with but little hand work.

Part of the preceding and what follows may seem like heresy to recommend, but my faith in it is attested by my practice and results for twenty-five years or more.

Stop cultivation the latter part of August or first part of September, and allow all weeds to grow for a cover crop and winter protection, which, when harrowed in with the asparagus brush and the light annual dressing of manure, will keep the soil well supplied with humus, which will not be the case if chemicals are used without stable manure and all top growth is gathered and burned.

If in the second year the shoots come of good size and very strong, they might as well be cut during the first week, as they are likely to be injured by frost, and it will hurt the roots no more to cut them than to let the frost kill them. The third year the shoots may be cut and marketed, to about June 1, and then should be allowed to grow, and kept free from weeds until the latter part of August. Although I am recommending letting the weeds grow late in the season, when the asparagus is ripening, I most decidedly recommend that the weeds be kept down during the growing season, so that the asparagus may have all the benefits to be derived from clean culture and high manuring during that period. The fourth and succeeding years the crop may be gathered and sold to about June 20 or 25, according to whether the season has been such as to make a large crop, and the market demands it.

During the cutting season the weeds are kept down by frequent cultivation between the rows, while those in the row are covered up, about June 1, by a tool, drawn by two horses, that straddles the row and draws the dirt into the row, making a ridge that covers the weeds so that they will not trouble for the rest of the cutting season. At the end of the cutting season all weeds are killed by leveling down the ridges by harrowing or cultivating and smooth harrowing, and for the rest of the season, until August 15 or September 1, by cultivators and horse hoes between the rows and hand hoeing in the rows.

Marketing.

For the Boston or New England market, the "grass," as it is generally called, should be cut so as to have green grass, or so that the principal part of the growth is above ground, instead of the white kind, or that which is cut mostly below the surface. The customary length of bunch is $8\frac{1}{2}$ or 9 inches, so that two bunches laid end to end will reach across a bushel box, bunches of the size that one dozen will fill a layer in the box and three layers will fill the box, which is $1\frac{1}{4}$ pounds per bunch, or 55 pounds per bushel. The stalks are cut in the field so that they will show about 6 inches of green growth and $2\frac{1}{2}$ inches of white after they are packed, tied and butted. The best tool for cutting is a knife with handle 7 inches long and blade 8 inches long by $1\frac{1}{4}$ inches wide, with dull sides, sharpened across the end, which should be square. There are knives on the market of this description, except that there is a deep swallow tail on the end, instead of being square. The objection to this form is the greater liability of injury to buds in using, the stalk not being entirely severed until the deepest part of the notch has gone through the stalk, and when that part is through the long points of the knife have gone their length beyond, which may be among the crowns of the roots, to the injury of some of them.

Each man cuts two rows at a time, and two men lay together between them the handfuls of grass they cut. After cutting, it is gathered in bushel boxes, tips overlapping in the middle of the box, taking care to lay the grass straight and even. It is then taken to the packing room, where it is sorted as it is packed for market. If the grass is such as it should be, with the care laid down in the foregoing pages, it will pay to make two grades. The better grade should be composed of only large, straight, full lengths of stalks, while in the poorer grade may be put the small, short and crooked ones, if not so crooked as to disfigure the bunches after being packed. At the packing room the grass is put on a table or bench, around which the packers sit and the tier and butter-off stand. A table 7 feet long by 5 feet wide will accommodate five or six packers, one tier and one butter-off and washer. The packers use a rack, made with a 2 by 4 by 12 inch base, with a $\frac{1}{2}$ inch headboard, 6 inches high and 4 inches wide. Two inches from the headboard is a U-shaped iron, $\frac{5}{16}$ inch in diameter, $2\frac{3}{8}$ inches high, the lower four-fifths of which describes a semicircle of $2\frac{1}{4}$ inches diameter. Six inches from the headboard is another similar iron, $2\frac{7}{8}$ inches high, the lower part of which describes a semicircle of $2\frac{3}{4}$ inches diameter. Between these two irons, and closer to the larger one than to the smaller, a channel is cut across the base, to put the tying material through when tying. Standing about 6 inches above the large table, in or near the center, is a small revolving table, about 2 feet square, from which the packers take the empty racks and to which they return them when filled, where they are convenient for the tier to reach to place in the tying machine. One man can tie what three to six can pack, according to the size of the grass, and how well it is packed. He needs to be a nimble man, of quick good judgment, in order to see that all the bunches are of the same size before putting the pressure on for tying. Under the old order of packing, where each packer tied his own packing by hand, there was too much variation in the size of bunch if there were many packers in the gang.

The tying machine is better understood by seeing it than from description. It consists of a double hook carried by a hinged and weighted arm fastened to the under side of the table, to which a treadle is hung, on which the tier stands to give pressure to the bunch when tying it. With this machine a man can tie much faster and tighter than by hand. The tying machine is placed midway on one side of the table, while at its left, fastened to one corner of the table, is the cutting machine, gauged to cut off all the butts the same length. The man cutting off butts also does the washing. He has a tub of water close by, into which the bunches are dropped as cut. They are then washed and placed upright in long troughs or sinks, and water put to the grass a few hours before packing in bushel boxes to send to market. Never let the grass get wet above the butts after it is once dry after washing, but keep it as cool and dry as possible, to prevent its commencing to spoil.

During bright and hot weather, when cutting, the grass will wilt somewhat in the field, but that is no objection, as it will pack better and tie tighter, and it freshens and swells to its normal size after being in the sinks of water a few hours. Care will have to be taken not to make the bunches quite as large as when the grass does not wilt, to allow for the swelling.

If for any reason the grass is to be held for a few days, and it cannot be put into cold storage, it is better not to bunch it as it comes from the field, but to carry it to a cold cellar and lay it on the floor. It can be kept in this way for a few days without much trouble.

The customary box in which it is sent to market is the common Boston bushel box, holding three layers of one dozen bunches each, and covered by four pieces of lath nailed across the top. In very hot or muggy weather it is well not to place any paper, or other close covering, over the grass, but to let it have all the air it can get. Within twenty miles of Boston it is boxed the afternoon of the day it is packed, and carried that afternoon or night, by wagon, to market, so that it is ready for sale early the next morning. If much farther than twenty miles from market it is not boxed until the next morning after packing, and is then sent by as early an express as possible.

While the market calls for the large grades of grass as strongly as it now does, — and it probably will continue to do so, — it will be to the grower's advantage to try to supply it. To have fields producing this quality of grass new beds need to be set out frequently, to take the place of the old ones as they fail. Twelve or sixteen years of cutting is as long as they will be in the most profitable stage. To destroy an old bed it is as well not to plow out the old roots, but to plow shallow, or wheel harrow above the rows, keeping down all growth from the roots for two or three years, and letting them rot in the ground. After four or five years the field can be plowed to any depth wished, and it is not robbed of a lot of fertility by carrying off all the roots. While killing out the roots any hoed crop can be grown, and almost any crop will do well on an old asparagus field.

There does not seem to be any efficient and economical way of preventing asparagus rust. The best thing to do is to get the most resistant variety, and after you have established a bed, to select from the most resistant and best market types of stalks, seed for setting new fields, or obtain seed from some one you know to be doing this.

During the last fifteen years the demand for asparagus has grown faster than the supply, and the prospect of good profit from the growing of it in the future is good, especially for the large grade. All the extra profit in growing the large grade does not come from the extra price received, but partly from the more economical handling of the crop. It takes the same time to cut and pack the same number of little stalks as it does of large ones, but, after they are packed and tied, there is not more than one-third or one-half as many bunches. Therefore get good stock, give it plenty of room, feed it high, give it the best of care, put up the product honestly, get a reputation for good grass, and the reward will be satisfactory.

ALFALFA AS A CROP IN MASSACHUSETTS.

BY PROF. WM. P. BROOKS, DIRECTOR MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

Alfalfa has been under trial, both at the experiment station and on a considerable number of private farms, for several years. It has been found that a good start and a thick stand are not very difficult to obtain, but in many cases, both on the experiment station grounds and on private farms, the alfalfa has frequently died out within two or three years, giving place, with greater or less rapidity, to grasses and clovers. During the past few years, however, we have been obtaining better success than formerly. There are now several small areas of alfalfa on station and college grounds which are from four to six years old and which are still in very good condition. The writer has heard also of a number of cases in which private farmers are meeting with much better success than was common a few years ago.

Even should alfalfa hold the ground only three or four years, it would, in the opinion of some of those who have given it longest trial, still be well worth growing on account of its high value for forage, whether green or dry.

The principal advantages of alfalfa as compared with clover are four: —

1. Larger total yield, if thoroughly successful. The experiments carried out at Amherst up to the present time have been upon too small a scale to determine the yield to be expected from alfalfa, but, so far as can be judged, it seems probable that in seasons with well-distributed and moderate rainfall a total yield in three crops of from five to six tons of hay may be anticipated on good land.

2. The first crop is ready to cut and feed at least two weeks earlier than clover.

3. It starts after cutting more quickly than clover, usually furnishing three crops annually.

4. It is considerably finer than clover, and is therefore more palatable and cures more easily.

So far as can be judged from figures showing composition, alfalfa apparently does not exceed the clovers in nutritive value to as great a degree as is often supposed. The following table illustrates this point: —

Composition of Clover and Alfalfa Hays.

	Water (Per Cent.).	Ash (Per Cent.).	Protein (Per Cent.).	Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Fat (Per Cent.).
Alfalfa hay,[1]	15.00	7.90	13.50	27.20	33.20	3.20
Alfalfa hay,[2]	13.24	7.29	16.14	31.49	40.52	1.56
Alsike clover hay,[2]	15.00	9.70	14.00	23.10	36.10	2.10
Medium red clover hay,[2]	15.00	7.60	13.20	24.20	37.40	2.60

[1] Calculated on the basis of two analyses published by the New Jersey Agricultural Experiment Station.

[2] Average of analyses of the Massachusetts Agricultural Experiment Station.

On account of its superior fineness alfalfa will usually prove somewhat more palatable than clover, but the figures of the above table indicate that there may be no very wide difference in the nutritive values of alfalfa and clover hays. Comparative determinations of the digestibility of these two kinds of hay, produced under American conditions, are, however, desirable.

Soil Requirements.

Alfalfa may be made to succeed on a variety of soils provided these meet certain requirements, but whatever the type of soil it should be naturally thoroughly underdrained. If standing water is found during any part of the growing season within less than six to eight feet of the surface alfalfa is sure to do poorly. It is essential, further, that there should be perfect surface drainage. Standing water or ice, particularly the latter, will destroy alfalfa in a relatively short time. The highest degree of success with alfalfa appears to have been attained on moderately heavy soils. The soils of the typical drumlins of the State, strong, retentive, gravelly loams, appear in most cases to be well adapted to this crop. A subsoil of medium texture, and one which will not retain too large a proportion of water, is desirable. It is highly important that the soil be free from the seeds or living roots of weeds. The presence of witch grass is highly undesirable. Localities where sweet clover, *Melilotus alba*, grows naturally are likely to be peculiarly adapted to alfalfa, as also are those districts where the soils are rich in lime.

Preparation of the Soil.

In preparing for alfalfa the most thorough possible tillage and such treatment as will leave the surface soil entirely free from weeds or the living roots of weeds, such as witch grass, are of prime importance.

If the soil is fertile, and if a very early crop which can be so cultivated as to leave the soil in good tilth and free from weeds will be profitable, then such a crop may wisely precede alfalfa; but it is desirable that such a crop be harvested not later than about the middle of July in order to allow a sufficient interval for the thorough tillage which is desirable before the seed of the alfalfa be sown.

If the cultivation of such an early crop as has been above referred to does not promise to be profitable, or if the soil has not been previously limed and enriched, then a summer fallow will be found to be highly beneficial. In this case the rule should be to plow in the fall if possible; if not, then in early spring, and to harrow with sufficient frequency during the spring and early summer to destroy all weeds as they start and to bring the soil into a fine mellow condition before sowing the seed. Under this system of management the surface soil is made mellow and fine, capillary connection between the surface and the subsoil is thoroughly established, so that water rises freely from below toward the surface, and the surface soil, as a result of the frequent stirring which it has received and the subsequent germination and later the destruction of successive crops of weeds, is brought into the best possible condition for the rapid, early growth of the alfalfa, unchecked by the competition of weeds. The following are the details for the system of preparation for alfalfa which is especially recommended: —

1. Plow the land the previous fall or in the early spring.
2. Apply lime at the rate of about 1½ tons per acre to the rough furrow, either in the fall or early spring, and immediately incorporate it thoroughly with the soil by the use of the disk harrow.
3. Harrow throughout the spring and early summer at intervals as frequent as may be necessary to destroy the successive crops of weeds as they start, and to bring the soil into the finest tilth.
4. About mid-spring, just previous to one of the harrowings which the land is to receive, apply the following mixture of materials per acre: basic slag meal, 1,500 to 2,000 pounds; high-grade sulfate of potash, 300 to 400 pounds; or, if it can be obtained, low-grade sulfate of potash, 600 to 800 pounds. This mixture should be spread evenly and at once thoroughly harrowed into the soil.
5. When ready to sow the seed apply the following mixture of materials per acre: basic slag meal, 300 pounds; nitrate of soda, 75 to 100 pounds. Spread this evenly and work in lightly with the smoothing harrow.

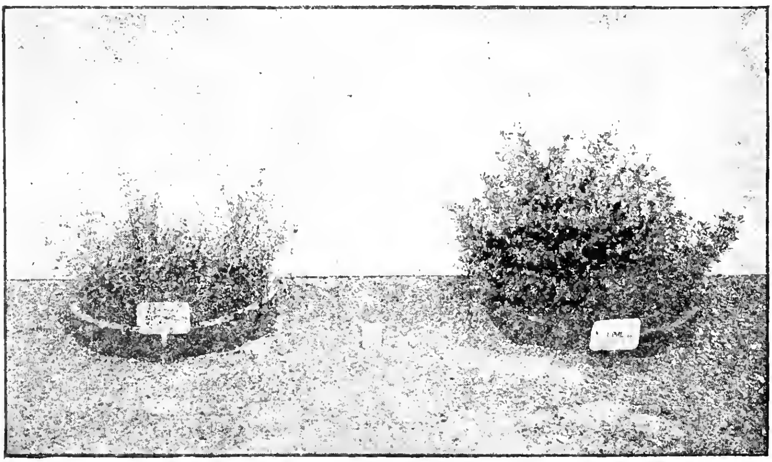
The Amount and Quantity of Lime needed.

For all soils which incline to be heavy and which show some tendency to work up into clods and hard lumps, some form of burnt lime will be found best. Three kinds of burnt lime are now offered for sale in our markets: (1) the ordinary lump lime, which should be slaked with just enough water to cause it to crumble into a fine, dry powder before application; (2) granulated lime, which can be spread at once, when it will slake in the soil; (3) the coarse lime, separated from the finer in the manufacture of hydrated lime by the modern method. This lime is suitable for immediate application and when mixed with the soil will take up moisture and slake. Either the granulated lime or the grade last referred to should prove especially effective for improving the texture and tilth of the heavy soils.

For use on the lighter soils, one of the so-called "agricultural" limes, which are in considerable measure made up of carbonate or air-slaked lime, will prove satisfactory.

There appear to be but few sections of the State where a comparatively heavy dressing of lime is not a necessity for satisfactory results with alfalfa. The cut clearly illustrates the benefit which usually follows.

Alfalfa.



No Lime. Lime.

The alfalfa shown in the cut is growing in cylinders 4 feet deep, which were first set into the ground. They were each then filled with equal quantities of thoroughly mixed soil. With the surface soil of one cylinder, lime at the rate of 1½ tons per acre was thoroughly mixed. The other was left without lime, and both then received a liberal application of fertilizers. Under the conditions of this experiment we know that the soil in the two cylinders was of precisely the same character at the start, and the difference in growth must surely have been due to the influence of the lime.

Fertilizers for Alfalfa.

There can be no one combination of fertilizers or no one mixed fertilizer which under all conditions will prove best. It will be generally admitted, however, by all qualified to judge, that on soils which are in a fairly productive condition at the start the fertilizers applied should furnish relatively large amounts of the mineral elements of plant food, among which phosphoric acid, potash and lime are the most important. Alfalfa, like other legumes, is capable of drawing upon the air for most of the nitrogen which it needs, and applied nitrogen in the form of a fertilizer in any large amounts is unnecessary. We may state the case even more strongly, — it is not only unnecessary, it may positively prove harmful. If it exercises a harmful effect, however, this will not usually be because the presence of nitrogen in the soil is necessarily injurious to the alfalfa, but because its presence increases the competition of the grasses for the possession of the field. In a soil well stocked with lime, phosphoric acid and potash, but without available nitrogen in considerable amounts, the grasses make only a feeble growth. If, in addition to the phosphoric acid, potash and lime, we apply to such soil too large amounts of nitrogen, the grasses in our humid climate will gradually come in, with the probability of crowding out the alfalfa with greater or less rapidity. It is the belief of the writer that combinations of basic slag meal and sulfates of potash are peculiarly adapted to alfalfa. The slag meal furnishes not only phosphoric acid but lime, which will help to bring the soil into condition for alfalfa and to maintain it in that condition. The sulfate of potash, on all the heavier soils especially, is superior to muriate. Many other suitable combinations of materials might be made up. Wood ashes should give good results. Combinations of such grades of bone meal as contain relatively low percentages of nitrogen and of either the low or high grade sulfate of potash should do well. Mixed fertilizers, containing not more than 1½ per cent of nitrogen but with 12 or more per cent of phosphoric acid and 8 to 10 per cent of potash, should generally give good results.

The Use of Manure.

Whether manure should be applied either in preparation for alfalfa or as a top dressing depends upon conditions. If a supply of fine manure, free from weed seeds, is available, and if the soil is in a very low state of fertility, a dressing of manure may be highly beneficial; but on soils already in good condition the application of manure is not called for, and from some points of view is undesirable. It almost invariably carries weed seeds, and its use produces the conditions already referred to under which, since it supplies an abundance of quickly available nitrogen, the grasses thrive. If manure is used, then it will usually mean that the grasses will tend to crowd out the alfalfa in greater degree than would be the case had manure been withheld. It seems wise, therefore, except upon soils which are exceptionally low in fertility at the start, to depend mainly upon fertilizers alone.

Seed.

Great care should be taken to secure the very best seed, and that grown as far to the north as possible should be preferred to southern grown seed. Buyers should be on their guard against seed mixed with dodder. One or two cases have been brought to the attention of the writer in which the experiments have been absolutely ruined because of the presence of the seed of this parasite mixed with the alfalfa seed sown. The seed of dodder is very minute, and the purchaser, if in doubt as to the freedom of any lot of seed offered from this parasite, should send it to the experiment station for examination. There are a number of varieties of alfalfa on trial in this country, but the experiment work carried on at Amherst has not thus far indicated a wide difference in the value of the different kinds offered by seedsmen.

The quantity of seed which usually seems to give most satisfactory results is about 30 pounds per acre.

Time and Method of Seeding.

It is believed that the best results with alfalfa will usually be obtained by sowing it alone about July 20 to August 5. Care should be taken to put the seed into the ground when the moisture conditions are such that it will germinate promptly. It is highly important that it should come up quickly in order to get started ahead of weeds. During the past two seasons, alfalfa sown about August 5 in Amherst has attained a height in excess of a foot previous to the coming of cold weather, and the alfalfa which has been sown at this season has made a thicker and more even stand, freer from weeds and grasses, than any which we have obtained by sowing at any other season.

Good results are sometimes obtained by sowing the seed early in spring, with oats or barley thinly sown as a nurse crop. Alfalfa, like the grasses and clover sown at that season, often starts well, but is often injured by the hot, dry weather likely to prevail when the nurse crop is cut.

In some of our early experiments in Amherst, alfalfa was sown in close drills, but this method has now been given up in favor of broadcast sowing, after the most thorough possible preparation of the soil to insure freedom from weeds. In the case of alfalfa sown late in July or early in August, it has been the practice in Amherst to allow all growth made during the autumn to remain uncut for winter protection.

Soil Inoculation.

In localities in which sweet clover does not naturally grow, inoculation of the seed or soil with the bacteria which develop nodules upon the roots, and which give the plant the capacity to assimilate atmospheric nitrogen, is advised. If sweet clover is indigenous in the locality such inoculation is unnecessary, as the bacteria which develop nodules on the roots of sweet clover appear to be identical with those found on alfalfa roots. If inoculation is necessary it can be carried out in two ways: —

1. An artificial culture may be obtained and used in accordance with the directions accompanying it. Such cultures are sent out both by the United States Department of Agriculture, Washington, D. C., and by a number of private companies. The cultures now offered appear to be much superior to those earlier produced, and the most recent experiments at the experiment station with a culture furnished by one of the private companies have given very satisfactory results. The use of a culture will, on the whole, be found rather less troublesome than the second method. In ordering a culture, it is necessary to name the crop for which it is wanted and the area which is to be sown.

2. Soil from an old and successful alfalfa field may be mixed with the soil of the area to be sown; 300 or 400 pounds per acre, if thoroughly stocked with the needed bacteria, will prove sufficient, and it is possible that less would answer. If soil is used, it should be remembered that exposure of the germs to the light, even if only for a short time, destroys their vitality. It is advisable, therefore, to harrow in the germ-carrying soil as promptly as possible after spreading.

Leaf Spot or Rust.

Alfalfa appears to be peculiarly subject in our climate to this parasitic disease. The presence of the disease is indicated by the appearance of small, dark-colored spots upon the lower leaves. If the weather conditions are favorable to the rapid increase of the parasite it spreads quickly to the upper leaves, and later first the lower leaves and then the upper may turn yellow and fall. In some cases the disease shows itself only on the lower leaves; the foliage on the upper part of the plant continues healthy and the injury may not be great. In damp or rainy weather the disease, however, often spreads with great rapidity, the growth of the crop is checked and the vitality of the plants is greatly weakened.

When this disease shows a tendency to spread rapidly, it is best to cut the alfalfa immediately. Under this treatment a healthy growth will soon start, while if the diseased plants are allowed to stand they will be greatly weakened, and the subsequent crops much reduced. During the past season leaf spot has been unusually prevalent and in some fields has done great injury. Just how serious the disease will ultimately prove cannot at present be stated.

If leaf spot shows itself in a newly seeded field, while the plants are young, it is best to go over it with the mowing machine, allowing the cuttings to lie where they fall. They will serve to furnish mulch and winter protection, which are so greatly needed in our climate, and their presence does not necessarily appear to increase the probability of the spread of the disease.

Harvesting Alfalfa.

Alfalfa should usually be cut as soon as it is in bloom. If allowed to stand much beyond the period of early bloom the plants start much less promptly after being cut and the total yield of the season will be relatively small. The last cutting in any season should not be too late. It is desirable that there should be a considerable growth remaining on the field for winter protection.

After cutting, alfalfa should be allowed to lie, with possibly one turning, until it is wilted. It should then be put into windrows and later into cocks, where it should be allowed to remain until cured. If hay caps can be used the results will be more satisfactory. Should the time required in curing exceed about five days, the cocks should be moved to avoid injury to the roots, and it is desirable, as in the case of clover, which is often similarly handled, to remove the caps and open or turn over the cocks on the morning of a good day, when it is judged to be sufficiently cured to be put in.

Annual Top-dressing.

If the crop has been successfully inoculated, or if the nodules which have been referred to are abundant on the feeding rootlets of the alfalfa plants, it will not be necessary to top-dress with materials furnishing nitrogen, or, at least, if such materials are at all required, as may be the case upon soils which are naturally very poor and light, they should be used only in moderate quantities. It is necessary, however, in order to secure large crops to supply the mineral elements of plant food in abundance. The following mixture of materials is recommended, annually, per acre: basic slag meal, 1,200 to 1,500 pounds; high-grade sulfate of potash, 250 to 350 pounds; or low-grade sulfate of potash, 500 to 700 pounds. This mixture may be applied either in the autumn or in very early spring.

Conclusion.

While the writer does not yet feel perfectly confident that alfalfa will establish itself in all localities as one of our valuable farm crops, he would express himself as now beginning to hope that it can be made to succeed. He would, however, counsel some caution at the start, and would urge that small trial areas be put in in all localities where soils of the right character are found. He would call particular attention to the fact that the successful cultivation of alfalfa would not only mean a valuable addition to our forage crops, but would also mean soil improvement, for where alfalfa has been successfully grown the soils are sure to be rendered more productive. This improvement in the case of alfalfa would be a consequence, first, of the extensive subsoiling due to the deep penetration of the great tap roots of the plant; and, second, to an accumulation of nitrogen in roots and stubble, drawn in the first instance from the air. It will be understood that when an alfalfa sod is plowed this nitrogen will become available to succeeding crops.

CELERY GROWING, STORING AND MARKETING.

BY HENRY M. HOWARD, DIX FARM, WEST NEWTON, MASS.

The raising, bleaching and keeping of celery is easy enough, if certain methods are carefully pursued. Success is sure if the right thing is done at the right time in the right way. Any one who follows the directions and methods mentioned in this article will be sure to succeed in growing and keeping celery. You may succeed if you do not exactly follow these methods, because there are other ways of doing these things beside those mentioned here.

Soils.

Almost any soil will grow good celery when that soil is properly prepared and kept in good condition. A soil that will grow good crops of beets, onions or lettuce will grow good celery. The soil must be rich, moist and loose. A low, moist, cool soil will grow good celery in midsummer to sell in July and August, but is not a good soil for that to be harvested in November. A heavy loam will carry a good crop to maturity in September or later. To have a crop mature in September it must be set in June. A light, sandy soil or a gravelly loam may be set to celery from July 20 to August 10, and made to yield an excellent crop. This last soil should not be set to celery before July 20, as the cost for care and water would be too great.

Varieties to Plant.

Be sure to buy your seed of the same firm every year, and insist on having the same strains and varieties that market gardeners use, — Paris Golden for early use and Giant Pascal for late use. These two varieties are largely cultivated, and are as good as any that are grown. The French strains are best.

The Paris Golden makes a good celery to use up to November, and is easily bleached with boards. The Giant Pascal may be had ready for the table from September 10 on, and will keep as well as any variety. It must be bleached with soil or grown in the pit, to be of good quality.

Methods of growing the Plants.

Plants may be started in flats in the house, or under glass in a hotbed or greenhouse. Prepare a flat thus : Take a box not over 2 inches deep, and with other dimensions of any convenient size, sift in 1 inch of sharp sand or coal ashes, and then fill in the box level full with good sifted garden soil. Press the whole down and level the surface. Sow the seed broadcast and sift on a little more loam, covering the seed a little less than ⅛ inch. Keep moist and warm until the plants appear, which should be in from one to three weeks, according to temperature and age of seed, but chiefly temperature. Keep the plants growing, and prick out in a hotbed or cold frame, setting about 300 plants to the sash. The plants should be kept under glass, and made to grow by proper care in watering, ventilating and keeping warm at night, using mats on the glass for that purpose. Seed sown in flats or under glass March 1 should give plants large enough to prick out April 10. These plants, if carefully grown, should be ready to go into the field by May 10.

Another way to get good plants is to sow in rows 6 inches apart in a hotbed or cold frame from March 1 to March 15. The ground should be kept moist and warm until the plants appear, and should then be stirred between the rows, and the plants ventilated and cared for the same as when started in flats.

Good plants for the main crop can be grown by sowing the seed broadcast or in rows in the open field as early in the month of March as you can sow peas. Cover the seed not more than ⅛ inch. These plants should appear in about three or four weeks; less attention than is required in the methods previously mentioned will give plants of good size to set after early crops of lettuce, beets or beans. Celery seed may be sown up to May 1 with good prospect of getting plants large enough to set in July and August.

Market gardeners raise many plants in greenhouses and hotbeds to set on low land for celery to market in July and August. The plants for all celery marketed later than that come from seed sown with a machine in the field, in rows 8 to 12 inches apart.

If your plants are not growing as rapidly as you wish, give a little nitrate of soda and plenty of water. You must be careful, or the plants will suffer from too much nitrate of soda. If the plants are getting too large, cut back the tops and loosen the roots, to check their growth and start new roots and tops. The effect produced by loosening the roots with a fork is very much the same as that of transplanting, and far more economical. Plants should not be thicker than four or five to the inch in the row, and must be thinned if they stand thicker than this. If sown too thick broadcast, it will be best to transplant all plants, setting them in rows about 6 inches apart, and the plants as close as possible in the row. If a broadcast bed gets too weedy, it will be found cheapest and best to transplant to a new bed, using plenty of water until the plants become established.

The Preparation of the Soil.

It is well understood that in order to have a good garden, manure is needed. Fresh horse manure is good manure to plow in for a garden, and 5 cords every year are needed for a garden of $\frac{1}{4}$ acre. If you will use that much manure you will find that whatever you plant grows better than it did before and matures more quickly, and that your crops do not feel the effects of dry weather as badly.

For celery prepare the land by plowing in all weeds and refuse and what manure you need after the first crops of peas, beans or beets are removed. Harrow and drag the surface, and then you may wait for right weather conditions. If they do not come, and you are ready to set the plants, harrow and drag again and then wet down the whole surface of the soil with water, using 1 inch of water, which would amount to 27,180 gallons to the acre. There is nothing else that will do as much good just at this time. Lay off the rows 2 to 5 feet apart, and set the plants as soon as the land is in fit condition. If both early and late celery are grown, you may set the rows of late celery between the rows of early, the rows of each variety being 4 feet or more apart. This method of planting enables you to get a good row of celery every 2 feet. By setting the plants 6 inches apart in the row you can get one good root of celery for each square foot of your land.

Each person setting plants should set 400 or more an hour, and the plants should be so firmly set that in trying to pull one out by a leaf the leaf will break before the plant will start to come out of the ground. If the weather continues dry after the plants are set, more water should be given them.

As soon as a day or two after the plants are set they may and should be shove-hoed, and this style of hoeing should be continued every four or five days until the plants shade the ground.

Celery likes a soil well prepared by plowing, harrowing and dragging, and will do best where fresh manure is plowed in. If the land is not wet, water must be applied before the plants are set. If the plants must be pulled any length of time before setting, they should be stood in water for a few minutes and then placed in the shade until wanted for setting. New white roots will start to grow at once, and in a day or two after setting you will be able to see that the plants are growing. Boys may pull and drop the plants for the men to set.

Water should be used freely before and sparingly after setting the plants. A $\frac{3}{4}$-inch hose with 65 to 75 pounds pressure will run 600 to 700 gallons of water an hour, and will take something like four days to wet down an acre of land sufficiently for setting celery, costing about $14 or $15 for water and labor. Some sort of a labor-saving sprinkler system should be used. The writer has tried several such, and is satisfied that there is no system better or more economical than the Skinner system. The pipes may be laid on the surface of the ground when preparing the land, and may be left there until the celery is nearly grown. Should it need watering when nearly mature, set the pipes up on stakes about 3 feet above the su. face of the ground. This system is made of iron pipe and brass fixtures, and will last a long time. It will be found very satisfactory in any garden of $\frac{1}{4}$ acre or over. Most other systems require more labor and also the use of considerable hose, which soon wears out and is sure to injure more or less plants while being used.

If only Paris Golden celery is grown, the rows may be from 2 to $2\frac{1}{2}$ feet apart, and do well. Many market gardeners have also tried growing the Giant Pascal celery in rows that distance apart, and continue to do so, bleaching the crop in the pit. Another way of setting that has been tried by many, and seldom tried a second season, is that of setting the plants 1 foot apart each way. You can get in as many plants if they are set 6 inches apart in rows 2 feet apart, and the cultivation is much simpler, and can be largely done with a horse and a five-tooth cultivator.

Cultivating.

The whole idea of cultivating celery is to keep the ground loose and cultivation shallow, and it is just as important to cultivate in a wet time as when there is continued dry weather. The ground is apt to get hard in wet weather, and the roots get too numerous near the surface; then a period of dry weather follows, and the cultivation cuts off so many roots that the crop suffers and is more liable to disease. With proper preparation of the soil and proper cultivation of celery we have no fear of disease, and no use for nitrate of soda or spraying with Bordeaux mixture to prevent blight. Nitrate of soda is good to make celery move along a little faster, and it is safe to use 200 to 300 pounds to the acre between the rows, or 2 pounds to a row 100 feet long in a garden.

Bleaching.

The early or Paris Golden celery may be bleached with boards and gotten out of the way, so that the late celery or Giant Pascal can be banked with earth. This is the plan used where you wish to sell all the celery from the field. The boards used are rough boards, not less than 10 inches wide, 12 feet long and 1 inch thick. These same boards are used in making storage pits for the winter celery. The boards are set up on edge as straight as possible, and kept in place by slats nailed across the upper edges of the boards, about 2 feet from the ends. The space between the boards through which the celery grows should be left at least 4 inches wide. Many market gardeners use a heavy galvanized-wire hook to drop over the edges of the two boards. These hooks are very easy to handle, and very convenient when taking out celery. They are safe, doing away with sharp nails for horses or men to step on. The time needed for celery to bleach in the boards is from one to three weeks, according to the weather and the growth of the celery. It is not safe to set up boards to celery after the 1st of October. The celery is apt to bleach slowly after that, and a frost is liable to occur after October 22 that will injure the celery in the boards.

Giant Pascal celery may be bleached very early in September by earthing up. Great care is needed that the plants be dry, well pressed together, and not buried when putting the dirt up to them by means of the plow, the hoe and the shovel. The soft earth is plowed up to the row, the hoe is used to press the dirt in firmly, and the shovel is used to carry and pack the dirt still higher up on the stalks. A 10-inch bank will do excellently for September banking. After the bank is up for a week the celery should be examined every day, as it is very liable to rust in the bank at this time of year. Not much should be banked at a time thus early in the season, and every few days a little more may be banked, thus having a continuous and increasing supply coming on for market. It is best to drive a stake at the first row of each new lot banked, and write on the stake the date of banking. You will find the celery ready to use in about ten days if banked early in September.

Where Giant Pascal celery is planted by itself to be sold from the field, the rows should be 3½ feet apart. Every other row can be earthed up early and sold, and then a broader, thicker bank put up to the row which is left, to be taken out as late as November 25. Almost all the celery around Boston is housed by November 20. These later-banked rows may be the very best celery to try to keep late in storage, if the celery gets bleached only a very little. Usually, the later the celery is put in storage the later it will keep.

Storing.

Celery is prepared for storing away in pits or cellars by banking it in the field about a week before it is to be put in. Near Boston we begin to put the celery into the pits by October 18, and continue to store it away every day when the weather is favorable until the crop is all in. Choose days that are not too windy or wet, and get the celery to the pit and set up before the roots dry out. In plowing out the celery, a good plowman with one good horse will soon be able to turn out the rows so flat as to look like machine work, and not a plant will be bruised or hurt. Then we give the root a little kick with the foot and a little shake with the hand, trim off the loose or crooked outside leaves, and lay the roots in piles of convenient size to load. Some farmers trim the celery at the pit; but it saves much time in handling and teaming to trim it in the field, and this is the method usually followed.

The celery is set in the pit in rows 3 to 4 inches apart, and the plants touching in the row. The plants are set about 3 inches deep in these rows, and the dirt made firm enough on the roots to keep the celery standing upright.

If you wish to keep celery very late, into April or May, you must give the plants more room in the pit, setting them at least 3 inches apart each way, and be attentive to covering and ventilating. The roof of the pit must be water tight, and supplied with ventilators every 10 feet. The covering on the roof should be 8 inches of leaves or strawy manure, or about 1 foot of salt hay. If there is a good covering on the pit, it will be safe to give ventilation even on very cold days. There should be thermometers in the pits to guide as to temperature. The pits should be kept from sweating, and enough air should be supplied to keep the celery tops dry. The temperature should be kept as nearly at 32° F. as possible, if it is desired to keep the celery late. With a pit well covered, an outside temperature of 20° and an inside temperature of 35°, some ventilation should be given and the pit cooled down to 32° and kept dry. If a pit gets too cold, a space large enough to set a cast-iron coal stove should be cleared, a good coal fire built, and it will soon be warmed up.

A pit which is to stand over winter needs to have a double-pitch roof, 7 feet high at the ridge, about 3 feet at the eaves, and should be well banked on the ends and sides with loam. The width of the pit will be about 23 feet when 12-foot boards are used on the roof. The ridge should be a 2 by 6 inch plank, supported every 5 feet by a post; the purlines to support the roof boards may be of 2 by 6 to 3 by 4 inch stuff, with a post every 5 feet. The sides of the pit may be of earth, or of earth and plank. A walk 1 foot wide, from one end of the pit to the other along the middle, nearly under the ridge, is convenient and aids in getting a closer view of conditions inside the pit. The ventilators are made by using two boards right over the posts supporting the ridge and purlines, and these ventilators are on each side of the pit, and alternate. They may be thrown wide open or opened just a few inches at the top, according to the weather. The celery is removed by opening wide one of these ventilators near where the celery is ready to come out. Celery pits need a great deal of attention to ventilation, if you wish to keep the celery late.

Marketing.

The earliest celery in the market is Paris Golden. Often by July 10 we find this celery coming on the market in fine shape. When several roots are needed to make a bunch, they are fastened together by nails through the root. Many times a single root is large enough for a bunch. Eighteen bunches are packed in a bushel box. The Paris Golden is a very handsome celery when well grown and well put up for market. It has a strong flavor, is tough and will stand up well. It grows large, is a good keeper and a good money maker. It is often bleached with earth, the same as Giant Pascal celery, and when so bleached is much better for eating.

All celery should be kept covered with wet paper or bagging after it is put up for market, and kept as cool as possible. Use plenty of ice, chopped fine, and plenty of paper on early celery, if you would have it look well and command the top price.

The Giant Pascal celery is put up for market the same as the early celery. The bunches are made as regular in size as possible; three to five roots are put in a bunch, and eighteen bunches are made to fill a bushel box. The Pascal is a large, strong-growing celery. It is of mild flavor, and brittle. It has a waxy look, a nutty flavor and a crispness which make a great demand for it as soon as it appears in the market. The very best, cleanest and slickest-looking Pascal celery can be had by bleaching it in a pit. Set the plants as before described in a pit, having taken pains to have the soil in the pit well wet down, keep the pit a little close until the plants get rooted, and give air according to growth desired. Great care must be exercised, or the whole pit of celery will come forward too fast and be difficult to sell in the short time in which it ought to go, especially if your market is small.

Aim to put up your celery so well that there will be a strong demand for your mark.

For small gardens, where a fresh supply is wanted daily, a whole tubful of plants may be prepared from the pit at one time, leaving the roots on and having about one pailful of water in the tub.

In summing up, the essentials of success in the celery business are as follows: good seed, sown early in rich soil; the plant must be kept growing; transplanting should be done only after the land is properly prepared; cultivation should be frequent and shallow; water beside rainfall should be used if necessary; bleaching must be carefully attended to; storage pits must be well built and ventilated; and when the crop is grown, it should be put in fancy shape and sold for the highest price.

QUINCE CULTURE.

BY PROF. F. C. SEARS, PROFESSOR OF POMOLOGY, MASSACHUSETTS AGRICULTURAL COLLEGE.

The following notes on quince culture are given in response to a request from the secretary of the State Board of Agriculture for something on the subject which might be sent out to residents of the State from whom inquiries are frequently received for information as to this fruit. It is not supposed that the industry will ever grow to large proportions in Massachusetts. In fact, from the very nature of the fruit and its uses there can never be more than a very moderate demand for it. But as a part of the home fruit plantation, or as a modest part of the commercial orchard, it is certainly deserving of more attention than it has received in the past. In fact, even when they are planted, quince trees seem to be more systematically neglected than other fruits, which is certainly stating the case strongly.

As every one knows, the quince never makes more than a large bush or a very small tree, 15 feet being the extreme for height, so that they may readily be included in even a small plantation of fruits. And while, as ordinarily seen, the tree is straggling and unkempt, owing to lack of care, yet when given a little intelligent attention, particularly as to pruning, it makes an attractive little tree; and when it is in full bloom very few fruit trees are more beautiful. The blossoms are large and snowy white, shaded with a delicate pink, and would make an attractive sight at any time, but, coming as they do, when other fruits are out of bloom, they seem doubly beautiful.

As an article of diet the quince takes a high position, and deserves far more general use than it receives. Quince marmalade and quince preserves recall to every one's mind his grandmother's fruit closet; and while preserves are not indispensable, like flour and sugar and tobacco, yet in case of unexpected guests a well-stocked fruit closet brings a feeling of security. We shall have more to say on the uses of the quince in a later paragraph. Just now we merely wish to establish the principle that the quince is worthy of wider use than it at present receives.

Soils and Fertilizers.

In the choice of a spot in which to grow quinces, one is usually very much restricted, since they generally form a small and relatively unimportant part of the home fruit plantation, which is located only with regard to its convenience from the house. Yet if one is allowed a choice, as is usually the case when one is setting a really commercial plantation, soils, windbreaks, exposures, etc., may all be considered.

I do not think the quince is an exacting fruit as to soils. Certainly we have all seen it growing on a great variety of soils with excellent success (when one considers the utter neglect to which it is generally subjected). I recall, in particular, a row of old quince trees growing along a roadside in decidedly sandy soil which have year after year given a crop of fruit. I will not say it was a good crop or that it was good fruit, but considering their handicap these old trees did wonders, so no one need give up having quince marmalade because the soil is sandy. Yet most authorities agree, and the writer's observations tally therewith, that the ideal quince soil is a reasonably heavy clay loam, which is sufficiently well drained so that the water does not stand either in or upon the soil, and yet which is of such a nature and has been handled in such a way as to make it retentive of moisture. This may seem a somewhat difficult combination of characters to secure, but it is not unreasonably so. A good clay loam which has not too retentive a subsoil will give the first requisites. If the subsoil is heavy, then the land should be tile-drained; and of course the lay of the land should be such as to allow surface water to drain off. It only remains to keep up a good supply of humus in the soil and to cultivate the land instead of allowing the trees to stand in sod, as is usually done. Both these are of prime importance in getting the water into the soil and in holding it there. Of course, quinces will do *something* in sod; that has been too abundantly proved in Massachusetts to be disputed, for about all the quinces we grow are produced in that way; but with the soil requirements suggested, every one (except possibly the extreme sod crank) will agree that cultivation is by all means the best method of soil management, since it allows incorporating plenty of humus in the soil and keeping up the earth mulch to prevent evaporation.

With a soil such as we have selected, and with the treatment we have suggested (cultivation and cover crops), I do not believe any application of nitrogen will be necessary after the first two years. For these two years I have found that an ounce of nitrate of soda to each tree will give all the growth necessary, even in decidedly poor soil. This should be scattered about the trees as soon as growth gets fairly under way in the spring. The first year it ought to cover a circle with a diameter of say three feet (the tree of course being the center of the circle), and the second year a circle perhaps five feet in diameter. Potash and phosphoric acid may be used much more liberally with young trees just set. A ½ pound of a mixture made up of 3 pounds of high-grade sulphate of potash and 5 pounds of acid phosphate will give excellent results, and this may be gradually increased (always having due regard to the way the trees respond) till at full bearing the orchard may get from 100 to 250 pounds of potash and from 200 to 500 pounds of the phosphate, though for bearing trees I should use, at least part of the time, basic slag meal as a source of phosphoric acid instead of the acid phosphate.

Varieties.

Compared with other fruits there are very few varieties of quinces, and, indeed, of these few a very small percentage is really of any particular value. Thomas lists 14 varieties in his "Fruit Culturist," and Budd and Hansen give 17 in their "Horticultural Manual." Out of this number only 4 or 5 have reached commercial importance over any extent of the United States.

The varieties which seem to me to be of sufficient value, or to have been sufficiently tested, to warrant one in including them in a list for planting in Massachusetts, are as follows: —

Orange or Apple. — This variety, of European origin, is one of the oldest and best known, and is often recommended as the only commercial sort for Massachusetts. I do not quite endorse this view, but it is certainly the leading variety. The chief objection to it is that it has been so long propagated, often by seeds, that several strains have been developed, some of which are not very valuable. The tree is fairly vigorous and spreading in its growth. The fruit is variable, as suggested above, but is typically rounded, not pear shaped and with distinct flattening at the ends. The color is fine golden and the surface not unduly fuzzy. It ripens about October, but will often keep in good condition up to midwinter. The flesh is firm, but cooks up tender and soft.

Champion. — This is an American variety, having originated in Connecticut. The tree is a vigorous grower, being more upright and taller than the Orange, and the fruit matures somewhat later than that variety; in fact, in some localities it does not ripen well. The fruit is large and very distinctly pear shaped, with tender flesh and delicate flavor. This would certainly stand next to the Orange in popularity.

Rea, or Rea's Mammoth. — This variety makes a small tree, but the fruit is large, sometimes very large, distinctly and abruptly pear shaped, a rich orange in color and with a very smooth skin. The flesh is of excellent quality, and the fruit is ready for use earlier than most other sorts.

Meech or Meech's Prolific. — This variety also originated in Connecticut, and resembles the Orange considerably. The fruit is usually obscurely pyriform in shape, of a fine orange color, very fragrant, and of fine quality.

A fifth variety which might be added, though the writer has little personal knowledge of it, is the Bourgeat. This was recently imported from France and has given excellent results in some places. Mr. E. C. Howard of Belchertown, in particular, has been much pleased with it.

Selecting Trees and planting out.

In the choice of nursery stock most growers select quince trees two or three years old. The writer would never go over two years, and would even prefer strong one-year trees. The arguments are the same as with any other fruit trees. The younger tree is apt to be less disturbed by transplanting and to take hold better for this reason. One is apt to get better stock in one-year trees, since only the best and most vigorous trees reach saleable size at that age. And, above all, it allows one to head the tree low, which is certainly the only way to head quinces. Among the larger tree fruits there may be some question on this point, at least there is room for argument, but the quince is at best not much more than a shrub, so that the familiar argument of wanting to get the team up under the branches will not apply. In the writer's opinion 12 inches is plenty high enough to head a quince. If one-year stock is used the tree may be simply cut off at this point and allowed to form a head from new branches sent out below this.

As to distance apart, authorities differ, but from 10 to 15 feet is usually recommended. With repressive pruning (heading in each year's long, straggling growth) it will certainly be many years before quinces will crowd each other even at 10 feet, and that is the distance which the writer has generally adopted.

In the setting of the trees no special treatment is necessary. I believe that fall setting might perhaps be justified here more often than with other fruits, for the reason that the ideal quince soil being on the moist side is apt not to be ready for planting as early in the spring as some others. My own belief is that very early spring setting is the best for almost any fruit trees, and that next to this is very late fall setting. The trees ought to be set at least a couple of inches deeper than they stood in the nursery, since the quince is naturally a shallow-rooted tree and the roots will tend to work up nearer the surface. After setting, clean cultivation should be practiced. As in most other phases of the care of the quince, there are no special reasons for this farther than the one already suggested, that the quince thrives best under comparatively moist soil conditions. And, for the same reason, in selecting a cover-crop choose one which makes a good growth, like buckwheat or barley, or, for a nitrogenous cover-crop, vetch or soy beans. This should be sown the middle or last of July.

Fruit-bearing and Pruning.

The method of bearing fruit, in the quince, is one of the most interesting and unusual among all the tree fruits. There are no winter fruit buds as in most other fruits, but each spring the lateral buds on the shoots of the previous year's growth send out new shoots, and after these shoots have grown for a few inches (usually from 3 to 6) a single

FIG. 1. — Young quince tree, just coming into bearing, showing few long shoots.

FIG. 2. — Young quince tree, not yet in bearing, showing long terminal shoots, which need heading in.

blossom is produced on the end of the shoot. This, of course, temporarily stops the growth in that direction, and if the blossom sets a fruit there is no further growth at this point for the season. If it does *not* set fruit, however, one of the lateral buds on the shoot will frequently start into growth and continue the lengthening of the branch, sometimes for a foot or more. All this means that on those branches where a quince tree sets fruit its yearly growth is very slight indeed, and if it bears abundantly, the tree will present a rounded top, looking almost as though it had been sheared, as in the case of the tree in Fig. 1. Whereas, if the tree sets little fruit, a young tree in particular may make a long, spreading growth, which will give it the appearance shown in Fig. 2.

We are now in position to consider the matter of pruning, which is chiefly concerned with keeping the tree from growing ragged and out of shape, as it will most certainly do if neglected, and in keeping up a supply of thrifty one-year-old wood from which the bearing shoots may start each spring. As in other fruits, the main pruning may be done at almost any part of the dormant season, but preferably about March, and a good pair of hand shears such as are used in grape pruning is all that is necessary for practically all of the work. The first operation is to shorten in the long terminal shoots, shown in Fig. 2, and unless there is special reason for wanting the tree to enlarge, these may be cut back from two-thirds to three-fourths of their growth, or even cut out altogether in some cases. The next operation is to go through the tree and thin out the entire top. The severity of this thinning will depend altogether on the previous treatment of the tree. If it has been neglected, it may be necessary to remove a large amount of wood, so as to induce an abundant new growth; while if it has been well cared for, there may be only here and there a crowding branch to remove. In any case, experience (either one's own or that of another) is the only sure guide. But the aim ought to be to keep the head sufficiently open so that the center of the tree may not become "blind," or devoid of one-year wood. As compared with other fruits, however, the quince may be allowed to form rather a thick top, since it never attains large size and consequently the sun and air will penetrate to the center of the tree through a thicker top.

Insects and Fungous Pests.

The quince is really troubled with very few insect or fungous enemies in well-kept orchards. Of course the neglected and run-down trees, which are the too common rule, are likely to be attacked in various ways, but where trees are given anything like modern treatment the number of enemies is relatively very small. Even deer, the newest and worst enemy of apple orchards in Massachusetts (worst because protected by the State), are said not to browse on quince trees.

Among fungous troubles, by all means the most important and most common here in Massachusetts are the quince rust and the leaf blight or fruit spot. Of these two, according to the writer's observation, the rust is much more common, but when the leaf blight does occur it is apt to do much more damage. The rust attacks both the fruit and the twigs, and at a certain stage, particularly on the fruit, it produces long, thread-like growths over the surface of the affected parts, which are orange in color and very conspicuous. On the twigs it produces knots not unlike the black knot of the plum, though without the pimply appearance of surface which the plum knots have. Frequently the fungus works entirely around the branch, causing it to break off. The fungus causing this disease is one of those curious forms which have two stages of growth. One is the disease of the quince we are discussing, and the other is found upon cedar trees. The treatment would therefore be to destroy affected cedar trees, at least those near the quince orchard, and to cut off and burn the affected parts of the quince, whether fruit or twigs. Then, in addition, thorough spraying with Bordeaux mixture will usually hold it in check. The writer has found that an application early in the spring, shortly after the leaves appear, a second one just before blossoming, and a third just after the blossoms fall will usually almost completely protect the orchard.

The second disease, the leaf blight or fruit spot, is, as I have said, likely to be more serious than the rust when it does occur. It produces on the leaves small dots, red-brown in color and circular in outline, which may coalesce so as to form larger irregular spots. In severe cases the leaves turn yellow and drop off, sometimes leaving the tree entirely bare by the last of August. On the fruit it shows as dark-brown sunken areas scattered over the surface. Fortunately, this disease, though serious when allowed to go untreated, is fairly easily controlled by sprayings, and practically the same sprayings given for the rust will give satisfactory results with this disease.

Among insects there are three which deserve to be mentioned: the codling moth, the borer and the curculio. The codling moth is the same fellow who produces the "wormy" apple, and is to be fought in the same way, viz., by adding arsenate of lead or Paris green to the Bordeaux used just after the blossoms fall. Paris green should be used at the rate of 6 ounces to 50 gallons of Bordeaux, and arsenate of lead at 3 to 4 pounds to the same amount of Bordeaux.

Borers are usually not troublesome in cultivated orchards, but the trees should be watched, and when they are attacked the borers must be dug out, or a wire run into the burrow till the insect is reached. In sections where borers are likely to be troublesome the trees ought to be examined in late spring and early fall, particularly just at the surface of the ground. This will usually be entirely effective in keeping them down.

The last insect is the curculio, which attacks the fruit in much the same way that the apple is attacked, though it is by no means as common an enemy. These insects may usually be controlled somewhat by spraying, just before the blossoms open, with Paris green or arsenate of lead, as outlined for the codling moth. But the surest way to get rid of them is to jar them on to a sheet spread under the tree. This is a slow and tedious method, but one which is practiced by many commercial growers.

Picking and Marketing.

Quince trees ought to begin to bear by the fourth or fifth year and should reach full bearing by ten years. The life of the orchard of course depends on the care it receives, but some of the commercial orchards of New York have remained healthy and productive for forty years.

While the quince is a firm, hard fruit, it is easily bruised, and such damages show up very plainly. It ought therefore to be handled with care, from the time it is picked till placed upon the market. If picked directly into half-bushel baskets, and carried in these to the storage house, the bruising is perhaps as little as possible. For market they may be packed in almost anything, from a grape basket to a barrel. Where one can reach the retailer direct, large-sized grape baskets are excellent, but barrels and half barrels are frequently used. Practically the same arguments apply to the different packages as apply to apples.

Uses.

Like a great many other good things quinces are not used as generally as they ought to be. It is not the design of these notes to say all that might be said on any phase of the subject, but it does seem that a few suggestions as to some of the more common ways of serving quinces would be in order. The writer can personally recommend the following receipts. He cannot say that he has tried them all, but he has tried the "results" and knows that they are good. They are taken from various reliable cook books.

As quinces are of such a strong flavor, a few of them will make a large quantity of delicious marmalade, jelly and preserves by using apples in combination with them. The quinces should be cooked in water until soft *before* adding sugar, for if sugar is added when cooking begins, the quinces will become hard.

Canned Quinces. — Pare and core quinces and an equal quantity of sweet apples. Use one third the weight of sugar dissolved in enough water to make a syrup. Cook slowly until tender.

Quince Marmalade. — Pare and core quinces and cook until soft in enough water to cover them. Then rub through a sieve and add three quarters the weight of sugar. Cook twenty minutes and put into jelly glasses.

Quince Honey. — Pare and grate five large quinces. Add five pounds of sugar to one pint of boiling water. When sugar is dissolved, add the grated quince and cook twenty minutes. Turn into jelly glasses.

Quince Jelly. — Put parings and imperfect quinces into a preserving kettle, with one quart of water to two of the fruit. Cook slowly for about two hours. Then strain, measure juice and bring to the boiling point. Add an equal quantity of hot sugar and boil until a drop of it placed upon a cold dish hardens. A nice jelly is made by using one-half apple juice in the above receipt.

Preserved Quinces. — Pare and core quinces. Place in a kettle with enough water to cover them and cook until soft. Then add sugar equal in weight to amount of fruit, and cook until it reaches the desired color.

GRAPE CULTURE.

BY MR. EDWARD R. FARRAR OF LINCOLN, MASS.

For the commercial growing of grapes two things are essential,— aptitude for the work and a favorable location, where the late spring or early fall frosts are not likely to destroy the crop. If either of these is lacking one will do well to give his attention to some other crop.

Cold air settles on the lower levels something as water does, this being referred to as frost drainage, so that an elevated hill slope is needed for grapes, preferably with a south or southeast exposure. If there is a body of water at the foot of the hill so much the better, as the air moving down over the water is warmed, and rises, giving a current of air which will occasionally save a crop, as it did this year on a corner of my vineyard that slopes toward a pond, the rest of the fruit being nearly all killed by the frost in June this season.

The slope and the character of the land should be such as will ripen the fruit early, as the price drops very materially when the New York or western grapes come into the market, making it difficult to dispose of our crop at a profit. Windbreaks, protecting the vineyard from the strong prevailing winds, are a help. The injury to the leaves by high winds gives favorable conditions for the entrance and growth of fungous diseases.

Soils.

Grapes prefer a light, friable soil, and cultivation and cover crops help to keep it in this condition. Occasionally, with special care, a rocky or steep hillside may be used.

Fertilizers.

Fertilizers should be used that will be ample for growing the fruit, but without making undue growth of wood. Stable manure is more apt to promote fungous growth than are commercial fertilizers.

Varieties.

For commercial uses Moore's Early, Worden and Concord are the best varieties. An additional list would be Winchell, Campbell's Early, Diamond and Niagara.

For the home garden a selection might be made from the following varieties: Brighton, Campbell's Early, Concord, Delaware, Diamond, Herbert, Moore's Early, Niagara, Winchell and Worden.

The following brief descriptions of these varieties are compiled from Bulletin 315 of the New York Agricultural Experiment Station: —

Brighton.— Originated in New York in 1870; tendrils, continuous; self sterile; stamens, reflexed; cluster, very large to medium in size and medium to loose in compactness; berry, medium to large in size and round to oval in form; color, red; flavor, very sweet; quality, very good; season, midseason; use, for dessert and market; well recommended; of high quality, productive; earlier than Concord; a good market grape.

Campbell's Early.— Originated in Ohio in 1892; tendrils, intermittent; fertile; stamens, upright; cluster, very large to medium in size and close to medium in compactness; berry, large in size and round in form; color, purplish black; flavor, sweet and vinous; quality, good; season, early; use, dessert and market; well recommended; one of the standard commercial grapes.

Concord.— Originated in Massachusetts in 1843; tendrils, continuous and irregular; fertile; stamens, upright; cluster, large to medium in size and close; berry, about medium in size and round to oval in form; color, black; flavor, sweet and slightly foxy; quality, good; season, midseason; use, for dessert and market; well recommended; hardy and productive; the standard market grape.

Delaware.— Originated in New Jersey (?) in 1849; tendrils, intermittent; fertile; stamens, upright; cluster, medium to small in size and close; berry, small to medium in size and round in form; color, light red; flavor, vinous, spicy and sweet; quality, best; season, midseason; use, dessert, market and wine; well recommended; the standard American grape for quality.

Diamond.— Originated in New York in 1870; tendrils, intermittent; fertile; stamens, upright; cluster, medium to large in size and close; berry, about medium in size and round to oval in form; color, green to yellowish green; flavor, spicy; quality, very good; season, midseason; use, dessert, market and wine; well recommended; one of the best white grapes; worthy of more general cultivation.

Herbert.— Originated in Massachusetts in 1852; tendrils, intermittent; sterile; stamens, reflexed; cluster, medium to large in size and loose; berry, about medium in size and round in form; color, black; flavor, tart; quality, good to very good; season, midseason; use, dessert; recommended; on account of quality, one of the best table grapes.

Moore's Early.— Originated in Massachusetts in 1871; tendrils, continuous; fertile; stamens, upright; cluster, medium in size and compactness; berry, large to medium in size and round in form; color, purplish black to black; flavor, foxy and sweet; quality, fair to good;

season, early; use, dessert and market; well recommended; the standard early commercial grape.

Niagara.— Originated in New York in 1868; tendrils, continuous; fertile; stamens, upright; cluster, large to medium in size and medium in compactness; berry, about medium to large in size and oval in form; color, green to yellowish green; flavor, foxy, sweet and tart; quality, good to very good; season, midseason; use, dessert and market; well recommended; the standard white grape for the commercial grower.

Winchell.— Originated in Vermont in 1850; tendrils, irregular; fertile; stamens, upright; cluster, large to medium in size and loose to medium in compactness; berry, about medium to small in size and round in form; color, light green; flavor, juicy and sweet; quality, very good to best; season, early; use, dessert and market; well recommended; the standard early green grape.

Worden.— Originated in New York in 1863; tendrils, continuous; fertile; stamens, upright; cluster, large and close; berry, large in size and round in form; color, dark purple to black; flavor, sweet, juicy, foxy and mild; quality, good to very good; season, early midseason; use, dessert and market; well recommended; the standard early black grape for home use and market.

Planting.

The holes should be dug about 10 inches deep and the plants carefully set out, using either strong one-year-old plants or two-year-old plants. The vines should be purchased of one of the large, reliable firms in the grape regions of New York. The rows should be set 8 feet apart, with the vines 6 to 8 feet apart in the rows. I prefer early spring planting.

The land should be in good condition, with plenty of humus. Ground bone or some other slow-acting fertilizer may be dug in where the vines are set. For the first two years light posts, with one or two wires, may be used. After that substantial posts, with two to four wires, will be needed.

Pruning.

The first year the vines should be cut back to two buds. These should be allowed to grow as long as they will. The next year the vines may be cut the height of the lower wire, and two shoots again be allowed to grow, breaking the others off soon after they start. The object of this severe pruning is to get a strong root system established, not allowing too much of the vine to go into unnecessary top. The third year the best cane may be left 3 to 6 feet long, according to the strength of the vine.

To get a good crop of large clusters strong canes of well-ripened wood are needed, the fruit being grown only on the wood of the previous year's growth. To obtain such, various methods are used. Probably the best way is to have one cane on the trellis run from that vine to the next, so that when the vines are in place on the trellis there will be on one of the wires a continuous line of bearing wood, and on a wire underneath this two canes for the next year's bearing may be grown, the best one of them to be used for the next year's fruiting.

Another good method is to have two or four arms on the vines, so placed that on the second and fourth wires there will be a continuous line of bearing wood. Where this method is used a number of the poorer shoots may be broken off when young.

Another way, practiced considerably in New York, is to have the vine along the lower wire, the other shoots being grown vertically and tied to the other wires. Another way is to let the vine grow pretty much as it will, cutting away all but two or three buds on the stronger last year's shoots.

Summer Pruning.

If the vines have wintered favorably a number of the smaller buds may be rubbed off soon after they start, and all those on wood more than one year old, unless wanted for next year's bearing. About the time the blossoms open, by pinching back the ends of the new growth the life of the vine is forced back into the bunches, helping them to set large clusters. The pinching back should be done so as to leave about five leaves on the cane beyond the bunch of fruit. Side shoots will start, which may be cut back two or three times during the season. The new leaves, being of a light color, are easily seen, and only the stronger growth needs cutting back.

Girdling.

Ringing or girdling the vine may sometimes be used to advantage. This is done by taking off the bark about an inch wide around the vine, the theory being that the sap goes up in the wood and down in the bark. By cutting the bark the sap is forced into the growth above the part girdled, and by keeping the vine cut back the fruit is usually increased in size, and ripens from a week to ten days earlier. The girdling should be done about the middle of July. The part of the vine girdled dies in the winter. Only one-half of the vine should be girdled, as about that proportion is needed to keep up the vigor of the vine. If too much of the vine is girdled the fruit does not ripen well, and the vine is weakened. I have practiced girdling more or less for fifteen years, and see no injury to my vineyard from it.

Thinning the Fruit.

Soon after the fruit is set the vines should be gone over, and where there are more bunches than are needed the smaller ones should be taken off, so that the fruit the vine is able to carry will be in as few bunches as possible.

Spraying.

For fungous diseases spraying is a preventive rather than a cure, as after the fungous diseases are well started spraying has little effect in checking them. A good spraying with a strong solution of copper sulphate, before the buds start, covering thoroughly the vines and also the posts, often helps out very much the rest of the season. By adding arsenate of lead to this spraying mixture it will help take care of the earlier insects. Just before the blossoms open a spraying of Bordeaux and arsenate of lead should be used, covering the bunches thoroughly. This repels and usually checks the work of the rose bugs. They like to eat the grape blossoms, and are one of the few insects not affected by contact or stomach poisons. Another spraying ten days later is needed, and occasionally a fourth spraying.

The chief diseases of the grape are anthracnose, black rot, downy and powdery mildew. The chief insects affecting the grape are the flea beetle, grape-fruit worm, leaf hopper and rose bug. These are usually controlled by the sprayings above referred to.

Marketing.

Grapes are usually disposed of to the best advantage by marketing as soon as they are well ripened. Moore's Early and Winchell should be disposed of as soon as suitable, as the first is liable to have the fruit shell off and the other loses tone.

The package should be such as suits the market where they are sold. I use an eight-quart diamond basket, which holds from ten to twelve pounds.

In years like the present the smaller bunches can be picked before they are quite ripe, and sold for preserving. In local markets there is often considerable call for grapes for that use.

Prices are not such as were received thirty or forty years ago, but for several years past have ranged from 2½ to 7 cents per pound, averaging about 4 cents.

I usually begin selling in August, and my crop is generally all marketed by the 20th of September. I have had no loss from fall frosts since 1893.

There is many a sheltered nook about buildings or yard where a few vines might be grown. It is always well to keep one's family well supplied with choice fruit.

NINTH ANNUAL REPORT

OF THE

STATE NURSERY INSPECTOR.

PRESENTED TO THE BOARD AND ACCEPTED,
JANUARY 10, 1911.

NINTH ANNUAL REPORT OF THE STATE NURSERY INSPECTOR.

To the State Board of Agriculture.

I have the honor to submit herewith the ninth annual report of the State Nursery Inspector.

The ordinary work of inspection during 1910 was, in part, of its customary nature, 146 different places having been visited, controlled by 136 owners. Of these, 117 received certificates; in 10 cases the nurseries were in such condition that certificates were not issued; 7 persons have no stock this year, though they do not intend to discontinue the business, and 2 have decided to become agents hereafter.

The usual inspection this year found a considerable increase in the amount of nursery stock grown in Massachusetts. There was also a noticeable increase in the cost of living while at work; and enough days were lost by rain to make this an appreciable factor in the cost. It became evident, before the work was completed, that the appropriation would be insufficient to accomplish what is required by law, and accordingly the situation was placed before His Excellency the Governor and the Council. As a result, an additional appropriation of $100 was received, but even with this addition the work has exceeded the appropriation by about $250, which has thus far been carried by the inspectors themselves.

It was stated in the last annual report of this office that, in spite of all possible precaution, a gypsy moth egg mass would probably some day escape discovery, and be shipped with the stock. This prediction became a fact last spring, though of several cases reported only one proved to have been on stock examined by the inspectors. The States where the infested stock was received, however, were very much disturbed by finding gypsy and brown-tail moths coming into their territory from Massachusetts, and orders were prepared which would prevent Massachusetts nurserymen from selling any stock there. This was a very serious matter, and, if carried into effect, the result would have been the entire loss of a business amounting each year to more than a million dollars, for as soon as one State would issue such an order all the others would immediately follow the same policy.

As there was no organization of nurserymen in the State, information of the probable debarring of Massachusetts stock was sent to the State Nursery Inspector as the only person in touch with the nurserymen, and he at once urged a further consideration of the matter, and that at least an extension of time be allowed before these orders should take effect. He also assumed the authority to call a meeting of those nurserymen of the State who were most vitally concerned, to take the subject under consideration. This meeting was held at the office of the secretary of the Board of Agriculture, in May, and at that meeting the Massachusetts Nurserymen's Association was organized, and a committee appointed to meet the inspectors of the other States concerned, in the hope of finding some way by which the proposed discrimination against Massachusetts stock could be avoided. Such a meeting was arranged for and was held, June 11, at New York City. At that time the entire problem of providing such an examination and supervision of Massachusetts stock as would satisfy the other States was thoroughly discussed. Those in charge of the work in the other States finally consented to withhold the discriminating orders on condition that each shipment of stock from a Massachusetts nursery into the other States concerned should be immediately reported to the nursery inspector of the State to which the stock should go, giving date of shipment and name and address of the consignee. A second condition was that nurseries within the territory occupied by the gypsy moth or brown-tail moth should be inspected after September 15 by the State Nursery Inspector or his deputies, and stock shipped after that date from such nurseries not so inspected would not be admitted to the States concerned.

While this action was far more favorable than that which had been contemplated, it at once caused serious difficulties. The ordinary inspection work had required the expenditure of about the entire appropriation, and, with the normal increase in acreage, it was evident that the cost of this supplementary inspection could not be met. There would be over fifty nurseries to examine, and this must be done after September 15, and yet quickly enough thereafter to avoid holding up the business of these nurseries. The problem was how to obtain enough trained men to examine these nurseries in a thorough manner, within a reasonable time after September 15, and where to find the money this would cost. This was, in a measure, solved by the kindness of Mr. D. M. Rogers, in charge of the government work in suppressing the gypsy and brown-tail moths. Mr. Rogers kindly offered the assistance of several of the men in his employ as soon as they could be spared from their regular work, and in this way the services of five additional inspectors were available for a portion of the time. The expense of the work was finally assumed by the nurserymen whose places received this inspection, and thus the immediate difficulties were removed. In this connection the assistance given by Mr. Rogers deserves full and grateful recognition.

The sections of the law relating to the inspection of orchards and other regions liable to be in such condition as to cause financial loss to neighboring residents (sections 8 to 12) have been made use of in several cases during the year, and expenses connected with this work have been a factor in producing a shortage in the appropriation. The cases concerned have all been satisfactorily settled, and the trees or other plants which were found to be a real menace have been cared for in accordance with the orders of the inspector, so far as can be learned.

For many years nursery stock has been introduced to some extent into Massachusetts from abroad, and for some time has been rapidly increasing in amount. As the brown-tail moth and San José scale were probably brought into this country on such stock, and as there are still many other dangerous pests which may be brought in at any time in this way, it is important to examine all imports to discover and destroy such pests before they shall have an opportunity to establish themselves here.

Until about two years ago it was practically impossible to learn of these imports, the custom house officials being under no obligations to furnish such information. For the last two years, however, this information has been supplied to the different States by the Bureau of Entomology of the United States Department of Agriculture, and it is now possible to examine the imports as they arrive at their various points of destination. Lack of funds has prevented any large amount of this work, but in a few instances an examination was possible, the contents of perhaps one hundred cases being examined to discover any insects or diseases which might be present on the stock. The results showed the importance, and, indeed, the absolute necessity, of watching our imports carefully if we are not to receive other pests as serious as the gypsy and brown-tail moths. Among the shipments the worst case of crown gall ever seen by the inspector was discovered, including forty-five out of fifty plants tied together in one bundle. Another shipment was abundantly supplied with the West Indian peach scale, which has already received some attention because of its abundance on a shipment of cherries from Japan for planting on the White House grounds at Washington, resulting in the destruction of the entire shipment. If the authorities of other States consider it of prime importance to watch all consignments of import stock carefully, Massachusetts cannot afford to admit this stock without a careful examination. As a result of the slight amount of examination possible last spring, five different pests or diseases were found, any one of which, if it had escaped unnoticed, might have added another to the number of foes this State is now obliged to fight.

It has just been stated that examination of about one hundred cases or other parcels of stock resulted in finding five insects or diseases liable to become dangerous to our trees or other plants, but it cannot be determined how many other kinds of pests, and how many specimens of the five already discovered were brought in on the uninspected consignments. As the inspector has received notice of the shipment into the

State during 1910 of 3,383 cases, bales or consignments in some form, it would seem important to provide that this stock be given careful attention hereafter.

At the present time, therefore, the nursery inspectors must examine the nurseries of the State, now much larger than when the present appropriation was made; must respond to all requests for the examination of orchards and other places where financial loss is probably involved, although no increase of appropriation was allowed for this purpose; must give a supplementary inspection of all nurseries in the gypsy and brown-tail moth territory, for which no financial allowance has been made; and, unless the State is to acquire an additional list of dangerous foreign pests, must inspect all imports from foreign countries, for which purpose no particular appropriation has been made, all this work being supposedly paid for from the $2,000 originally appropriated.

To do this any longer is impossible. A larger appropriation must be provided or the work must be stopped, and when this work stops, a business involving about $2,000,000 will practically stop; protection of our trees and shrubs from the neglect of others will cease; new pests will appear from abroad and spread over the State, and a large factor in the protection of our trees and other plants will be removed.

To properly inspect our nurseries for the various pests and diseases liable to be present, to provide for necessary orchard and field examinations, and to properly examine imported stock, a large increase over the present appropriation is necessary, and I would respectfully urge upon the members of the Board of Agriculture the importance of this increase, and ask their endorsement of this proposition and their active support of some bill for this purpose before the Legislature. The inspector understands that the nurserymen of the State are also of the opinion that changes are necessary, and it may be desirable to confer with the Massachusetts Nurserymen's Association and settle upon some one bill as representing the wishes both of the Board and of the nurserymen.

FINANCIAL STATEMENT.

Appropriation,	$2,000 00	
By Governor and Council,	100 00	
		$2,100 00
Compensation of inspectors,	$1,192 50	
Traveling and necessary expenses,	891 73	
Supplies (postage, printing, etc.),	15 72	
		2,099 95
Unexpended balance,		$0 05

The continued co-operation of the secretary of the Board of Agriculture and of his assistants in the office with the inspector and his deputies has been of much assistance during the year, and it is a pleasure to record here our appreciation of this.

Respectfully submitted,

H. T. FERNALD,
State Nursery Inspector.

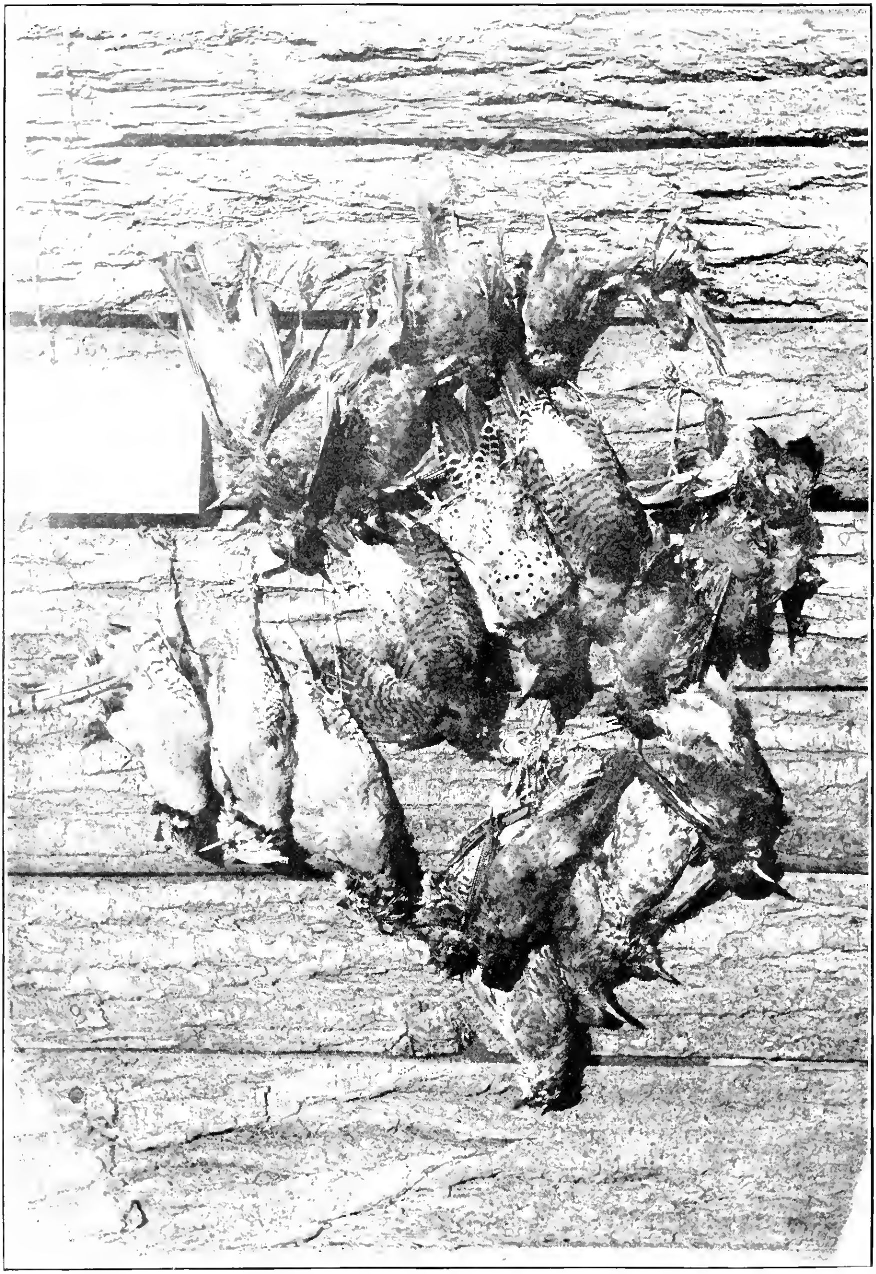
AMHERST, Jan. 1, 1911.

THIRD ANNUAL REPORT

OF THE

STATE ORNITHOLOGIST.

Synopsis presented to the Board and Accepted, January 10, 1911.



Twelve robins, three jays, three flickers, two hermit thrushes and one purple finch. Found on an Italian. Had no gun; was carrying game for three who had guns. He had copy of law in Italian language in pocket. (Photograph by Wilbur F. Smith.)

THIRD ANNUAL REPORT OF THE STATE ORNITHOLOGIST.

The Work of the Year.

Educational Work.

The demand for lectures by the State Ornithologist continues unabated. Thirty-seven free lectures have been given during 1910. Engagements for five hundred might have been taken had time permitted, but the work of preparing the special report on wild fowl, game birds and shore birds, authorized by the Legislature in 1910, made it impossible to accept many engagements to lecture. This report is still in process of preparation, and will be ready for distribution during the latter part of the year 1911.

Song Birds destroyed by Aliens.

Some complaints have been received regarding the killing of birds by foreigners. The census of 1905 gives the foreign-born population of Massachusetts at 918,044. Many of these aliens come from southern Europe, or from other countries where the killing of song birds is a common practice. When these people arrive in this country the tendency to continue such depredations is very marked. A hunter's license law which went into effect in the year 1909, and which requires all aliens who hunt to pay a license fee of $15, has reduced the number of foreign hunters. It has probably kept at least 20,000 of them from hunting in Massachusetts, but some are now evading the law by using short guns, that may be concealed in their clothing, or by utilizing traps, nets or bird lime. Great numbers of small birds, such as flickers, jays, robins, bluebirds, sparrows, thrushes and warblers, are killed by these people and used for food. The frontispiece of this report shows 12 robins, 3 blue jays, 3 flickers, 2 hermit thrushes and 1 purple finch which were concealed on the person of an Italian who was arrested by a game warden in Connecticut. This hunter had no gun, but was carrying the "game" for three people who did the shooting. He had a copy of the game laws printed in Italian in his pocket. The heads of about 100 robins were found where some Polish hunters had dressed them in a New Hampshire city, and in Massachusetts an Italian was taken with 40 birds, mostly flickers, on his person. These are only a few of the instances that have come to light.

Complaints are made that the laws are not enforced, and that some of the wardens are inactive, but conditions have been very much improved since the hunters' license law was passed. Before that time there were many Italian camps where the ground was strewn with feathers, and it was reported that in some instances hardly a bird was left alive in the woods. It is difficult, even under present conditions, to stop this practice among foreigners, and the laws will never be fully enforced until every one interested in the protection of birds uses his influence in the right direction.

The Massachusetts Audubon Society has printed an appeal to the Italians, advising them of the laws protecting song birds and requesting better observance. The Commission on Fisheries and Game have notices printed in Italian for distribution by any one who is interested. An appeal must be made to the religious instructors of foreigners to use their influence toward securing obedience of the law, and the children in the schools should be taught the value of birds, and urged to protect rather than destroy them.

Birds feeding on the Eggs of the Gypsy Moth.

Enforcement of the laws protecting the smaller birds is now imperative, for many of them feed more or less on the gypsy moth and the brown-tail moth.

In 1896, when my report was published on birds feeding on the gypsy moth, birds were not known to eat the eggs of these moths; but in the last decade evidence has been accumulated to the effect that birds are now learning to feed upon these eggs. At first egg clusters were found slightly damaged, as if pecked at; later the birds were seen pecking at them.

Messrs. H. B. Bigelow and Wilfred Wheeler of Concord have noticed that the birds are eating these eggs. The question at once arises whether the birds do not scatter more eggs than they eat, and leave them to hatch on the ground. But Mr. Wheeler and Mr. Wilson H. Fay state that they have watched the birds feeding on these eggs and have searched carefully on the newly fallen snow below, but have been unable to find any eggs there. Formerly the birds merely pecked into the cluster, scattering the eggs about; now they are learning to eat them clean. I examined many trees in Concord where the birds had been at work, and found many egg clusters from which all the eggs had been removed. Mr. Fay spent several winter days observing the birds. He reports that he saw a downy woodpecker peck into an egg mass one hundred and twenty times within a minute. He states that chickadees, brown creepers and golden-crowned kinglets also apparently eat the eggs. Dr. G. W. Field, chairman of the Massachusetts Commission on Fisheries and Game, informs me that nuthatches eat them. Dr. A. W. Tuttle of Cambridge states that at his camp the birds have destroyed a great part of the eggs of the gypsy moth. He regards the downy woodpecker as the most efficient worker in this respect.

Fear has been expressed that the eggs of the moth may pass through the alimentary canals of the birds unbroken and undigested, and may afterwards hatch, and that in this way the birds will become distributors of the insects. Experiments that were made before 1896 with the crow and the English sparrow showed that the eggs which passed through the digestive tract of those birds were killed in the process of digestion, although the shells of some of them were unbroken. This indicates that there is no distribution of living eggs to any distance by egg-eating birds, and if the birds are beginning to eat the eggs of this moth, they will probably become as useful eventually as European birds, which have been known to check the inroads of the moth in parks and on large estates, merely by eating the eggs in the fall, winter and spring. This is the most vulnerable stage of the moth, as the eggs remain upon the tree for the greater part of the year. The blue jay and a few other species are now believed to be quite destructive to the caterpillars of the brown-tail moth during the winter. In some localities the caterpillars have been removed from nearly all the webs on the trees. It is believed that the blue jay is the most effective of these winter caterpillar hunters. This subject will be further investigated during the coming year.

Most of the month of June and much of the remainder of the year were devoted to an investigation of the introduced starling.

European Methods of attracting Birds.

The success of the efforts of Europeans in protecting birds has attracted a great deal of attention in this country. Many articles and essays dealing with the various attempts to promote these methods have been published in Europe. Societies and communities, as well as individuals, have taken the matter up in many parts of Europe. Government authorities have taken up the question of bird protection, particularly in the European forest work. International conventions for the purpose of consulting regarding bird protection have been held. Perhaps the most eminent success in bird protection by one individual has been attained by Baron von Berlepsch at Seebach. Recently a volume by Martin Heisemann, giving the results of the baron's efforts, entitled "How to attract and protect Wild Birds," has been translated into English, and is now distributed by the National Association of Audubon Societies in this country. Baron von Berlepsch has carried out the principles of game protection in the conservation of small birds. He plants trees and shrubbery to attract birds, trims and prunes his trees and shrubbery in such a way as to afford nesting places for the birds, and has invented nesting boxes and feeding appliances that have proved so successful that the 3,000 nesting boxes put up on his estate at Seebach are nearly all occupied by birds, and the number of birds on his estate far exceeds the number in equal areas in other parts of the country. As a result of the protection of the birds on his estate a caterpillar plague which swept the country in that region had no effect upon his trees, and his entire plantation stood out like a green oasis amid the bare and barren countryside.

Many of the bird boxes and appliances used by Baron von Berlepsch have been imported into this country, and I have watched the results with a good deal of interest. Undoubtedly the methods he used are considerably in advance of our own. Attempts have been made to manufacture such nesting boxes and other appliances in this country, and recently Mr. Philip E. Perry, of 39 Clarke Street, Lexington, has perfected a machine for the manufacture of these nesting boxes, and it is hoped that they will be given an extensive trial in our woods, fields and orchards during the coming years.

It is not difficult to increase the number of chickadees and some other species which feed on the gypsy and the brown-tail moth by putting up nesting boxes in summer and a little suet upon the trees in winter, and it is my intention during the coming year to make a trial of these and other methods in Massachusetts. Mr. Ernest Harold Baynes of Meriden, N. H., has produced some bird food houses similar to those used by Baron von Berlepsch, and they are very successful in attracting the birds.

The Starling.

The European starling (*Sturnus vulgaris*) was introduced into New York City in 1890, and has now reached Massachusetts. It is a native of western central Europe, winters south to Africa and is accidental in Greenland. It may be described briefly as follows: length, 8½ inches; adult male: black with purple and green reflections, the feathers of the upper parts more or less tipped with pale buff; under tail-coverts edged with white; beak yellow; feet flesh-colored, tinged with brown; female: spotted below as well as above; young: uniform ash brown, faintly streaked with darker.

The starling may be readily recognized by its general appearance and manner of flight. It is about the size of the red-winged blackbird, but has a very short tail. It is usually dark in color, and during the breeding season its bill is bright yellow. Those who see it for the first time usually describe it as a blackbird with a yellow bill. In flight it flutters much like a meadow lark, but seldom sails as the lark does.

The Starling in Europe.

In order to get some idea of what we may expect of the starling in this country we must first glance at its history in Europe. There it is one of the most abundant birds. In some sections it has been more numerous in the past than it is now, but on the other hand it is now increasing in numbers in other regions. Most of the starlings in northern European countries pass the winter in southern Europe, but reappear in the north very early in the spring, sometimes before the snow is gone; and in much of the northern part of its range a few individuals are resident throughout the winter. Although it resembles our blackbirds somewhat in appearance, it differs widely from them in its breeding habits. In Europe it nests in hollow trees, in holes or crevices in rocks, walls, cliffs and buildings. Like the house sparrow it is a close companion of man during the breeding season. In building its nest it occupies suitable places about the eaves, and utilizes bird houses and nesting boxes as the house sparrow does. It lays from four to seven greenish-blue eggs and usually raises two broods each season. It is a very gregarious species, and even during the breeding season may be seen in small flocks, a few individuals or a family often consorting together. By midsummer these small flocks begin to congregate into larger ones, containing hundreds of individuals, and increasing sometimes in the fall to thousands and tens of thousands. The largest flights are seen at the roosts. Usually the starlings from a large area concentrate on some marsh at night, where they roost in the reeds, and from these centers they scatter over the country to feed each day, returning every evening to the same roost, until the approaching winter, with its scarcity of food, compels them to wander about in search of it, or to resort to more southern regions.

The accounts of the vast numbers congregated at the roosts as related by European ornithologists are almost incredible. Their numbers are set down as hundreds of thousands and sometimes as "millions," but such statements are probably somewhat exaggerated. It is certain, however, that these birds gather at the roosts in "clouds," such as are sometimes seen in the south, where our swallows concentrate in countless thousands at night over a marsh, and discharge their numbers into the reeds like a waterspout descending from a cloud. A similar manner of going to roost is attributed to the starling. Like our cowbird, it seems fond of frequenting pastures or places where cattle are kept. It is said to even alight on the backs of cattle and sheep in search of ticks and other insects that infest them. It is pre-eminently a ground feeder, and feeds on lawns and in grass fields, and also to some extent in gardens and plowed lands. It destroys grubs, earthworms, snails and many of the insects which ordinarily infest grass lands and the droppings of cattle. It is generally conceded in Europe that the benefits it confers on the farmer far exceed the harm it does by attacks on fruit or crops. Nevertheless, there are many instances on record where the starling has become a pest to the farmer. The habit of collecting in enormous flocks is the great element of danger. When a great number of any species having grain-eating or fruit-eating propensities is collected in one locality it is capable of doing great harm in a very short time. Such flights, however, are often productive of good.

The forest authorities in Bavaria, during an invasion of the spruce moth or "nun" in 1889–91, noted great flights of starlings, which were credibly estimated to contain as many as 10,000 in a flock, all busy feeding on the caterpillars and pupæ of this moth. The attraction of starlings to such centers was so great that market-gardeners seriously felt their absence in distant parts of the region.

The injury that starlings are capable of doing in Europe may be judged from the following accounts. Mr. A. Butler Duncan of New York writes that he has known the starling to become a "perfect pest" in England. What the starling does to fruit in Great Britain is told in an extract from the "Agricultural Students' Gazette," quoted by S. H. Goodwin in "Bird-Lore," May–June, 1908, p. 130.

The starling is a splendid bird on grass land, foraging for leather jackets (larvæ of craneflies), wire worms, etc.; rids the sheep of a few of their ticks; but in a fruit district it comes in droves into the strawberries and attacks the cherries wholesale (Hereford); peas, apples, plums, as well as cherries (Kent), also raspberries. Very valuable insect destroyers, but getting too numerous (Nott). In my fruit field (between Marden and Colchester) I do not suffer very much from blackbirds and thrushes, nor do I grudge them their toll in return for their song. Only one bird is dangerous to my crops, — that is the starling. He threatened the utter destruction of our strawberry, raspberry, cherry, gooseberry and currant, and some other crops. These birds are said to come to us from the marshes as soon as the young are hatched. And they come in millions; in flocks that darken the sky. Their flight is like the roar of the sea, or like the trains going over the arches. Their number increased rapidly each year. I can look back to the time when there were few, and have watched their increase for forty years, till now it is intolerable (Essex). The starling is a terror, and life around here is hardly worth living; you must have a gun always in your hand, or woe betide the cherries; they come in thousands (Sittingbourne, Kent).

Miss Gertrude Whiting of New York City writes me that in Switzerland enormous flocks of starlings come down like black clouds on the vineyards. In ten or fifteen minutes they pluck the fruit absolutely clean, and the cultivator is robbed of his year's crop. In the south of France starlings are said to be similarly destructive to the olive crop. This indicates what would happen in America were the starlings to become abnormally numerous.

It is of particular interest to learn what we can of the nature of the starling in its own country in its relations to other birds. In Europe the starling is known to eat the eggs and the newly hatched young of sparrows, but this habit does not seem to have been generally noted. Mr. Clinton G. Abbott, who is very familiar with the bird in Europe, writes me that he considers its pugnacious nature to be by far the most serious objection to the starling, and that no birds which nest in holes can have any peace at all until all the starlings are satisfied. "Many a time," he writes, "have I noticed the British woodpeckers laboriously boring holes in the hard wood, only to find that after a couple of weeks' work a pair of starlings had laid claim to the apartment." The woodpecker never gives up without a fight, but the starling is always victorious, and "the next day trailing straws from the entrance of the cavity show the presence of these new and slovenly tenants." The pugnacity of the starling does not seem to be generally noted in the works of European ornithologists, but apparently at times they have battles among themselves. The following copy of an ancient tract, for which I am indebted to the kindness of Mr. Samuel N. Rhoads of Haddonfield, N. J., is both quaint and interesting.

THE WONDERFUL BATTEL OF STARLINGS:

Fought at the City of Cork, in Ireland, the 12th and 14th of October 1621. As it hath been credibly informed by divers noblemen and others of the said Kingdom, etc. London, Printed for N. B. 1622.

Cork is a City in the West of Ireland, in the Province of Munster; for Situation, and all Commodities, which Sea or Land may afford, not inferior to any City in that Country. About the 7th of October last, Anno 1621, there gathered together, by Degrees, an unusual Multitude of Birds called Stares, in some Countries known by the Name of Starlings. Quality bold and venturous, among themselves very loving, as may appear by their Flights, keeping together all Times of the Year, excepting the Breeding-Time. It is, and hath been an old Proverb, that Birds of a Feather hold and keep together; which hath even been a common Custom in these as much as in any other Kind whatsoever: But now the old Proverb is changed, and their Custom is altered clean contrary. For at this Time, as these Birds are in Taste bitter, so they met to fight together the bitterest and sharpest Battel among themselves, the like, for the Manner of their Flight, and for the Time the Battel did continue, never heard or seen at any Time, in any Country of the World. (I believe)

We read in the Histories of our own Country, that, in the twelfth Year of King Richard II. the Gnats mustered together at Shine now called Richmond, in great Abundance, with so great a Multitude, that the Air was obscured and darkned by them. They fought so violent a Battel among themselves, that, by Estimation, two Parts of them were slain, and fell to the Ground. The Number of those which were killed was so great that they were taken up with Shovels, and swept together with Besoms, that Bushels were filled with them, the third Part having gotten the Victory, flew away and vanished, no Man knew whither.

Now to come to the Fight of our Birds, the Stares or Starlings: They mustered together, at this above-named City of Cork, some four or five Days before they fought their Battels, every Day more and more increasing their Armies with greater Supplies; some came as from the East, others from the West, and so accordingly they placed themselves, and as it were incamped Themselves Eastward and Westward about the City: During which Time their Noise and Tunes were strange on both Sides, to the great Admiration of the Citizens and the Inhabitants near adjoining, who had never seen, for Multitude, or ever heard, for loud Tunes which they uttered, the like before, Whereupon they more curiously observing the Courses and Passages they used, noted, that from those on the East, and from those on the West, sundry Flights, some twenty and thirty in a Company, would pass from the one Side to the other, as it should seem employed in Embassies; for they would fly and hover in the Air over the Adverse Party, with strange Tunes and Noise, and so return back again to that Side from which as it seemed, they were sent.

And farther it was observed, that, during the Time they assembled, the Stares of the East sought their Meat Eastward, as the Stares of the West did the like Westward; no one flying in the circuits of the other.

These Courses and Customs continued with them until the 12th of October, which Day being Saturday, about Nine of the Clock in the Morning, being a very fair and a Sun-shine Day, upon a strange Sound and Noise, made as well on the one Side as the other, they forthwith, at one Instant, took Wing, and so mounting up into the Skies, encountered one another with such a terrible Shock, as the Sound amazed the whole City and the Beholders. Upon this sudden and fierce Encounter, there fell down in the City, and into the Rivers, Multitudes of Starlings or Stares, some with Wings broken, some with Legs and Necks broken, some with Eyes picked out, some their Bills thrust into the Breast and Sides of their Adversaries, on so strage a Manner, tht it were incredible, except it were confirmed by Letters of Credit, and by Eye-Witnesses with that Assurance which is without all Exception.

Upon the first Encounter they withdrew themselves backward, East and West, and with like Eagerness and Fury encountered several Times; upon which all these Stares fell down, in like strange and admirable Manner, as upon the first Encounter. They continued this admirable and most violent Battel till a little before Night, at which time they seemed to vanish, so that all Sunday, the 13th of October, none appeared about the City.

Upon this Sunday divers passengers came out of Suffolk, who sailing betwixt Gravesend and Woolwich, they heard a loud and strange noise and Sound in the Air, whereupon casting their Eyes upward, they saw infinite Multitudes of Stares fighting in all violent Manner together, with a Crow or Raven flying betwixt them, for the Flight being so high, they could not perfectly discern whether it was Crow or Raven. These Birds had also several Encounters, making strange Sound and Noise; and ever as they divded and retired themselves, the Crow or Raven was seen in the Midst: But what Slaughter was made they could not observe, because the Evening was somewhat dark, and the Battel was fought over Woods more remote off; but for more assured Proof of this Fight the Sunday before-named, there are, at this Time, in London, diverse Persons of Worth and very honest Reputation, whom the Printer of this Pamphlet can produce, to justify what they saw, at Cause shall require, upon their Oaths.

Now to return to the last Battel fought, at Cork, by these Stares Upon Monday, the 14th of October, they made their Return again, and, at the same time, the Day bring as fair a Sun-shine Day as it was the Saturday before, they mounted into the Air, and encountered each other with like violent Assaults, as formerly they had done, and fell into the City upon the Houses, and into the River, wounded and slaughtered in like Manner as before is reported: But at this last Battel there was a Kite, a Raven and a Crow, all three found dead in the Streets rent, torn and mangled.

In this precedent Narration, one Report will cause most admiration, and that is, the Stares or Starlings, forbearing and absenting themselves from Cork, upon Sunday, being the 13th of October, should that same Day be seen to fight near, or not far off from Woolwich; whether the same Stares it may be held in respect of the Distance of the Place by Sea and Land, improbable. But this Improbability is soon answered; for as the Fight at Cork may seem strange and improbable, yet being most assured that such a Battel was fought, it may be as probable, in the Wonderful Works of Almighty God, that, notwithstanding the Distance of the Place, these may be the same Stares.[1]

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[1] Morgan, J.: "Phœnix Britannicus", a miscellaneous collection of scarce and curious tracts, No. 1, pp. 250-253, London, 1731.

The above extracts indicate that the starling has some undesirable qualities, and as such qualities are often accentuated when a bird is introduced into a new country, we cannot view the introduction of the starling without some apprehension. The fact that it is generally considered a desirable species in northern Europe ought not to have convinced any one that it would be so in America, and its introduction here ought never to have been undertaken. When imported into New Zealand it became a very destructive pest, and no one can tell what may be the result of its acclimatization here. Since the successful introduction of the starling in America the Bureau of Biological Survey of the United States Department of Agriculture has been given authority to regulate the importation of foreign mammals and birds into this country, and in the future there is very little likelihood that the zeal of misguided persons who wish to import foreign species will have such results as followed the introduction of the house sparrow. The Biological Survey now has agents in every port where foreign species are likely to come in, all shipments are examined and if the bird or mammal is considered at all dangerous it is destroyed; thus we have been able to keep out the mongoose and several undesirable species of birds. But the starling, introduced before these regulations went into effect, has increased so fast and spread so far that the question now to be considered is whether it is to prove an undesirable addition to the fauna of the country, and, if not, whether its increase can be controlled and regulated.

The Starling in America.

Its Introduction. — Probably we shall never know how many attempts have been made to introduce the starling into this country. I have learned of several. Mr. William Conant of Tenafly, N. J., states that he had a tame starling there in a cage in 1884. At least six other starlings came about the cage of his pet bird, which he finally liberated and it disappeared. These starlings are believed to have reached Tenafly from Tuxedo, where several European species, including the English pheasants and partridges, were liberated at that time. Some of the pheasants and European partridges also reached Tenafly.

Mr. Van Brunt Bergen of Brooklyn, N. Y., writes that Mrs. Doubleday liberated several pairs of starlings at Bay Ridge eight or ten years ago. They came from England. But the introductions undertaken by Mr. Eugene Scheifflin at Central Park, New York City. are credited as the first to be successful. The first of his importations numbered 80 birds, which were liberated on March 6, 1890, and 40 more were released on April 25, 1891. Some of these birds remained in the park or its vicinity, and bred there, but in 1891, 20 appeared on Staten Island, and in 1896 they had increased their numbers and had extended to Brooklyn. In 1898, according to Dr. T. S. Palmer of the Biological Survey, the species had obtained a strong foothold in the neighborhood of New York City. It had reached Stamford, Conn., and Plainfield, N. J. One hundred birds were liberated near Springfield, Mass., in 1897, but Mr. Robert O. Morris of Springfield states his belief that they did not survive the following winter. It may be possible that they went south, but not one was reported from Springfield again until the year 1908. In the meantime they had spread over the first 40 miles of Long Island, up the Hudson River to Ossining and beyond, through much of eastern New Jersey and into Pennsylvania and Delaware.

In June, 1910, I was able, through the co-operation of the Bureau of Biological Survey, United States Department of Agriculture. to make an investigation of the distribution, food and habits of the starling in America. Several trips were made to Springfield, Mass.; Connecticut; Long Island, N. Y.; New Jersey and one to Pennsylvania. A large correspondence was begun with people in all the States in which the starling has been found. One hundred and two starlings were collected, and the contents of their stomachs were examined by Prof. F. E. L. Beal of the Biological Survey. On this investigation the present report is based.

It is important to compare what is known of the status and habits of the starling in this country with its history and habits in Europe, for by such a comparison we may be able to forecast its probable relation to other birds and to agriculture in Massachusetts.

Its Increase and Dissemination. — When the brief period that has elapsed since the introduction of the starling (twenty years) and the small number introduced are considered, it must be conceded that the increase and the dissemination of the species have been rapid. It has not increased or spread so rapidly as did the house sparrow (commonly called English sparrow), but the sparrow's numbers sprang not from one importation but from many, that took place at widely scattered localities during a series of years, — something that has been prevented in the case of the starling. Its increase has been rapid in most of the region now occupied by it, where it is in many places second in numbers only to the sparrow and the robin. The testimony of 110 correspondents whose residences are scattered over five States shows that the starling is increasing fast. All state as a result of their observation that it is increasing, and most of them say that its accession is rapid. Only 18 have seen no increase in their localities or find the increase slow. They, however, are resident mainly near where the starling was first introduced, and where it has nearly reached the limit of food supply or nesting places. Even in Brooklyn, however, Mr. Edward W. Victor, who keeps a careful daily account of the birds observed at Prospect Park, records an average of 29 starlings daily in 1908, 31 in 1909 and 41 in 1910. Mr. Jno. H. Sage of Portland, Conn., states that two pairs were seen there in 1908, and that by June, 1910, the number had increased to about 100. During the breeding season the starling is rather quiet and secretive, and its numbers are not fully realized, but in the fall its large flocks become very conspicuous, and people are prone to exaggerate its numbers for the reason that these flocks roam over the country for miles, frequently appearing and disappearing and giving the impression of great abundance. The most convincing proof of increase comes in the statements of people who saw the starlings in flocks of from 1,000 to 3,000 in the fall of 1909, and who now find them in the same localities in flocks estimated to contain from 8,000 to 10,000. In the region about New York City, including Long Island, Staten Island and parts of the Hudson River valley, also portions of New Jersey, where the sparrow is more abundant than I had ever seen it anywhere else in this country, there appeared to be at least 50 sparrows to every starling in June, 1910, but it is quite probable that the ratio has now been very materially changed in many places by the increase of the starling.

The spread of the starling since 1900 may be seen by the following statement.

In the year 1900 it appeared at Flushing, L. I.; East Orange, N. J.; Chilmark, N. Y. (Scarborough-on-Hudson); Norwalk, Stamford and New Haven, Conn. In 1901 the first birds are recorded from Delaware, taken near Odessa. In 1904 the starling had reached Rye, N. Y.; and Trevose, Bucks County, Pa. In 1905 it is recorded from Newburg, N. Y.; Elizabeth, N. J.; and West Philadelphia, Pa. In 1906, Danbury, Wethersfield and Hartford, Conn.; New Brunswick, Princeton, Red Bank and Vincentown, N. J., were included in its range. In 1907 it was seen in Stonington, Windsor, Bethel, Southington and New London, Conn.; Upper Montclair, Morristown and Tuckerton, N. J.; and Setauket, Syosset and Orient, L. I. In 1908 it was seen in Millersville, Pa.; Bedford Hills, N. Y.; Portland and New Milford, Conn.; and Springfield, Mass. In 1909 it had reached Rhinebeck and Pleasantville, N. Y., and one was said to have been seen at Rochester, but none have been noted there since. It was also met with at Milburn, N. J.; Bristol, Pa.; and Chester, Conn.

Since the above was written I have learned from Mr. Israel R. Sheldon of Providence, R. I., that starlings have been breeding for "two or three years" at Silver Springs, R. I., on the east shore of Narragansett Bay, about 3 miles below Providence. They must have reached this point in 1908 or 1909, if not earlier. He states that they nest in the peaks of the roofs of some cottages, behind some lattice work, and that he has seen as many as 8 at one time. As the noise that they make disturbs the cottagers their nesting has been repeatedly interfered with, which may account for the fact that they have not increased much. This is the only authentic occurrence of the starling in Rhode Island that has come to my notice, but as Providence is many miles from Stonington, Conn., the easternmost record hitherto recorded, starlings are probably domiciled in other Rhode Island towns.

The increase and spread of the starling is due to its fecundity and its general fitness for the battle of life. It often has two broods in America, as it has in Europe. I am satisfied of this by my own observation and by the statements of other observers, and believe this to be the rule, although in some localities I could find no evidence of a second brood. On the other hand, it seems not improbable that a third brood is sometimes reared; but this needs confirmation. The starling's physical fitness for the struggle for supremacy is seen at once on an examination of its anatomy. It is a very hardy, muscular and powerful bird. It has the physical characteristics of a little crow. It is exceedingly tough and wiry, and the bill, its principal weapon of offense and defense, is superior in shape to that of a crow. It is nearly straight, long, heavy, tapering, and nearly as keen as a meat axe, while the skull that backs it is almost as strong as that of a woodpecker. Mentally the starling is superior to the sparrow, and while brave and active in the face of any foe that it can master, it shows the acme of caution and intelligence in its relations with man or any other creature too powerful for it to cope with. While it is comparatively fearless where it is unmolested, it is always on its guard, and if hunted becomes more wary than a crow. It is a handsome bird, and though it has little merit as a songster, it has many pleasant whistling and chattering notes and some talent as a mimic. Its alarm note is a harsh, rasping, low-pitched call.

Its insect-eating habits, its beauty and its cheery notes have already made it many strong friends in this country who will stoutly protect it, and this protection, together with the bird's ability to take care of itself and keep out of danger, precludes all possibility of its extermination here if it proves undesirable.

Were rewards or bounties offered with a view to its extinction, blackbirds, meadowlarks and other native species, which consort with the starling, would be among the chief sufferers. The starling is here to stay, and we must make the best of it. Whether its presence will result in more good than harm will depend largely on the ratio of its increase. We now know enough of its habits in this country to forecast some of the results that may be expected from an excess of the species.

The Starling drives Certain Native Birds from their Nests. — When any animal is successfully introduced into a new country, and increases rapidly, its advent naturally tends to upset the biologic balance. Its native natural enemies have been left behind in its own country, where it had a settled and established place in a series of natural forces, that had been in existence for centuries, and it becomes an interloper in the new land, among conditions and forms of life entirely new. If the species is weak or unfit for its new environment, or if it is introduced into a land differing much in climatic conditions from its own, it dies out and no disturbance results; but if it is strong and fit, and the climate is suitable, it is likely to increase abnormally in numbers, and it cannot so increase without displacing some of the species native to the soil.

The starling is a hardy, capable and prolific bird, which, like the sparrow, has had many centuries of experience in getting its living in populated countries and cultivated regions in close relationship with man, and in such an environment it has survived and thriven. It thus has an advantage over our native species similar to that enjoyed by the sparrow, which, subsequent to its introduction here, displaced so many native birds during the latter quarter of the nineteenth century. How can the bluebird or the house wren, which have been accustomed to life about human habitations for a comparatively short time, compete with such a bird as the starling?

The friends of the sparrow argued that it would fill a void in our city life that no native bird could possibly occupy, inasmuch as it would always have in the streets a plentiful supply of food that would otherwise be mainly wasted, and that it would be able to maintain itself where native birds would starve. No such argument can be advanced in favor of the starling. If there was an opening for the sparrow it was filled long ago, and the starling cannot occupy the place in our urban life now filled by the sparrow, even if it drives out the latter. No doubt in the city the starling is preferable to the sparrow, but it cannot displace the sparrow without indirectly making trouble for native species also. The sparrow and the starling will live together, as in England, but the starling will drive the sparrow away from all nesting places that are suitable for its own use, and the sparrow will in turn eject tree swallows, martins, bluebirds, wrens and other native birds from their present nesting places, that it may secure homes in place of those taken by the starling. Already this adjustment is going on. First in the city, then in the suburbs, and finally in the country our native birds which normally nest in hollow trees will be driven to the wall if the starling continues to increase in numbers, and there is now no adequate check to its increase in sight. In America as in Europe the starling seeks nesting places about buildings. It breeds in dovecotes, such church steeples as furnish safe nesting places, in holes and crevices about houses, in niches under the eaves, in electric light hoods, bird houses, nesting boxes, woodpecker holes and hollow trees. Therefore, in seeking nesting places it comes directly in competition with domestic pigeons, screech owls, sparrow hawks, flickers and other woodpeckers, crested flycatchers, martins, bluebirds, tree swallows and wrens, and as it extends its range to the west and south it must compete with other species. In the region already occupied it has proved itself capable of driving out all the above-mentioned species, except the screech owl, which doubtless will prove its master.

In America the starling is not regarded as particularly pugnacious except where it has to fight for nesting places or for food. In such cases it is combativeness personified, and its attacks are well directed and long continued. Usually in its competition with the sparrow there is no fighting, for the sparrow soon learns that it is no match for the starling, and the contest degenerates into a straw-pulling match, each bird alternately clearing out the nesting material that the other brings. If the owner of the nest joins battle with the starling and fights stubbornly it is driven off, or it is sometimes killed in its nest. This daring interloper attacks birds much larger than itself, and the evidence shows that almost invariably it prevails in the end. The sparrow, the bluebird and the flicker have been credited with repelling it for a time, but eventually the starling wins, because of its increasing numbers, courage and fitness. As the starling comes, native birds, whose nesting places it covets, must go, and many of these birds are more desirable than the starling. The skillful manner in which it evicts the flicker inspires the observer with a certain admiration for its superior strategy and prowess. The starlings quietly watch and never interfere while the flicker digs and shapes its nesting place in some decaying tree; but when the nest is finished to the satisfaction of the starlings it is occupied by them the moment the flicker's back is turned. On the return of the flicker a fight ensues, which usually results in the eviction of the starling in the hole, which, however, keeps up the fight outside while another enters the hole to defend it against the flicker, which, having temporarily vanquished the first, returns only to find a second enjoying the advantages of possession. As Mr. Job says, the flicker is confronted with "an endless chain of starling," and finally gives up.[1]

In this way or some other the starlings, working together, always succeed in driving the flicker from its home, in which they immediately begin to build. The moment the flicker gives up vanquished, the starlings leave him entirely alone, allowing him to hew out another hole, either in the same tree or in one near by, when a similar fight ensues with more starlings; and so the flicker is driven literally from pillar to post, until it has prepared sufficient homes for the starlings in its neighborhood, and all are satisfied, or until it gives up

[1] Job, Herbert K.: "Danger from the Starling," "The Outing," November, 1910, p. 149.

in disgust, and leaves the vicinity of its aggressive neighbors. The principal spring work of the flicker in the future will be the preparation of nesting places for the starling. It is probable that the hairy woodpecker and the redheaded woodpecker also will serve as *carpinteros* for the interloper, but the downy woodpecker will probably be exempt from such service, as the entrance to his domicile is too small to admit the starling. There is no evidence that the starling has attempted to dispossess the screech owl; but Mr. Clifford M. Case of Hartford, Conn., states that he has seen a starling whip and drive away a male sparrow hawk. Many correspondents report that flickers, bluebirds, English sparrows and wrens have been driven from their nesting places in old orchards by the starlings.

Mr. Clifford H. Pangburn of New Haven says that his records show a considerable decrease in the number of bluebirds since the starlings came. There is no way to prevent this except in the case of the smaller species, which may be protected by providing them with nesting boxes having an entrance hole not over 1½ inches in diameter.

At my request Mr. William H. Browning, who has many starlings occupying nesting boxes on his estate, put up in front of the entrance to one of them a small board in which a hole 1½ inches in diameter had been bored. Starlings which then had young in the box were unable to enter.

The starling will compete with native birds for their food supply. Mrs. P. R. Bonner of Stamford has observed the intruder frequently attacking robins and other birds, and driving them away from a lawn where they formerly fed. The starling is a sphinx-like bird and ordinarily treats other birds with a sort of contemptuous tolerance. In winter it even permits robins, blackbirds and meadowlarks to join its great flocks, but as these flocks increase they must eventually clean up most of the winter food supply of wild berries, and leave our native winter birds without sufficient sustenance.

Other Injurious Habits of Starlings. — The food of the starling in America seems to be similar in general character to that which it consumes in Europe. It is particularly useful there, however, because of its fondness for the destructive land snails, which are very numerous in many regions.

It cannot be expected that it will be thus beneficial here, for we are not similarly afflicted in this country. The starling can give no service here that cannot be equally well performed by our own blackbirds, meadowlarks, bobolinks, sparrows and other birds, but it will be useful where these birds are not numerous enough to keep the insect enemies of grass lands in check. Already, however, the starling has begun to show a capacity for harmfulness which may be expected to become more prominent as its numbers increase. In the breeding season small flocks go to the cherry trees, and as they alight for a few minutes a shower of cherry stones will be heard. Sometimes they strip a tree completely and then go to another. In other cases they feed in a desultory way, taking toll from all the trees in a neighborhood.

Mr. William T. Davis of New Brighton, N. Y., describes the destruction of pears by starlings which he observed on Oct. 17, 1907, illustrating his statement by a reproduction from a photograph of two of the ruined pears ("Bird-Lore," November, December, 1907, p. 267). Fully one-third of each pear was eaten.

Many observers state that the starling eats apples; but this habit appears thus far to be confined mainly to apples left on the trees late in the fall, after the crop has been gathered. Mr. W. S. Bogert of Leonia, N. Y., asserts that it pecks open withered apples for the seeds. Nevertheless, it sometimes eats ripe fruit in the fall. Mr. Albert W. Honywill of New Haven, Conn., has seen starlings eating apples, and Mr. James D. Foot of Rye, N. Y., states that they will alight in an apple orchard and take a peck or two at the finest fruit.

Such flocks also sometimes descend on a strawberry bed and considerably reduce the crop.

In the fall, when they gather into large flocks of a thousand or more, they are often very destructive to corn in the ear. In Europe they feed to some extent on small grains, but I have not seen any evidence of that here. In New Jersey in the month of June they seemed to prefer the cherry trees to the wheat fields, and did not appear to molest the wheat at all. A few gardeners claim that they pull sprouting corn and eat peas. Mrs. Frank L. Allen of West Haven states that she watched the starlings at work destroying her lettuce and radishes. Sometimes they have the habit of pulling up young plants.

Mr. Alfred C. Kinsey writes that he noticed the parent birds supplying nestlings with what proved to be the staminate flowers of the hickory. Later on in different localities the same peculiarity was noticed. If such feeding becomes extensive it will bring about a failure of nut crops. He has also noticed these birds on grape vines and in trees wantonly tearing off large pieces of leaves, as well as doing damage to various fruit crops. Some observers assert that the starling also destroys the buds of trees, but I have been unable to get definite evidence on this point.

Food of the Starling. — Examination of the stomachs of 102 starlings collected in 1910, 41 of which were nestlings, seems to show that the food of the starling in this country is similar to that taken by it in Europe. The proportion of animal food is very large and consists chiefly of insects. Only 3 birds had taken earthworms, which composed 17.33 per cent of their stomach contents; 18 birds had eaten both millipeds (or thousand legs) and spiders; 22 had taken millipeds but no spiders, and 18 had eaten spiders but no millipeds. The average percentage of millipeds in 22 stomachs was 39.89 per cent.

Caterpillars represent the largest items of insect food. Fifty-two birds, or more than half the number taken, had eaten caterpillars, which formed over 45 per cent of their stomach contents. These appeared to be mainly, if not entirely, hairless larvæ, among which Geometrids or inch worms, were recognized. Probably a large percentage of these caterpillars were Noctuids, or cutworms, as I frequently recognized cutworms in the bills of the parent birds when they were feeding their young. Very few moths were noted in the stomachs, but some tineid cocoons were found in one. *Datana ministra,* an apple tree pest, was recognized in 1 stomach.

More of the birds had taken beetles than had eaten caterpillars; but the beetles formed a smaller average percentage of the food. Fourteen had taken Elaterids (commonly known as snap beetles) or their larvæ (wire worms), which formed 10.92 per cent of their stomach contents. The larvæ of this beetle, the wire worm, is well known to agriculturists as a destructive enemy to grain and garden crops, but many native birds eat it. The Carabidæ, or ground beetles, were represented in 42 stomachs. While these beetles are generally regarded as useful insects, they have been known to become injurious where they have increased abnormally, therefore their destruction cannot be set down to the discredit of the starling. The genus *Calosoma* is represented in 1 stomach. This genus is believed to contain only beneficial insects. One bird had taken some Lampyrids. Three had taken the *Leptinotarsa decemlineata,* or Colorado potato beetle, which formed 16.67 per cent of the stomach contents. If the starling acquires the habit of eating Colorado potato beetles it may prove useful in this respect. Only few native birds eat them. Eleven starlings had taken a few scarabæid beetles, which formed on the average 8.54 per cent of the stomach contents. Weevils were represented in 28 stomachs, and constituted 7.07 per cent of their stomach contents. Beetles of the genus *Lachnosterna,* commonly called May beetles, or their larvæ, commonly known as white grubs, were represented in 13 stomachs, and comprised 14.53 per cent of their contents. These beetles are very destructive, as the white grub feeds on the tubers and roots of plants. This genus is one of the well-known enemies of grass and garden crops, but many of our native birds feed upon all forms of the insect. Two birds had taken chrysomelid beetles, which feed on the foliage of trees. The notorious elm-leaf beetle is a member of this group, but they formed only 2 per cent of the stomach contents of these two birds.

The orthoptera are represented by grasshoppers in 17 stomachs, forming 19.88 per cent of their contents. There were also a few crickets. This is rather a small showing, as practically all birds eat grasshoppers, but probably a larger proportion of grasshoppers would have been found later in the season.

The Hemiptera, or bugs, were found in only 3 stomachs, and Diptera in only 1, the proportion of each being very small. Hymenoptera were found in 17 stomachs. This order was represented mainly by ants. It seems probable that the starling does not destroy many of the useful parasitic flies of this order.

The nestlings were fed with food similar to that taken by the adults, but they were given a larger proportion of young, or larvæ, such as caterpillars and other soft-bodied insects, while the adults fed more on mature beetles and similar hard-bodied insects.

The vegetable food consisted very largely of fruit. The birds were taken during the cherry season, and 18 stomachs contained an average of 56.17 per cent of the skin, pulp and stones of domestic cherries. In 7 cases the skin or pulp of fruit, which could not be fully identified, composed 31.71 per cent of the stomach contents; mulberry seed and pulp in 9 cases composed 35 per cent of the stomach contents, and grape pulp composed the greater part of the stomach contents in 1 case. This grape pulp must have been secured from greenhouse fruit. Possibly an investigation of the stomachs of starlings during the grape season would reveal a much larger percentage of this fruit. Only a few nestlings had eaten fruit. A few stomachs contained fragments of grasses, which may have been taken accidentally in procuring insect food. Portions of vegetable stems also were found. A few seeds of *Polygonum*, *Rhus radicans* and other plants were found, which suggest that later in the season seeds and wild fruits may form a larger proportion of the food of the starling.

Among the miscellaneous substances found was a portion of some small crustacean and a bit of shell. Fifteen stomachs were empty and 3 nearly empty. A large proportion of these was taken on the roost at night, on or before 8 o'clock, and as the birds were feeding until about 7 o'clock, and as they usually go to roost with a full stomach, it is fair to assume that the digestion of the starling is rapid enough to empty its stomach within an hour.

The starling is not numerous enough in Massachusetts to do any appreciable injury to fruit crops, vegetation or native birds. Thus far it is undoubtedly beneficial here, as it does some good by destroying noxious insects. Under our laws it is protected at all times, but if its numbers increase unduly it may be necessary to deny it the legal protection now afforded to insectivorous birds.

In closing this report I gratefully acknowledge the courtesies tendered by Dr. T. S. Palmer and Prof. F. E. L. Beal of the Bureau of Biological Survey, United States Department of Agriculture, Washington, D. C., who have rendered possible this investigation and report; and also to record my indebtedness to the list of correspondents appended, who have furnished information regarding the starlings in Europe and America. The stomachs of the starlings collected by me were examined by Professor Beal, who kindly furnished me a list of the contents. Much assistance was also rendered by Messrs. B. S. Bowdish of Demarest, N. J.; W. W. Grant of Englewood, N. J.; W. S. Bogert of Leonia, N. J.; Courtenay Brandreth of Ossining, N. Y.; Samuel N. Rhoads of Haddonfield, N. J.; Rev. A. B. Dolan of Agawam, Mass.; and Robert O. Morris and William Dearden of Springfield, Mass.

Respectfully submitted,

EDWARD HOWE FORBUSH,
State Ornithologist.

Appendix.

List of Observers Who have contributed Information about the Starling.

Abbott, Clinton G.,	New York City.
Allen, Mrs. Frank L.,	West Haven, Conn.
Anderson, Mrs. J. C.,	Englewood, N. J.
Andrews, Russell G.,	Southington, Conn.
Archbold, J. A.,	Buffalo, N. Y.
Armitage, P. F.,	Coudersport, Pa.
Bailey, Wm. L.,	Ardmore, Pa.
Banks, Miss M. B.,	Westport, Conn.
Barron, George D.,	Rye, N. Y.
Batten, George,	Brooklyn, N. Y.
Beal, Prof. F. E. L.,	Washington, D. C.
Beers, H. W.,	Bridgeport, Conn.
Behr, Edward A.,	Brooklyn, N. Y.
Benedict, Theodore H.,	New York City.
Bergen, Van Brunt,	Brooklyn, N. Y.
Bevin, V. D.,	New York City.
Bignell, Mrs. Effie,	New Brunswick, N. J.
Bishop, Dr. Louis B.,	New Haven, Conn.
Black, R. Clifford, Jr.,	New York City.
Bogert, M. T., Dr.,	New York City.
Bogert, W. S.,	Leonia, N. J.
Bonner, Mrs. P. R.,	Stamford, Conn.
Borland, William G.,	New York City.
Brandreth, C.,	Ossining, N. Y.
Brennecke, George,	Brooklyn, N. Y.
Brewer, A. R.,	Glenridge, N. J.
Brockway, Arthur W.,	Hadlyme, Conn.
Bronson, W. W.,	Washington, Conn.
Brooks, F. M.,	Brooklyn, N. Y.
Brown, James F.,	North Stonington, Conn.
Brown, Ronald K.,	New York City.
Browning, J. Hull,	Tenafly, N. J.

Browning, William H., . . .	New York City.
Brundage, Benjamin, . . .	Danbury, Conn.
Buck, Henry Robinson, . .	Hartford, Conn.
Burr, Freeman F., . . .	New Haven, Conn.
Callaway, W. T., ...	Millburn, N. J.
Case, Clifford M., ...	Hartford, Conn.
Chamberlin, S. T., ...	Derby, Conn.
Chapman, F. M., ...	New York City.
Cherrie, George K., . . .	Brooklyn, N. Y.
Childs, John Lewis, . . .	Floral Park, N. Y.
Clark, Charles H., ...	East Orange, N. J.
Cleaves, Howard H., . . .	Prince's Bay, L. I., N. Y.
Clemson, George N., . . .	Middletown, N. Y.
Colgate, R. R., ...	New York City.
Comey, Arthur C., ...	Utica, N. Y.
Comstock, George W., . . .	Essex, Conn.
Conant, William, ...	Tenafly, N. J.
Cook, L. G., ...	New York City.
Cox, Wilmot T., ...	New York City.
Craft, Miss Laura F., . . .	Glen Cove, N. Y.
Cromwell, James W., . . .	Summit, N. J.
Crosby, Maunsell S., . . .	Grasmere, Rhinebeck, N. Y.
Dana, Miss E. A., ...	Englewood, N. J.
Davis, Miss Elizabeth D., . .	Pittsfield, Mass.
Davis, Elizabeth King, . . .	Tuxedo, N. Y.
Davis, Mary A., ...	New York City.
Davis, William T., . . .	New Brighton, N. Y.
Dewey, C. A., ...	Rochester, N. Y.
Digmey, J., ...	Bernardsville, N. J.
Dimock, George E., Jr., . .	Elizabeth, N. J.
Dixon, Frederick J., . . .	Hackensack, N. J.
Dodge, Charles W., . . .	Rochester, N. Y.
Dows, Tracy, ...	New York City.
Duncan, A. B., ...	Hempstead, L. I., N. Y.
Duryee, A., ...	Summit, N. J.
Dyer, E. Tiffany, ...	Southampton, L. I., N. Y.
Eaton, Clinton J., ...	Georgetown, Mass.
Eaton, Elon Howard, . . .	Geneva, N. Y.
Ellison, W. W., ...	East Orange, N. J.
Ells, George P., ...	Norwalk, Conn.
Enders, John O., ...	Hartford, Conn.
England, I. W., ...	Passaic, N. J.

Field, E. B.,	Hartford, Conn.
Foot, James D.,	Rye, N. Y.
Fowler, Henry W.,	Philadelphia, Pa.
Gibson, Wm. H.,	Tarrytown, N. Y.
Gilman, Mrs. George L.,	Granville, N. Y.
Grant, W. W.,	New York City.
Graves, Mrs. Charles B.,	New London, Conn.
Greene, Mary A.,	Groton-on-Hudson, N. Y.
Grinnell, Dr. George Bird,	New York City.
Hadden, Dr. Alexander,	New York City.
Hale, Thomas, Jr.,	Yonkers, N. Y.
Hardon, Mrs. Henry W.,	New York City.
Harper, Francis,	College Point, N. Y.
Harral, Mrs. E. W.,	Bridgeport, Conn.
Havemeyer, H. O., Jr.,	New York City.
Herdman, D.,	Middletown, Conn.
Herrick, Harold,	New York City.
Hicks, Mrs. Benjamin D.,	Old Westbury, N. Y.
Hix, George E.,	New York City.
Hollyer, James,	Athenia, N. J.
Honywill, A. W., Jr.,	New Haven, Conn.
Horsfall, Bruce,	Princeton, N. J.
Hoyt, William H.,	Stamford, Conn.
Hussey, William H.,	East Orange, N. J.
Huyler, W. C.,	Tenafly, N. J.
Jacot, A. D.,	Sandy Hook, Conn.
Job, Herbert K.,	West Haven, Conn.
Johnson, Walter A.,	New York City.
Kent, Edward G.,	East Orange, N. J.
Kerr, Mrs. John C.,	New York City.
King, Miss Anna,	Arrochar, N. Y.
Kinsey, Alfred C.,	Summit, N. J.
Kittredge, S. D.,	Hastings-on-Hudson, N. Y.
Kunhardt, W. B.,	Reading, Pa.
Langdon, W. G.,	New York City.
Latham, C. R.,	Windsor Locks, Conn.
Lawrence, Townsend,	Flushing, L. I., N. Y.
Lee, Charlotte E.,	Huntington, L. I., N. Y.
Leigh, B. W.,	West End, N. J.
Lemmon, Isabel McC.,	Englewood, N. J.

Loonsberry, Miss Leonora, . .	Bedford, N. Y.
Lounsbery, R. P., ...	New York City.
Lowell, Sidney V., . . .	Brooklyn, N. Y.
Macy, Mrs. V. Everit, . . .	Scarborough-on-Hudson, Chilmark, N. Y.
Mager, F. Robert, ...	Yonkers, N. Y.
Maghee, J. H., ...	Morristown, N. J.
Maloy, J. H., ...	New York City.
Marsh, Miss Ruth, . . .	East Orange, N. J.
Mastick, Mrs. Seabury C., . .	Pleasantville, N. Y.
Matheson, William J., . . .	New York City.
McCook, Philip J., . . .	New York City.
McCormick, Dr. H. D., . . .	Cedar Grove, N. J.
Meeker, Jesse C. A., . . .	Danbury, Conn.
Merritt, Mrs. D. F., . . .	Montclair, N. J.
Merritt, Mrs. George P., . .	Hartford, Conn.
Metcalf, Manton B., . . .	Orange, N. J.
Metcalf, Willard L., . . .	Falls Village, Conn.
Miller, H. H., ...	Peapack, N. J.
Miller, Hiram S., ...	Springs, N. Y. (Gardiner's Island).
Miller, W. DeW., ...	New York City.
Mills, H. O., ...	Unionville, Conn.
Moore, C. DeR., ...	New York City.
Morris, Lardner V., . . .	Brooklyn, N. Y.
Morris, Robert O., . . .	Springfield, Mass.
Morris, Dr. Robert T., . . .	New York City.
Mulford, Miss Sarah M., . .	West Roselle, N. Y.
Newcomb, William, . . .	Tenafly, N. J.
Nichols, J. T., ...	New York City.
Nichols, John W. T., . . .	New York City.
Pangburn, Clifford H., . . .	New Haven, Conn.
Palmer, Dr. T. S., ...	Washington, D. C.
Parsons, R. L., ...	South Orange, N. J.
Pease, E. Lynn, ...	Thompsonville, Conn.
Pennock, C. J., ...	Kennett Square, Pa.
Pierrepont, John J., . . .	Brooklyn, N. Y.
Pitkin, F. E., ...	Brooklyn, N. Y.
Porter, Louis H., ...	Stamford, Conn.
Post, William S., ...	New York City.
Potts, Thomas, ...	Brooklyn, N. Y.
Prime, Miss Cornelia, . . .	Huntington, L. I., N. Y.

Rathborne, R. C.,	Newark, N. J.
Reinhold, Dr. A. J.,	New York City.
Rhoads, Samuel N.,	Haddonfield, N. J.
Riis, Jacob A.,	New York City.
Robinson, F. B.,	Newburg, N. Y.
Robotham, Cheslar,	Newark, N. J.
Roddy, Prof. H. Justin,	Millersville, Pa.
Rogers, Charles H.,	New York City.
Russ, E.,	Hoboken, N. J.
Sage, Jno. H.,	Portland, Conn.
Sauter, Fred,	New York City.
Scheifflin, Eugene,	New York City.
Schroeder, Arthur,	Montclair, N. J.
Seccomb, Mrs. E. A.,	Plainfield, N. J.
See, Alonzo B.,	New York City.
Seton, Ernest Thompson,	Cos Cob, Conn.
Shannon, William Purdy,	New York City.
Shaw, Mrs. C. W.,	Mountainville, N. Y.
Sheldon, Israel R.,	Providence, R. I.
Shoemaker, Henry W.,	New York City.
Simmons, George O.,	Brooklyn, N. Y.
Smith, Theo. H.,	East Orange, N. J.
Smith, Wilbur F.,	South Norwalk, Conn.
Stiles, Edgar C.,	West Haven, Conn.
Stone, Herbert F.,	Stapleton, L. I., N. Y.
Stone, Witmer,	Philadelphia, Pa.
Thomas, Emily Hinds,	Bryn Mawr, Pa.
Tinkham, Julian R.,	Upper Montclair, N. J.
Titus, E., Jr.,	New York City.
Townsend, Wilmot,	Brooklyn, N. Y.
Treat, Willard E.,	Silver Lane, Conn.
Tweedy, Edgar,	Clinton, Conn.
Underhill, Alice L.,	Yonkers, N. Y.
Victor, Edward W.,	Brooklyn, N. Y.
Van Name, Willard G.,	New Haven, Conn.
Wadsworth, Mrs. Richard C. W.,	Irvington-on-Hudson, N. Y.
Walker, David R.,	Waterbury, Conn.
Watson, Miss Jane S.,	East Avon, N. Y.
Weston, Miss Helen,	West New Brighton, L. I., N. Y.
Wetmore, Mrs. Edmund,	Fort Salonga, L. I., N. Y.

White, Harold H., ...	Brooklyn, N. Y.
White, W. A., ...	Brooklyn, N. Y.
Whiting, Miss Gertrude, . .	New York City.
Whiton, S. G., ...	Brooklyn, N. Y.
Wilcox, T. F., ...	New York City.
Wilde, Mark L. C., . . .	Camden, N. J.
Wildman, A. D., ...	Yonkers, N. Y.
Willever, J. C., ...	New York City.
Williams, B. S., ...	New York City.
Wills, Charles T., ...	New York City.
Winters, H. D., ...	Watkins, N. Y.
Wright, Mrs. Mabel, . . .	Fairfield, Conn.

FIRST ANNUAL REPORT

OF THE

STATE INSPECTOR OF APIARIES.

PRESENTED TO THE BOARD AND ACCEPTED,
JANUARY 10, 1911.

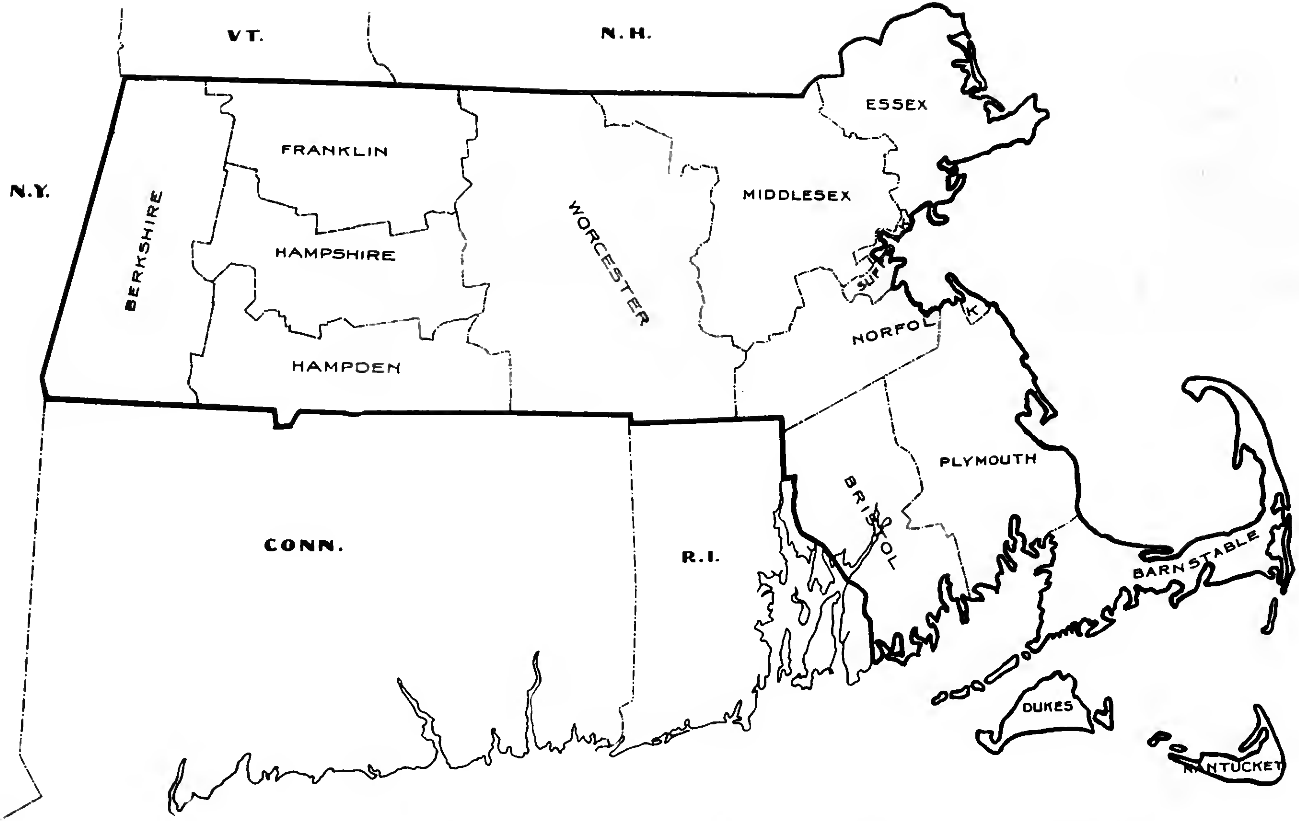
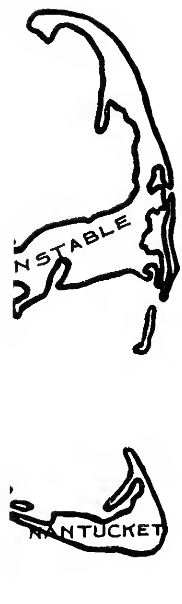


PLATE I. Map showing the present status of the distribution of American foul brood and European foul brood in Massachusetts.


NSTABLE
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FIRST ANNUAL REPORT OF THE STATE INSPECTOR OF APIARIES.

To the State Board of Agriculture.

I respectfully present the first annual report of the State Inspector of Apiaries, whose services were available beginning July 1, 1910.

Brood Diseases of Bees.

The season has been favorable for making a pronounced beginning in the check of brood diseases of bees, — American foul brood and European foul brood. The results demonstrate primarily that these diseases are infinitely more prevalent and generally distributed than has been heretofore supposed. In some localities of a hundred square miles or more nearly every colony has been found in a serious condition. The possibility of successfully controlling these diseases has been shown to the satisfaction of beekeepers.

Public Nuisance. — Colonies of bees infected with brood diseases are public nuisances as they occur throughout the State. They endanger property, handicap the efforts and mar the investments of the most earnest and painstaking beekeepers. They not only reduce the returns of the industry, but also make sales of bees and bee products difficult and uncertain. The annual loss caused is inestimable, affecting not only the beekeeper, but also the orchardist, market gardener, cucumber grower, cranberry grower and other agriculturists.

Infectiousness. — That a single case of disease may endanger a whole beekeeping community has been repeatedly observed. Honey is largely the medium through which the disease is spread. Comparison might be made to the transmission of typhoid fever and other human diseases in milk and water. Bees are eager to rob and pillage honey from any source. Thus, if a colony becomes so reduced by the progress of disease that it no longer defends itself against the attacks of "robbers," or if the infected colony dies, then each colony in a radius of miles becomes subject to infection. From all points of the compass robber bees set upon the germ-laden honey and carry it back to their respective hives. It having been demonstrated that a relatively small amount of infected material may transmit the disease, infection throughout a whole countryside may obviously result from a single colony ignorantly or carelessly handled. The recognized infectiousness of brood diseases is also emphatically illustrated by the policy of the United States Department of Agriculture. If disease is discovered in a town, not only the town but the county is considered infected area. Although a much greater array of evidence of infectiousness might be given, yet it is apparent that where these diseases exist unsuppressed, they are comparably as dangerous to beekeeping interests as smallpox is to the human community.

The Suppression of Diseases is fundamentally important. — All beekeeping, — raising bees for market, queen rearing, honey production, — and with it the best interests of the horticulturist, is dependent upon the reduction of these diseases. There is ground for belief that before many years interstate trade in bees, queens and possibly products will be restricted by law from a State where diseases are unsuppressed to a State where they are under control or do not occur. This would seriously affect Massachusetts bee men, particularly those who raise queens or bees for the trade, unless the general occurrence of infection is reduced. The seemingly spontaneous and general demand, by those who use bees, for what might be termed "certified stock," explained elsewhere, has its relation here. If bees pronounced by expert authority "free from disease" are unobtainable in Massachusetts, it must be expected that trade which would otherwise come to the State, from without and from within, will go elsewhere.

The interests of the United States Department of Agriculture are largely focused on the study of the nature, dissemination, remedial measures and distribution of American foul brood and European foul brood. Between 70 per cent and 80 per cent of their appropriation for apicultural investigations is spent in this study, regarding it fundamental to progress, or even success, in the industry. Significant, also, of the scope and importance of this phase of beekeeping is the literature, which numbers hundreds and doubtless thousands of titles in all languages, meaning a world-wide movement.

Influence on the Conditions of the Industry. — Bees thrive and may be profitable in any part of Massachusetts, though some localities are the superior of any in the northeastern United States. Bee diseases have had an incalculable effect on the way that bees are kept, on the number which are kept, on commercial enterprise and the expansion of beekeeping and indirectly on agriculture itself. The conditions and returns from the industry may be truly measured in terms of the relative distribution of American foul brood and European foul brood. In some localities it is regarded as impossible to raise bees at all; not, it has been found, owing to the lack of forage or other unfavorable conditions, but rather to the subtle and repeated inroads of brood diseases.

Usefulness of Bees to the Agriculturist.

By far the greatest service of bees is to agriculture in its broad sense, in particular to practical and commercial horticulture.

The Orchardist. — If the aims and ideals of the orchardist are to be realized, bees are a primary essential; but colonies of bees which can be depended upon must be available. The writer has had numerous inquiries for bees to be used in the orchard, in order to obtain, as one man put it, a little better set or an off-year set, thus getting advantage of the grower who depends upon the fluctuations of his neighbors' bees. It is in the unfavorable year that prices run high, and experience shows that healthy bees should be at hand to work the blossoms under such conditions.

The Small Fruit Grower. — The small fruit grower can profit similarly. There is perhaps no flower which the bees work more freely and vigorously than the raspberry. Practically all small fruits respond to the visits of bees.

The Market Gardener. — The market gardener in many instances already keeps bees; and inquiries point to this becoming more general. For instance, the growers of melons, cucumbers and squashes find a failure in their crops when bees are scarce or lacking, and an increase of yield when bees are present in abundance, as was specifically observed last summer. A Massachusetts grower of melons, in a region badly infected with bee diseases, — a large percentage of the bees having been killed off, — had an extraordinary yield as the result of hiring, as an experiment, a single healthy colony of bees. It is said that $4,000 worth of melons were sold at his door.

The Cucumber Grower under Glass. — No horticulturist is more dependent upon the services of healthy, dependable colonies than the grower of cucumbers under glass. It has been accurately estimated that at least 2,000 colonies are annually put into the greenhouses. Only the strongest, most healthy colonies can endure, or even be of service, in this unfavorable environment of extreme heat, humidity and confinement. If the bees fail, and the grower is obliged to send for more or delay until he can find them, set after set of the crop passes in unfruitfulness. Thus in a few days hundreds of dollars may be lost. For the past few years greenhouse cucumber growers have complained that bees are less serviceable than formerly, that they "go to pieces in the house," which is comparable to the "bad luck" complaint of beekeepers. Without systematic visits to the greenhouses, the growers' misfortunes have already been traced directly to brood diseases.

The Cranberry Grower. — There are a few cranberry growers who are beekeepers, and have reported that they consider this insect of decided value in setting the fruit. The observations of Dr. Franklin also indicate a bright future for the utilization of bees in the cranberry bog. Already inquiries have come desiring to know, for instance, the number of colonies necessary for a bog of a given size.

In the cranberry industry $1,500,000 represents the product of upwards of 2,000 growers. This industry increased 182 per cent between 1895 and 1905, and is still gaining, Dr. Franklin figuring that at least 2,000 acres have been added within the last few years. Here again is a branch of horticulture, placing dependence on bees, which should have absolutely healthy stock.

This statement of the uses to which bees are put, aside from the apicultural phase, indicates the diversity, scope and far-reaching complexity of the bee-disease situation. Instead of being a minor industry, beekeeping is fundamental to agricultural interests and occupations involving millions of dollars. Instead of being a condition that will right itself, it is evidently retarding the progress not only of the beekeeper, but also of the fruit grower, the market gardener, the hot-house cucumber grower and other agricultural industries.

Concern of the Beekeeper.

The beekeepers who have had inspection are anxious that it should continue, fearing reinfection of restored areas. Others foresee the annihilation of the industry, disaster to market gardening, seed production, orcharding and the like. At least what ground has been gained should be held. From other parts of the State there have been requests for help, and these still continue. It has been physically impossible to respond to some of the most urgent calls from areas where the diseases are in the worst stages, in Berkshire and about Springfield, for instance. In these localities the disease is so prevalent that at least six weeks in each will be required to make any headway.

The beginner in beekeeping and the one who wishes to increase his apiary are at a loss to know where they can buy, with certainty, bees which they can depend upon. The horticulturist is in a similar situation. This is the graver situation, because the growers of cucumbers under glass use upward of 2,000 colonies of bees annually in their houses. Moreover, they are seldom practical apiarists and have to trust the beekeeper, who, if not informed in the matter of disease, may sell colonies which will go to pieces immediately in the greenhouse, causing the cucumber producer hundreds of dollars loss within a few days. The reverse of the situation is also true. If the beekeeper is not given the protection of inspection, and the assurance that his bees are in a healthy condition, he is fearful that the grower of cucumbers will fail to buy his bees, going out of the State to get them if necessary. Thus the market is endangered.

It has come to light this season that as soon as the disease situation is under control there will be additional investment in bees from the commercial standpoint. One man from without the State is already buying up colonies, and plans to put several hundred in Massachusetts. Another beekeeper has spoken of running a series of out-apiaries in a certain promising portion of the State. Unfortunately, however, the locality is in one of the worst infected regions, and, unless it is cleaned up, will prevent the venture. Yet in disease-free environment it is entirely feasible, and would mean the maintaining, under advanced methods, of a thousand or more colonies. Such an enterprise, properly managed, would bring distinction and recognition to Massachusetts from all over the country.

Voluntary Inspection. — By far the most pronounced effort of the beekeepers to throw off the burden of disease and restore the profitable industry in that superior Berkshire country was by the service of voluntary or self-appointed inspectors. Before the act of the Legislature one experienced beekeeper took three towns in his vicinity, some one else took another group of towns, and so the territory was divided. These self-appointed inspectors doubtless did much good; they at least learned the deplorable condition and the losses of many hundreds of colonies of bees about them, but, as one of them said, they lacked authority. Then there was the personal expense, the demands of other duties, which would mean only intermittent service or work of short duration. It had its significance in that it showed that the effort to solve the problem has merit, underlies a profitable vocation, has the confidence of the beekeepers, and is desired and supported by them.

Certification. — Hardly had the work of inspection been begun than the writer had requests for the names of persons who could supply bees positively free from infection. Of late the requests have been even more numerous, not only from beekeepers or prospective beekeepers, but from orchardists, market gardeners, growers of cucumbers under glass, and even from cranberry growers. Beekeepers and growers of cucumbers under glass in particular have repeatedly made disappointing purchases of bees. Colonies have failed to do well and often have died. This is known to have been due to the presence of disease in the colonies when sold. It is also known that disease has been introduced into apiaries which otherwise were healthy. Although the writer is glad to believe that the sale of diseased bees has been unintentional, nevertheless the disastrous effects are unchanged. It introduces doubt and distrust into the bee market, and is particularly discouraging to the beginner, who falls a victim to what amounts to fraud. From the unfortunate experiences throughout the State has arisen the demand, spontaneously and simultaneously, for bees which can be pronounced by expert authority free from disease. It has been suggested that there should be some system of certification, similar, perhaps, to the certification of nursery stock. Those who have had their bees examined may tell the purchaser of the fact, but the larger beekeepers and those who raise bees for sale urge more than that. They would have a certificate of health to send with each shipment. The inspector sees how it will be possible to arrange for this, but greater detail and labor will be consequent. Certainly it deserves serious consideration.

The system should be of advantage in two ways, giving assurance to the bee raiser and protection to the purchaser. Thus it should tend to give the sale of bees in Massachusetts precedence, should increase such sale materially, and, consequently, the production. Aside from the healthy stimulus to beekeeping, the horticulturist who is dependent upon disease-free stock for success in his crops will benefit in proportion.

STATUS.

Past Conditions. — In 1908 a survey of the occurrence of bee diseases was published.[1] At that time definite cultural information determined the occurrence in 8 towns. Similar data for adjoining States indicated an even greater distribution, especially along the boundary line. Besides this definite knowledge from 8 towns, beekeepers' reports showed probable infection in even greater areas. It is significant of the accuracy of interpretation of the beekeepers' reports that several of the localities then supposed to be infected have since been demonstrated to be in a serious condition. When the previous report was published, European foul brood was known to occur in and west of Worcester County only; its apparent spread is referred to below. In the past, efforts to eradicate disease have been individual and periodic. Such efforts can never accomplish the desired end, and it is also discouraging to the individual and to all who watch his efforts. Success requires the co-operation and systematic effort of every beekeeper in the community. Inspection will furnish the medium of co-operation and add the opportunity for instruction and assistance.

Process of Inspection. — An effort has been made to become personally familiar with the disease situation in the State. General occurrence made it necessary to select some of the worst infected areas for treatment. With a focus of infection as a beginning, examining each colony, the circle of examination was gradually expanded until a limit of disease was found. Each infected colony was distinctly marked. Personal instructions for treatment and often demonstrations were given. When necessary, apiaries were revisited. The investigation in the latter part of the season disclosed a considerable number of diseased colonies which it was necessary to hold over for treatment next spring. Instructions and caution for the safe maintenance until spring were given. A record of all transactions with each beekeeper has been kept on individual record cards.

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[1] "Bee Diseases in Massachusetts," by Burton N. Gates, Bureau of Entomology, United States Department of Agriculture, Bulletin 75, Part III.; also, Massachusetts Agricultural Experiment Station, Bulletin 124 (out of print).

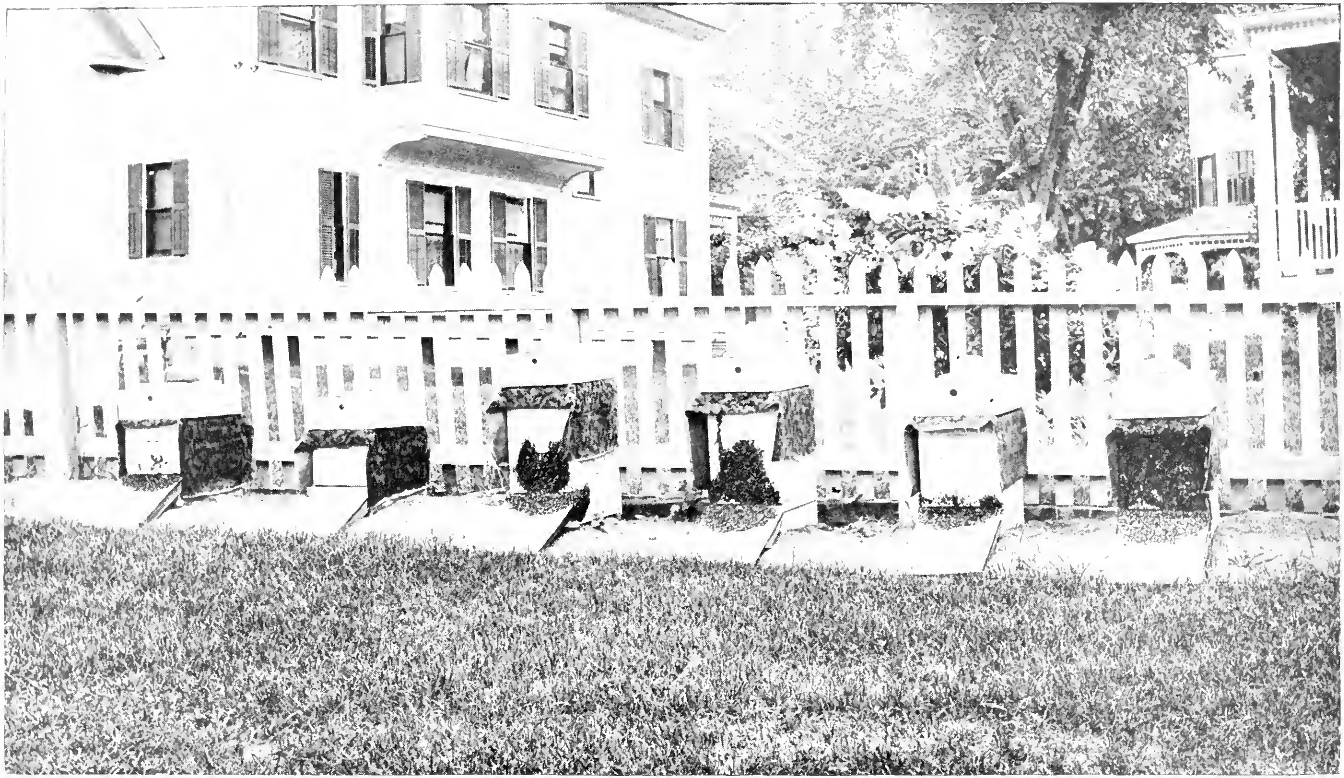


PLATE II. This neat appearing apiary, with apparently strong colonies, was regarded by the owner as healthy until examination showed each colony infected with American foul brood.

Benefit v. Disaster. — In the localities where treatment has been applied beekeepers have learned not only that it is possible to save their colonies, even those badly infected, but also that the brood, the wax, the honey, the hives and the like may be utilized. It is not now the task and does not entail the loss which treatment formerly incurred, when it was thought necessary to burn everything infected, bees and all. For illustration: one beekeeper had some 30 colonies, all of which were infected and some of which were so reduced that they were regarded as useless and hopeless; they would have died within a few weeks. All were treated late in July. When these bees were put into winter quarters the disease had not reappeared. The beekeeper sold some 175 pounds of wax (which wholesales at about 30 cents a pound), 600 pounds of honey, $69 worth of bees and queens, and has on hand 29 colonies of bees in prime condition, worth at least $200. In its former condition his apiary would have been appraised at nothing, since a diseased colony of bees is without value. Furthermore, colonies regarded as hopeless were stimulated with the brood removed from other colonies. In one instance, at least, a colony which had less than a pint of bees was increased so that it could not be crowded into two hive bodies; it gave a surplus of honey.

On the other hand, to show the disaster sustained by one beekeeper, out of 55 colonies put into winter quarters last fall, 50 were dead last spring. Those remaining had advanced cases of American foul brood and were successfully treated. Yet this beekeeper sustained a loss greater than half the present appropriation. To make a bad matter worse, the evidence is that the apiarist unwittingly purchased the disease.

Present Conditions. — It is difficult to draw just and adequate conclusions from a tabulation of the number of apiaries visited, the number of beekeepers in the State, the number of colonies examined and those found infected. Only the most general interpretation of the situation is possible. The list of beekeepers has been increased over the former list by about 25 per cent. The indications are that the 2,500 now recorded does not fully represent the total number. About one-seventeenth (140) of the apiaries were visited. Many of these required revisiting, so that the total number of calls is much greater than 140. About 900 colonies were examined, a considerable number of which were re-examined, bringing the total number of manipulations to between 1,500 and 2,000. As a whole, over 25 per cent of the colonies examined were diseased, yet this does not indicate the probable ratio of infection. In some localities it was not possible to make a thorough and systematic search for disease this season, the effort being rather to determine its presence, preparatory to further work. Some towns show more than 90 per cent of infection.

Cleaning up the Apiaries. — A person continually losing colonies is likely to leave empty hives and refuse about the yard. In several instances the writer encountered bee-keepers who could not tell in how many of the 15 or 20 hives standing around the bees were alive. After turning over a dozen or more box hives it was surprising to find more than one or two with life. Almost invariably the apiary has succumbed to foul brood. Incidentally this illustrates the need of spreading information, but more especially in regard to the way in which infection is frequently gained. As the colonies die bees from elsewhere rob many remaining stores of honey. Boards of health forbid the exposure of materials from the sick room; a comparable measure is equally important in combatting infectious diseases of bees. Fortunately, several hundred empty hives were removed from the apiaries this season.

The Map. — The accompanying map and tables (see page 213) show in detail the results of the investigation of 1910. Areas in cross hatch indicate where disease probably occurs; solid color marks infection proved by cultural examination or inspection. Although the probable infection areas are somewhat similar to those in the previous report, they are the result of information for the present year.

The Apparent Spread of the Disease. — While diseases were formerly known to occur in 8 towns, there is an increase to 32, or 400 per cent. While this might be interpreted as a spread of the disease, it shows rather, that inspection confirms what has been maintained for several years, — that this malady is widespread.

The Probable Spread of European Foul Brood. — European foul brood, formerly known only in Worcester County and west, has apparently spread east to the coast, having been found late in the season in Boston and adjoining towns. Thus it now occurs from boundary to boundary of the State. This is, perhaps, the most alarming feature of the present situation. Its gradual march from west to east has been watched for several years. Inasmuch as it spreads more rapidly and is perhaps the more disastrous of the two diseases the greatest precaution is warranted.

Berkshire County and Vicinity. — Berkshire County and vicinity is one of the most promising apicultural localities in the northeastern United States, one beekeeper having remarked that there is a continual flow of nectar from frost until frost. Wild thyme (*Thymus serpyllum* L.), heretofore not supposed to occur in America, but highly valued in England for its honey, was found by hundreds of acres; it is said to yield a surplus in the Berkshire district. Clover, basswood, raspberry, sumac, buckwheat and other plants give crops. Were it not for these superior conditions there is doubt if a colony of bees could have survived the inroads of disease. The situation is so grave that it was found impracticable to undertake treatment until at least six or eight weeks could be devoted to it. Yet it is in this locality that the most evident demand for inspection has been manifested by the self-appointed inspectors already referred to.

The Connecticut Valley. — That the situation is especially bad in part of the Connecticut valley has been known for several years. The focus is around Springfield, but the extent was found too great to warrant systematic control this year. However, in a few isolated localities it is possible to do something preparatory to another season. Great numbers of bees have been lost in this section.

Worcester County and Vicinity. — Two of the worst foci of infection were placed under control. Southborough was the center of one area inspected and treated, and there, another year, beekeepers should be in a position to get a harvest. Leominster and vicinity showed nearly every colony diseased, but it is being held in check. Although it was impossible to treat all of the stock so late in the season, many colonies were shaken. The remainder are being held for treatment next spring, instructions having been given for safely wintering them. In the spring it is hoped that the work may be followed up, in order to expand the circle of examination. In Worcester and vicinity, where there are a large number of bees, and where the disease is admitted to be prevalent, a beginning has been made. Worcester should be the center of another circle of inspection, being expanded to meet those about Leominster and Southborough. In Worcester County, while the figures are only suggestive, more than 50 per cent of the colonies examined were diseased, and a much greater per cent of the apiaries visited had diseased colonies in them. An area of probable infection is so pronounced in the vicinity of Barre and Dana that several weeks' work will be necessary in this excellent apicultural district.

Eastern Massachusetts. — The work in the eastern part of the State has had merely a beginning, the most pronounced feature being the discovery of European foul brood in and around Boston. This one fact, together with indications of widespread infection of American foul brood, and in consideration of the vast local agricultural investment in lines which require the service of healthy, dependable colonies of bees, evinces the urgency for immediate remedial measures. It is also important to consider that a large part of the bees raised in the east are sold and shipped, so that if diseases, especially European foul brood, are not checked, there is the gravest danger that they will have become scattered throughout eastern New England.

European Foul Brood, Massachusetts, 1910.[1]

Berkshire County.
Egremont.
Great Barrington.
Monterey.
Mount Washington.
New Marlborough.
Pittsfield.
Sheffield.

Hampden County.
Brimfield.
Chicopee.
Longmeadow.
Ludlow.
Monson.
Springfield.

Hampshire County.
Granby.
Greenwich.
South Hadley.

Middlesex County.
Arlington.
Belmont.
Medford.

Suffolk County.
Boston.

Worcester County.
Barre.
Dana.

Worcester County — Con.
Fitchburg.
Hardwick.
Holden.
Lancaster.
Leominster.
Lunenburg.
New Braintree.
Oakham.
Petersham.
Sterling.
Worcester.

American Foul Brood, Massachusetts, 1910.[1]

Bristol County.
Freetown.

Essex County.
Amesbury.
Ipswich.

Hampden County.
Chicopee.
Longmeadow.
Ludlow.
Springfield.

Middlesex County.
Arlington.
Ashland.
Belmont.

Middlesex County — Con.
Framingham.
Hopkinton.
Marlborough.
Medford.
Newton.
Waltham.

Norfolk County.
Sharon.
Walpole.
Weymouth.

Plymouth County.
Abington.
Rockland.

Worcester County.
Auburn.
Berlin.
Charlton.
Fitchburg.
Grafton.
Leominster.
Millbury.
Northborough.
Oxford.
Southborough.
Southbridge.
Sterling.
Sturbridge.
Upton.
Westborough.
Worcester.

[1] *Italics* indicate positive infection; roman indicates area which is doubtless infected.

Financial Statement, Dec. 31, 1910.

Appropriation,		$500 00
Services of inspector, 66 days at $5,	$330 00	
Traveling and necessary expenses,	133 99	
Unexpended balance (appropriation expires March 31, 1911),	36 01	
		$500 00

Miscellaneous Work.

Correspondence. — It should be noted that an especially large number of communications have been received. Incoming and outgoing letters number upwards of 1,100, which, when it is considered that little was known of this office for the first few months, means, on the basis of a year, a large amount of detail in excess of other office and field work.

Meetings attended. — On twelve occasions the inspector addressed organizations of beekeepers and horticulturists upon the problem of diseases and kindred beekeeping topics, in Amherst, Blackstone, Boston (two), Lee, Canton, Southborough, Stoughton and Worcester (four).

Proposed Demonstrational Meetings. — A large number of men may be met, given instruction in combating diseases and prepared for personal assistance by means of the demonstrational meetings. Thus far these meetings have proved important and timesaving. If these are held under the auspices of beekeepers' societies they will serve a double end, instruction and the added function of the society, which is such a valuable factor in promoting the industry. In order that the State may be covered another year, no less than ten of these distinctively disease demonstrations should be held, exclusive of lectures where the subject of disease may form part of the discussion.

Publications. — That beekeepers might have a concise statement of the nature, treatment and methods of control of brood diseases, the writer prepared in July, for publication, Bulletin No. 1, Apiary Inspection Series, entitled "Brood diseases of bees, their treatment, and the law for their suppression in Massachusetts." This was published at the expense of the State Board of Agriculture. Over 3,000 copies have been distributed. It will be desirable to circulate, before the opening of spring, a brief warning against the further spread of the diseases. Colonies which have died during the winter from the disease, if not properly handled before bees fly, can readily infect hundreds of other colonies by robbing the infected honey. A circular giving precautionary measures should do much to prevent the spread by this means.

The Problem.

Concisely, the problem is one of education. That bees may be diseased, and that these diseases are depressing, destructive and even annihilating to the beekeeping industry, is relatively a new point of view. Yet bee diseases are at the root and foundation of beekeepers' troubles and "bad luck." The way to relieve the situation is to inform the beekeeper, educate him to know the diseases in all their phases, show him how to treat them and guard against them. Intimately associated is the opportunity to educate along other lines of apiculture. As a matter of fact, in the past season the writer has spent quite as much time among beekeepers giving them insight into modern methods, showing "short cuts," new implements, how to increase their harvest to more nearly what it should be, and kindred subjects, as in actual inspection of bees. In many instances it has been found absolutely necessary to instruct in what might seem the most trivial, simple, beginner's subjects, as, for instance, the proper use of the smoker, yet this merely illustrates what beekeeping needs. It thus becomes evident that, while the inspection of disease should be regarded centrally and primarily important, this is but one slight phase of the general betterment of the industry. It illustrates one of the ideals of educational methods, namely, taking the results of scientific investigation into the field to the man who is to use them, — the farmer, the beekeeper.

It is the writer's earnest desire that ample provision be made for the general educational benefits which should accompany inspection of bees for disease; this will assure a normal, well-rounded and balanced advance in beekeeping rather than a one-sided development.

The general condition of apiculture has been found to be relatively low. It is estimated that in western Massachusetts a minimum of $30,000 worth of honey might be harvested annually. Where once there were hundreds of colonies, there are now but one or two. Were it not that bees thrive there extraordinarily, the writer believes that none would have survived disease. European foul brood has repeatedly devastated the apiaries, until it is a common expression, "There is no use trying to keep bees any more, they won't do anything." Yet there is a small fortune dried up in the flowers every year because no bees harvest it. In many parts of the State the beekeepers have become disheartened, they scarcely realize why, except that, as they say, they have had "bad luck." For illustration: where a few years ago there were from 75 to 100 colonies of bees in one town of from 30 to 40 square miles, the writer could not find the slightest trace of a bee, wild or under domestic control. In talking with the farmers it was learned that fruits and vegetables were failing. Is there not a reason? Yet this killing out of the bees was directly traced and determined as the result of disease, the last colony having succumbed within a year.

Beekeepers need stimulation, encouragement, instruction, to enable them to cope with the disastrous situation which threatens to overthrow the industry. The subtle influences of disease have been working for several years. The possibilities of the industry warrant its promotion; the general interests of agriculture demand that healthy bees be maintained.

To Summarize.

The work thus far has revealed the fact that the disease situation may be controlled in Massachusetts as successfully as has been demonstrated in New York and elsewhere, but that an additional sum will be essential for the best ultimate economy. The sooner general enlightment is afforded not only the quicker will be the recovery of the industry and the greater the returns, but the less the aggregate expenditure. That the early spring and summer is the most suitable time for work and results has not been emphasized, yet this is the key to success. It is urgent that the services of the three additional men provided for by existing legislation be available in April, in order to accomplish simultaneous work in four parts of the State and obtain control of the situation. To permit this work being done to best advantage, along the lines indicated, $2,000 should be available annually.

ACKNOWLEDGMENTS.

The writer would express his hearty appreciation of the co-operation of the beekeepers, and thank them for hospitality so frequently extended. Dr. Phillips and staff of the Bureau of Entomology of the United States Department of Agriculture have furthered the work by diagnosis of material. It is particularly gratifying to hear, as the writer frequently has, the deserved recognition and appreciation by the beekeepers of the interest and concern in their affairs shown by the State Board of Agriculture and its secretary. It is a pleasure to speak of the beekeepers' appreciation and to thank them all for their courtesy and material assistance in fighting the infectious diseases of bees.

Respectfully submitted,

BURTON N. GATES,
State Inspector of Apiaries.

JAN. 10, 1911.

TWENTIETH ANNUAL REPORT

OF THE

DAIRY BUREAU

OF THE

MASSACHUSETTS STATE BOARD OF AGRICULTURE,

REQUIRED UNDER

CHAPTER 89, SECTION 12, REVISED LAWS.

PRESENTED TO THE BOARD AND ACCEPTED,
JANUARY 10, 1911.

Dairy Bureau—1910.

CHARLES M. GARDNER, Westfield, *Chairman.*
HOWARD A. PARSONS, North Amherst.
GEORGE W. TRULL, Tewksbury, P. O. Lowell, R. F. D.

Secretary.

J. LEWIS ELLSWORTH, *Executive Officer and Secretary of the State Board of Agriculture.*

General Agent.

P. M. HARWOOD.

Address, Room 136, State House, Boston.

REPORT OF THE DAIRY BUREAU.

During the year just closed 7,922 inspections have been made, 220 cases entered in court, of which 218 were won, and 35 meetings have been addressed by the general agent. Of the court cases, 139 were for violation of the oleomargarine laws, 77 for violation of the renovated butter law, and 4 for violation of the milk adulteration law. The Bureau has inspected most of the creameries and large milk-distributing depots in the State, and has found them, as a rule, in a satisfactory condition. There are now 12 co-operative and 11 proprietary creameries in the State. Two creameries that in Shelburne Falls and the Greylock in Cheshire, have gone out of business within the year.

While the Bureau has done much in the way of protecting the public from fraud and the makers and dealers in butter from unfair competition, and while more than the usual amount of educational work has been done, but little milk work has been attempted, and this for two reasons. First, our appropriation is insufficient, and second, the field is well covered by another State department and by local milk inspectors, now generally active all over the Commonwealth. The few cases we have undertaken have been upon request.

The Dairy Situation.

In view of the present transportation situation and the fact that approximately three-fourths of all the milk brought into Boston by rail and nearly all of that brought in from without the State is now pasteurized before being offered for sale, the hope of the Massachusetts farmer seems to lie in whatever demand there is for a good clean article of near-by raw milk, produced under conditions which inspire confidence and therefore demand a better price than that received for milk which cannot be safely sold without resorting to pasteurization.

As an illustration of what can be done where there is a good understanding between reasonable local authorities and willing-to-co-operate milk producers, the city of Brockton stands out prominently, milk being generally sold in that city this winter at 9 cents per quart. In the report of the milk inspector of Brockton for 1909 he cites 25 dairies with bacteria count averaging below 50,000 per cubic centimeter, of which 18 averaged below 25,000 and 7 below 10,000 each. In commenting on the 3 dairies having the lowest bacteria count, the inspector says: "Neither of these has found it necessary to generally remodel the barn or install costly new apparatus, but careful personal supervision of the work by the owner has placed these dairies in the lead." Other good illustrations might be given in other cities, but this one suffices to show that where there is a will to produce a clean article of milk there is a way; and also illustrates a willingness on the part of the public, confidence established, to pay the price.

The number of cows assessed in Massachusetts April 1, 1910, was 166,048, which is 2,173 less than were assessed in 1909 and 15,763 less than were assessed in 1906, the average annual decline for the last four years being 3,942. The amount of milk brought into Boston by rail has also continued to fall off, according to the Railroad Commissioners' figures. For twelve months, Dec. 1, 1908, to Nov. 30, 1909, the figures were 108,082,936 quarts; for corresponding months in 1909–10, 100,606,362½, — a decrease of 7,376,573½ quarts. The corresponding months in 1905–06 showed 114,233,976 quarts. On this basis of 114,000,000 quarts in 1906, a normal increase with the growth of population ought to have shown 123,000,000 quarts of fluid milk brought into Boston by rail in 1910.

Condensed Milk.

There is little doubt but that condensed milk, in whatsoever form it appears, has recently made serious inroads upon the milk trade in this Commonwealth. Not only is this true of Boston and other cities, but there is hardly a hamlet so small or so remotely situated that the little cans of this article have not found their way to the shelves of the grocery store or the meat market. Yet with a possible exception not a can of this milk is produced or condensed in Massachusetts. The local storekeeper thus sends his money out of the State for condensed milk, while at the same time he complains if the local farmer buys dry goods or groceries outside his own town. When the consumer buys condensed milk instead of clean, fresh milk produced by local dairymen, because he is loath to pay the latter a living price, does he know whether or not he is paying a greater relative price for condensed milk and at the same time getting a relatively inferior article? If not, he should post himself as to the facts. Condensed milk has its use, a niche to fill, namely, wherever fresh fluid milk cannot for any reason be obtained or kept in proper condition; but until this milk can be offered for sale at less price than it now is, or can be proven to be more nutritious as a food than an equal value of clean, raw, whole milk, there is little excuse for either its purchase or use wherever the latter is obtainable at present prices. We have found, from the purchase and analysis of a number of samples of condensed milks, facts similar to those discovered by Professor Jordan, and reported by him last year, that the average cost was around 11 cents per fluid quart equivalent for condensed milk on the basis of the Massachusetts standard of 3.35 per cent milk fat. In this connection it should be remembered that ordinary fluid milk averages a higher percentage of fat than that required by law, thus rendering the comparison more than fair to condensed milk. Professor Jordan also reported that condensed milk varied greatly in its bacteria count, all the way from "very low" to 10,000,000 per cubic centimeter. Our own investigation of sixteen brands purchased at random showed, through Professor Prescott's examination, variation of from less than 100 to 1,350,000 per cubic centimeter. It therefore appears that condensed milk is not always sterile.[1] Examinations made by our chemist, B. F. Davenport, M.D., by Herman C. Lythgoe, analyst of the State Board of Health, and by Prof. James O. Jordan of the Boston Bureau of Milk Inspection, indicate that condensed milk is seldom prepared from milk rich in fat, but oftentimes from apparently below-standard milk. Therefore it would seem that the least we can ask is the passage by the Legislature of a bill requiring that a label, bearing a formula for extending with water, for home use, be securely attached to each container of evaporated, concentrated or condensed milk sold or offered for sale in this Commonwealth, and that the formula thus attached be such that the milk product resulting be not below the Massachusetts standard for whole milk. Such a law should carry with it a suitable penalty in case the milk thus extended fails in any instance to conform to the present legal requirements for whole milk.

So long as a milk standard is maintained in this State it is manifestly unfair that these prepared milks from other States should come into our markets without either standard or guarantee as regards their solid food content. We suggest the following, which is the same bill that the Bureau used its best efforts to have passed last year: —

An Act relative to the Labeling of Evaporated, Concentrated or Condensed Milk.

Section 1. Every container of evaporated, concentrated or condensed milk sold or offered for sale, or had in possession or custody with intent to sell, by any person, firm or corporation within this commonwealth, shall have plainly printed thereupon in the English language, or attached thereto on some firmly affixed tag or label, a formula for extending the said evaporated, concentrated or condensed milk with water, and the said formula must be such that the milk product resulting shall not be below the Massachusetts standard for milk solids and fat for whole milk.

[1] It should be said, in justice to evaporated unsweetened milk, that it is usually found to be practically sterile, and is also sold at a relatively less price than the sweetened condensed milk.

SECTION 2. Whoever, himself or by his servant or agent or as the servant or agent of any person, firm or corporation, sells, exchanges or delivers, or has in his custody or possession with intent to sell, exchange or deliver, any container of evaporated, concentrated or condensed milk, within this commonwealth, not marked or labeled in compliance with the provisions of section one of this act, shall for the first offence be punished by a fine of not more than one hundred dollars, for a second offence by a fine of not less than one hundred nor more than two hundred dollars, and for a subsequent offence by a fine of five hundred dollars or by imprisonment for not less than three months nor more than six months.

SECTION 3. This act shall take effect on the first day of September in the year nineteen hundred and eleven.

OLEOMARGARINE FROM NATIONAL STANDPOINT.

The total amount of uncolored oleomargarine withdrawn United States tax paid in year ending June 30, 1910, that is, what was sold in this country, was 135,149,429 pounds, or 97 per cent of the whole, and the tax at ¼ cent per pound amounted to $337,898.57. If, as is now proposed, 2 cents per pound had been paid as tax on this same amount the revenue would have increased sevenfold, and would have amounted to $2,703,188.58. In view of this fact we are constrained to ask three questions. First, does the consumer want to pay this increased tax? Second, does the consumer want his oleomargarine colored to more closely imitate creamery butter, thus increasing the chance of his being more readily imposed upon by being required to pay an approximate creamery price for it? Third, why does the oleomargarine manufacturer wish to re-establish a system which was really responsible for the necessity for laws to protect the consumer from fraud from the outset? This question of taxing oleomargarine and thus restricting the use of coloring matter in its manufacture is of vital importance to producers, dealers and consumers; therefore all should be alive to the situation, and see to it that no ill-advised legislation takes place in our national Congress.

CO-OPERATION.

This Bureau has on several occasions in the past advocated a State dairymen's association, and we believe that such an organization, properly officered and managed, would work out for the benefit of the Massachusetts milk-producing farmers, and, indirectly, for the consuming public as well.

Personnel of the Bureau.

In January, 1910, Messrs. Richardson, Paige and Jewett, by reason of expiration of their terms, ceased to be members of the Board of Agriculture, and therefore were ineligible for reappointment on the Bureau. His Excellency Governor Draper was, therefore, called upon, for the first time since its original organization, to select an entirely new Bureau, which he did, appointing Charles M. Gardner of Westfield, Howard A. Parsons of Amherst and George W. Trull of Tewksbury. The executive force, agents, chemists, etc., are as follows: executive officer and secretary, J. Lewis Ellsworth; general agent, P. M. Harwood; B. F. Davenport, M.D., of Boston, and F. W. Farrell of the Emerson Laboratory, Springfield, have done the chemical work. A small amount of bacteriological work has been done by Prof. Samuel C. Prescott of Boston. A. W. Lombard has continued to act as agent, and five others have been temporarily employed from time to time.

Summary of Police Work.

Total number of inspections,	[1] 7,922
Number of inspections where no sample was taken,	6,121
Number of samples of butter and oleomargarine, all purchased,	1,724
Number of samples of milk and cream,	136
Cases entered in court,	220
Meetings addressed by the general agent,	35

Cases prosecuted during the twelve months ending Nov. 30, 1910, by months and courts, with law violated, and results, are as follows: —

[1] There were 53 extra samples taken during the year, therefore this number is 53 less than the sum of the next three items.

Court.	Month.	Number.	Law violated.	Convicted.	Discharged.
Holyoke, Police,	December,	16	Oleomargarine,	16	-
Somerville, Police,	December,	2	Oleomargarine,	2	-
Brockton, Police,	December,	5	4 oleomargarine, 1 milk.	5	-
Worcester, Central District,	December,	1	Milk,	-	1
Springfield, Police,	December,	1	Milk,	1	-
Cambridge, Third Eastern Middlesex District.	December,	8	6 renovated butter, 2 oleomargarine.	8	-
Lowell, Police,[1]	December,	3	Oleomargarine,	3	-
Lynn, Police,	December,	4	Oleomargarine,	4	-
Cambridge, Third Eastern Middlesex District.	January,	2	Oleomargarine,	2	-
Haverhill, Northern Essex District.	January,	2	Renovated butter,	2	-
Holyoke, Police,	January,	4	Renovated butter,	4	-
New Bedford, Third Bristol District.	January,	12	Oleomargarine,	12	-
East Boston, District,[2]	January,	4	Renovated butter,	4	-
Ayer, Northern Middlesex District.	January,	2	Renovated butter,	2	-
Northampton, Hampshire District.	February,	1	Oleomargarine,	1	-
North Adams, Northern Berkshire District.	February,	2	Renovated butter,	2	-
Worcester, Central Worcester District.	February,	35	9 renovated butter, 26 oleomargarine.	35	-
Fitchburg, Police,	March,	4	Oleomargarine,	4	-
Fall River, Second Bristol District.	March,	26	16 renovated butter, 10 oleomargarine.	26	-
Quincy, East Norfolk District.	March,	1	Renovated butter,	1	-
Orange, Eastern Franklin District.	March,	4	Oleomargarine,	4	-
Athol, First Northern Worcester District.	March,	2	Oleomargarine,	2	-
Gardner, First Northern Worcester District.	March,	2	Renovated butter,	2	-
Holyoke, Police,	April,	10	2 renovated butter, 8 oleomargarine.	10	-
Lawrence, Police,	April,	6	Renovated butter,	6	-
Salem, First Essex District,	April,	1	Renovated butter,	1	-
Gloucester, Eastern Essex District.	April,	4	Oleomargarine,	4	-
Worcester Central District,	April,	2	Oleomargarine,	2	-
Lynn Police,	May,	18	Renovated butter,	18	-
Chicopee, Police,	May,	1	Oleomargarine,	1	-
Southbridge, First Southern Worcester District.	May,	2	Oleomargarine,	2	-
Chelsea, Police,	May,	2	Oleomargarine,	2	-
Taunton, First Bristol District.	May,	1	Oleomargarine,	-	1
Springfield, Police,	June,	2	Oleomargarine,	2	-
Marlborough, Police,	June,	2	Oleomargarine,	2	-
Fall River, Second Bristol District.	June,	2	Oleomargarine,	2	-
Boston, Municipal,[2]	June,	2	Renovated butter,	2	-

[1] Filed on payment of costs.
[2] In connection with the Boston Bureau of Milk Inspection.

Court.	Month.	Number.	Law violated.	Convicted.	Discharged.
Concord, Central Middlesex District.	June, . .	2	Renovated butter,	2	-
Northampton, Hampshire District.	June, . .	2	Oleomargarine, .	2	-
Woburn, Fourth Eastern Middlesex District.	July, . .	2	Oleomargarine, .	2	-
Fall River, Second Bristol District.	July, . .	2	Oleomargarine, .	2	-
Wareham, Fourth Plymouth District.	July, . .	2	Oleomargarine, .	2	-
Nahant, Police, ...	August, .	2	Oleomargarine, .	2	-
Oak Bluffs, Dukes County District.	September, .	2	Oleomargarine, .	2	-
Salem, First Essex District,	September, .	1	Milk, . . .	1	-
Salem, First Essex District,	November, .	3	Oleomargarine, .	3	-
Concord, Central Middlesex District.	November, .	2	Oleomargarine, .	2	-
Woburn, Fourth Eastern Middlesex District.	November, .	2	Oleomargarine, .	2	-
Totals, ...	. . . . .	220	. . . . .	218	2

Note. — The Bureau is especially indebted to the milk inspectors of Boston, Chicopee, Lowell, Northampton, Revere, Salem, Springfield, Taunton and Worcester for assistance which has resulted in cases in court. We also record our indebtedness to all others who have aided us in any way.

The charges in the several cases entered in court for the year ending Nov. 30, 1910, have been as follows: —

Selling renovated butter in unmarked packages, ...	77
Selling oleomargarine when butter was asked for, ...	35
Selling oleomargarine without being registered, ...	4
Selling oleomargarine without sign in store, ...	2
Selling oleomargarine in unmarked packages, ...	3
Selling oleomargarine from unmarked wagons, ...	8
Furnishing oleomargarine in restaurants, etc., without notice to guests, ...	87
Selling milk containing added water, ...	4
	220

The following is a list of inspections without samples and the number of samples taken in the years 1903–10, inclusive: —

Year.	Inspections without Samples.	Samples taken.
1903,	4,135	1,395
1904,	4,456	1,157
1905,	4,887	971
1906,	4,985	576
1907,	4,538	1,374
1908,	5,516	1,575
1909,	5,003	1,869
1910,	6,121	1,960
Totals,	39,641	10,877
Averages,	4,955+	1,359+

Oleomargarine.

No licenses for the sale of colored oleomargarine were issued in this State, and no sales of such goods have been discovered by the agents of the Bureau during the year.

The high price of butter has boomed the oleomargarine trade. Some idea of the extent may be obtained from a perusal of the following list of United States licenses for the sale of uncolored oleomargarine, in force in Massachusetts in November, 1909, and November, 1910, showing the increase of the latter over the former: —

	1909.	1910.
Wholesale licenses in Boston,	13	21
Wholesale licenses in other cities,	8	9
Total,	21	30
Retail licenses in Boston,	46	91
Retail licenses in other cities and towns,	465	607
Total,	511	698

The following figures, taken from the annual report of the United States Commissioner of Internal Revenue for 1910, show the production, withdrawn tax paid, and withdrawn for export of the two classes of oleomargarine, as defined by act of May 9, 1902, covering a period of eight years, since it went into effect on July 1, 1902: —

Oleomargarine (Pounds).

Year.	Product taxed at Rate of 10 Cents per Pound.			Product taxed at Rate of ¼ Cent per Pound.		
	Produced.	Withdrawn Tax paid.	Withdrawn for Export.	Produced.	Withdrawn Tax paid.	Withdrawn for Export.
1903,	5,710,407	2,312,493	3,334,969	67,573,689	66,785,796	151,693
1904,	3,785,670	1,297,068	2,504,940	46,413,972	46,397,984	123,125
1905,	5,560,304	3,121,640	2,405,763	46,427,032	46,223,691	137,670
1906,	4,888,986	2,503,095	2,422,320	50,545,914	50,536,466	78,750
1907,	7,758,529	5,009,094	2,695,276	63,608,246	63,303,016	129,350
1908,	7,452,800	4,982,029	2,522,188	74,072,800	73,916,869	109,480
1909,	5,710,301	3,275,968	2,403,742	86,572,514	86,221,310	112,958
1910,	6,176,991	3,416,286	2,767,195	135,685,289	135,159,429	97,575
Total,	47,043,988	25,917,673	21,056,393	570,899,456	568,544,561	940,901

Renovated Butter.

The violations of the renovated butter law in this State during the year have been more than double what they were in 1909. The high price of butter has caused more of the goods to be used than was the case then, but, considering the amount sold, the number is not excessive, except from an ideal standpoint. There is one licensed concern in this State manufacturing renovated butter. Most of the goods are offered for sale in print form.

The following figures, from the same source as the preceding table, show the production and withdrawn tax paid of renovated butter, 1902–10: —

Renovated Butter (Pounds).

Year.	Production.	Withdrawn Tax paid.
1903,	54,658,790	51,223,234
1904,	54,171,183	54,204,478
1905,	60,029,421	60,171,504
1906,	53,549,900	53,361,088
1907,	62,965,613	63,078,504
1908,	50,479,489	50,411,446
1909,	47,345,361	47,402,382
1910,	47,433,575	47,378,446
Total,	430,633,332	430,231,082

Butter.

The annual statement of the Chamber of Commerce, as will be seen by appended tables, shows further decrease in the consumption of butter during 1910. This is undoubtedly due, in a large measure, to the high price, wholesale average, of 30.2 cents per pound, the highest figure reached in many years.

The following table shows the average quotation for the best fresh creamery butter, in a strictly wholesale way, in the Boston market for the last nine years, as compiled by the Boston Chamber of Commerce: —

Month.	1910. Cents.	1909. Cents.	1908. Cents.	1907. Cents.	1906. Cents.	1905. Cents.	1904. Cents.	1903. Cents.	1902. Cents.	1901. Cents.
January,	33.5	30.9	29.7	30.4	25.2	28.0	22.7	28.0	25.0	25.0
February,	30.5	30.0	32.1	31.7	25.2	31.6	24.6	27.0	28.5	25.0
March,	32.0	29.1	30.2	30.2	25.5	28.0	24.1	27.0	29.0	23.0
April,	31.5	27.9	28.4	32.2	22.2	29.1	21.6	27.5	32.0	22.0
May,	29.0	26.6	24.1	31.4	19.9	23.9	19.9	22.5	25.0	19.5
June,	28.2	26.4	24.5	21.3	20.2	20.7	18.4	22.75	23.5	20.0
July,	28.6	27.2	23.6	25.9	21.0	20.6	18.3	20.5	22.5	20.0
August,	29.6	28.2	24.5	26.0	23.8	21.6	19.1	20.0	21.5	21.0
September,	29.6	31.3	25.3	29.2	25.6	21.2	20.8	22.0	23.5	22.0
October,	29.4	31.7	27.5	29.9	26.9	22.1	21.5	22.5	21.5	21.5
November,	30.2	31.4	29.5	27.1	27.6	23.0	24.1	23.5	27.0	24.0
December,	30.0	32.9	31.0	27.5	30.7	23.9	25.7	24.5	28.5	24.5
Average,	30.2	29.5	27.5	28.48	24.48	24.47	21.73	26.23	25.0	22.3

The Chamber of Commerce figures regarding the butter business in Boston for 1909 and 1910 are as follows: —

	1910. Pounds.	1909. Pounds.
Carried over,	8,030,740	8,960,328
Receipts for January,	2,763,388	3,198,459
Receipts for February,	2,735,471	2,258,740
Receipts for March,	3,202,183	2,762,898
Receipts for April,	2,617,479	3,089,744
Receipts for May,	7,953,512	4,810,649
Receipts for June,	13,294,088	11,309,791
Receipts for July,	10,529,244	11,357,950
Receipts for August,	8,371,256	8,648,239
Receipts for September,	7,455,963	7,406,408
Receipts for October,	5,499,123	5,140,375
Receipts for November,	2,904,893	2,813,504
Receipts for December,	2,094,240	2,257,397
Total supply,	77,451,580	74,014,482
Exports for year, deduct,	13,650	44,050
Net supply,	77,437,930	73,970,432
Storage stock December 31, deduct,	12,272,624	8,030,740
Consumption for year,	65,165,306	65,939,692

Condensed and Evaporated Milks.

Table showing Results of Bacteriological Examination of Different Brands of Condensed and Evaporated Milk.

Sweetened Condensed Milk.

Brand.	Bacteria per Cubic Centimeter, 20° C. (96 Hours).	Bacteria per Cubic Centimeter, 37° C. (24 Hours).
Vermont,	240,000	210,000
Eclipse,	30,000	34,000
Ruby,	1,150,000	1,350,000
Red Cross,	260,000	320,000
Tip Top,	15,000	35,000
Rose,	355,000	330,000
Challenge,	100	150
Eagle,	570,000	410,000
Cupid,	650	750
Standard,	700,000	550,000
Average,	332,075	323,990

Table showing Results of Bacteriological Examination, etc. — Concluded.

Unsweetened Evaporated Milk.

Brand.	Bacteria per Cubic Centimeter, 20° C. (96 Hours).	Bacteria per Cubic Centimeter, 37° C. (24 Hours).
Peerless,	Less than 100	Less than 100
Wilson's,	Less than 100	150
Highland,	Less than 100	Less than 100
Gold,	Less than 100	Less than 100
Van Camp's,	500	2,100
Gold Cross,	Less than 100	Less than 100

Table showing Cost of Equivalent of Milk Fat contained in a Quart of Milk, up to the Massachusetts Standard of 3.35 Per Cent, in the Following Brands of Sweetened Condensed Milk and Unsweetened Evaporated Milk. Calculations made upon Basis of Weight, Fat Content and Price of Each Brand.

Sweetened Condensed Milk.

Brand.	Cost per Quart (Cents).	Brand.	Cost per Quart (Cents).
Tip Top,	9.24	Red Cross,	9.64
Eclipse,	13.60	Eagle,	13.52
Vermont,	9.03	Cupid,	12.41
Summit,	11.61	Challenge,	10.30
Standard,	11.73	Ruby,	12.73
Rose,	10.73	Heather,	11.81
		Average,	11.36

Unsweetened Evaporated Milk.

Highland,	11.09	Gold Cross,	7.86
Wilson's,	9.11	Gold,	9.58
Van Camp's,	10.15	Average,	9.39
Peerless,	8.55		

Table showing Price per Can, Weight of Contents, Per Cent of Fat and Times Massachusetts Fat Standard for Milk, in Twelve Samples Sweetened Condensed and Six Samples Unsweetened Evaporated Milk.

Sweetened Condensed Milk.

Brand.	Price per Can. (Cents).	Net Weight of Contents. (Ounces).	Fat (Per Cent).	Times the Standard for Fat.
Challenge,	10	$12\frac{5}{8}$	8.90	2.66
Rose,	12	$14\frac{13}{16}$	8.70	2.59
Tip Top,	11	$14\frac{13}{16}$	9.28	2.77
Eagle,	15	$14\frac{11}{16}$	9.00	2.68
Vermont,	11	$14\frac{7}{8}$	9.50	2.83
Eclipse,	12	$14\frac{13}{16}$	7.50	2.24
Ruby,	11	$12\frac{3}{8}$	9.90	2.95
Standard,	12	$14\frac{1}{8}$	8.40	2.50
Red Cross,	12	$14\frac{13}{16}$	8.20	2.44
Cupid,	9	$14\frac{3}{16}$	6.50	1.94
Summit,	10	$13\frac{3}{4}$	7.20	2.15
Heather,	10	$11\frac{1}{4}$	8.70	2.60

Unsweetened Evaporated Milk.

Brand.	Price per Can. (Cents).	Net Weight of Contents. (Ounces).	Fat (Per Cent).	Times the Standard for Fat.
Peerless,	11	16	9.30	2.77
Gold,	10	$16\frac{1}{8}$	7.50	2.23
Highland,	10	12	8.70	2.59
Wilson's,	10	$16\frac{15}{16}$	7.80	2.33
Van Camp's,	10	$15\frac{13}{16}$	7.20	2.15
Gold Cross,	10	$16\frac{3}{8}$	9.00	2.68

Milk.

The following analyses of milk, taken in November, 1910, from the patrons of a milk shipping station in western Massachusetts, show milk of excellent quality, with no attempt at adulteration. The herds were composed of natives, and Holstein and Jersey grades.

Sample Number.	Pounds Milk.	Number Cows.	Fat (Per Cent).	Total Solids (Per Cent).	Refraction.
1,	157	12	4.9	14.24	43.8
2,	173	13	4.2	13.23	43.3
3,	97	6	3.4	12.06	42.7
4,	76	9	4.6	13.91	43.8
5,	123	21	5.2	14.40	43.5
6,	128	7	4.0	12.60	42.8
7,	173	10	4.7	13.79	43.5
8,	104	12	3.8	12.75	43.0
9,	61	9	4.6	13.62	43.4
10,	74	5	3.6	12.24	42.6
11,	62	12	5.0	13.96	43.1
12,	94	11	4.9	13.44	42.0
13,	60	5	4.9	14.15	44.1
14,	114	11	4.1	13.01	43.5
15,	193	24	5.1	13.77	42.9
16,	56	15	5.2	14.18	43.0
17,	52	10	5.1	14.18	42.6
18,	98	11	5.0	14.52	43.7
19,	84	13	4.2	13.17	43.2
20,	248	26	3.8	12.37	42.2
21,	170	15	4.6	13.75	43.3
22,	118	16	3.9	12.64	43.2
23,	236	9	3.9	12.59	42.6
24,	145	17	4.2	12.98	42.5
25,	182	23	4.6	13.85	43.2
26,	31	12	4.4	13.75	44.3
27,	84	11	4.4	13.85	43.5
28,	114	8	4.6	13.74	43.2
29,	114	21	4.5	13.20	41.8
30,	262	33	4.1	13.62	43.4
31,	96	11	4.1	13.02	42.0
32,	67	13	4.1	13.11	43.1
Average,	122.4	13.46	4.49	13.42	43.02

Milk brought into Boston by Different Railroads, Dec. 1, 1909, to Nov. 30, 1910, as reported by the Railroad Commissioners (Quarts).

Date.	Boston & Albany.	Boston & Maine.	New York, New Haven & Hartford.	Total.
1909.				
December,	1,239,835	5,448,159	2,376,820	9,064,814
1910.				
January,	1,261,493	5,271,660	2,511,295	9,044,448
February,	1,129,956	4,839,106	2,238,771	8,207,833
March,	1,308,125	5,475,064½	2,528,599	9,311,788½
April,	1,319,982	6,343,029	2,410,224	10,073,235
May,	278,791	5,218,864	2,388,932	7,886,587
June,	965,608	5,638,992	2,266,220	8,870,820
July,	1,165,639	5,599,752	2,411,087	9,176,478
August,	891,673	4,679,669	2,037,164	7,608,506
September,	904,062	4,444,055	1,881,451	7,229,568
October,	943,466	4,482,585	2,004,881	7,430,932
November,	799,828	3,938,947	1,962,578	6,701,353
Total,	12,208,458	61,379,882½	27,018,022	100,606,362½

Milk brought into Boston by Railroad for Twelve Months ending November 30 of Each Year (Quarts).

1906,	114,233,976
1907,	109,882,190½
1908,	103,381,278½
1909,	108,082,936
1910,	100,606,362½
Total decrease in four years,	13,627,613½
Average annual decrease,	3,406,903⅜

Number of Cows assessed in Massachusetts.

May 1, 1906,	181,816
April 1, 1910,	166,048
Total decrease in four years,	15,768
Average annual decrease,	3,942

Local Milk Inspectors.

Milk Inspectors for Massachusetts Cities, 1910.

Beverly,	Henry E. Dodge, 2d.
Boston,	Prof. James O. Jordan.
Brockton,	George E. Bolling.
Cambridge,	Dr. Ernest H. Sparrow.
Chelsea,	Arthur H. Upton.
Chicopee,	C. J. O'Brien.
Everett,	E. Clarence Colby.
Fall River,	Henry Boisseau.
Fitchburg,	John F. Bresnahan.
Gloucester,	George E. Watson.
Haverhill,	Homer L. Conner, M.D.
Holyoke,	James K. Morrill.
Lawrence,	Eugene A. McCarthy.
Lowell,	Melvin F. Master.
Lynn,	Alexander S. Wright.
Malden,	J. A. Sanford.
Marlborough,	John J. Cassidy.
Medford,	Winslow Joyce.
Melrose,	Caleb W. Clark, M.D.
New Bedford,	Herbert B. Hamilton, D.V.S.
Newburyport,	T. D. Donahoe.
Newton,	Arthur Hudson.
North Adams,	Henry A. Tower.
Northampton,	George R. Turner.
Pittsfield,	Eugene L. Hannon.
Quincy,	Edward J. Murphy.
Salem,	John J. McGrath.
Somerville,	Herbert E. Bowman.
Springfield,	Stephen C. Downs.
Taunton,	Lewis I. Tucker.
Waltham,	Arthur E. Stone, M.D.
Woburn,	P. T. McDonough.
Worcester,	Gustaf L. Berg.

Milk Inspectors Massachusetts Towns, 1910.

Adams,	Dr. A. G. Potter.
Amesbury,	E. S. Worthen.
Andover,	Franklin H. Stacy.
Arlington,	Dr. L. L. Pierce.
Attleborough,	Caleb Parmenter.
Barnstable,	George T. Mecarta.
Belmont,	Prof. Samuel C. Prescott.

Brookline,	Frederick H. Osgood.
Clinton,	Gilman L. Chase.
Greenfield,	M. L. Miner, D.V.S.
South Hadley Falls,	George F. Boudreau.
Hyde Park,	James G. Bolles.
Leominster,	William H. Dodge, D.V.S.
Ludlow,	A. L. Bennett, D.V.S.
Monson,	Dr. Charles W. Jackson.
North Attleborough,	Hugh Gaw, V.S.
Palmer,	Edward F. Brown.
Revere,	Joseph E. Lamb.
South Framingham,	Charles N. Hargraves.
Stoneham,	George H. Allen.
Wakefield,	Harry A. Simonds.
Ware,	Fred E. Marsh.
Watertown,	Luther W. Simonds.
Westfield,	William H. Porter.
Williamstown,	C. L. Whitney.
Winchendon,	Frederick W. Russell, M.D.
Winchester,	Morris Dineen.

Creameries, Milk Depots, etc.

Co-operative Creameries.

Number and Location.	Name.	Superintendent or Manager.
1. Ashfield,	Ashfield Creamery,	William Hunter, manager.
2. Belchertown,	Belchertown Creamery,	M. G. Ward, president.
3. Cummington,	Cummington Creamery,	D. C. Morey, superintendent.
4. Easthampton,	Hampton Creamery,	W. H. Wright, treasurer.
5. Egremont (P. O. Great Barrington).	Egremont Creamery,	E. A. Tyrrell, manager.
6. Monterey,	Berkshire Hills Creamery,	F. A. Campbell, manager.
7. New Boston,	Berkshire Creamery,	F. M. Rugg, president.
8. New Salem (P. O. Millington).	New Salem Creamery,	W. A. Moore, treasurer.
9. Northfield,	Northfield Co-operative Creamery Association.	Chas. C. Stearns, superintendent.
10. Shelburne,	Shelburne Creamery,	Ira Barnard, manager.
11. Westfield (P. O. Wyben),	Wyben Springs Creamery,	C. H. Kelso, manager.
12. West Newbury,	West Newbury Creamery,	R. S. Brown, treasurer.

Proprietary Creameries.

Number and Location.	Name.	Owner or Manager.
1. Amherst,	Amherst Creamery,	Tait Bros., managers.
2. Amherst,	Fort River Creamery,	E. A. King.
3. Brimfield,	Crystal Brook Creamery,	F. N. Lawrence.
4. Everett,	Hampden Creamery Company,	Hampden Creamery Company.
5. Fitchburg, 26 Cushing Street.	Fitchburg Creamery,	G. S. Learned.
6. Gardner,	Boston Dairy Company,	Boston Dairy Company.
7. Groton,	Lawrence Creamery,	Myron P. Swallow.
8. Heath,	Cold Spring Creamery,	I. W. Stetson & Son.
9. Hinsdale,	Hinsdale Creamery,	Ashley B. Clark, treasurer.
10. Marlborough,	Este's Creamery,	F. F. Este.
11. North Brookfield,	North Brookfield Creamery,	H. A. Richardson.

Educational.

Amherst,	Dairy Industry Course, Massachusetts Agricultural College.	W. P. B. Lockwood, professor in charge.

Milk-distributing Depots.

Name.	Location.	Manager.
Alden Bros.,	Boston office, 1171 Tremont Street, Depot, 24-28 Duncan Street.	Charles L. Alden.
Boston Dairy Company,	Boston, 484 Rutherford Avenue,	W. A. Graustein.
C. Brigham Company,	Cambridge, 158 Massachusetts Avenue.	John K. Whiting.
C. Brigham Company,	Worcester, 9 Howard Street,	C. Brigham Company.
Deerfoot Farms,	Southborough,	S. H. Howes.
Elm Farm Milk Company,	Boston, Wales Place,	James H. Knapp, treasurer.
H. P. Hood & Sons,	Boston, 494 Rutherford Avenue, branch, 24 Anson Street, Forest Hills.	Charles H. Hood.
	Lynn, 193 Alley Street.	
	Malden, 425 Main Street.	
	Salem, 252 Bridge Street.	
	Watertown, 289 Pleasant Street.	
	Lawrence, 629 Common Street.	
Springfield Co-operative Milk Association.	Springfield,	F. B. Allen.
Tait Bros.,	Springfield,	Tait Bros.
Wachusett Creamery,	Worcester,	E. H. Thayer & Co.
D. Whiting & Sons,	Boston, 570 Rutherford Avenue,	George Whiting.

Milk Laboratory.

Name.	Location.	Manager.
Walker-Gordon Laboratory,	Boston, 793 Boylston Street, . .	George W. Franklin.

Receiving Depots for Milk for Shipments to New York City.

F. D. Shove Milk Factory,	West Stockbridge, ...	C. M. Riggs.
Willow Brook Dairy Company.	Sheffield, ...	Frank Percy.

Expenses.

The following is a classified statement of the expenses for the year ending Nov. 30, 1910: —

Bureau: compensation and traveling expenses, . .	$453 27
Agents: compensation, ...	2,425 84
Agents: traveling expenses and samples purchased, .	2,922 71
General agent: traveling and necessary expenses, . .	435 83
Chemists: analyses, tests, court attendance, ...	1,449 40
Printing and supplies, ...	312 95
Total, ...	$8,000 00

P. M. HARWOOD,
General Agent.

Accepted and adopted as the report of the Dairy Bureau.

CHARLES M. GARDNER.
H. A. PARSONS.
GEORGE W. TRULL.

SEVENTH ANNUAL REPORT

OF THE

STATE FORESTER.

Synopsis Presented to the Board and Accepted,
January 10, 1911.

SEVENTH ANNUAL REPORT OF THE STATE FORESTER.

INTRODUCTION.

Forestry work during the past year has received its due share of interest on the part of our Massachusetts people. It is a pleasure to be able to report that in general the forestry and moth work have so amalgamated that not only more efficiency but greater economy is the result.

The depredations of insect pests, fungous diseases and forest fires must be successfully dealt with and controlled if we are to succeed in establishing and maintaining a modern forestry system throughout this Commonwealth.

From the first the forestry work has been popular, while the moth work, on the other hand, has savored of unpopularity, for many reasons, but chiefly because of the law requiring property owners, through taxation, to defray a portion of its expense.

It has taken time to organize and perfect the work of combating the gypsy and brown-tail moths. It is believed to be a conservative estimate when we say that we have increased our efficiency toward moth control fully one-third during the past season, and without additional appropriations.

It has been the earnest endeavor of the State Forester, since the moth work has been placed under his care, to overcome, if possible, anything that has a tendency to create a misunderstanding, and also to secure legislation that would meet definite requirements and hence general public approval.

The legislation enacted by the last General Court has already proved of great assistance, and it is hoped that our requests as outlined at the conclusion of this report will meet with the favorable consideration of your honorable body.

It is believed that there are few departments in the State that have a more enthusiastic, self-sacrificing and loyal corps of employees than has this one. "A live-wire organization" is our slogan.

The demands upon the office of the State Forester for examinations and advice on forestry matters have been greater than ever; also, forestry literature, lectures and demonstrations have been constantly requested throughout the year. Fire-warning notices and forest-law posters have been generally distributed and are in greater use than ever.

The growing interest in equipping our towns with some modern fire-fighting apparatus is certainly encouraging. The legislation of last year, whereby the poorer towns receive State aid, has been of great assistance. The comparative efficiency of towns with and without equipment for fighting forest fires during the past season is proverbial. Towns with equipment were practically free from fires, while those without such equipment were largely burned over.

The reforestation work is extremely popular, and it is believed that the State can well afford to enlarge the appropriation for this work, as under our present method the State cannot possibly lose.

The State Forester feels frank to say that the outlook in this department was never brighter.

Organization.

The same general plan of organization as that outlined last year has been continued throughout the season. Our constant aim has been toward greater efficiency and raising the standard of the work. Our purpose is to encourage cities and towns to first secure competent forest wardens and moth superintendents, and then to desist from constant changes. It takes time to get a man well broken into the work, and thereafter he is of the greatest value.

The present organization of the State Forester's staff is as follows: —

STAFF.

Mr. F. W. RANE, B.Agr., M.S.,	State Forester.
Mr. L. H. WORTHLEY,	Assistant Forester, in charge of moth work.
Mr. H. O. COOK, M.F.,	Assistant Forester, in charge of forestry management.
Mr. R. S. LANGDELL,	Assistant Forester, in charge of nursery work.
Mr. H. F. GOULD, M.F.,	Assistant Forester.
Mr. J. H. POTTS,[1]	Assistant, forest fire work.
ALDEN T. SPEARE,	Assistant, moth disease work.
Mr. CHAS. O. BAILEY,	Secretary.
Miss ELIZABETH HUBBARD,	Clerk, in charge of accounts.
Miss CHARLOTTE JACOBS,	Clerk, in charge of mail and office.
Mr. WM. A. HATCH,	Division Superintendent, Division 1, as follows: Danvers, Hamilton, Ipswich, Lynn, Lynnfield, Nahant, Peabody, Revere, Salem, Swampscott and Wenham.
Mr. JOHN W. ENWRIGHT,	Agent, Division 2, as follows: Arlington, Bedford, Burlington, Carlisle, Everett, Lexington, Malden, Melrose, No. Reading, Reading, Saugus, Stoneham, Wakefield, Wilmington, Winchester and Woburn.
Mr. GEORGE A. SMITH,	Agent, Division 3, as follows: Belmont, Boston, Brookline, Cambridge, Chelsea, Concord, Hyde Park, Lincoln, Medford, Natick, Needham, Newton, Somerville, Waltham, Watertown, Wayland, Wellesley, Weston and Winthrop.
Mr. FRANK A. BATES,	Agent, Division 4, as follows: Abington, Avon, Braintree, Cohasset, Hingham, Holbrook, Hull, Milton, Quincy, Randolph, Rockland, Scituate, Weymouth and Whitman.
Mr. FRANCIS C. WORTHEN,	Division Superintendent, Division 5, as follows: Amesbury, Boxford, Georgetown, Groveland, Merrimac, Middleton, Newbury, Newburyport, Rowley, Salisbury, Topsfield and West Newbury.
Mr. JOHN J. FITZGERALD,	Division Superintendent, Division 6, as follows: Andover, Billerica, Chelmsford, Dracut, Haverhill, Lawrence, Lowell, Methuen, North Andover and Tewksbury.
Mr. WM. W. COLTON,	Division Superintendent, Division 7, as follows: Ashby, Ashburnham, Ayer, Dunstable, Fitchburg, Groton, Lunenburg, Pepperell, Shirley, Townsend, Westford and Westminster.
Mr. CLARENCE W. PARKHURST,	Division Superintendent, Division 8, as follows: Bellingham, Canton, Dedham, Dover, Foxborough, Framingham, Franklin, Medfield, Medway, Millis, Norfolk, Norwood, Plainville, Sharon, Sherborn, Stoughton, Walpole, Westwood and Wrentham.
Mr. CHAS. W. MINOTT,	Agent, Division 9, as follows: Acton, Berlin, Bolton, Boxborough, Clinton, Harvard, Hudson, Lancaster, Leominster, Littleton, Marlborough, Maynard, Sterling, Stowe and Sudbury.

[1] Resigned.

Mr. George A. Sands, . .	Division Superintendent, Division 10, as follows: Ashland, Blackstone, Grafton, Holliston, Hopedale, Hopkinton, Mendon, Milford, Northborough, Northbridge, Southborough, Upton, Uxbridge and Westborough.
Mr. Harry B. Ramsey, . .	Agent, Division 11, as follows: Athol, Auburn, Barre, Boylston, Brookfield, Charlton, Douglas, Dudley, Gardner, Holden, Hubbardston, Leicester, Millbury, Orange, Oxford, Paxton, Petersham, Phillipston, Princeton, Rutland, Royalston, Spencer, Sturbridge, Sutton, Templeton, Webster, West Boylston, Winchendon and Worcester.
Mr. John A. Farley, . . .	Agent, Division 12, as follows: Carver, Duxbury, Halifax, Hanover, Hanson, Kingston, Marshfield, Norwell, Pembroke, Plymouth and Plympton.
Mr. Lewis W. Hodgkins, . .	Agent, Division 13, as follows: Attleborough, Bridgewater, Brockton, East Bridgewater, Easton, Lakeville, Mansfield, Middleborough, North Attleborough, Raynham, Taunton and West Bridgewater.
Mr. John F. Carleton, . .	Division Superintendent, Division 14, as follows: Barnstable, Bourne, Brewster, Dennis, Falmouth, Marion, Mashpee, Orleans, Rochester, Sandwich, Truro, Wareham, Wellfleet and Yarmouth.
Mr. Saul Phillips, . . .	Division Superintendent, Division 15, as follows: Beverly, Essex, Gloucester, Manchester, North Shore Woodlands and Rockport.

Co-operative Scientific Staff.

L. O. Howard, Ph.D., . .	Chief United States Bureau of Entomology, Washington, D. C., *Parasites and Predaceous Insects.*
Theobald Smith, Ph.B., M.D., .	Professor of Comparative Pathology, Harvard University, *Diseases of Insects.*
Roland Thaxter, Ph.D., . .	Professor of Cryptogamic Botany, Harvard University, *Fungous Diseases affecting Insects.*
E. L. Mark, Ph.D., LL.D., . .	Director of the Zoölogical Laboratory, Harvard University, *Protozoa and Insect Life.*
W. M. Wheeler, Ph.D., . .	Professor of Entomology, Harvard University, *Experimental Entomologist.*
C. H. Fernald, Ph.D., . .	Professor of Entomology, Massachusetts Agricultural College, *Consulting Entomologist.*
Frank H. Mosher, . . .	Entomologist in charge of laboratory.

List of Forest Wardens and Local Moth Superintendents.

[Alphabetically by towns.]

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Abington,	287	B. E. Wilkes, chief fire department,	C. Frederick Shaw.
Acton,	181	Wm. H. Kingsley,	James O'Neil.
Acushnet,	275	Henry F. Taber,	A. P. R. Gilmore.
Adams,	7	John Claney,	-
Agawam,	93	D L. White, P. O. Feeding Hills,	- -
Alford,	24	John H. Wilcox,	- -
Amesbury,	228	James E. Feltham, chief fire department,	A. L. Stover.
Amherst,	67	G. E. Stone, tree warden,	
Andover,	212	J. H. Playdon, tree warden,	J. H. Playdon.
Arlington,	193	Walter H. Pierce, chief fire department,	Wm. H. Bradley.
Ashburnham,	104	Arthur H. Skillings, chief fire department.	Chas. A. Billings.
Ashby,	158	Wm. S. Green,	H. A. Lawrence.
Ashfield,	50	Chas. A. Hall,	- -
Ashland,	200	H. H. Piper,	Michael Geoghan.
Athol,	105	Frank P. Hall, chief fire department,	Geo. E. Whitney.
Attleborough,	265	Hiram Packard, chief fire department, 3 Hope Street.	Wm. E. S. Smith.
Auburn,	123	J. Fred Searle,	J. Fred Searle.
Avon,	259	James W. McCarthy, Pratt Street,	Willard W. Beals.
Ayer,	169	Chas. E. Perrin,	Daniel W. Mason.
Barnstable,	315	Henry C. Bacon, P. O. Hyannis,	Harry W. Bodfish.
Barre,	142	D. H. Rice,	George R. Simonds.
Becket,	23	Elmer D. Ballou,	- -
Bedford,	179	Chas. E. Williams,	W. A. Cutler.
Belchertown,	73	James A. Peeso, constable,	Nelson Randall.
Bellingham,	326	L. F. Thayer,	Henry A. Whitney.
Belmont,	194	John F. Leonard, chief fire department,	Chas. H. Houlahan.
Berkley,	271	Gideon H. Babbitt,	J. M. Alexander.
Berlin,	139	Walter Cole, constable,	Ernest C. Ross.
Bernardston,	39	E. E. Benjamin,	- -
Beverly,	220	Robt. H. Grant, chief fire department,	Josiah B. Brown.
Billerica,	173	Geo. C. Crosby, chief engineer fire department.	Henry E. Marion.
Blackstone,	114	Thomas Reilly,	A. J. Gibbons.
Blandford,	81	C. O. Shultz,	- -
Bolton,	146	Chas. E. Mace,	Chas. E. Mace.
Boston,[1]	-	- - -	D. Henry Sullivan.
Bourne,	311	Walton E. Keene,	Stillman B. Wright.

[1] No forest area.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Boxborough,	182	M. L. Wetherbee,	John J. Sherry.
Boxford,	218	Harry L. Cole,	Chas. Perley.
Boylston,	138	Chas. S. Knight, metropolitan watchman,	George A. Vickery.
Braintree,	244	Jas. M. Cutting, special police, P. O. South Braintree.	Oscar A. Hubbard.
Brewster,	318	T. B. Tubman, highway surveyor, North Brewster.	James E. Eldridge.
Bridgewater,	293	Edwin S. Rhoades,	Walter E. Rhodes.
Brimfield,	99	Geo. E. Hitchcock,	- -
Brockton,	286	Harry L. Marston, chief fire department,	N. S. Souther
Brookfield,	120	David N. Hunter,	J. H. Conant.
Brookline,	237	Geo. H. Johnson, chief fire department,	Ernest B. Dane.
Buckland,	49	Wm. Sauer, P. O. Shelburne Falls,	- -
Burlington,	178	Walter W. Skelton, tree warden,	Walter W. Skelton.
Cambridge,[1]	-	- - -	J. F. Donnelly.
Canton,	249	Lawrence Horton, fire engineer, P. O. Ponkapoag.	Augustus Heminway.
Carlisle,	171	A. Lapham,	G. G. Wilkins.
Carver,	304	Herbert F. Atwood,	Herbert F. Atwood.
Charlemont,	42	Fred. D. Legate,	- -
Charlton,	115	Carlos Bond,	John G. Hammond.
Chatham,	320	Geo. W. Ryder, West Chatham,	Geo. B. Bassett.
Chelmsford,	172	Arthur E. Barton,	M. A. Bean.
Chelsea,[1]	-	- - -	J. A. O'Brien.
Cheshire,	11	Chas. D. Cummings,	- -
Chester,	80	Wm. H. Babb,	- -
Chesterfield,	63	Chas. A. Bisbee, P. O. Bisbee,	- -
Chicopee,	87	John H. Pomphret, chief fire department,	- -
Chilmark,	308	Ernest C. Mayhew,	Almon S. Tilton.
Clarksburg,	3	Robert Lanfair, R. F. D. No. 1, North Adams.	- -
Clinton,	145	Wm. Clark,	Wm. McGown.
Cohasset,	246	Wm. J. Brennock, captain fire department.	Joseph E. Grassie.
Colrain,	37	Wm. H. Davenport,	- -
Concord,	180	G. M. Morrell, chief fire department,	H. P. Richardson.
Conway,	51	Chas. Parsons, tree warden,	- -
Cummington,	60	W. S. Gabb, P. O. Swift River,	- -
Dalton,	14	Alvah K. Cleveland, North Street,	- -
Dana,	147	Thos. L. Thayer, P. O. North Dana,	- -
Danvers,	345	Thomas E. Tinsley,	Thomas E. Tinsley.
Dartmouth,	278	Sylvanus P. Hawes,	- -

[1] No forest area.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Dedham,	241	Henry Harrigan,	George A. Phillips.
Deerfield,	52	Wm. L. Harris,	- -
Dennis,	317	Alpheus P. Baker, constable, P. O. South Dennis.	H. H. Sears.
Dighton,	272	Ralph Earle,	D. F. Lane.
Douglas,	112	W. L. Church,	Walter E. Carpenter.
Dover,	240	John Breagy,	Harold McKenzie.
Dracut,	163	Frank H. Gunther, chief fire department,	Thomas F. Carrick.
Dudley,	110	F. A. Putnam,	Joseph N. O'Kane.
Dunstable,	161	Archie W. Swallow,	James A. Davis.
Duxbury,	303	Fred. B. Knapp,	Henry A. Fish.
E. Bridgewater,	298	Loren A. Flagg, chief fire department, P. O. Elmwood.	Benjamin Taylor.
East Longmeadow,	95	E. J. Speight,	- -
Eastham,	322	W. Horton Nickerson, road surveyor,	N. P. Clark.
Easthampton,	77	Frank P. Newkirk, tree warden,	- -
Easton,	264	John Baldwin, chief fire department, North Easton.	R. W. Melendy.
Edgartown,	309	Manuel Roberts,	Theodore S. Wimpenny.
Egremont,	29	Frank W. Bradford, Great Barrington, R. F. D. No. 3.	- -
Enfield,	74	Chas. W. Felton,	- -
Erving,	46	Chas. H. Holmes, P. O. Farley,	- -
Essex,	223	Otis O. Story, tree warden,	Otis O. Story.
Everett,[1]	-	- - -	James Davidson.
Fairhaven,	276	Albert C. Aiken,	Geo. W. King.
Fall River,	280	William Mulligan, tree warden,	Wm. Mulligan.
Falmouth,	312	Herbert N. Lawrence,	W. B. Bosworth.
Fitchburg,	157	Geo. H. Hastings,	Geo. H. Hastings.
Florida,	5	E. L. Jeffries, North Adams, R. F. D. No. 3.	- -
Foxborough,	261	Ernest A. White, chief fire department,	Samuel J. Johnston.
Framingham,	197	Josiah S. Williams, P. O. Nobscot,	N. I. Bowditch.
Franklin,	255	Ed. S. Cook, dealer in wood and lumber,	John N. Stobbert.
Freetown,	274	Andrew M. Hathaway, P. O. Assonet,	Gilbert M. Nichols.
Gardner,	153	Geo. S. Hodgman,	T. W. Danforth
Gay Head,	343	Leander B. Smalley, Menemsha,	L. B. Smalley.
Georgetown,	224	Clinton J. Eaton,	Clinton J. Eaton.
Gill,	45	Lewis C. Munn,	- -
Gloucester,	234	Sydney F. Haskell, Essex Avenue,	Herbert J. Worth.
Goshen,	61	Sydney F. Packard, Williamsburg, R. F. D. No. 2.	- -
Gosnold,	344	Harold S. Veeder, P. O. Cuttyhunk,	- -

[1] No forest area.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Grafton,	125	Sumner F. Leonard,	Chas. K. Despeau.
Granby,	79	C. N. Rust,	- -
Granville,	91	Lawrence F. Henry,	- -
Great Barrington,	25	Dan W. Flynn, 54 Russell Street,	- -
Greenfield,	44	Wm. A. Ames, tree warden,	Wm. A. Ames.
Greenwich,	327	Wm. H. Walker, P. O. Greenwich Village,	- -
Groton,	167	Jas. B. Harrington, chief fire department,	Joseph F. Bateman.
Groveland,	225	Sydney E. Johnson, 311 Center Street,	Raymond B. Larive.
Hadley,	66	Edward P. West, tree warden,	- -
Halifax,	299	Edwin H. Vaughn,	Frank D. Lyon.
Hamilton,	222	Fred Berry, P. O. Essex, R. F. D.,	Erle G. Brewer.
Hampden,	97	John S. Swenson,	- -
Hancock,	9	Chas. F. Tucker,	- -
Hanover,	295	Chas. E. Damon, P. O. Box 113, North Hanover.	Lyman Russell.
Hanson,	296	Albert L. Dame, tree warden, P. O. South Hanson.	A. L. Dame.
Hardwick,	141	Myron N. Ayers,	- -
Harvard,	152	Benjamin J. Priest,	Geo. C. Maynard.
Harwich,	319	John Condon,	John H. Drum.
Hatfield,	65	John M. Strong, P. O. West Hatfield,	- -
Haverhill,	216	John B. Gordon, chief fire department,	Geo. F. Moore.
Hawley,	48	Ernest R. Sears, tree warden, P. O. Charlemont.	- -
Heath,	36	S. G. Benson,	- -
Hingham,	289	Geo. Cushing, chief fire department,	Arthur W. Young.
Hinsdale,	15	Lewis B. Breague, tree warden,	- -
Holbrook,	247	E. W. Austin,	Wm. Haydon.
Holden,	136	Henry E. Holt,	H. E. Holt.
Holland,	101	O. F. Howlett, P. O. Southbridge, R. F. D. No. 2.	- -
Holliston,	202	Waldo E. Coolidge,	Geo. H. Moody.
Holyoke,	85	Chas. C. Hastings,	- -
Hopedale,	328	Walter F. Durgin, superintendent of parks.	Walter F. Durgin.
Hopkinton,	201	R. I. Frail,	F. F. Baldwin.
Hubbardston,	149	Ernest A. Young, tree warden,	Ernest A. Young.
Hudson,	199	Fred W. Trowbridge, chief fire department.	Frederick P. Hosmer.
Hull,	329	Smith F. Sturgis, tree warden, P. O. Allerton.	John Knowles.
Huntington,	70	Daniel B. Mack,	- -
Hyde Park,	330	Harry G. Higbee,	Harry G. Higbee.
Ipswich,	223	Augustus J. Barton,	James A. Morey.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Kingston,	301	Arthur B. Holmes,	Carl C. Faunce.
Lakeville,	283	Nathan F. Washburn, P. O. Middleborough.	S. T. Nelson.
Lancaster,	151	Everett M. Hawkins, chief fire department.	Geo. F. Morse, Jr.
Lanesborough,	10	King D. Keeler,	- -
Lawrence,	214	Chas. G. Rutter, chief fire department,	Isaac Kelley.
Lee,	22	Jas. W. Bossidy,	- -
Leicester,	122	Chas. White, P. O. Cherry Valley,	J. H. Woodhead.
Lenox,	18	Geo. W. Fitch,	- -
Leominster,	155	Fred A. Russell,	S. R. Walker.
Leverett,	57	Orman C. Marvel,	- -
Lexington,	188	Azor P. Howe,	E. P. Merriam.
Leyden,	38	Herma W. Severance, P. O. Bernardston,	- -
Lincoln,	187	Edwin R. Farrer, tree warden,	Edw. R. Farrer.
Littleton,	170	A. E. Hopkins,	Alfred Hopkins.
Longmeadow,	94	Oscar C. Pomeroy,	- -
Lowell,	165	Edward S. Hosmer, chief fire department,	Chas. A. Whittet.
Ludlow,	88	Edward E. Chapman,	- -
Lunenburg,	156	Clayton E. Stone,	Myron E. Harvey.
Lynn,	331	Nathan M. Hawkes, park commissioner,	Albert C. Doak.
Lynnfield,	209	Thos. E. Cox, P. O. Wakefield, R. F. D.,	Alfred W. Copeland.
Malden,	191	Frank Turner, chief fire department,	George W. Stiles.
Manchester,	236	Frederick Burnham,	John D. Morrison.
Mansfield,	263	Herbert E. King,	W. O. Sweet.
Marblehead,	332	Wm. H. Stevens,	Wm. H. Stevens, 2d.
Marion,	306	Geo. B. Nye,	James H. Morss.
Marlborough,	198	Chas. H. Andrews, chief fire department,	Timothy J. Brennan.
Marshfield,	292	Edward E. Ames,	P. R. Livermore.
Mashpee,	313	Joseph A. Peters,	Watson F. Hammond.
Mattapoisett,	281	Everett C. Stetson,	Geo. E. Barrows.
Maynard,	184	Arthur J. Coughlan, Maynard's block,	Albert Coughlan.
Medfield,	252	Waldo E. Kingsbury, chief fire department.	Geo. L. L. Allen.
Medford,	192	Chas. Bacon, chief fire department,	Wm. J. Gannon.
Medway,	254	Clyde C. Hunt, captain fire department,	Frank Hager.
Melrose,	-	- - -	John J. McCullough.
Mendon,	119	Geo. B. Cromb,	Frank M. Aldrich.
Merrimac,	227	Edgar P. Sargent,	Chas. R. Ford.
Methuen,	213	Herbert B. Nichols,	Alfred H. Wagland.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Middleborough,	284	C. W. Weston,	- -
Middlefield,	342	Thos. H. Fleming, P. O. Bancroft,	- -
Middleton,	211	Oscar H. Sheldon,	B. T. McGlauflin.
Milford,	127	Elbert M. Crockett, chief fire department.	Patrick F. Fitzgerald.
Millbury,	124	Wm. E. Horn,	Edw. F. Roach.
Millis,	253	Chas. La Croix,	Fred Holland.
Milton,	242	Nathaniel T. Kidder, park commissioner,	Nathaniel T. Kidder.
Monroe,	34	S. R. Tower,	- -
Monson,	98	Omer E. Bradway,	- -
Montague,	53	Fred W. Lyman, lumber dealer,	- -
Monterey,	28	J. H. Bills,	- -
Montgomery,	82	Frank C. Preston, P. O. Huntington,	- -
Mt. Washington,	30	Ira L. Patterson,	- -
Nantucket,	333	Albert R. Coffin,	Geo. M. Winslow.
Nahant,	-	Thos. Roland,	Thomas Roland.
Natick,	204	Wm. E. Daniels,	H. H. Hunnewell.
Needham,	238	Howard H. Upham, chief fire department.	Ernest E. Riley.
New Ashford,	6	Wm. E. Baker,	- -
New Bedford,	277	Edward F. Dahill, chief fire department,	Chas. F. Lawton.
New Braintree,	131	E. L. Havens,	- -
New Marlborough,	32	Jas. McLaughlin, P. O. Mill River,	- -
New Salem,	55	Rawson King, P. O. Cooleyville,	- -
Newbury,	231	Wm. P. Bailey,	O. B. Tarbox.
Newburyport,	230	Chas. P. Kelley,	Chas. P. Kelley.
Newton,	205	Walter B. Randlett, chief fire department, P. O. West Newton.	Chas. I. Bucknam.
Norfolk,	256	Andrew R. Jones,	C. Albert Murphy.
North Adams,	4	H. J. Montgomery, chief fire department,	- -
North Andover,	215	Geo. A. Rea,	Peter Holt.
N. Attleborough,	262	Harvey W. Tufts, chief fire department,	F. P. Toner.
North Brookfield,	129	Harold A. Foster,	Samuel D. Colburn.
North Reading,	175	Irving F. Batchelder,	Geo. E. Eaton.
Northampton,	72	Frederick E. Chase,	- -
Northborough,	140	T. P. Haskell,	T. P. Haskell.
Northbridge,	117	W. E. Burnap, P. O. Whitinsville,	Arthur F. Whitin.
Northfield,	40	Fred. W. Doane,	- -
Norton,	266	Alden G. Walker,	Owen G. Walker.
Norwell,	290	John Whalen,	John H. Sparrell.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Norwood, . .	250	J. Fred Boyden, chief fire department, .	H. Frank Winslow.
Oak Bluffs, . .	334	Frank W. Chase, ...	Patrick P. Hurley.
Oakham, . .	135	Chas. H. Trowbridge, ...	Chas. H. Trowbridge.
Orange, . .	47	Frank M. Jennison, ...	F. M. Jennison.
Orleans, . .	321	Chas. F. Poor, ...	Albert A. Smith.
Otis, . . .	27	Chester R. Cromwell, ...	- -
Oxford, . . .	335	T. M. Harrington, ...	Chas. G. Larned.
Palmer, . .	89	James Summers, chief fire department, P. O. Box 333.	C. H. Keith.
Paxton, . .	130	Fred A. Durgin, ...	Louis M. Robinson.
Peabody, . .	219	Michael V. McCarthy, Forest Street, .	James F. Callahan.
Pelham, . .	68	E. A. Harris, P. O. Amherst, . .	- -
Pembroke, . .	294	Jos. J. Shepherd, ...	Calvin S. West.
Pepperell, . .	160	Geo. G. Tarbell, P. O. East Pepperell, .	John Tune.
Peru, . . .	16	John Frizell, ...	- -
Petersham, . .	148	Geo. P. Marsh, ...	Frank A. Hathaway.
Phillipston, . .	106	Wm. Cowlbeck, P. O. Athol, R. F. D. No. 3.	Wm. H. L. Coulbeck.
Pittsfield, . .	13	Lucien D. Hazard, ...	- -
Plainville, . .	59	Edward C. Barney, ...	Chas. N. Snell.
Plainfield, . .	309	Lestan E. Parker, ...	-, -
Plymouth, . .	302	Herbert Morissey, ...	Abbott A. Raymond.
Plympton, . .	300	Thomas W. Blanchard, ...	David Bricknell.
Prescott, . .	69	Waldo H. Pierce, P. O. Greenwich Village,	- -
Princeton, . .	150	W. A. Williams, ...	Frank A. Skinner.
Provincetown, .	325	James H. Barnett, ...	John M. Burch.
Quincy, . .	243	Peter J. Williams, chief fire department,	Andrew J. Stewart.
Randolph, . .	248	Chas. A. Wales, chief fire department, .	James E. Blanche.
Raynham, . .	270	John V. Festing, chief fire department, .	Geo. M. Leach.
Reading, . .	176	Herbert E. McIntire, ...	Henry M. Donegan.
Rehoboth, . .	268	Silas A. Pierce, ...	Stephen W. Robinson.
Revere,[1] . .	-	- - -	Geo. P. Babson.
Richmond, . .	17	T. B. Salmon, ...	- -
Rochester, . .	282	Wm. N. Smellie, ...	Chester B. Morse.
Rockland, . .	288	John H. Burke, clerk fire board, . .	Frank H. Shaw.
Rockport, . .	235	A. J. McFarland, P. O. Box 91, . .	Frank A. Babcock.
Rowe, . . .	35	Merritt A. Peck, ...	- -
Rowley, . .	232	Daniel O'Brien, ...	Daniel O'Brien.
Royalston, . .	102	Willard W. White, P. O. South Royalston,	W. W. White.

[1] No forest area.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Russell,	83	Sidney F. Shurtleff, highway surveyor,	- -
Rutland,	143	Henry Converse, chief fire department,	H. Edw. Wheeler.
Salem,[1]	-	- - - -	Amos Stillman.
Salisbury,	229	Wm. H. Evans,	Henry C. Rich.
Sandisfield,	33	Lyman H. Clark, P. O. New Boston,	- -
Sandwich,	314	John F. Carleton, P. O. Spring Hill,	B. F. Denison.
Saugus,	207	Ole C. Christiansen,	Thos. E. Berrett.
Savoy,	8	Herbert H. Fitzroy, P. O. Savoy Center,	- -
Scituate,	291	Ernest R. Seaverns, chief fire department.	Percival S. Brown.
Seekonk,	267	John L. Barker, P. O. Attleborough, R. F. D. No. 4.	Harold F. Thompson.
Sharon,	251	A. A. Carpenter,	T. J. Leary.
Sheffield,	31	Arthur H. Tuttle,	- -
Shelburne,	43	H. O. Fiske, P. O. Shelburne Falls,	- -
Sherborn,	203	Milo F. Campbell, South Sherborn,	J. P. Dowse.
Shirley,	168	Melvin W. Longley, P. O. Shirley Centre,	A. A. Adams.
Shrewsbury,	132	Wm. E. Rice,	Frank L. Ott.
Shutesbury,	58	Minor A. Haskell,	- -
Somerset,	336	Wm. F. Griffiths, Swansea, R. F. D.,	Chas. Riley.
Somerville,[1]	-	- - -	Asa B. Pritchard.
South Hadley,	78	Joseph Beach, P. O. South Hadley Falls,	- -
Southampton,	76	Geo. W. Tyler,	- -
Southborough,	337	Harry Burnett, tree warden,	Harry Burnett.
Southbridge,	109	Aimee Langevin, Olney Avenue,	Joseph Proulx.
Southwick,	92	Lowell A. Mason,	- -
Spencer,	121	A. F. Howlett, chief fire department,	Geo. H. Ramer.
Springfield,	86	Burton Steere, assistant fire chief,	Wm. F. Gale.
Sterling,	144	G. F. Herbert,	Jos. H. Kilbourn.
Stockbridge,	21	Geo. Schneyer, P. O. Glendale,	- -
Stoneham,	190	Geo. E. Sturtevant, chief fire department,	Geo. M. Jefts.
Stoughton,	258	Jesse E. Smith,	Wm. P. Kennedy.
Stow,	183	Wm. H. Parker, P. O. Gleasondale,	Geo. A. Patterson.
Sturbridge,	108	Chas. M. Clark, P. O. Fiskdale,	- -
Sudbury,	185	F. E. Bent,	Wm. E. Baldwin.
Sunderland,	338	A. C. Warner,	- -
Sutton,	116	R. W. Richardson,	John E. Gifford.
Swampscott,	339	Geo. P. Cahoon, chief fire department,	Everett P. Mudge.
Swansea,	273	Thos. L. Mason, R. F. D. No. 2,	E. C. Gardner.

[1] No forest area.

List of Forest Wardens and Local Moth Superintendents — Con.

Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Taunton,	269	Fred. A. Leonard, chief fire department,	Alvaro Harnden.
Templeton,	107	Henry H. Seaver, P. O. Baldwinville,	John B. Wheeler.
Tewksbury,	364	Herbert W. Pillsbury,	Harris M. Briggs.
Tisbury,	310	Elmer C. Chadwick,	Presbury S. Luce.
Tolland,	90	Eugene M. Moore,	- -
Topsfield,	218	Geo. F. Averill,	C. W. Floyd.
Townsend,	159	F. J. Piper, chief fire department,	Geo. E. King.
Truro,	324	Naylor Hatch,	Joseph H. Atwood.
Tyngsborough,	162	Otis L. Wright,	Howard E. Noble.
Tyringham,	26	Geo. F. Knapp,	- -
Upton,	126	E. M. Baker, chief fire department,	Geo. H. Evans.
Uxbridge,	113	Louis F. Rawson,	H. T. Newell.
Wakefield,	208	Samuel T. Parker,	W. W. Whittredge.
Wales,	100	W. W. Eager,	- -
Walpole,	340	Horace A. Spear, Jr.,	Philip R. Allen.
Waltham,	195	Geo. L. Johnson, chief fire department,	Warren M. Ryan.
Ware,	75	L. S. Charbonneau, P. O. Box 25,	Fred E. Zeissig.
Wareham,	305	A. C. Keyes,	J. J. Walsh.
Warren,	119	Joseph St. George,	Alfred A. Warriner.
Warwick,	41	Chas. A. Williams,	- -
Washington,	19	Geo. Messenger, R. F. D., Becket,	- -
Watertown,	206	John C. Ford, tree warden,	John C. Ford.
Wayland,	196	Clarence S. Williams, Cochituate,	Daniel Graham.
Webster,	111	Arthur G. Pattison,	Carl Klebart.
Wellesley,	239	Fletcher M. Abbott, tree warden,	Fletcher M. Abbott.
Wellfleet,	323	Edwin P. Cook,	Everett S. Jacobs.
Wendell,	51	Geo. A. Lewis,	- -
Wenham,	221	Jacob D. Barnes, tree warden,	Jacob D. Barnes.
West Boylston,	137	Frank H. Baldwin, agent Metropolitan Water Board.	Chas. H. Baldwin.
West Bridgewater,	285	Warren P. Laughton,	Octave Belmore.
West Brookfield,	128	J. H. Webb,	- -
West Newbury,	226	Silas M. Titcomb, P. O. Byfield,	Robert J. Forsythe.
West Springfield,	341	A. A. Sibley,	- -
West Stockbridge,	20	Bernard Manning,	- -
West Tisbury,	307	Wm. J. Rotch,	John Pease.
Westborough,	133	James H. McDonald, chief fire department.	Walter Sullivan.
Westfield,	84	Geo. H. Byers, chief fire department, Arnold Street.	- -

List of Forest Wardens and Local Moth Superintendents — Con.

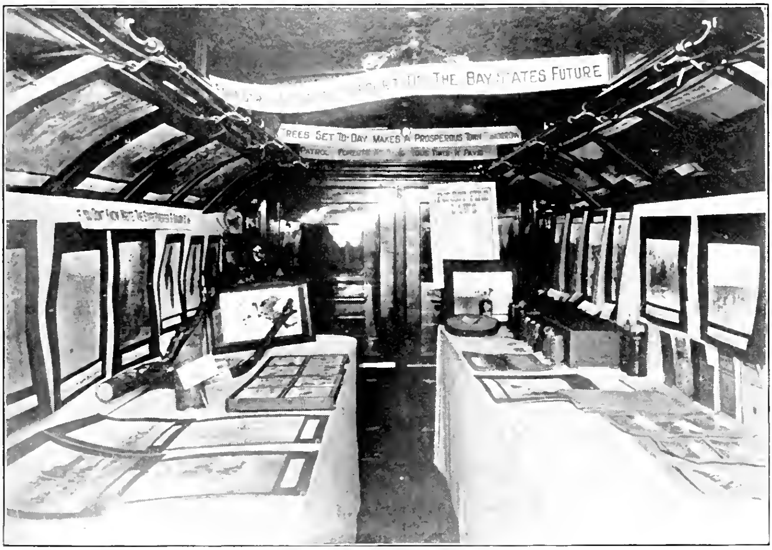
Town or City.	Badge No.	Forest Warden.	Local Moth Superintendent.
Westford, . .	166	John A. Healey, P. O. Graniteville, .	Harry L. Nesmith.
Westhampton, .	71	Levi Burt, ...	- -
Westminster, .	154	John C. Goodridge, chief fire department.	Stillman Whitney.
Weston, . .	186	Edward P. Ripley, ...	Edw. P. Ripley.
Westport, . .	279	Herbert A. Sanford, ...	Jonathan B. Hicks.
Westwood, . .	251	Percy R. Dean, ...	C. H. Southerland.
Weymouth, . .	215	J. R. Walsh, East Weymouth, . .	Chas. L. Merritt.
Whately, . .	56	James A. Wood, ...	- -
Whitman, . .	297	Clarence A. Randall, tree warden, . .	Clarence A. Randall.
Wilbraham, . .	96	Henry I. Edson, P. O. North Wilbraham,	- -
Williamsburg, .	64	Howard C. Pomeroy, ...	- -
Williamstown, .	2	Daniel Hogan, ...	- -
Wilmington, . .	174	Joseph M. Hill, chief fire department, North Wilmington.	Oliver McGrane.
Winchendon, .	103	Arthur L. Brown, chief fire department, .	John G. Folsom.
Winchester, . .	189	Irving L. Symmes, chief fire department,	Samuel S. Symmes.
Windsor, . .	12	H. W. Ford, ...	- -
Winthrop,[1] . .	-	- - -	Frank W. Tucker.
Woburn, . .	177	Frank E. Tracy, chief fire department, .	James H. Kelley.
Worcester, . .	131	Arthur V. Parker, ...	Harold J. Neale.
Worthington, .	62	Howard C. Brewster, ...	- -
Wrentham, . .	260	E. S. Stone, captain fire department, .	Wm. M. Gilmore.
Yarmouth, . .	316	Seth Taylor, ...	Chas. R. Bassett.

[1] No forest area.

New Legislation.

The following new legislation, relative to forestry matters, was enacted by the last General Court.

As the liberation of fire balloons during seasons of drought has been the cause of several extremely damaging forest fires during the past few years, and as their continued use would be a constant menace to property in the future, it seemed imperative that legislation should be enacted which would eliminate this danger. The following law was therefore passed: —



A view of the State Forester's exhibit on the better farming electric train.

ACTS OF 1910, CHAPTER 141.

AN ACT TO PROHIBIT THE USE OF FIRE BALLOONS.

Be it enacted, etc., as follows:

It shall be unlawful within any city or town in this commonwealth for any person to liberate or fly fire balloons of any description. Whoever violates this act shall be punished by a fine of not more than one hundred dollars, or by imprisonment for not more than one month, or by both such fine and imprisonment. [*Approved March 2, 1910.*

The enactment of the following law will undoubtedly result in lessening the number and size of forest fires, by stimulating a desire on the part of many towns to adopt reasonable preventive measures, and to provide proper apparatus to extinguish fires when they do occur. This law is dealt with more in detail in the chapter devoted to forest fires.

ACTS OF 1910, CHAPTER 398.

AN ACT RELATIVE TO PROTECTION AGAINST FOREST FIRES.

Be it enacted, etc., as follows:

SECTION 1. Every town in the commonwealth with a valuation of one million five hundred thousand dollars or less which appropriates and expends money, with the approval of the state forester, for apparatus to be used in preventing or extinguishing forest fires or for making protective belts or zones as a defence against forest fires, shall be entitled, upon the recommendation of the state forester, approved by the governor, to receive from the treasury of the commonwealth a sum equal to one half of the said expenditure, but no town shall receive more than two hundred and fifty dollars.

SECTION 2. A sum not exceeding five thousand dollars in any one year may be expended in carrying out the provisions of this act.

SECTION 3. This act shall take effect upon its passage. [*Approved April 13, 1910.*

So numerous have been forest fires in Barnstable and Plymouth counties within the past few years, the cause of which in many cases has been attributed to the carelessness and indifference of berry pickers and camping parties, that many prominent citizens of those counties petitioned for legislation which, if properly enforced, would serve to lessen the danger of fire from the above-named source. The following law was therefore enacted: —

Acts of 1910, Chapter 478.

An Act relative to the Picking of Berries and Flowers and to Camping and Picnicking during Certain Months in the Counties of Barnstable and Plymouth.

Be it enacted, etc., as follows:

Section 1. It shall be unlawful for any unnaturalized, foreign-born person to pick wild berries or flowers, or to camp or picnic, upon any land of which he is not the owner, within the counties of Barnstable and Plymouth, between the first day of April and the first day of December, without first obtaining written permission so to do from the owner or owners of the land. The said written permit shall not be transferable, and shall be exhibited upon demand to the forest warden, or his deputies, of the town wherein the land is located, or upon demand of any sheriff, constable, police officer or other officer authorized to arrest for crime. Failure or refusal to produce said permit upon such demand shall be prima facie evidence of a violation of this act, and any forest warden or any duly authorized deputy forest warden, police officer, sheriff or other officer authorized to arrest for crime, may arrest without warrant any person who fails or refuses to display for inspection the said permit upon the demand of any of the officials named in this act.

Section 2. Whoever violates any provision of this act shall be punished by a fine of not more than fifty dollars, or by imprisonment for not more than thirty days, or by both such fine and imprisonment. [*Approved May 3, 1910.*

In response to the suggestion made by Governor Draper in his inaugural address, as well as the recommendation contained in the annual report of the State Forester, the law relative to the suppression of the gypsy and brown-tail moths was so amended as to make the office of local moth superintendent appointive rather than elective, and the appointees subject to the approval of the State Forester. The object of this legislation was to insure the appointment of thoroughly competent men to have charge of this important work in the cities and towns of the Commonwealth. The amendment was as follows: —

ACTS OF 1910, CHAPTER 150.

AN ACT RELATIVE TO THE APPOINTMENT OF LOCAL SUPERINTENDENTS FOR THE SUPPRESSION OF THE GYPSY AND BROWN TAIL MOTHS.

Be it enacted, etc., as follows:

SECTION 1. Section four of chapter three hundred and eighty-one of the acts of the year nineteen hundred and five, as amended by section two of chapter two hundred and sixty-eight of the acts of the year nineteen hundred and six, and by section one of chapter five hundred and twenty-one of the acts of the year nineteen hundred and seven, is hereby further amended by striking out at the beginning thereof, the words "Cities and towns by such public officer or board as they shall designate or appoint, shall under the advice and general direction of said superintendent", and inserting in place thereof the words: — The mayor and aldermen in cities and the selectmen in towns shall annually in the month of March or April appoint a local superintendent for the suppression of gypsy and brown tail moths. Said superintendent shall, under the advice and general direction of the state forester, — also by inserting after the word "herein", in the eighth line, the words: — The appointment of a local superintendent shall not take effect unless approved by the state forester, and when so approved, notice of the appointment shall be given by the mayor and aldermen or the selectmen to the person so appointed, — so that the first paragraph of said section as amended will read as follows: — *Section 4.* The mayor and aldermen in cities and the selectmen in towns shall annually in the month of March or April appoint a local superintendent for the suppression of gypsy and brown tail moths. Said superintendents shall, under the advice and general direction of the state forester, destroy the eggs, caterpillars, pupae and nests of the gypsy and brown tail moths within their limits, except in parks and other property under the control of the commonwealth, and except in private property, save as otherwise provided herein. The appointment of a local superintendent shall not take effect unless approved by the state forester, and when so approved, notice of the appointment shall be given by the mayor and aldermen or the selectmen to the person so appointed. When any city or town shall have expended within its limits city or town funds to an amount in excess of five thousand dollars in any one fiscal year, in suppressing gypsy or brown tail moths, the commonwealth shall reimburse such city or town to the extent of fifty per cent of such excess above said five thousand dollars.

SECTION 2. This act shall take effect upon its passage. [*Approved March 2, 1910.*

In order to legalize the acceptance by the State Forester, on behalf of the Commonwealth, of bequests or gifts made for the purpose of promoting forestry in Massachusetts, the following law was enacted: —

ACTS OF 1910, CHAPTER 153.

AN ACT TO AUTHORIZE THE STATE FORESTER TO ACCEPT BEQUESTS OR GIFTS ON BEHALF OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

SECTION 1. The state forester, with the approval of the governor and council, is hereby authorized to accept, on behalf of the commonwealth, bequests or gifts to be used for the purpose of advancing the forestry interests of the commonwealth, under the direction of the governor and council, in such manner as to carry out the terms of the bequest or gift.

SECTION 2. This act shall take effect upon its passage. [*Approved March 3, 1910.*

An act was passed to provide funds for carrying on the gypsy and brown-tail moth work, and for experimenting with parasites for destroying said moths, as follows: —

ACTS OF 1910, CHAPTER 234.

AN ACT MAKING APPROPRIATIONS FOR THE SUPPRESSION OF THE GYPSY AND BROWN TAIL MOTHS.

Be it enacted, etc., as follows:

SECTION 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the commonwealth from the ordinary revenue, for the purposes specified, to wit: —

For the suppression of the gypsy and brown tail moths in the year nineteen hundred and ten, and for expenses incidental thereto, a sum not exceeding one hundred and fifty thousand dollars, the same to be in addition to any amount heretofore appropriated for this purpose.

For experimenting with parasites or natural enemies for destroying said moths, and for expenses incident thereto, a sum not exceeding fifteen thousand dollars, in addition to any unexpended balance of a former appropriation for this purpose.

SECTION 2. This act shall take effect upon its passage. [*Approved March 18, 1910.*

ACKNOWLEDGMENTS.

It gives the State Forester great pleasure to acknowledge the continued valuable services and loyal support which he has received through his assistants and workers in this department,

whether it be in the office or field work, throughout the year. The work on the part of all has been enthusiastically and willingly undertaken. All of the members of the staff are entitled to the greatest possible credit for their efficient services.

He also desires to express his great appreciation of the generous treatment and kindly assistance rendered him by all citizens, boards and officials with whom he has come in contact, and again to emphasize the kindly co-operation on the part of the United States government through Dr. L. O. Howard of the Bureau of Entomology and Mr. D. M. Rogers, field agent; also of Harvard University, through Dean W. C. Sabine and the departments represented on the co-operative scientific staff.

Steam Railroad "Farming Special" Train.

The needs of better farming methods and a much greater production from farming lands are receiving much attention all over this country. Here in our own State this feeling has been materially augmented during the past year through the earnest endeavors of the State Forester, the State Board of Agriculture and the Massachusetts Agricultural College, aided by the Boston & Albany Railroad, to exploit the opportunities that exist for land owners of the Old Bay State. In line with this movement, the Boston & Albany Railroad ran a "Better Farming Special" over its road March 30 and 31 and April 1 and 2, consisting of five observation cars, fully equipped with exhibits representing every branch of agriculture and forestry.

The "Better Farming Special" visited the following cities and towns: —

Wednesday, March 30. — Westfield; Pittsfield; Cheshire; North Adams.

Thursday, March 31. — Chester; Springfield; Enfield; New Salem; Athol.

Friday, April 1. — Templeton; Barre Plains; Ware; Palmer; East Brookfield.

Saturday, April 2. — Worcester; Westborough; South Framingham; Milford.

At each place the special was met by hundreds of farmers, who in many instances had driven miles to enjoy the privilege of listening to the lectures on the many themes relating to farming, as given by the representatives of the Massachusetts Agricultural College and the State Board of Agriculture; also, the development of forestry and the work of suppressing the gypsy and brown-tail moths, as presented by the State Forester and his assistants. At some of the stations were gathered whole schools, in charge of their teachers, and great interest was shown by them in both the lectures and the exhibits.

One entire car was devoted to forestry, under the direction of the State Forester, and included in the exhibits were the following: —

Pine seedlings, varying in age from one to three years.

Photographs showing modern and approved methods of forestry management and reforestation work.

Photographs showing fires, and damage done by same.

Complete equipment for forest-fire fighting.

Living gypsy moth caterpillars.

Living brown-tail moth caterpillars.

Mounted specimens showing the life history of the gypsy and brown-tail moths.

A large collection of parasites, such as have been imported from abroad.

Living Calosoma beetles.

Several species of native predaceous beetles of the gypsy moth.

Photographs showing different methods used in moth-suppression work.

Photographs of apparatus used in moth-suppression work.

Trees showing the proper method of treating cavities by tin patching.

Oak tree, showing brown-tail moth webs in their winter stage.

Living egg parasites.

Specimens of many other insects of economic importance.

The forest-fire wagon, designed and equipped under the direction of the State Forester, attracted much attention and received favorable comment from scores of town officials, who manifested a great deal of interest in the forest-fire problem. Another feature of the State Forester's exhibit which created widespread interest was the living specimens of the gypsy and brown-tail moth caterpillars, which gave to hundreds of people their first opportunity to see these dangerous insect pests.

Evening meetings were held at North Adams, Athol and

Worcester, and large and enthusiastic audiences were addressed by leading men on agricultural and allied topics.

The enterprise from start to finish was declared a pronounced success, and without doubt proved to be a valuable factor in stimulating and advancing the farming and forestry interests of Massachusetts.

Electric Railroad "Farming Special" Train.

So marked was the value of the exhibition to the farming interests of the territory traversed by the Boston & Albany special that the officials of the New England Investment and Security Company, which controls between nine hundred and one thousand miles of trolley lines in western Massachusetts, immediately tendered the Agricultural College and State department, without expense, every facility and convenience which they had to offer in running a trolley special over their lines in sections of the State not covered by the former trip.

In accordance with this plan, on April 14 four cars, equipped in practically the same manner as those of the Boston & Albany special, left Amherst on a three-days tour of education. The itinerary was as follows: —

Thursday, April 14. — South Hadley; Russell; Huntington; Springfield.

Friday, April 15. — North Wilbraham; Brimfield; Sturbridge; Charlton Center.

Saturday, April 16. — Oxford; Holden; Sterling; Worcester.

Much enthusiasm and interest greeted the special at every stop. At South Hadley nearly three hundred students of Mt. Holyoke College attended the demonstrations and enjoyed the lectures.

A splendid agricultural rally was held at Springfield on the evening of the 14th, under the auspices of the Springfield Board of Trade, where over five hundred business men listened to an address by President Butterfield of the Massachusetts Agricultural College, in which he impressed upon them the importance of co-operation in advancing the interests of commercial farming in our State.

This was undoubtedly the first trolley "farming special" ever attempted in this country, and its success proves that a grand service can by this means be rendered agricultural education in the future.

Publications of the State Forester.

It has been the aim of the office to publish as rapidly as possible such information as our people desire regarding forestry in its various phases. As requests came in, the department has anticipated the requirements, and has written bulletins which give in a practical and workable way detailed information, so that our people will not lack for guidance in actually accomplishing something, if they are so inclined.

At present we have a list of bulletins which cover fairly well the general information most likely to be required. By being able to furnish a bulletin which goes more into detail than is possible in a letter, the State Forester can do himself great justice.

We do not attempt sending out the whole list of bulletins unless specially requested to do so, or unless we feel sure that they are likely to be appreciated and used. The department has a mailing list of about 3,000 names of those who have shown some special interest in forestry. The mailing list is revised occasionally by writing and asking if the bulletins are still desired.

Two publications issued by the State Forester were so eagerly sought after that the Legislature believed it advisable that they be sold at cost; hence they are the only exceptions in the list. These are especially valuable in the identification of trees and in school work. The list of publications of the department follows: —

*1. Forest Trees of Massachusetts: how you may know them. A Pocket Manual.
*2. The Study of Trees in our Primary Schools.
3. Massachusetts Wood-using Industries.
4. The Evergreens. Methods of Study in Public Schools.
5. Re-forestation in Massachusetts.
6. How and when to collect White Pine Seed.
7. Forest mensuration of the White Pine. How to estimate Standing Timber.

8. How to make Improvement Thinnings.
9. We must stop Forest Fires in Massachusetts.
10. Forest fire-fighting Equipment in our Towns.
11. The Gypsy and Brown-tail Moths.
12. The Annual Report of the State Forester.
13. Laws relating to Forestry, and the Suppression of the Gypsy and Brown-tail Moths.
14. Colored Plates of the Gypsy and Brown-tail Moths and Calosoma Beetle.
15. Suggestions in Regard to Municipal Forests: a Practical Example.

[NOTE. — Under the resolves authorizing their publication, the two bulletins marked * must be sold by the State Forester at a price not less than their cost. Thus, the price of "Forest Trees of Massachusetts: how you may know them," is 5 cents a copy at the office, 6 Beacon Street, Boston, or 2 cents extra by mail; and of "The Study of Trees in our Primary Schools," 12 cents a copy, or 8 cents extra by mail. Any other bulletins in the list may be obtained at the office, or will be mailed upon request without cost.]

GENERAL FORESTRY.

Examinations of Woodland.

The examination of private woodland for owners requesting such examination, one of the oldest branches of our work, has been carried on as in former years, and the even distribution over the whole year of the applications for such examinations, without extra solicitation on the part of this office, seems to indicate a steady and healthy interest on the part of the owners of this class of land. The work, as was explained last year, consists usually of a visit to the land in company with the owner or some other interested person, advice as to treatment given verbally on the ground, and often a subsequent written report.

This year an attempt has been made to keep in closer touch with examinees and the manner in which the recommendations of the office are carried out, by making a personal inspection, usually at a time when in the locality on other business. In this way owners were made to feel that an interest was being taken in their work, and in every case the office has felt well repaid by the results.

It has not been possible to make such inspections in large numbers, partly because the work was not begun till well along in the year, and partly because only those owners are visited where it is felt that enough time has elapsed to make the visit profitable. Enough has been done, however, to prove the advantages of the plan, and it is intended to push the work steadily during the coming season.

The following table gives a list of the examinations made, their location and area. A table of costs will be found at the end of this section of the report.

Owner.	Town.	Area (Acres).
Allen, P. R.,	Walpole,	5
Bent, F. E.,	Sudbury,	30
Borden, N. E.,	South Framingham,	60
Boston & Northern Street Railway,	Groveland,	38
Brayton, A. P.,	Somerset,	13
Brochu, J. E.,	Attleborough,	100
Burnett, H., trustee,	Hopkinton,	116
Chandler, J. F.,	Tyngsborough,	10
Creamer, F.,	Peru,	40
Cummings, W. O.,	Tyngsborough,	10
Cushing, J. S.,	Norwood,	2½
Dewar, D. W.,	Carlisle,	40
Eddy, Mary B.,	Newton,	10
Emerson, Dr. A. W.,	Norwood,	100
Fitchburg Water Board,	Westminster and Fitchburg,	400
Forrest, W. P.,	Foxborough,	22
Fowle, D. H.,	Newbury,	30
Fuller, W. A.,	Clinton,	49
Fuller, W. A.,	Harvard,	107
Fuller, W. A.,	Bolton,	128
Gerrish, Isabel F.,	Ashland,	47
Green, F. C.,	Bourne and Plymouth,	400
Harriman, C. S.,	North Wilmington,	4
Holmes, E. B.,	Abington,	30
Horne, W. N.,	Foxborough,	32
Hunnewell, H. H.,	Natick,	250
Jones, J. L.,	Halifax,	1,400
Lawrence, I. P.,	Ashburnham,	200
Mahoney, T. J.,	Wareham,	¼
Main, F. H.,	Lanesborough,	200
Manning, W.,	Marion,	400
Massachusetts Agricultural College, branch farm,	Sandwich,	20
Minns, Susan,	Princeton,	127
Minot, W.,	Wareham,	50
Morey, E.,	Ashland,	20
Nelson, H. W.,	Marshfield,	45
Pickman, D. L.,	Bedford,	400
Robinson, C. E.,	Hinsdale,	800
Sawyer, A. H.,	Salisbury,	30
Sears, Julia M.,	Tyngsborough,	30

Owner.	Town.	Area (Acres).
Seavey, H.,	Canton,	125
Simmons, H. F.,	Hanover,	10
Stevens, E. A.,	Duxbury,	40
Stevens, H. H.,	Marlborough,	30
Tenney, C. H.,	Methuen,	75
Tracy, Harriet E.,	Peru,	175
Webber, F. S.,	South Hadley,	10
White, J. H.,	Bridgewater,	25
Willets, H.,	New Marlborough,	200
Total,		6,495

In all, 17 inspections have been made, with an aggregate area of 1,080 acres: —

Owner.	Town.	Area (Acres).
Bird, C. S.,	Walpole,	60
Bridgman, H. A.,	Shirley,	15
Burbank Hospital,	Fitchburg,	400
Burgess, J. K.,	Dedham,	50
Codman, Catherine,	Dedham,	18
Emery, Miss M. E.,	West Newbury,	55
Fisher, Lewis N.,	Walpole,	7
Fiske, Warren,	Harvard,	200
Holmes, E. B.,	Abington,	30
Hutchins, C. L.,	Concord,	25
Joslin, E. P.,	Oxford,	100
Needham Water Board,	Needham,	5
Plympton, Mrs. A. L.,	Dover,	10
Prescott, C. W.,	Concord,	60
Stevens, Chas.,	Sudbury,	5
Thorndike, R. K.,	Millis,	20
Walpole High School,	Walpole,	20

Woodland Management.

The forestry department wishes to lay especial emphasis on another recent development of its work; namely, management of private woodlands by the owner, under the continuous supervision of this office. Under this plan, several private owners are this winter carrying on regular thinning improvement cutting, fire-line making and other forestry operations, under the more or less regular instruction and general supervision of a forestry assistant.

In one instance, that of the Burbank Hospital, treated more fully elsewhere, a regular lumbering operation was completed.

In any case the plan is doubly advantageous, both to the owner and the office, in that it is made possible for such owners to employ the same men used by the reforestation department in its spring planting, thus getting the profit of experienced labor at the same price that would have to be paid for inferior workmen; while at the same time the office is pleased to offer its men continuous employment, instead of losing all trace of them immediately at the close of the planting season. The owner, of course, pays all cost of the work, including travelling expenses of the expert from this office, the assistance only being given free.

In addition to the advantages already indicated, there is the far-reaching one of having within the State an ever-increasing number of men, and more particularly of competent bosses, who understand not only woods work but woods work along practical forestry lines; this body of men to act as a nucleus around which to build up an effective force for carrying out the many and increasingly difficult forestry problems which are pressing for immediate solution.

Owners and towns where the work described above either is or soon will be under way are as follows: —

R. B. Symmington, Plymouth, has thinned about 50 acres.

Francis C. Green, Buzzard's Bay, will make fire lines, thin and possibly plant.

Frederick W. Burnham, Buckland, is clear-cutting and thinning about 50 acres; will later turn over to State to plant.

I. P. Lawrence, Ashburnham, is planting 25 acres and may do some thinning.

It is hoped that in future we may be able to report a still further increase in this work, and one in keeping with its importance.

Forest Working Plan for the Burbank Hospital.

A year ago last spring the trustees of the Burbank Hospital asked this office to examine 250 acres of woodland belonging to the hospital. Mr. Cook, the assistant forester who made the examination, was greatly impressed with the evidence of present and future value in the land, and convinced the trustees that they should have a working plan made for the place. This was done in the fall of the same year. In this plan each type of land was carefully mapped out, and the treatment to be accorded each type was explained. In general, the report recommended the cutting of mature growth, the thinning and improving of growing stands, and the planting of such vacant land as was not needed for pasturing cattle.

Three lots were selected for immediate cutting. The first was covered with a growth of mixed hard woods, — chestnut, birch, pine, beech, oak, maple and hemlock. From the standpoint of merchantable volume, chestnut and white pine were the most prominent trees, and ranged in size from 7 to 25 inches, the average being from 12 to 16 inches. The plan for cutting called for the removal of all trees over 7 inches in diameter, breast high, except a few pines which were to be left to seed the cut-over land. The merchantable trees were to be left uninjured as far as possible, limbs and tops were to be worked up into cord wood, and the rest of the slash piled and burned. Practically all the chestnut, oak, pine, birch and hemlock trees were of merchantable size, whereas the maple and beech were very generally below it. The reason for selecting this lot for immediate cutting was that it had been more or less severely injured by fire in past years, and it was feared that the trees were slowly dying.

The second lot was 4 acres of heavy white pine, nearly pure. The trees averaged 15 inches in diameter, breast high, and 70 feet in height. It was estimated to run 35,000 feet to the acre, but turned out to contain much more. This lot was cut clean, with the exception of a few of the large, limby trees, which were left to seed the cut-over land. About 8 trees to the acre, and placed as evenly as possible over the cut area, were selected for this purpose. The spreading, bushy specimens were selected as

Pine trees left standing for reseeding purposes, on the Burbank Hospital property, at Fitchburg.

seed trees, because they produce the most seed and at the same time are the least valuable as lumber. Here, as on the other lot, the slash was piled and burned.

The third bunch of timber covered only 1½ acres, and was made up almost entirely of sprout chestnut. This lot was selected because the trees were over-mature, had decayed butts and were going back.

The method of handling this work, as agreed upon by Dr. Tower, superintendent of the hospital, and Mr. Cook, was briefly as follows: —

The chopping was to be done under the direct supervision of this office, and Mr. Winifred Eaton, one of our most trusted employees, was made foreman of the chopping gang. This arrangement was made because it was felt that the ordinary choppers could not be depended on to carry out the provisions of the working plan. This office looked on the job as an experiment in conservative logging, and was therefore anxious that everything be done in good faith. The sawing and sticking was done under contract by a Mr. Spencer, a portable-mill man. The hauling of the logs was done by the men and horses belonging to the hospital farm. Partly because these men were not experienced in this work, and partly because they had to pile the logs on skids, to remain until the mill was set up, the cost of logging was higher than is usual in this kind of work.

The following table shows the cost of the above operation: —

Operation.	Total.	Per 1,000 Feet.
Camp, material and tools,	$59 50	$0 19
Labor on camp,	15 70	05
Repairing old roads,	12 00	04
Chopping 95 cords pine, at 90 cents per cord,	85 50	90[1]
Chopping 110 cords hard woods, at $1.10 per cord,	121 00	1 10[1]
Lumber, 303,000 feet,	463 50	1 53
Sawing lumber,	695 75	2 30
Burning brush,	47 60	16
Logging and sticking,	888 70	2 93
Total, excluding cord wood,	$2,182 75	$7 20

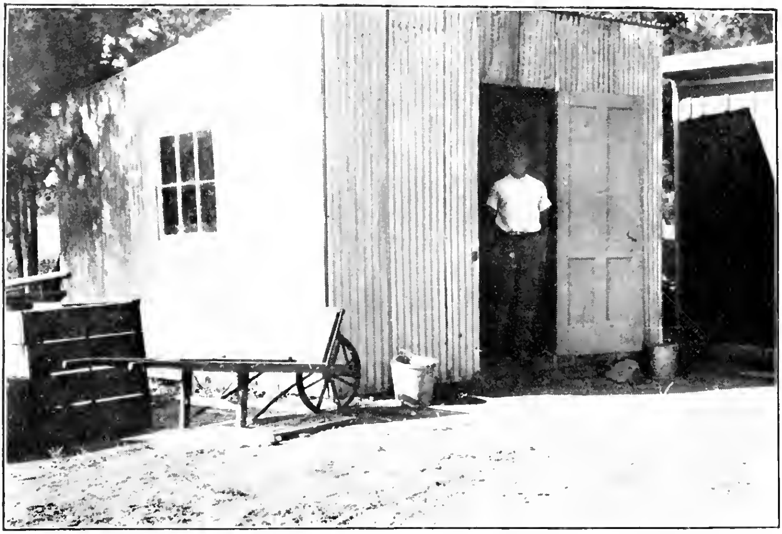
[1] Per cord.

The total product was made up of both timber logs (303,000 feet) and cord wood (205 cords). In order to get at the cost of chopping the lumber, we deducted the value of the cord wood chopping, allowing 90 cents for each of the 95 cords of pine and $1.10 for each of the 110 cords of hard wood, these being the prices current for that work in that vicinity. The cost of chopping is somewhat higher than the average for that kind of work, — approximately 30 cents per 1,000 feet more; but the most of this difference can be laid to the labor of piling the brush for burning, and some to necessity for caring for the smaller trees.

Owing to the fact that a large number of timber lots were cut off in the neighborhood of Fitchburg last winter, the lumber market there experienced a slump, so that the hospital superintendent was unable to dispose of his supply at a price equal to what we had hoped for. For the 175,000 feet of round-edge pine he received $15 per 1,000 feet as it lay stacked on the lot; for the 53,000 feet of square-edge pine, $21; and for the 75,000 feet of mixed hard woods, only $14. The gross returns were $4,788, — an average price of $15.80 per 1,000 feet. Deducting from this amount $2,182, the cost of logging, sawing, etc., the net returns were $2,606, or $8.60 per 1,000 feet. This sum is somewhat more than they would have received had they sold the stumpage outright to a lumberman, because an offer of $8 per 1,000 feet was made for it. Also, under such circumstances the cutting would have been carried out without any regard for the future of the land, and the slash left in such a condition that a bad fire would have been unavoidable. We should estimate that the total extra cost of disposing of the slash on this job was about 40 cents per 1,000 feet of lumber cut.

Marking for Gypsy Moth Thinning.

In addition to examinations for private owners, and the marking entailed thereby, the work of the forestry assistants was extended over numerous areas in the eastern section of the State for thinning done by the gypsy moth employees. It was felt that the men, after cutting an area so marked, would soon be able to combine a working knowledge of forestry methods



A portable steel shack, — one of those in use by the State Forester's department. Size, ten by twelve feet; capable of handling twelve men.

The State Forester's nursery at Amherst. White pine transplants in the foreground.

with their already excellent acquaintance with gypsy moth requirements.

A total area of about 490 acres was marked for this sort of thinning, about 425 acres of which lay on the north shore of Massachusetts Bay, in the towns of Beverly, Manchester, Gloucester, Wenham and Essex. About one-half of the cutting done on the north shore was marked for by the forestry assistants, and it is now felt that the men are quite familiar with their methods of work.

Other localities in which marking was done or advice given were Tyngsborough, Tewksbury, Wareham, Hingham, Mashpee and Newton. In the latter place, where a particular effort was made to sell the cord wood product, the amount realized not only paid the cost of cutting, but also of cleaning up the brush, leaving a slight margin of profit.

Surveying.

Considerable surveying has been done by the forestry department during the year, including nearly all the unsurveyed lots taken under the reforestation act. These lots, by towns, are as follows: Buckland, 165 acres; Wellfleet, 52 acres; Harwich, 14 acres; Peru, 80 acres; Colrain, 12 acres; Oakham, 100 acres; a total of 449 acres.

Maps have been or are being made for all these lots. Besides this ordinary surveying and mapping, one topographic and forest map (in colors) has been made of a tract of land taken by the State under the reforestation act, and planted and managed by this office, known as the Lowe farm. This land lies in Colrain, has an area of 580 acres, and is the largest of the State plantations.

Reforestation Work.

The reforestation work has been carried on this year under the policy already established, and gives great promise of awakening the interest of mill owners, lumbermen and land owners to the necessity of replanting cut-over and waste lands. The lots planted last year, after being inspected this fall in some cases show as high as 97 per cent. of healthy growing trees, and in no case has more than 40 per cent. died out. Even at this early date some of these lots have started to fill their mission of demonstrating, and influencing land owners to undertake forest planting. One party not owning land suitable for reforestation bought over 200 acres of cheap waste land, and intends planting it in the coming spring. Another party, owning 50 acres of run-out pasture land, became interested through looking over one of these plantations where young pine had been planted on land similar to his own. Many other parties, becoming interested, set out smaller areas.

Deeds for 921 acres have been recorded and the land planted last spring. In order to carry on the work, five galvanized-iron shacks were constructed, which will accommodate from eight to ten men, these shacks enabling the men to live on the lot during the planting season, and doing away with the necessity of transporting the men to and from work, as had been the case when the lot was a number of miles from any town. The average cost of planting was brought to a slightly lower cost through the use of these shacks and other economical methods.

State Plantations, 1910.

Town.	Acres.	Type of Land.	Variety planted.
Colrain,	80	Run-out pasture,	Norway spruce.
Colrain,	80	Run-out pasture,	Norway spruce.
Belchertown,	10	Run-out pasture,	White pine.
Colrain,	169	Run-out pasture,	White pine.
Colrain,	52	Run-out pasture,	Norway spruce.
Sandwich,	38	Burnt-over land,	Pitch and Scotch pine and Norway spruce.
Peru,	68	Run-out pasture,	Norway spruce and white pine.
Peru,	12	Run-out pasture,	Norway spruce and white pine.
Shirley,	14	Cut-over land,	White pine.
Hubbardston,	100	Cut-over land,	White pine.
Spencer,	14	Cut-over land,	White pine.
Paxton,	54	Cut-over land,	White pine.
Brookfield,	70	Cut-over land,	White pine.
Oakham,	100	Cut-over land,	White pine.
West Brookfield,	30	Cut-over land,	White pine.
Carlisle,	30	Cut-over land,	White pine.
Total area,	921		

Planting done under Advice of State Forester.

Name.	Town.	Variety.	No. of Trees.
Amherst Water Company,	Amherst,	White pine,	15,000
N. D. Bill,	South Worthington,	White pine,	300,000
Needham Water Company,	Needham,	White pine,	5,000
Leominster Water Company,	Leominster,	White pine,	7,000
Long Island Almshouse,	Long Island,	White pine,	45,000
Dr. E. P. Joslin,	Oxford,	Norway spruce,	5,000
Brown Bros. and John Folsom,	Winchendon,	White pine,	150,000
Fred Barclay,	Spencer,	White pine,	20,000
I. P. Lawrence,	Ashburnham,	White pine,	20,000
Walter Clark,	Paxton,	White pine,	10,000
State Colony for Insane,	East Gardner,	White pine,	14,000
Faunce demonstration farm,	Sandwich,	White pine, etc.,	500
W. R. Rich,	Truro,	Pitch pine,	1,000
F. P. Stratton,	Concord,	Norway spruce,	1,000
Henry Pike,	Paxton,	White pine,	1,300

Forest Nursery.

The State forest nursery at Amherst will have about 2,000,000 two-year-old white pine seedlings fit for planting next spring. A large part of them should be transplanted in the nursery, if arrangement can be made for sufficient ground. Last spring we were able to use about 900,000 in the reforestation work, and transplanted at the nursery 250,000, that we might have trees which when planted in the most exposed places will grow sucessfully. We have also a good stand of one-year-old white pine and Norway spruce. The following table gives the estimated stock on hand at the nursery: —

Variety.	Age (Years).	No. of Trees.
White pine seedlings,	2	2,000,000
White pine seedlings,	1	2,500,000
Pitch pine seedlings,	2	25,000
Pitch pine seedlings,	1	25,000
Norway pine seedlings,	2	5,000
Austrian pine seedlings,	1	20,000

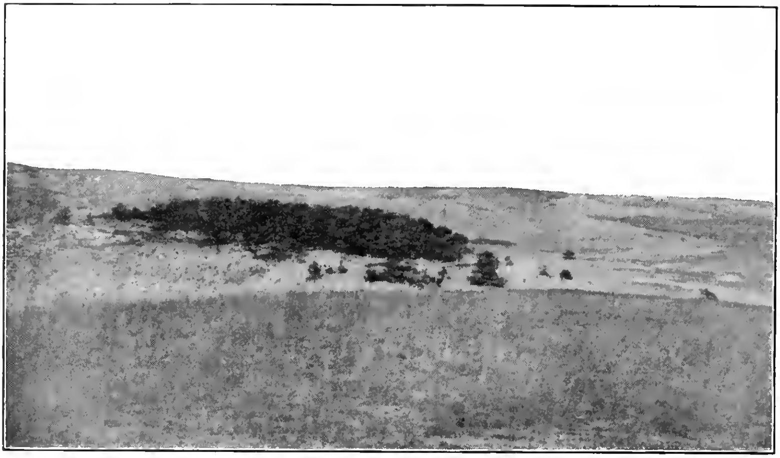
Variety.	Age (Years).	No. of Trees.
Scotch pine seedlings,	1	40,000
Norway spruce seedlings,	1	500,000
Balsam fir seedlings,	2	5,000
Hemlock seedlings,	2	5,000
Red spruce seedlings,	2	2,000
Black locust seedlings,	1	20,000
Catalpa speciosa seedlings,	1	5,000
Total,	-	5,152,000

Variety.	Age (Years).	No. of Trees.
White pine transplants,	4	25,000
White pine transplants,	3	250,000
Norway spruce transplants,	3	25,000
Black locust transplants,	2	2,000
Honey locust transplants,	2	2,000
Total,	-	304,000

Since the planting of last spring, the large number of applications by land owners to reforest their waste land under the reforestation act make it plain that it will be impossible to replant all the land which would be turned over to the State, unless the present limited appropriation is increased. At this time last year only about 500 acres of land had been offered under the act, the balance for last spring's work being taken over during the winter; this year already over 1,200 acres have been offered. Never before has such interest been taken in the work, and the outlook for the coming months is that many more tracts will be offered; and as under the present appropriation only about 1,000 acres can be planted, steps should be taken by the coming Legislature to meet the situation.

Instruction in Planting.

While the planting on State land occupies most of our attention during the spring, to the partial exclusion of other work, an attempt was made last year to give practical assistance on the ground to owners inexperienced in forest planting, who were for the first time trying the experiment on a large scale. Advice of this nature was given to the following owners: —



A natural seeding-in of pitch pine on the Cape. The land in the foreground is to be planted by the State Forester.

The beginning of a nursery at East Sandwich, Cape Cod, 1910. Four-year-old white pine transplants on left, set last spring; seed boxes of Scotch and Austrian pine on right.

Faunce demonstration farm, Sandwich, set out 500 seedlings.
Long Island Hospital, Boston harbor, set out 45,000 seedlings.
Fitchburg Water Board, Westminster, started a forest nursery.
E. P. Joslin, Oxford, set out 5,000 seedlings.
Needham Water Board, Needham, set out 5,000 seedlings.
I. P. Lawrence, Ashburnham, set out 25,000 seedlings; also set out 15,000 in a nursery.
State Colony for Insane, Gardner, set out 14,000 seedlings.

Reports from some of this work seem to indicate as good results as can be expected in the short time that has elapsed.

The seedlings at Long Island are in good condition, and it only remains to be seen how they will endure the coming winter.

The stock on the farm at Sandwich is in good shape, and it will be put to a rigid test this winter, having been planted as a windbreak against the heavy gales so prevalent on the Cape.

Portable Steel Shacks.

In the reforestation work of the past few years we have had difficulty in keeping the expense of planting uniform. There are many conditions that are accountable for it, such as the size and condition of the area, — as a larger tract can be handled more cheaply per acre than a smaller one; price of seedlings, etc.; but the greatest factor to be reckoned with has been the question of caring for the laborers. In some cases it was necessary to transport the men night and morning to and from the field, which was an extra expense. In order to overcome this, the department has constructed several portable steel shacks (see accompanying photograph), which are used to house and board the labor on the ground. These shacks were constructed in the State Forester's warehouse. The whole construction is of galvanized-iron sheets, which are held together with bolts and clasps. The only wooden parts are the door and two window sashes, one on each side. Twelve men can thus be accommodated. The following outline gives the size of the shack, equipment for setting it up, cooking utensils and planting tools used in the work; the approximate cost is also given.

With this device the whole environment of the work is improved, and the results, from an economic standpoint, are far more satisfactory. These shacks are used only when the plantings are in a locality where it is difficult to get board and room for the men, or where the work is at a distance from boarding places.

Cost of Steel Shack and Equipment.

Shack.

Size, 12 feet by 12 feet square; height, 9 feet front, 7 feet back,		
1 sliding window on each side,		$75 00
1 door in center of front,		
6 double bunks, 4 feet wide, 2 feet 4 inches between each,		

Equipment.

1 cook stove,	$5 00	
2 lanterns,	2 00	
1 kerosene can,	25	
1 hammer, axe and saw,	2 50	
1 pair wire cutters,	45	
2 shovels,	1 20	
1 chisel,	75	
		$12 15

Cooking Utensils.

1 large coffee pot,	
3 large kettles and covers,	
1 small kettle and cover,	
2 large frying pans,	
1 bean pot,	
3 large spoons,	$4 00
2 large knives,	
2 small knives,	
12 cups, plates, knives, forks and spoons,	
1 dipper,	
1 dish pan,	

Planting Tools.

6 grub hoes,	$3 00	
12 pails,	2 50	
		$5 50

1 chest for carrying equipment.

The bedding is furnished by the men.

Forest Fires of 1910.

It is with considerable reluctance that each year we include in our annual report a chapter on this painful subject, — painful, because forest fires are the greatest obstacle to the advancement of practical forestry in this Commonwealth, and because they form one of the most difficult problems with which we are obliged to deal; yet for these very reasons this chapter cannot be omitted from this book.

The subject of forest fires has been most vividly presented to the people of the United States during the past summer by the disastrous fires which raged in the northwest. We in our little State cannot experience such enormous conflagrations as these; yet the fire demon each year lays its insidious claws on a valuable portion of our natural heritage.

Last year 215 of the 354 towns and cities of the Commonwealth reported that they had 1,385 forest fires; 28, or 8.6 per cent., said that they had none; and 92, or 27.7 per cent., failed to report. There are 18 towns and cities which have little or no forest land, and therefore do not appoint forest wardens. On account of the large number of towns not reporting, we may be sure that the figures which we have are very conservative. The wardens reported that these fires damaged the woodland to the extent of $205,383. As we have emphasized in our previous reports, the figures for money damage are very inadequate, as many wardens will not report the damage, because they feel incapable of estimating it; and even when they try, they cannot set a value on the young growth killed and the gradual deterioration of the soil. In the cost of fighting fires, we have data which is not a matter of guesswork, although this is incomplete, because in towns and cities having an organized fire department, where the members are paid a regular salary, the cost of fighting woodland fires of course cannot be obtained. In 1905 the State Forester made a careful canvass of all the towns, and came to the conclusion that the annual cost of fighting fires was about $30,000. Our figures would seem to indicate that this conclusion was correct. When we spread this sum over the 300 towns in the State, it does not make a very large sum for each individual community; but it must be remembered that this expense is borne in large part by a few towns, and usually the poorest and least able to bear it. An annual bill of $1,000 for forest-fire fighting is a serious burden on a town whose entire yearly expenditure may not amount to more than $15,000. This forest-fire menace is a two-edged sword, for, while it cuts its way into the town treasury, it is at the same time destroying the property which supplies the revenue to that treasury.

The present system of collecting fire reports in this office was inaugurated three years ago, and we thought that it would give opportunity for an interesting study if the data for 1908, 1909 and 1910 were placed side by side. Perhaps the most striking feature is the similarity in the totals for number of fires, acres burned and damage done. Looking at the table more closely, we find some interesting variations. For instance, the figures for March, 1910, greatly exceed those for March, 1908 and 1909. Spring came early last year, and the season of spring fires was present sooner than usual. There were comparatively few fires during the summer, although it was accounted a dry one. On the Cape, where most of the summer fires occur, they had considerable rainfall during July and August. The drought in October is reflected in the fire data for that month. The October fires were very severe, in that they burned in the peat and humus, many of them for weeks, and only severe rains extinguished them.

We find in the table of causes comparisons of more importance and interest. We find, for instance, that the number of fires caused by the railroads has steadily decreased, and we feel that this represents real progress on their part, although plenty of room is left for improvement. The number of fires caused by the burning of brush materially increased, and this would seem to be a cause for disappointment, in view of the general adoption of the present law; but owing to the provisions of this very law, which make it easier to place responsibility, it is the number of fires reported with this cause, and not the actual number of fires caused by burning brush, which have increased.

Fires caused by the careless use of matches in the hands of boys, fishermen, hunters, berry pickers, etc., have been the cause of more concern during the past year than ever before. Although the number under this head is not large, there is no doubt that most of the fires labelled "Unknown" would be placed in this column if they could be traced out; so that we feel sure that they cause as many fires as the railroads, and are more dangerous, because the smoke is everywhere, while the railroad fire is confined to a certain district, and can be more or less anticipated. The time has not arrived when we can get a sweeping injunction prohibiting all smoking in the woods; but there is no doubt that by the necessary gradual posting of all private land against trespassing this condition will come in time.

As long as we have forest fires, there will be problems connected with them, and their solution will not come all at once: but there are certain features which can and should have immediate attention. In the first place, the office should have the services of a man whose entire time can be spent on forest-fire work. An assistant or chief forest warden, so called, would find a very considerable portion of his time taken up in carrying out the provisions of the fire-equipment reimbursement act; another portion would be well occupied in the collecting and listing of reports; and the remainder could be well used in visiting and assisting whatever forest wardens seemed to require such aid. If the Legislature should add to the authority of the State Forester other duties in the line of fighting fires and making arrests, this assistant would be a very busy man indeed.

FOREST FIRES OF 1910.

MONTHS.	Acres.	Damage.	Cost to put out.	No.
February,	5	–	–	2
March,	12,666	$57,740	$3,839	438
April,	13,782	68,867	5,125	413
May,	4,236	13,957	1,738	116
June,	137	980	490	23
July,	1,041	6,509	1,627	76
August,	165	1,275	763	44
September,	2,900	15,035	1,456	25
October,	7,068	40,064	7,885	196
November,	107	400	427	24
No date given,	114	556	125	28
Totals,	42,221	$205,383	$23,475	1,385

COMPARATIVE CAUSES OF FOREST FIRES FOR THE PAST THREE YEARS.

Causes.	1908.		1909.		1910.	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Unknown,	314	24.4	360	25.1	413	32.9
Railroad,	494	38.3	497	34.7	362	28.8
Burning brush,	119	9.0	149	10.4	203	16.2
Smokers, hunters, berry pickers, etc.,	161	12.0	140	9.7	124	9.9
Steam saw-mills,	12	1.2	5	.5	1	.1
Children,	71	6.0	92	6.4	75	5.9
Miscellaneous,	118	9.1	190	13.2	78	6.2
Too late for tabulation,	-	-	63	-	129	-
Totals,	1,289	100	1,496	100	1,385	100

COMPARATIVE DAMAGES BY FOREST FIRES FOR THE PAST THREE YEARS.

Months.	1908.		1909.		1910.	
	Acres.	Damage.	Acres.	Damage.	Acres.	Damage.
January,	-	-	13	-	-	-
February,	-	-	12	-	5	-
March,	236	$420	1,577	$4,763	12,666	$57,740
April,	16,262	52,731	12,515	72,195	13,782	68,867
May,	5,856	48,506	4,322	38,080	4,236	13,957
June,	1,195	17,824	405	11,870	137	980
July,	6,109	28,783	11,992	26,396	1,041	6,509
August,	1,567	22,320	1,940	10,833	165	1,275
September,	1,062	3,140	1,092	21,413	2,900	15,035
October,	7,084	29,960	384	1,805	7,068	40,064
November,	301	1,468	585	612	107	400
No date given,	-	-	246	1,515	114	556
Totals,	39,672	$205,152	35,083	$189,482	42,221	$205,383

FOREST-FIRE EQUIPMENT.

The Legislature last spring passed an act authorizing the State Treasurer to reimburse towns, having a valuation of one and a half millions or less, 50 per cent. of whatever sum they might spend for forest-fire-fighting equipment, provided this sum does not exceed $500, and provided also that the equipment purchased has the approval of the State Forester. As the law was not passed until after the time of the annual town meetings, only a few places have been able to avail themselves of its provisions, and but a small part of the appropriation of $5,000 was therefore expended. This appropriation, however, is a continuing one. and the same sum will be available next year. It is expected that many towns will vote this spring to spend money for this purpose. Wardens and selectmen of 17 towns have already assured this office that they will urge the matter at the next annual meeting. The following table contains the names of the towns that have received reimbursement, the amount thereof, and the kind of equipment purchased: —

TOWNS RECEIVING FIRE-EQUIPMENT REIMBURSEMENT.

Towns.	Amount of Reimbursement.	Nature of Equipment.
Ashland,	$15 75	Johnson pumps and pails.
Boxford,	45 60	Chemical extinguishers.
Dighton,	58 67	Extinguishers and cans.
Georgetown,	39 39	Extinguishers, cans and shovels.
Greenwich,	25 95	Chemical extinguishers.
Hanson,	100 77	Wagon and other equipment.
Mashpee,	34 55	Extinguishers and shovels.
Middleton,	49 50	Extinguishers.
Norwell,	50 00	Extinguishers.
Oakham,	138 00	Extinguishers.
Pembroke,	203 75	Wagon, extinguishers, etc.
Phillipston,	48 65	Extinguishers.
Prescott,	48 16	Extinguishers.
Raynham,	50 00	Extinguishers.
Westminster,	55 91	Extinguishers and cans.
West Newbury,	24 00	Extinguishers.

In addition to the above list, the towns of Bedford, Charlton, Hanson, North Reading, Tewksbury, Sterling, Sandwich and Wrentham have already purchased equipment, the reimbursement on which will amount to $1,600; but, as their accounts were not received before November 30, we were not able to list them in our table. All of these towns except Charlton purchased a full wagon equipment.

In this connection it is pertinent for us to call attention to our two model forest-fire wagons. These were built by the State Forester in order that the officials of the towns wishing to purchase forest-fire equipment may see what we consider an ideal form of apparatus. The plan of this outfit was made up only after a careful study had been made of existing forest-fire apparatus in several towns.

The larger wagon is intended for two horses, and costs, all equipped, about $450. The equipment consists of fourteen chemical extinguishers; fourteen galvanized cans, each holding two extra charges of water and chemicals; shovels; rakes; mattocks; and spare chemical charges. This equipment is carried in racks and cases, not only so that it will ride safely, but also so that it can be conveniently carried into the woods. Eight men can find accommodation on this wagon.

The smaller wagon, drawn by one horse, has all the equipment of the larger, but less in amount. It will carry four men, and costs, all equipped, about $300. These two wagons were exhibited this fall at the Marshfield, Barnstable, Worcester, Clinton, Barre and Palmer fairs, where they attracted general interest. The New Haven, Boston & Maine and New York Central railroads aided us in this exhibition work by transporting the wagons over their lines without charge. A small pamphlet describing these wagons has been published by this office, and may be had on application.

Forest-fire Deputies needed.

The State Forester wishes to repeat what was suggested last year under this head: —

The forest warden law has undoubtedly been tested far enough to be pronounced a success as another step in perfecting our organized efforts against forest fires. I now propose the idea of empowering the State Forester to appoint deputies at large to assist him. Many of our forest wardens need instruction and co-operation in getting their work well in hand. The best way to teach these men just how to accomplish results in fighting forest fires is to confer with them right on the ground, and

The slash remaining following the lumbering of a pine lot at Concord. Here is where we must guard against fire.

The brush or slash conditions following lumbering of a mixed growth at Petersham. This is typical of most sections, and forms the base or tinder-box that causes our destructive forest fires.

demonstrate what can be accomplished and how it can be done. There are experienced men whom the State Forester could in times of emergency delegate to assist, and, if need be, with authority to take charge.

In the case of the gypsy and brown-tail moth agents, these men are at present mounted on motor cycles, and hence are familiar with the country. They are already State employees, and men interested in the preservation of the forests. They will gladly acquaint themselves with modern methods of fighting forest fires, and, were they appointed deputies authorized to assume responsibility, the State would have their services at no extra compensation. Of course this would apply only throughout the moth-infested territory, but other plans could be worked out for the remainder of the State at a minimum cost.

Disposing of the Slashings or Brush.

As a result of the discussion of this matter in the last annual report, the State Forester has had many inquiries and has discussed the matter with practical men. That the slashings left from limbing are a great menace, and one of the basal dangers causing forest fires, there can be little question. At the present time this office is carrying on some experiments to determine the expense of handling the slash, and the results are looked forward to with much interest. No one desires to hinder the wood-lot operator, or to cause him any extra expense; but when the expense of piling and burning the brush is once determined, it can be dealt with as a part of the business transaction. We must conserve for the future welfare of the town and Commonwealth, as well as for the present. It is high time, therefore, that some reasonable State regulations should be made.

Forest-fire Lookouts.

Last year attention was called to the value of forest-fire lookouts, and the advisability of our experimenting somewhat, to determine whether their use would be applicable to our conditions. We were unable to spare any of our regular appropriation for doing anything in this line; and hence, with the exception of the Plymouth tower, which was erected by the town of Plymouth a few years ago, there are no others in the State.

Since our last report New Hampshire has established several lookout stations, and the results derived from their first season's use are very satisfactory.

Maine has a number of these lookouts scattered throughout the so-called wild or forest lands, and the State makes an annual appropriation of $60,000 a year for these stations and for fire-patrol work. The work of the Forest Commissioner of Maine is primarily that of forest-fire protection.

New York has forest-fire lookout stations established throughout the Adirondacks, and values them very highly.

The point may be raised that the States named have a much larger forested area than has Massachusetts. This is true; but this State is quite thickly populated, and the dangers from fires are therefore proportionately greater, as man himself seems to be the destructive force. There is no doubt that the small outlay required for the services of men to attend a few lookouts at high points in this State, together with the installation of telephones, would have been repaid many times over during the past season in the saving of forest values by stopping fires in their incipiency. There is nothing like having a system for getting results. If this outlook plan could be added to the present forest warden system, it is believed that it would be an economic step in the right direction.

Fire Lines and Protective Moth Belts.

Each forest warden should plan to interest his town in doing something in the way of making fire lines. By making a beginning and doing a little each year the importance and value of the work will demonstrate itself. The widening of all wood roads or cleaning a strip and running plowed furrows, together with separating the débris, etc., if done in advance, precludes the danger from fires, so common at present. This winter this department has been fortunate in finding enough of this sort of work, largely on private estates, to employ a number of our men in making fire lines. By finding the men employment at this season, we shall be able to keep them the year round. Men familiar with the work and understanding modern methods accomplish much more than inexperienced men.

These fire lines may be utilized for operating the lots, as occasion demands; also, they enable one to combat the dreaded moth pests.

RAILROAD CO-OPERATION IN FOREST-FIRE FIGHTING.

During the past season there have been many evidences of co-operative assistance on behalf of the railroads with the State Forester and the forest wardens in preventing and fighting forest fires. Invariably when assistance has been asked from the main office of the railroads or the local section men, it has been furnished. In one instance of a fire which had not been set by the railroad, a forest warden reported that twenty-five men in the employ of the railroad came to his assistance without making any charge to the town for their services.

There were many instances where engines were reported as evidently having inefficient spark-arresters, and hence they were throwing out cinders and setting fires; but it is believed that in each case they were overhauled and improved.

Certainly there is already a great difference in the feeling of our rural people towards the railroads; and this is equally true, we are inclined to believe, of the railroad people as regards the protection of our woodlands and forests.

When the State Forester came to Massachusetts, in 1906, it was the consensus of opinion that the railroads were the great offenders in burning up our forests. If there was a railroad in the vicinity of the fire, it was always held responsible. Since our forest warden and permit laws were enacted, and we have been enabled to get at the real causes of forest fires, it is plainly shown that there are many causes for forest fires other than the railroads. The railroad fires, however, are still very numerous, and there are great opportunities for improvement; but let our forest wardens in each town co-operate and work harmoniously with all forces toward getting better results in checking and eliminating forest fires. All we desire is to get the exact facts, and then we shall be in a position to better the conditions.

The railroad officials are business men, and can be convinced of their duties as readily as any class of people. Instead of a forest warden finding fault and getting disgusted over railroad fires, the thing to do is to get direct proof and evidence, by having the number of the engine, the time of day, the date, etc., and then taking it up with the proper authorities. One warden has succeeded in getting the railroad people to keep some barrels filled with water on the right of way upon a bad up-grade which runs through woodland in his town. This same road has also supplied the section men on this section with two three-gallon hand extinguishers. Forest wardens little realize what they can accomplish until they try.

Power Sprayers as Forest-fire Equipment.

Attention was called in last year's report to the use of power sprayers in putting out forest fires. From our experience with the modern sprayers, which can be turned around in a small space, and hence may be readily handled, even in wood roads, they should be used more often. These machines can be adjusted to spray directly from the brook, pond or tank, so that they are adaptable for service when other equipment would be useless. If for no other purpose than to carry water, they can be made very serviceable, as they can be filled by their own power in about five minutes. The capacity of the tank is usually 400 gallons. As these sprayers are capable of throwing a stream to the top of the tallest trees, it is readily seen what a radius of fire could be reached and deadened by them. They have sufficient power to maintain a 300-pound pressure at the end of a 1,500-foot length of 1-inch hose. These same machines could also be used to great advantage for house fires in the country. As our towns need such a device for the protection of their trees, why not get all the good possible out of them?

Forest Fires in Germany.

A recent letter from Mr. F. B. Knapp, a Massachusetts man who is spending the year abroad with the Biltmore Forestry Schools, says: —

> They have practically no forest-fire problem here, and I should say that it is chiefly due to *respect for law and order.*

The State Forester appreciates the above statement, for it comes from a man who has shown much interest at home in these matters; in fact, he is the forest warden of Duxbury, where good work has been done.

A plantation of white pine, thirty years old, at South Orleans, on the Cape. Who says white pine will not grow on the lower Cape?

State Subsidy to Towns for Forest-fire Protection.

The law enacted last winter, which assists all towns having a valuation of one and one-half millions or less in purchasing fire equipment to the extent of 50 per cent., or an amount not exceeding $500, was passed too late to be taken advantage of by most towns, as their annual town meeting had been held.

At the coming spring town meetings it is believed that many will accept the assistance. The State Forester has a brief pamphlet in press that will be sent to all towns in time for their consideration before the spring meetings.

Public Addresses.

As many engagements have been filled throughout the year as the State Forester could accept, and at the same time consistently carry on his other duties. The custom of placing the responsibility upon organizations of securing an audience of at least one hundred has made our efforts more effective and better appreciated. It has been practically impossible to meet all the demands from local clubs and private organizations; hence we have invariably requested that, in so far as possible, these meetings be thrown open to the public.

The usual course of lectures was given at the Massachusetts Agricultural College during January.

Lectures before Scientific Organizations.

The State Forester has had several requests to lecture outside the State, as well as at home, and the following were accepted: Lehigh University, Bethlehem, Pa., in their special lecture course on forestry; the New Hampshire Horticultural Society, annual meeting at Manchester; the Society for the Promotion of Agricultural Science, annual meeting at Washington, D. C.; the American Society of Economic Entomologists, annual meeting at Boston; the Economic Club; Williams College, at Williamstown; the Massachusetts Reform Club; High School Principals Association; the Society for the Protection of New Hampshire Forests, at Bretton Woods, N. H.; etc.

State Firemen's Association.

The annual meeting of the State Firemen's Association was held at Lowell during the week beginning September 19, and the State Forester addressed the organization on Thursday evening, September 22, on the subject, "Forestry, and Fire Menace of the Same."

This organization has been ready to co-operate and assist the department at all times, and their good offices have been highly appreciated.

During the past summer, at a meeting of the officials of the above association and the State Forester, it was agreed that the fire-permit act should apply to cities as well as to towns.

Thinning Bulletin.

The bulletin by the State Forester's assistant, Mr. H. O. Cook, on "Thinning," referred to as being in press last year, was received from the press early in the year, and has proved of great value in assisting us in getting this information into the hands of those who contemplate improving their woodlands.

This bulletin is opportune, as it meets a definite place in the handling of woodlands in the worst moth-infested sections; and it helps not only in making better forestry conditions, but, with the poorer trees and dead wood removed, the work of spraying and treating woodlands is greatly simplified.

Bulletin on Reforestation and Nursery Work.

Reforestation and the growing of young trees is at present a subject of great interest to our people. In order to give detailed and exact knowledge, the bulletin was carefully planned and published, and we have every reason to believe that it covers the subject as clearly and as practically as any publication available. It was written by Mr. R. S. Langdell, assistant in charge of the State nursery at Amherst, who also has charge of the reforestation work throughout the State. We believe it hits the nail on the head, and is of great assistance in the State work.

The Chestnut Bark Disease.

This disease, as reported last year, does not seem to have caused any great amount of damage as yet in this State. We had received but one direct notice of its appearance here, when a letter came from Dr. Haven Metcalf, stating that he had reports of four outbreaks in Massachusetts. The State Forester has taken the matter up with Dr. Metcalf, and has also written to Prof. George Stone of the Agricultural College at Amherst. If occasion demands, further notice will be given, calling attention to the disease and showing how the infested trees should be treated.

The precaution mentioned last year will apply not only to the chestnut, but to all trees; namely, that any tree that becomes unhealthy, particularly in the woodlands or forest, should be removed, thus minimizing the danger.

Conference of State Foresters and Forest Wardens.

A meeting was held at Bretton Woods, N. H., during the first week in August, under the auspices of the Society for the Protection of New Hampshire Forests, at which various State foresters and forest wardens held a conference. The State Forester and many other Massachusetts people attended, including Mr. Guild, secretary of the Massachusetts Forestry Association, Congressman Peters, Forest Warden Knapp of Duxbury, etc. The meeting proved a very interesting and instructive one. The following paper was presented by the writer: —

The Massachusetts Forest Warden System.

Massachusetts has had the town forest warden system in practice long enough to feel that it is a pronounced success. The idea of having an authorized town, and, in a sense, a State official in each town who is clothed with sufficient power to get results in a broad forestry movement, makes a splendid nucleus for better future results.

It is the aim of the State Forester to secure for these positions public-spirited citizens who have their town interests as regards forestry matters at heart, and then get them all the assistance possible. When a man is broken in, the aim of the State is to retain him in the work.

The duties of the forest warden in Massachusetts are multitudinous, and he will never lack for things to do. The following are some of the forest warden's main duties: —

Interest in all forestry matters. Appointed by selectmen, subject to the approval of the State Forester, he has the power to appoint and discharge deputies. State Forester's power to hold meetings for educating forest wardens. Forest warden chief forest fire fighter in the town. Forest warden source of information on reforestation in the town. Forest warden, ideas on thinning and pruning trees. Forest warden read or have read fire laws in schools. Forest warden post fire laws and warnings. Forest warden deal with railroads in his town. Forest warden have ideas on forest taxation. Forest warden assist State Forester on forest data, maps, etc. Forest warden tell when seed and seedlings are plenty. Forest warden start a town nursery. Forest warden, amount, kind and price of cheap lands. Forest warden, town lands accepted and planted. Forest warden encourage forestry in town schools, grange, farmer's clubs, woman's clubs, etc. Forest warden handle town insect troubles. Forest warden assist in encouraging beneficial birds. Forest warden plan fire campaign, fire belts, have fire extinguishers well placed, telephone calls, etc. Forest warden, power to arrest without a warrant within certain restrictions, etc.

The whole purpose, as I see it, is to adopt modern ideas and systematize our efforts along well-defined channels, whereby results are made possible. The working out of a forest warden system in a thickly settled State like Massachusetts might not adapt itself to some sections of Maine and northern New Hampshire, but with modifications it could be made to do so. In Massachusetts about 5 per cent. of the forest products used are grown in the State; hence we have a good market, and with modern methods of forestry management, made possible through local and State officials, the value from possible forest products can be made very great. What is true of Massachusetts is equally true in other New England States in more or less degree.

Expenditures and Receipts.

In accordance with section 6 of chapter 409 of Acts of 1904, as amended by Acts of 1907, chapter 473, section 2, the following statement is given of the forestry expenditures for the year ending Nov. 30, 1910: —

Forestry Expenditures.

Salaries of assistants,	$5,346 47
Travelling expenses,	1,001 78
Stationery, postage and other office supplies,	369 37
Printing,	960 37
Instruments,	48 55
Forest warden account,	499 92
Nursery,	2,222 15
Sundries,	143 13
	$10,591 74

REFORESTATION ACCOUNT.

Seedlings,	$2,204 70
Land,	1,035 00
Labor,	5,124 68
Equipment,	694 63
Travelling,	670 83
Express,	311 21
Sundries,	57 74
	$10,098 79

Turned over to the treasurer for publications,	$102 60
Turned over to the treasurer for seedlings,	243 50
Turned over to the treasurer for cord wood,	118 13
	$464 23

Reimbursement to towns for fire-fighting apparatus,	$1,469 56
Unexpended balance,	3,530 44
Total appropriation,	$5,000 00

In accordance with section 5 of the above-named chapter, the following statement is given of the receipts for travelling and subsistence: —

LECTURES.

Mansfield Men's Club,	$1 00
Andover Grange,	1 20
Newburyport Neighborhood Club,	30
Rockport Men's Club,	90
Saugus Laymen's League,	1 10
Littleton Women's Club,	1 42
Malden Board of Trade,	2 00
Somerville Board of Trade,	20
Bellingham Pomona Grange,	1 40
Foxborough Grange,	3 15
Boston Public Library, Field and Forest Club,	3 00
Quincy Men's Club,	5 00
Buzzards Bay,	2 40
Athol Improvement Society,	4 04
Bolton Pomona Grange,	1 50
Boylston Grange,	2 50
Fitchburg Pomona Grange,	2 28
Harvard Grange,	1 84
Phillipston Grange,	3 50
Amesbury Improvement Society,	40
Hatfield Men's Club,	5 00
Bristol County Academy of Science,	2 00
Hingham Association,	$1 70
Massachusetts Board of Agriculture,	5 69
Cornell Club,	1 50
American Forestry Association,	25 00
Course of Lectures, M. A. C.,	–[1]
Woronoco Club, Westfield,	5 40
Newburyport Club,	3 00
Pilgrims' Club, New Bedford,	2 50
Williams College,	11 34
Middlesex Sportsman's Show,	1 04
Newton High School,	75
Winchester Unitarian News Club,	1 96
South Bristol Farmers' Club,	3 00
Worcester Horticultural Society,	–[1]
Heptorean Club,	1 50
Phi Delta Theta Club,	2 25
Farmers' Week, M. A. C.,	–[1]
Fish and Game Association,	–[1]
Palmer's Woman's Club,	4 00
Winchendon Board of Trade,	5 00
Winchester High School,	1 21
Barre Library Association,	4 48
Danvers Bird Club and Grange,	1 25

[1] Paid.

LECTURES — *Concluded.*

Wellesley Grange,	$3 00	State Fireman's Association,	$3 50
Massachusetts Reform Club,	1 22	Hanover Fireman Muster,	1 50
Pepperell Woman's Club,	2 00	New Hampshire Horticultural Society,	5 50
Lehigh University,	24 31	Springfield Board of Trade,	5 00
Pierce School,	1 07	Roxbury Woman's Club,	2 00
Institute State Board of Agriculture,	7 45	Massachusetts Forestry Association,	–[1]
Grange field day, West Newton and Yarmouth,	10 59	Society for the Protection of New Hampshire Forests,	25 10
Montwait Chautauqua,	1 15	American Association of Economic Entomologists,	2 00
Cape Cod Cranberry Association,	2 20		
Franklin County Pomona Grange,	8 11		
State Prison teachers,	1 30		

EXPENSES INCURRED IN EXAMINATION WORK, CHARGED TO OWNERS.

Allen, P. R.,	$0 70	Main, F. H.,	$5 44
Bent, F. E.,	50	Massachusetts Agricultural College, Faunce demonstration farm,	5 00
Borden, N. E.,	74	Minns, Susan,	2 50
Boston & Northern Street Railway,	1 32	Minot, W.,	2 00
Brayton, A. P.,	2 00	Morey, E.,	1 00
Brochu, J. E.,	1 40	Nelson, H. W.,	1 20
Burnett, H., trustee,	70	Pickman, D. L.,	1 50
Chandler, F. F.,	62	Robinson, C. E.,	2 85
Cummings, W. O.,	62	Sawyer, A. H.,	1 50
Cushing, J. S.,	50	Sears, Julia M.,	1 40
Dewar, D. W.,	1 25	Seavey, H.,	50
Eddy, Mary B.,	15	Simmons, H. F.,	1 25
Emerson, Dr. N. W.,	18	Stevens, E. A.,	1 50
Forrest, W. P.,	1 00	Stevens, H. H.,	1 14
Fowle, D. H.,	1 80	Stone, G. (W. Manning),	2 35
Fuller, W. A.,	1 50	Tenney, C. H.,	1 16
Gerrish, Isabel F.,	1 00	Tracy, Harriet E.,	2 85
Green, F. C.,	2 40	Webber, F. S.,	3 05
Harriman, C. S.,	68	White, J. H.,	1 20
Horne, W. N.,	90	Fitchburg Water Board,	2 00
Hunnewell, H. H.,	50		
Jones, J. L.,	1 20		
Lawrence, I. P.,	6 50	Total,	$71 37
Mahoney, T. J.,	1 82		

EXPENSES INCURRED IN SUPERVISION OF MANAGED WOODLANDS, CHARGED TO OWNERS.

F. C. Green,	$4 80
R. B. Symmington,	20 00
	$24 80

EXPENSES INCURRED IN GIVING INSTRUCTION IN PLANTING, CHARGED TO OWNERS.

E. P. Joselin,	$2 35
Long Island, transportation furnished,	–
Fitchburg Water Board,	4 85
Needham Water Board, no expense,	–

[1] Paid.

EIGHTEENTH SEMIANNUAL REPORT

OF THE

CHIEF OF THE CATTLE BUREAU.

PRESENTED TO THE BOARD AND ACCEPTED,
JANUARY 10, 1911.

REPORT.

BOSTON, Jan. 10, 1911.

To the State Board of Agriculture.

In submitting to your honorable Board, as required by statutory provisions (section 3, chapter 116, Acts of 1902), this, the eighteenth semiannual report of the Chief of the Cattle Bureau, it seems fitting to state, by way of preface, that, as I have been in charge of the office only since Oct. 5, 1910, the report which is for the year ending Nov. 30, 1910, must necessarily, so far as its tabulations of work performed are concerned, represent, in a large degree, the administration of my predecessor. Of course it includes also the work performed since the date of my commission, a period of barely two months.

In preparing such details as the report contains I have had to rely upon the office force, and I wish to place on record my appreciation of the unvarying courtesy and willing co-operation rendered by it. These assistants are very efficient, and display, because of their long service and marked intelligence, a most enviable knowledge of and intimacy with the detailed clerical work of the Bureau. Under their careful routine even the minutest detail is correctly checked up, and there is at all times, and open to public inspection, a complete statistical record on all matters coming within the jurisdiction of the Bureau.

I commend to your consideration the tables herewith submitted.

RABIES.

The following table shows the prevalence of rabies during the year ending Nov. 30, 1910: —

	Dogs.	Cattle.	Cats.
Killed or died with rabies,	51	3	-
Killed by owners or died in quarantine, not rabid,	55	-	-
Released from quarantine,	75	1	1
Animals still in quarantine,	47	1	-
Totals,	228	5	1
Grand total,	234 animals.		

One dog, released March 21, developed rabies and was killed on May 25. Another dog, released September 16, because its owner claimed it was out of town the day the rabid dog to which it was supposed to have been exposed ran through the town, developed rabies and died November 2.

The veterinarian of the Boston Board of Health reports 4 cases of rabies in dogs in that city during the year, making a total for the entire State of 55 mad dogs. The total number of dogs having rabies during the year ending Nov. 30, 1909, in Massachusetts, including Boston, was 154; this shows a decrease of 99 cases for 1910.

During 1910 Dr. Frothingham has examined the brains of 37 animals for rabies, of which 19 have proved positive cases and 18 have proved to be negative. One dog's head sent to Dr. Frothingham was so decomposed he could not examine it, and another head was so badly injured by shooting that it was not possible for an examination to be made of it.

Glanders.

There has been a marked diminution in the number of cases of glanders and farcy reported in Massachusetts during the year ending Nov. 30, 1910, from the previous twelve months.

During the year ending Nov. 30, 1909, 684 cases of glanders or farcy were recorded, beside which there were 17 animals under observation at the end of the year. Twelve of these were later released, and 5 were killed as having glanders. Adding these 5 to the 684 cases previously decided makes a total of 689 animals killed, or which have died, that were quarantined prior to Dec. 1, 1909.

During the year ending Nov. 30, 1910, 1,067 horses or mules have been reported, including those dealt with in stable tests. Of these, 676 have been killed as having glanders or farcy, 357 have been released and 24 were still held for further examination. Of the 676 killed for glanders or farcy during the year, 362 were from cities and towns outside of Boston, and 314 from the city of Boston.

There was a decrease of only 7 cases for the entire State from the previous year. In Boston there was an increase of 36 cases, as the veterinarian of the Boston Board of Health reports 314 cases for the year ending Nov. 30, 1910, as against 278 cases for the previous year. There seems to be an increase in the number of cases of glanders found in Worcester, as there were reported 28 cases of glanders and farcy during the year ending Nov. 30, 1910, as against 14 cases reported the previous year. On the other hand, in Somerville there was a decrease of 10 cases, 32 cases having been reported for the year ending Nov. 30, 1910, as against 42 cases the previous year. In Fall River there were only half as many cases, 12 horses having been killed during the year ending Nov. 30, 1910, and 24 the previous year. In Cambridge there was a decrease of 11 cases, 50 having been reported for the fiscal year of 1909 and 39 for the year ending Nov. 30, 1910.

Sixteen stable tests have been undertaken during the year, 21 cases of glanders having been found in these stables previous to making the tests. Three hundred and seven horses were tested with mallein; of these, 164 were released, 60 were killed on account of having glanders and 24 are held for further tests.

The reports of rendering companies, as required by section 111 of chapter 75 of the Revised Laws, as amended by chapter 243 of the Acts of 1907, continue to be of much value in furnishing information of cases of glanders or farcy which would not otherwise be brought to the attention of the Chief of the Cattle Bureau, as the following table illustrates: —

Reports of Rendering Companies.

Rendering Companies.	Number of Reports.	Number of Cases.	Number in Boston.	Number out of Boston.	Number outside of Boston not previously reported.
William S. Higgins, Saugus,	6	6	-	6	2
Home Soap Company, Millbury,	17	6	-	6	-
Lowell Rendering Company,	14	4	-	4	3
James E. McGovern, Andover,	27	9	-	9	4
Muller Brothers, North Cambridge,	28	83	5	78	6
W. H. Nankervis, Marlborough,	2	-	-	-	-
New Bedford Extractor Company,	4	4	-	4	-
New England Rendering Company, Brighton,	14	44	11	33	12
Parmenter & Polsey Fertilizer Company, Peabody,	9	13	-	13	1
N. Roy & Son, South Attleborough,	22	16	-	16	2
A. E. Southwick, Mendon,	3	-	-	-	-
N. Ward Company, South Boston,	51	302	253	49	5
Whitman & Pratt Rendering Company, North Chelmsford,	8	6	-	6	-
Worcester Rendering Company,	26	5	-	5	2
Totals,	231	498	269	229	37

Annual Inspection of Neat Cattle, Farm Animals, and Premises upon which the Former are kept.

About the middle of September the following circular letter was sent to the inspectors of animals in the cities and towns of the State, together with the necessary books in which to record the results of their work, and blank forms of certificates of health to be given owners in conformance with section 18, chapter 90 of the Revised Laws: —

Commonwealth of Massachusetts,
Cattle Bureau of the State Board of Agriculture,
Room 138, State House, Boston, Sept. 15, 1910.

Directions to Inspectors of Animals.

Inspectors of animals are hereby directed to make a general inspection of the neat stock and incidentally other farm animals in their respective towns, as required by chapter 90 of the Revised Laws, such inspection to commence October 1 and to be completed before the fifteenth day of November.

Wherever inspectors examine animals and find them free from contagious disease, they will give owners certificates of health, as provided for in section 18 of the law, from the book of blanks (Form No. 2) furnished for that purpose. Books will also be provided (Form No. 1) for carrying out the provisions of sections 17 and 24 of chapter 90 of the Revised Laws.

Inspectors will not say on any report, "Same as last year," but will make a full and complete report on every place inspected, including all dimensions and measurements provided for on the blank, and answer in full all questions as to the light, ventilation, sanitary surroundings, and water supply, as well as the number of cattle kept in each stable, and give a complete list of other animals in spaces provided in the book.

Inspectors of animals are not to quarantine any cattle as tuberculous, unless they show sufficient evidence of disease to make it possible to condemn them on a physical examination, or show evidence of tuberculosis of the udder.

It is also requested that, if cases of tuberculosis in animals are found, inspectors keep a record of them for a few days, and then when animals are quarantined, several can be quarantined at once and duplicates sent here, so that the agent of the Cattle Bureau can see a number at one visit, instead of having to go every two or three days to see one animal at a time, thus avoiding running up expenses as much as possible.

It is also the duty of inspectors of animals to quarantine cattle brought into this State from without the limits of the Commonwealth, if the owner has not had a permit from this Bureau, the same to remain in quarantine until ordered released by the Chief of the Cattle Bureau or his agent.

Inspectors of animals, in case they suspect the presence of any contagious disease among any species of domestic animals, are to quarantine such animals and send duplicates to the Chief of the Cattle Bureau.

Contagious diseases, under the provisions of section 28, chapter 90 of the Revised Laws, include "glanders, farcy, contagious pleuro-pneumonia, tuberculosis, Texas fever, foot-and-mouth disease, rinder-pest, hog cholera, rabies, anthrax or anthracoid diseases, sheep scab, and actinomycosis."

The necessary books for the inspection will be forwarded at once. Please report immediately if not received by October 1. When inspection is completed return book, Form No. 1, at once by express.

AUSTIN PETERS,
Chief of Cattle Bureau.

The following table embodies a condensed report of the doings of the inspectors of animals in making the annual inspection, which complies with the requirements of section 24, chapter 90, Revised Laws: —

Net Results of Annual Inspection of Animals and Farm Premises.

Number herds inspected,	31,484
Number neat cattle inspected,	227,164
Number cows inspected,	168,026
Number herds kept clean and in good condition,	27,742
Number sheep inspected,	27,092
Number swine inspected,	105,363
Number goats inspected,	894
Number stables inspected,	32,832
Number stables well located,	28,412
Number stables well lighted,	25,483
Number stables well ventilated,	27,421
Number stables kept clean,	28,420
Number stables with good water supply,	30,309
Number stables improved since last inspection,	1,523

Tuberculosis.

The work for the eradication and control of bovine tuberculosis can, as usual, be grouped under three heads: first, the examination of animals quarantined by the local inspectors on suspicion of being diseased, and the appraisal and condemnation of those found by the agents to be tuberculous; second, the quarantining and testing of cattle intended for dairy or breeding purposes brought into Massachusetts from other States to the stock yards at Brighton, Watertown or Somerville, and those brought in on permits to other points; third, testing cattle with tuberculin for owners who are desirous of eradicating the disease from their herds.

The following figures show the number of neat cattle quarantined by local inspectors, the number for which warrants were issued, and the disposition made of the animals: —

Total number of cattle quarantined or reported for examination during the year,			2,595

Massachusetts Cattle.

Number released,	508		
Number condemned, killed and paid for,	1,119		
Number permit to kill, paid for,	115		
Number permit to kill, no award,	151		
Number died in quarantine, no award,	57		
Number condemned and killed, in process of settlement,	300		
Number in quarantine, unsettled,	5		
		2,255	

Cattle from without the State.

Number released,	8		
Number condemned and killed, no award,	314		
Number condemned, killed, no lesions found, paid for,	16		
Number condemned, killed, no lesions found, to be paid for,	2		
		340	
Total,			2,595

Of the above 340 interstate cattle, 233 were tested and retested at Brighton, 6 of which were released for slaughter and 227 condemned; no lesions were found in 10, for 8 of which the State has reimbursed the owners, and payment will be made for the remaining 2 upon presentation of claims by owners. Of the remaining 107 cattle (which were tested at other points than Brighton), 8 were found to show no lesions, for which the State has reimbursed the owners, and 2 were released on a third test.

In addition to the 2,595 head of cattle disposed of as above, 644 cattle and 267 swine have been reported by butchers, renderers and boards of health as having been found tuberculous at time of slaughter, all of which were rendered. Of this number, 431 cattle and 170 swine were slaughtered and condemned at the Brighton Abattoir.

Under the second group, the maintenance of a quarantine against other States to prevent the introduction of tuberculous cattle from outside sources into Massachusetts, the following figures show the number of animals brought in from without the State, and the disposition made of them: —

Receipts of Stock at the Watertown Stock Yards, from Dec. 1, 1909, to Nov. 30, 1910.

New Hampshire cattle,	4,687
Vermont cattle,	3,508
Massachusetts cattle,	2,048
Western cattle,	1,190
Sheep and lambs,	3,438
Swine,	3,477
Calves,	23,372

Receipts of Stock at the New England Dressed Meat and Wool Company's Yards at Somerville, from Dec. 1, 1909, to Nov. 30, 1910.

Maine cattle,	22
New Hampshire cattle,	519
Vermont cattle,	2,276
Massachusetts cattle,	7
Western cattle,	20,294
Canada cattle,	30,783
Sheep and lambs,	307,057
Swine,	1,008,800
Calves,	31,077

Receipts of Stock at Brighton, from Dec. 1, 1909, to Nov. 30, 1910.

Maine cattle,	7,816
New Hampshire cattle,	1,844
Vermont cattle,	2,077
Massachusetts cattle,	12,995
New York cattle,	2,322
Western cattle,	36,716
Canada cattle,	786
Sheep and lambs,	11,430
Calves,	73,105
Swine,	71,854
Cattle tested,	13,013
Cattle condemned,	171
Cattle killed on permit,	78
Cattle released after test,	12,764

The cattle upon which a tuberculin test is required are mostly milch cows to be offered for sale at the Brighton market Wednesdays, beside a few bulls and working oxen.

Those animals that come to Watertown or Somerville are taken to Brighton, and all of the testing is done at the stock barn there.

Report of Cattle brought into State during the Year to Points outside of the Quarantine Stations.

For dairy and breeding purposes, tested before shipment, .	1,020
For dairy and breeding purposes, tested after arrival, . .	5,354
For dairy and breeding purposes, awaiting test, . . .	4
Total, ...	6,378

Neat cattle on which no test was required, exclusive of cattle and calves for immediate slaughter, ...	909

The cattle and calves on which no test was required, exclusive of animals for immediate slaughter, were as follows: —

Returned from out-of-State pastures, ...	655
Calves under six months old, ...	163
Injured and killed, or died before tested, ...	9
Entered at auction sales, reshipped out of State, . . .	49
Kept in State for brief periods only, ...	33
Total, ...	909

The number of cattle and calves brought into the State for immediate slaughter cannot be given exactly. In round numbers there were 10,000 cattle and calves brought to the large abattoirs and other points outside the quarantine stations, intended for immediate slaughter.

Nearly all of the total number of animals given above were brought into the State on permits issued by the Chief of the Cattle Bureau, only 445 head having been brought in without permits, which were reported to the Bureau by railroad agents, local inspectors or others. Of these, 4 were tested before shipment, 8 were calves under six months old, 32 were slaughtered at once for beef, 1 was being returned from pasture, 27 were in the State temporarily, 23 of which remained only one day, and the remainder, 373 head, were tested by agents of the Cattle Bureau.

The following figures show the disposition of animals that were brought into the State to points outside the quarantine stations at Brighton, Watertown and Somerville, which failed to pass a satisfactory tuberculin test: —

Condemned on first test,	16
Condemned on second test,	83
Condemned on third test,	1
Died before a second test could be made,	2
Killed for beef without retest, on request of owner, subject to inspection,	7
Awaiting slaughter on first test, at request of owner,	2
Awaiting a second test,	5
Awaiting a third test after calving,	6
Total,	122

On the animals condemned as above, 4 warrants, with report of killing, have not yet been returned; 10 animals were found on post-mortem examination to be free from disease and have been paid for by the State; and 86 were found on post-mortem examination to be affected with tuberculosis. Of the 7 animals killed for beef on first test, 4 showed no lesions on post-mortem examination, 2 were diseased, and on 1 no report of result has been received.

There were 1,012 permits issued during the year, 157 of which were reported as not used.

Twenty-three permits were issued allowing cattle to be brought into the State for exhibition at agricultural fairs; 8 were issued for returning cattle from exhibition in other States; 9 were issued for pasturing herds in the State during the season; 2 allowing cattle to be unloaded in transit through the State; 2 allowing cattle to cross the line daily from pasture or farms in other States; and 3 allowing persons living near the line to drive cattle across the corner of the State, keeping the animals in the State for brief periods only.

For several years, at the request of the United States Department of Commerce and Labor, a report of the receipts of all live stock at the port of Boston has been sent to Washington each month. The report is made to show weekly receipts. The following table shows the totals, by months, for the past year: —

Receipts of Live Stock at Boston for Twelve Months ending Nov. 30, 1910.

For Month ending —	Cattle.	Calves.	Sheep and Lambs.	Swine.	Horses.
December 31,	17,453	7,932	27,141	117,710	1,935
January 31,	15,940	12,551	18,446	126,960	1,860
February 28,	12,106	10,742	14,151	103,397	1,510
March 31,	11,918	21,763	12,266	81,474	2,235
April 30,	8,378	18,430	14,518	65,753	2,047
May 31,	9,023	12,264	14,219	87,227	1,975
June 30,	9,459	12,197	22,623	143,752	2,520
July 31,	7,918	7,350	20,389	74,628	1,780
August 31,	7,624	6,334	41,111	67,021	1,679
September 30,	9,878	7,209	52,673	80,372	2,015
October 31,	8,064	5,450	39,837	66,951	1,670
November 30,	12,301	5,728	44,551	68,890	1,795
Totals,	130,062	127,950	321,925	1,081,135	23,021

The third division of the work consists in testing herds with tuberculin for owners who desire it, and is known as *voluntary request work*. The following figures show what has been done under this division: —

20 persons, in 12 different cities and towns, made voluntary requests to have their herds tested: —		
20 herds were tested, comprising		314 cattle.
Released,	219	
Killed on permit to kill, paid for,	75	
Killed on permit to kill, no award,	20	
	——	314 cattle.

In 2 of the animals killed no lesions were found on post-mortem examination.

After consultation with the authorities in charge of live-stock interests in the States of New York and Pennsylvania, the following order was issued on June 1: —

CATTLE BUREAU ORDER NO. 26.

COMMONWEALTH OF MASSACHUSETTS,
CATTLE BUREAU OF THE STATE BOARD OF AGRICULTURE,
BOSTON, June 1, 1910.

To Persons bringing Cattle into Massachusetts from the States of New York and Pennsylvania, and All Others whom it may concern: —

Section 5 of Cattle Bureau Order No. 15, as amended by Cattle Bureau Order No. 16, is hereby further amended so as to provide as follows: —

1. Certificates of tuberculin test on cattle to be shipped into Massachusetts from New York or Pennsylvania on permits obtained under the provisions of section 1 of Cattle Bureau Order No. 15, made by veterinarians in those States, will be accepted by the Chief of the Cattle Bureau provided: —

(*a*) That the test on cattle tested in New York State is approved by the Commissioner of Agriculture or the Acting Chief Veterinarian of the New York State Department of Agriculture, and the test is made with tuberculin furnished for the purpose by the New York State Department of Agriculture.

(*b*) That the test on cattle tested in Pennsylvania is approved by the Veterinarian or the Deputy-Veterinarian of the State Live Stock Sanitary Board, and the test is made with tuberculin furnished for the purpose by the State Live Stock Sanitary Board of Pennsylvania.

2. The Chief of the Cattle Bureau reserves the right to retest any cattle brought into this State under the provisions of section 1 of this order, if at any time a test is unsatisfactory to him.

3. This order does not apply to neat cattle shipped to the stock yards at Brighton, Watertown or Somerville.

4. This order shall be published by sending a copy to each inspector of animals in the Commonwealth, and by furnishing a copy to each shipper of cattle into the Commonwealth upon permits issued under the provisions of section 1 of Cattle Bureau Order No. 15.

This order shall take effect upon its approval.

AUSTIN PETERS,
Chief of Cattle Bureau.

Approved in Council, June 1, 1910.
E. F. HAMLIN,
Executive Secretary.

Owing to an apparent misunderstanding on the part of cattle owners as to what cattle might be termed "pasture cattle" within the meaning of the Cattle Bureau regulations, in July the following order was issued: —

CATTLE BUREAU ORDER NO. 27.

COMMONWEALTH OF MASSACHUSETTS,
CATTLE BUREAU OF THE STATE BOARD OF AGRICULTURE,
BOSTON, July 19, 1910.

To Persons bringing Cattle into Massachusetts, and All Others whom it may concern: —

Section 5 of Cattle Bureau Order No. 15, as amended by Cattle Bureau Orders Nos. 16 and 26, is hereby further amended by adding the following sentences: —

Cattle being returned to Massachusetts from without the State will not be looked upon as returning from out-of-State pastures unless they are returned to the farm of the person who originally sent them out of the State. Cattle sold to go out of the State and resold to return to other farms than those from which they were originally shipped, or cattle returning from without the State to premises other than those from which they were originally shipped, will not be looked upon as pasture cattle but will return subject to passing the tuberculin test.

This order shall be published by sending a copy to each inspector of animals in the Commonwealth, and by furnishing a copy to each shipper of cattle into the Commonwealth upon permits issued under the provisions of section 1 of Cattle Bureau Order No. 15.

This order shall take effect upon its approval.

AUSTIN PETERS,
Chief of Cattle Bureau.

Approved in Council, July 20, 1910.
E. F. HAMLIN,
Executive Secretary.

MISCELLANEOUS DISEASES.

The Cattle Bureau is called upon during the year to deal with other diseases of a contagious nature, in addition to rabies, glanders and bovine tuberculosis, and these diseases are usually classified under the title of "miscellaneous diseases." Among them are actinomycosis, hog cholera and allied troubles, symptomatic anthrax or blackleg, anthrax, Texas fever, and tuberculosis in other animals than cattle.

There have been very few cases of hog cholera, only 10 herds of swine having been quarantined for this disease. All but 2 of these herds have been released, as the disease has subsided and the premises have been disinfected. The remaining 2 herds are still under observation by this Bureau.

A suspected case of tuberculosis in a bay mare in Brockton was reported by the inspector of animals of that city. Some of the material taken from a tumor on the animal was sent to the bacteriologist of the Brockton Board of Health, who reported that the mare had tuberculosis. She was then tested with tuberculin and failed to give a reaction. It was then thought best to test her with mallein, to which she gave no reaction, and she was released from further observation by order of the Chief of the Cattle Bureau.

A number of cases of actinomycosis have been reported during the year, 12 in all. In two or three cases the disease affected the udder, and in such cases the animals were ordered killed at once, although in cases where cattle have recent lesions, involving the jaw, the owner is advised to feed liberally until in good flesh, and then kill for beef under the proper inspection.

In pastures where symptomatic anthrax or blackleg occurred the previous season the protective inoculation has been given to the young animals when the owners requested it. The material used for this preventive inoculation, as in the past season, has been furnished by the United States Bureau of Animal Industry, and sent to Dr. James B. Paige of the Amherst Agricultural College, who has prepared it for use in the treatment when required. One hundred and sixty-six young animals have been vaccinated in the towns of Ashburnham, Granville, Princeton, Rowe, Winchendon, New Marlborough, Townsend, Amherst, Florida, Greenwich and Prescott. Dr. Paige reports that he has heard from all but one of the owners of cattle inoculated during the year, and that not a single fatality has followed the vaccinations.

There have been a number of cases of mange in horses and cattle reported to this office, but as this is not a contagious disease under the law, the Chief of the Cattle Bureau has not felt entitled to spend much money in this direction, although the agents sent to examine these cases have given the owners professional advice in regard to the treatment of such animals.

The outbreak of anthrax in the western part of the State, which occurred in the fall of 1909, has been very nearly stamped out, only 11 animals having been reported as dying of this disease during the past year. At the request of owners, 21 cattle, 3 horses and 95 sheep were given the preventive inoculation. This treatment consists of two inoculations, the second one being given ten days after the first.

In the month of April the following order was issued in relation to this disease: —

CATTLE BUREAU ORDER NO. 24.

COMMONWEALTH OF MASSACHUSETTS,
CATTLE BUREAU OF THE STATE BOARD OF AGRICULTURE,
BOSTON, April 26, 1910.

To All Persons whom it may concern: —

By virtue of the power and authority vested by law in the Cattle Bureau of the State Board of Agriculture, under the provisions of chapter 90 of the Revised Laws and chapter 116 of the Acts of 1902, you are hereby notified that anthrax, which is a contagious disease and is so recognized under the laws of this Commonwealth, has occurred recently among domestic animals in the towns of Great Barrington and Sheffield. You are hereby further notified that in order to prevent the spread of this disease among domestic animals and to protect the public health in the localities where the disease exists, the Chief of the Cattle Bureau hereby issues the following order: —

1. The carcasses of any neat cattle, horses or other animals that may die of anthrax are not to be skinned or opened, but must be buried or cremated with the hides on. If they are buried they must be buried deeply, away from any water course, and the carcasses covered with quicklime. If any blood or excreta come from any animal in removing it to a place of burial such material must be scraped up and burned and the ground from which it was taken sprinkled with quicklime.

2. If any animals die of this disease in any stable the stable must be disinfected according to the rules and regulations of the Cattle Bureau.

3. No one is to make any autopsy upon or any incision into the carcass of any animal that has died of anthrax, unless he be an agent of the Cattle Bureau acting under the authority of the Chief of the Cattle Bureau at the time of making such autopsy or incision.

4. Any person owning an animal that he suspects of having anthrax, or losing an animal which he suspects may have died of anthrax, or any person hearing of the presence of this disease in any species of animal, is to immediately notify the local inspector of animals or the Chief of the Cattle Bureau or his agent.

This order is to be made public by inspectors of animals in the towns of Great Barrington, Sheffield, New Marlborough, Egremont, Alford, West Stockbridge, Stockbridge, Lee, Tyringham and Monterey posting three or more printed copies in public places in their respective towns, and by publication for two weeks in the "Berkshire Courier," a newspaper published weekly in the town of Great Barrington.

This order shall take effect upon its approval.

AUSTIN PETERS,
Chief of Cattle Bureau.

Approved in Council, April 27, 1910.
E. F. HAMLIN,
Executive Secretary.

FINANCIAL STATEMENT.

At the close of the last fiscal year, Nov. 30, 1909, there was on hand, as per the sixteenth semiannual report: —

Balance of appropriation for salaries and expenses for 1909,	$316 29	
Balance of appropriation for general work of the Bureau for 1909,	173 47	
		$489 76
Appropriation for salaries and expenses of 1910, chapter 38, Acts of 1910,	$7,000 00	
Appropriation for general work of the Bureau, chapter 165, Acts of 1910,	100,000 00	
		107,000 00
Total to be accounted for,		$107,489 76
Expended during the year: —		
For 754 head of cattle condemned and killed during the year 1909, paid for in 1910,	$16,087 50	
For 7 head of cattle condemned and killed prior to 1909, paid for in 1910,	145 00	
For 1,311 head of cattle condemned and killed during the year,	32,487 79	
For killing and burial, quarantine claims and arbitration expenses,	403 75	
		$49,124 04
For services of agents (exclusive of glanders work),	$16,577 35	
For expenses of agents (exclusive of glanders work),	5,898 91	

For expenses of quarantine stations, .	$8,056 25	
For expenses of glanders work, including services and expenses of agents, laboratory work and killing and burial, ...	8,641 87	
For laboratory expenses (exclusive of glanders work), ...	1,197 14	
For implements, ear tags, thermometers, etc., ...	625 82	
For salary of Chief of Bureau, . .	1,800 00	
For salary of clerk, ...	1,200 00	
For salaries of assistant clerks and stenographers, ...	1,655 00	
For office expenses, printing, postage, stationery, etc., ...	1,788 26	
For expenses of Chief of Bureau, . .	165 01	
		$47,605 61
Total expenditures, ...		$96,729 65
Balance from all accounts, Nov. 30, 1910, . . .		10,760 11
Total as above, ...		$107,489 76

This balance is made up from the following items: —

Balance of appropriation for salaries and expenses, 1909, ...	$306 41	
Balance of appropriation for salaries and expenses, 1910, ...	401 61	
Balance of appropriation for general work of the Bureau available for unsettled accounts of 1910, . . .	10,052 09	
		$10,760 11

The average price paid for condemned cattle for the year was $24.93.

There has been received during the year, from the sale of hides and carcasses of condemned animals, sale of ear tags, testing cattle for nonresident owners, etc., $4,620.41.

Claims for 302 head of cattle condemned and killed as tuberculous during the year remain unsettled, to be paid for on proof of claims, the appraised value of which amounts to $5,712.

Seventy-four stamps for branding carcasses of animals killed and inspected for food have been furnished to 50 cities and towns during the year ending Nov. 30, 1910.

To carry on the work of the Bureau in all parts of the State, the service of many agents, veterinarians and others, is obviously necessary. In assuming this office I determined to retain so far as possible the existing force of employees, believing that their experience and their knowledge of the territory in which they worked made them the best qualified to carry on the work successfully. Many requests for appointments were filed with me, and also many criticisms of existing methods and agents, but as my only purpose was to raise the standard of the work performed by the Bureau to the highest plane possible, I decided to judge the competency of agents myself, after a fair trial, and to make changes slowly, endeavoring always to retain those who proved most worthy. I am not wholly satisfied with the manner in which a considerable portion of the work is done, but we are, I believe, faced in the right direction, and time will see the problem worked out satisfactorily. In this small army of agents there are many whose work is highly creditable and characterized by earnest, honest endeavor. The good work done by this Bureau is largely due to the painstaking labor of these men.

As you are aware, I came into this position not as a professional appointee but as a practical handler of cattle and a dairyman. To the practical experience gained in many years of active association with the above-named interests, I shall add whatever may be gained (and I do not underestimate its value) by frequent consultation with the best scientific and veterinary authorities in the State and nation. I am pleased to report to your honorable Board that I have been assured of having at all times the professional advice of the best-known experts in matters pertaining to the professional phase of the animal industry. With such eminent professional assistance at the command of the Chief of the Bureau, and an earnest endeavor to conduct the work with all the care a successful private business demands, we may confidently look for progressive service in the State's behalf, and I trust ample justification will be found for the Bureau's establishment and continuance.

For several years it has been the custom to send official representatives of the Bureau to one or more annual gatherings of live-stock sanitary associations, interstate or national. The wisdom of this step needs no defence. In no other way can the local department impart its views on sanitary matters to its neighbors, or learn of methods adopted and practiced successfully elsewhere. Interchange of opinions and mutual acquaintance broaden all participants, widen their horizon and tend to a community of interest and protection. One such gathering has been attended by representatives of this Bureau during the year ending Nov. 30, 1910. At the meeting of the Eastern Live Stock Sanitary Association, held at Atlantic City, N. J., May 6 to 8, the Massachusetts Bureau was represented by my predecessor, Dr. Austin Peters, who was and is president of the organization. He was accompanied by Agent C. A. Dennen of Pepperell, and Dr. B. D. Pierce of Springfield.

In this connection, although it is of date outside the scope of this report, I wish to say that I had the honor to be commissioned by Acting Governor Frothingham to represent the State Cattle Bureau at the annual convention of the United States Live Stock Sanitary Association, held at Chicago, Ill., December 5 to 7, inclusive. The session was a most helpful one in many ways. I found a rapidly growing interest in the sanitary phase of the animal industry, and an earnest and honest desire to arrive at the best methods of handling the perplexities of the subject, and, what was most gratifying, a willingness to get together and to look beyond State lines. I was brought in contact with the heads of cattle departments of nearly every State west of New England, and with officials of the United States Bureau of Animal Industry. The representative from Massachusetts was received with great courtesy, and was elected first vice-president of the association.

CHANGES EFFECTED.

Sundry changes in regulations, which were found early in my administration to be imperatively necessary, but which could not be made effective until after the close of the fiscal and statistical year, Nov. 30, 1910, I have taken the liberty to insert in this report, feeling that your honorable Board is entitled to know the policy under which the department is now being conducted, and finding nothing in the statutes, after careful examination, which prohibits my so doing.

On December 21 the honorable Executive Council approved of certain amendments of Cattle Bureau Order No. 15, which I had submitted to it. The first change to which I desire to call your attention is in section 5, and is embodied in the following paragraph: —

> Certificates of tuberculin test made by qualified veterinarians residing in other States will be accepted, *provided* the test is made with tuberculin furnished or approved by State or federal government, and *provided also* that the certificates are *approved and endorsed* by the official in charge of live-stock interests in the State from which the cattle are shipped, or by his deputy. The Chief of the Cattle Bureau may in his discretion retest any or all tested cattle brought within the limits of the Commonwealth from other States.

In consultation with officials having charge of live-stock interests in all the near-by States, I found them willing to examine and pass upon all certificates of tuberculin test made by qualified veterinarians in their respective States, thus safeguarding the interests of this State and saving the shipper from possible loss. The old policy of the Bureau was to test cattle coming into the State after their arrival here. This practice resulted in loss to the shipper and necessarily advanced the price to Massachusetts buyers, for shippers, in establishing sales prices, naturally took into consideration the liability of losing one or more head from each carload. The reciprocal relations established by this amendment will, I am sure, work to the advantage of all concerned, and will not imperil our interests. The closing restriction it is believed protects all our rights, and is a deterrent in case any irregularities escape the vigilance of the authorities.

Another change in the same section provides as follows: —

> Cattle returning from out-of-State pastures or boarding places, satisfactory as to sanitary conditions to the Chief of the Cattle Bureau, will not be subjected to a tuberculin test if they have not been out of the State over six months, *provided* they bear ear tags furnished for this purpose by the Massachusetts Cattle Bureau the numbers of which have been forwarded to the office of the Bureau prior to the cattle being sent out of the State.

Under the old order abuses crept in and the department was unable to correct them. A herd returning from out-of-State pastures might or might not be the same cattle that left the State; it might be double or treble its original size; it might contain any number of cattle which had never been subjected to inspection by this Bureau. All of these things were possible because of the lack of means of identification. As amended, the regulation insists upon the use of the numbered ear tag, with office record of the same, before the herd leaves the State, and upon its return subjects all cattle not bearing the official tag to the tuberculin test.

Acting under the authority granted by chapter 90 of the Revised Laws, I have ordered the annual inspection of neat stock, other farm animals and premises, required by law, to be made between February 1 and March 15, instead of in the fall months, as has been the custom. This change I believe to be along a practical line. At the time of the fall inspection the cattle are in many cases scattered in pastures, and thus liable to escape that careful examination which the law contemplates. Then, again, at that season of the year their physical condition is at its best, rendering the discovery of disease more difficult. The change of date will allow the inspectors to more completely cover the ground, will show the cattle in their normal condition, and, what is very important, will give the inspector a clear understanding of the conditions under which they are housed.

RECOMMENDATIONS.

Right here I wish to say that this Bureau should have more extended authority over sanitary conditions of stables and other farm buildings. Nothing so directly affects the health of animals as the conditions under which they are housed. We may enter the stables and inspect the cattle; we may condemn the infected members of the herd, and order their removal. On the other hand, the barn may be reeking with filth, poorly lighted and ventilated, a hotbed of disease germs; yet into such dangerous surroundings, after we have taken out the diseased cattle, the owner may bring healthy cattle which in turn may become infected from these impure and unhealthy conditions. We should be clothed with power to open such barns to the air and sunlight and to cleanse them in a suitable manner, if our cattle work is to be crowned with success.

The State Board of Health has among its multifarious duties the supervision of buildings in which dairy cattle are kept, but its agents apparently do not see the conditions quite as we see them, nor do they have our opportunity to advise the needed reform at a time when such advice is most likely to be effective. A vesting of such authority in the Cattle Bureau would be in the interest of intelligent classification of work.

Another matter to which I desire to call your attention is one in which authority is divided between the State Board of Health and the Cattle Bureau. Under the law the Cattle Bureau furnishes stamps or brands to local boards of health applying therefor, to be used by meat inspectors in their respective localities. It also issues rules and regulations conforming to those of the United States Bureau of Animal Industry, under which the meat inspectors must work. But these inspectors are not appointed by this Bureau, nor is their appointment subject to its approval, and, still further, this Bureau cannot hold them responsible for any failure to perform their duties. They are responsible to the local boards of health, over which the State Board of Health has advisory power. Here seems to be an unnecessary tangle of authority that needs unraveling. It would seem that the State Board of Health might very properly furnish these stamps and formulate the regulations under which the appointees of the local boards of health carry on their work.

The office of local inspector of animals is of greater importance than is commonly recognized. The authorities of cities and towns, who have the appointing power, should exercise the greatest care in selecting these officials, and in my opinion this Bureau should have increased authority over these appointees, in order that they may work in harmony with the policy of the department. The present Chief would welcome an opportunity to consult with the local authorities on this subject, believing that their purpose, like his own, is to secure the most efficient men available. The State expects and should have in these local appointees men of practical efficiency, who, having been tried and found not wanting, should be retained in spite of political changes.

Conclusion.

The work of the Bureau has been largely directed toward the suppression of tuberculosis. I am of the opinion, and my opinion was formed long before I became associated with the department, and has been strengthened since, that it cannot be stamped out by any purely theoretical regulations. It can be largely suppressed, however, and all agencies leading to that end must be recognized and tactfully employed. Success will only be attained when there is, in addition to long-continued and persistent official effort of a practical nature, co-operation upon the part of the individual cattle owner. There is too often distrust of officials when there should be confidence. The agent of a department is looked upon as an enemy, a ruthless destroyer of property and a foe to be dreaded and avoided. A policy must be adopted that will restore confidence and afford equal protection, without excessive burdens, to the humblest cattle owner and the millionaire farmer alike. It shall be the aim of the present administration to work for such results. The State should seek to encourage the weaker class of dairymen, honest minded and well intentioned, and assist them in every legitimate way to establish herds that shall be a credit to the State and a source of profit to their owners. Once established on a healthy, profitable basis they would become a permanent source of supply to near-by consumers, who would thus secure a fresh, healthful product at a reasonable cost. The appalling decrease in the number of cattle owned in our State is sufficient proof of the need of such a policy.

The Massachusetts Cattle Bureau was not established for the purpose of persecution, nor can it work out the problems before it by a policy that relies upon prosecution. Its aim and intent is to restrain and correct abuses if they exist, and at the same time stimulate and encourage the cattle industry of the State and protect the health of its citizens. The present administration is willing and eager to give to all parties interested helpful and encouraging counsel. We want every farmer and stock owner in the State to feel free to consult the Bureau. In no better way can misunderstandings be cleared up and difficulties solved. To attain this ideal we must first have honest and faithful agents of the State, who will deal fairly with the people, and then we must have the co-operation and confidence of the cattle-owning public, which will only come when the true policy and aims of the Bureau are more fully understood. I am sure that with rational interpretation of the law, and a better knowledge of the benefits sought, the Cattle Bureau may become one of the most prized departments of the State, and that the producer and the consumer will eventually recognize in it an institution conducted for the welfare and protection of each.

Respectfully submitted,

FRED FREELAND WALKER,

Chief of Cattle Bureau.

FINANCIAL RETURNS

AND

ANALYSIS OF PREMIUMS AND GRATUITIES

OF THE

INCORPORATED SOCIETIES,

WITH

MEMBERSHIP AND INSTITUTES,

FOR THE YEAR 1910.

FINANCIAL RETURNS OF THE INCORPORATED

	SOCIETIES.	When incorporated.	Amount originally raised by Contribution. (R. L. 124, Sects. 1 and 3.)	Amount now held invested as Capital Stock. (R. L. 124, Sects. 3 and 12.)	Estimated Market Value of Property.	Total Assets.
1	Amesbury and Salisbury (Agricultural and Horticultural), . . .	1881	$1,002 32	[1] $8,121 97	$8,121 97	$8,121 98
2	Barnstable County, ...	1844	1,740 00	[2] 9,917 96	9,917 96	10,319 44
3	Blackstone Valley, ...	1884	3,000 00	[3] 5,000 00	5,000 00	5,501 04
4	Deerfield Valley, ...	1871	4,094 01	[3] 9,200 00	9,450 00	9,559 41
5	Eastern Hampden, ...	1856	3,000 00	[3] 7,000 00	7,000 00	7,076 14
6	Essex, ...	1818	4,527 20	[4] 16,150 16	15,860 00	16,150 16
7	Franklin County, ...	1850	3,768 00	[4] 11,295 10	11,295 10	11,295,10
8	Hampshire, ...	1850	3,255 26	[5] 5,065 00	5,050 00	5,065 00
9	Hampshire, Franklin and Hampden,	1818	8,141 29	[1] 21,135 00	21,166 27	21,446 27
10	Highland, ...	1859	3,262 00	[1] 3,120 00	3,120 00	3,120 12
11	Hillside, ...	1883	3,113 32	[6] 6,070 22	6,070 22	6,170 76
12	Hingham (Agricultural and Horticultural), ...	1867	17,406 15	[6] 4,676 31	4,676 31	4,720 88
13	Hoosac Valley, ...	1860	2,006 00	[7] 15,595 00	15,000 00	15,595 00
14	Housatonic, ...	1848	6,335 33	[4] 27,054 04	27,054 04	27,104 04
15	Lenox Horticultural, ...	1910	1,000 00	[8] 2,451 63	2,451 63	2,451 63
16	Marshfield (Agricultural and Horticultural), ...	1867	3,755 33	[1] 13,000 00	13,000 00	15,007 64
17	Martha's Vineyard, ...	1859	4,552 17	[9] 5,050 00	5,050 00	5,110 22
18	Massachusetts Horticultural, . . .	1829	525 00	[11] 564,524 70	830,172 06	848,433 72
19	Massachusetts Society for Promoting Agriculture,[12]	1792	-	-	-	-
20	Middlesex North, ...	1855	3,000 00	[13] 7,131 94	7,131 94	7,131 94
21	Middlesex South, ...	1854	3,000 00	[3] 12,000 00	12,200 00	12,350 20
22	Nantucket, ...	1856	3,500 00	[3] 3,200 00	3,200 00	3,230 43
23	Oxford, ...	1888	4,400 00	[8] 11,577 68	11,577 68	11,577 68
24	Plymouth County, ...	1819	9,550 00	[14] 2,037 19	2,037 19	2,037 19
25	Spencer (Farmers' and Mechanics' Association), ...	1888	4,034 00	[1] 10,350 00	10,350 00	10,543 89
26	Union (Agricultural and Horticultural), ...	1867	4,447 23	[1] 9,000 00	9,475 68	9,475 68
27	Weymouth (Agricultural and Industrial), ...	1891	10,270 00	[1] 11,270 00	11,270 00	11,304 51
28	Worcester, ...	1818	7,730 00	[2] 89,940 00	91,878 46	91,878 46
29	Worcester East, ...	1890	2,296 23	[6] 12,654 11	11,991 30	12,654 11
30	Worcester Northwest (Agricultural and Mechanical), ...	1867	3,400 00	[6] 13,361 61	13,361 61	13,361 61
31	Worcester South, ...	1855	3,127 40	[1] 14,130 00	14,130 00	14,478 88
32	Worcester County West, ...	1851	3,175 00	[1] 10,500 00	10,500 00	10,598 73
			$151,413 24	$941,679 62	$1,208,659 42	$1,232,871 86

[1] Invested in real estate, crockery, tables, etc.
[2] Invested in real estate and bank funds.
[3] Invested in real estate.
[4] Invested in real estate, stocks, bank funds, crockery, tables, etc.
[5] Invested in real estate, cash, crockery, tables, etc.
[6] Invested in real estate, bank funds, crockery, tables, etc.
[7] Invested in real estate and cash.

Societies for the Year ending Dec. 31, 1910.

Real Estate.	Notes.	Stocks and Bonds.	Bank Funds.	Bills due and unpaid.	Crockery, Tables, etc.	Cash on Hand.	Total Liabilities.	
$7,716 69	-	-	-	-	$405 28	$0 01	$1,500 00	1
8,000 00	-	-	$1,917 96	-	-	401 48	1,704 40	2
5,000 00	-	-	-	-	-	501 64	1,540 00	3
9,200 00	-	-	-	-	250 00	109 41	-	4
7,000 00	-	-	-	-	-	76 14	7,173 51	5
15,300 00	-	$360 00	-	-	200 00	290 16	10,000 00	6
10,000 00	-	1,000 00	45 10	-	250 00	-	2,838 00	7
5,000 00	-	-	-	-	50 00	15 00	2,275 08	8
20,335 00	-	-	231 27	$80 00	800 00	-	4,156 69	9
3,000 00	-	-	-	-	120 00	12	52 96	10
5,000 00	-	-	820 22	-	350 00	54	-	11
2,500 00	-	-	1,276 31	-	909 00	44 57	-	12
15,000 00	-	-	-	-	-	595 00	9,000 00	13
24,849 37	-	500 00	-	50 00	425 00	1,279 67	2,050 00	14
-	-	-	2,101 63	-	350 00	-	-	15
12,500 00	-	-	-	-	500 00	2,007 64	1,627 94	16
2,750 00	$100 00	-	2,000 00	49 00	200 00	11 22	[10] 27 00	17
518,564 63	-	255,700 00	-	-	55,907 43	18,261 66	-	18
-	-	-	-	-	-	-	-	19
-	4,412 00	-	2,639 89	-	-	80 05	-	20
12,000 00	-	-	-	38 00	200 00	112 20	10,048 00	21
3,200 00	-	-	-	-	-	30 43	-	22
11,000 00	-	-	77 68	-	500 00	-	2,150 00	23
-	-	-	1,988 51	-	39 00	9 68	-	24
9,400 00	-	-	-	132 00	950 00	61 89	1,943 00	25
8,000 00	-	-	475 68	-	1,000 00	-	1,504 91	26
11,000 00	-	-	-	-	270 00	34 51	4,602 00	27
74,530 22	-	-	15,409 88	-	1,938 36	-	-	28
11,534 00	-	-	662 81	-	457 30	-	-	29
13,000 00	-	-	61 61	-	300 00	-	3,050 00	30
13,530 00	-	-	-	-	600 00	348 88	1,584 20	31
10,000 00	-	-	-	-	500 00	98 73	637 50	32
$848,909 91	$4,512 00	$257,560 00	$29,708 55	$349 00	$67,462 37	$24,370 03	$69,465 19	

[8] Invested in bank funds, crockery, tables, etc.
[9] Invested in real estate, notes, crockery, tables, etc.
[10] Estimated.
[11] Invested in real estate, library, furniture, bonds and other securities.
[12] Represented on the Board by special enactment, and makes no returns.
[13] Invested in notes, banks fund and cash.
[14] Invested in bank funds, cash, crockery, tables, etc.

Financial Returns of the Incorporated Societies

	SOCIETIES.	Premiums due and unpaid.	Outstanding Bills.	Mortgages or Like Liabilities.	Total Receipts.	Bounty.	Income from Notes and Bank Funds.
1	Amesbury and Salisbury (Agricultural and Horticultural),	-	-	$1,500 00	$2,751 16	$600 00	-
2	Barnstable County,	$179 40	$125 00	1,400 00	9,513 18	600 00	$231 96
3	Blackstone Valley,	-	-	1,540 00	2,894 17	600 00	-
4	Deerfield Valley,	-	-	-	2,526 46	600 00	-
5	Eastern Hampden,	-	1,413 51	5,760 00	5,322 21	600 00	-
6	Essex,	-	-	10,000 00	3,420 82	600 00	1 11
7	Franklin County,	-	38 00	2,800 00	7,738 60	600 00	-
8	Hampshire,	3 50	21 58	2,250 00	2,785 14	600 00	-
9	Hampshire, Franklin and Hampden,	-	556 69	3,600 00	14,062 46	600 00	15 70
10	Highland,	-	52 96	-	2,111 27	600 00	-
11	Hillside,	-	-	-	1,520 06	600 00	16 70
12	Hingham (Agricultural and Horticultural),	-	-	-	876 07	600 00	49 52
13	Hoosac Valley,	-	-	9,000 00	6,289 00	600 00	-
14	Housatonic,	-	50 00	2,000 00	14,391 83	600 00	-
15	Lenox Horticultural,	-	-	-	393 00	-	-
16	Marshfield (Agricultural and Horticultural),	21 85	-	1,606 09	7,900 60	600 00	-
17	Martha's Vineyard,	-	[2] 27 00	-	1,222 27	600 00	84 50
18	Massachusetts Horticultural,	-	-	-	29,160 08	600 00	-
19	Massachusetts Society for Promoting Agriculture,[3]	-	-	-	-	-	-
20	Middlesex North,	-	-	-	960 27	600 00	360 27
21	Middlesex South,	-	398 00	9,650 00	3,328 40	600 00	-
22	Nantucket,	-	-	-	1,563 86	600 00	-
23	Oxford,	-	-	2,150 00	5,720 55	600 00	-
24	Plymouth County,	-	-	-	600 46	354 80	28 00
25	Spencer (Farmers' and Mechanics' Association),	-	143 00	1,800 00	2,659 64	600 00	-
26	Union (Agricultural and Horticultural),	-	204 91	1,300 00	2,725 01	600 00	-
27	Weymouth (Agricultural and Industrial),	-	502 00	4,100 00	3,946 50	600 00	-
28	Worcester,	-	-	-	32,024 31	600 00	599 71
29	Worcester East,	-	-	-	11,180 99	600 00	-
30	Worcester Northwest (Agricultural and Mechanical),	-	-	3,050 00	7,977 55	600 00	-
31	Worcester South,	107 45	76 75	1,400 00	10,176 54	600 00	-
32	Worcester County West,	37 50	-	600 00	3,817 48	600 00	-
		$349 70	$3,609 40	$65,506 09	$201,559 94	$17,754 80	$1,387 47

[1] Including trotting.

[2] Estimated.

FOR THE YEAR ENDING DEC. 31, 1910 — *Concluded.*

Income from Stocks and Bonds.	Received from New Members.	Received as Donations.	Received from All Other Sources.	Total Expenditures.	Premiums and Gratuities paid.	Current Running Expenses.	Interest.	All Other Expenses.	
-	$9 00	-	$2,142 16	$2,826 94	$759 95	$1,941 24	$75 00	$50 75	1
-	45 00	$205 00	8,431 22	9,111 70	1,072 65	6,124 05	2 34	1,912 66	2
-	30 15	51 71	2,212 31	3,393 13	744 49	1,253 37	65 00	330 27	3
-	32 00	13 74	1,880 72	2,254 36	794 11	850 15	-	596 36	4
-	58 00	-	4,664 21	5,246 07	897 41	4,088 61	260 05	-	5
$360 00	21 00	353 00	2,085 71	3,529 51	426 75	608 02	483 25	2,011 49	6
40 00	1 00	-	7,097 60	7,743 04	[1] 2,649 05	3,956 54	203 51	933 94	7
-	32 50	57 48	2,773 14	2,773 14	750 50	388 29	114 40	1,519 95	8
-	70 00	55 00	13,321 76	13,791 98	3,990 55	3,860 30	138 44	5,802 69	9
-	46 00	-	1,465 27	2,111 15	670 55	1,436 30	4 30	-	10
-	80 00	17 00	806 36	1,590 08	917 50	672 58	-	-	11
-	55 00	16 30	155 25	1,030 79	661 60	369 19	-	-	12
-	10 00	-	5,679 00	5,694 00	2,409 00	1,575 00	450 60	1,260 00	13
59 58	406 00	-	13,326 25	13,112 16	5,742 00	5,468 24	111 66	1,790 26	14
62 00	61 00	270 00	-	1,067 66	528 50	266 45	-	272 71	15
-	95 00	137 50	7,068 10	6,665 58	2,226 75	4,336 61	102 22	-	16
-	-	1 00	536 77	1,226 11	690 23	339 63	-	196 25	17
11,235 00	760 00	7,936 92	8,628 16	18,682 39	[4] 4,564 00	-	-	14,118 39	18
-	-	-	-	-	-	-	-	-	19
-	-	-	-	591 40	316 40	125 00	-	[2] 150 00	20
-	17 05	115 26	2,596 09	3,216 20	1,429 33	1,158 34	39 00	589 53	21
-	19 00	70 15	874 71	1,533 43	680 75	852 68	-	-	22
-	41 00	39 00	5,040 55	5,720 55	1,079 04	2,104 67	98 50	2,438 34	23
-	-	45 00	172 66	436 78	366 50	70 28	-	-	24
-	5 00	-	2,054 64	2,597 75	1,094 47	1,116 53	35 00	351 75	25
-	43 00	5 25	2,076 76	2,249 33	1,166 76	906 18	-	175 75	26
-	10 00	28 35	3,308 15	3,928 53	583 84	2,871 67	218 75	254 27	27
-	140 00	504 50	30,180 10	33,667 42	7,551 40	-	-	26,116 02	28
-	59 00	2,050 00	8,471 99	10,460 88	2,815 05	7,645 83	-	-	29
-	-	555 00	6,822 55	8,722 83	1,688 75	6,338 26	183 00	512 82	30
-	71 00	-	9,505 54	9,529 94	2,492 40	3,968 63	20 00	3,048 91	31
-	15 00	125 00	3,077 48	3,893 45	1,754 51	1,352 45	48 50	737 99	32
$11,756 58	$2,231 70	$12,652 16	$155,777 23	$187,398 28	$53,514 79	$66,045 73	$2,652 92	$65,171 10	

[3] Represented on the Board by special enactment, and makes no returns.

[4] Awarded in 1909; paid in 1910.

ANALYSIS OF PREMIUMS AND GRATUITIES, MEMBERSHIP AND

	SOCIETIES.	Total Amount offered in Premiums.	Total Amount awarded in Premiums and Gratuities.	Total Amount paid in Premiums and Gratuities.	Amount offered under Head of Farms, etc.	Amount awarded under Head of Farms, etc.	Amount paid under Head of Farms, etc.	Amount offered under Head of Farm and Pet Stock.
1	Amesbury and Salisbury (Agricultural and Horticultural)	$769 35	$769 35	$759 95	-	-	-	[1] -
2	Barnstable County,	2,484 85	1,253 05	1,072 65	$120 00	-	-	$1,164 00
3	Blackstone Valley,	1,081 15	822 60	744 49	145 00	$58 00	$58 00	703 50
4	Deerfield Valley,	1,176 25	806 85	794 11	-	-	-	900 00
5	Eastern Hampden,	1,339 00	897 76	897 41	98 00	-	-	798 00
6	Essex,	1,588 30	480 25	426 75	48 00	14 00	12 00	742 00
7	Franklin County,	[2] 4,250 00	[2] 2,790 71	[2] 2,619 05	-	-	-	2,500 00
8	Hampshire,	1,721 75	750 00	750 50	-	-	-	1,158 00
9	Hampshire, Franklin and Hampden,	[2] 4,040 55	[2] 3,990 55	[2] 3,990 55	50 00	-	-	1,605 00
10	Highland,	[2] 731 00	[2] 670 55	[2] 670 55	-	-	-	414 50
11	Hillside,	958 00	917 50	917 50	10 00	6 00	6 00	675 00
12	Hingham (Agricultural and Horticultural),	1,375 80	661 60	661 60	71 75	-	-	-
13	Hoosac Valley,	[2] 2,814 75	[2] 2,409 00	[2] 2,409 00	-	-	-	925 00
14	Housatonic,	[2] 6,809 75	[2] 5,742 00	5,742 00	-	-	-	2,038 00
15	Lenox,	661 50	528 50	528 50	50 00	-	-	-
16	Marshfield (Agricultural and Horticultural),	[2] 2,669 00	[2] 2,234 40	2,226 75	100 00	-	-	505 00
17	Martha's Vineyard,	664 25	701 55	690 23	-	-	-	392 75
18	Massachusetts Horticultural,	9,231 00	5,589 00	[3] 4,564 00	369 00	231 00	[3] 231 00	-
19	Massachusetts Society for Promoting Agriculture,[4]	-	-	-	-	-	-	-
20	Middlesex North,	566 50	373 15	316 40	-	-	-	208 75
21	Middlesex South,	[2] 1,800 00	[2] 1,339 25	[2] 1,429 33	104 70	36 75	36 75	309 45
22	Nantucket,	[2] 1,200 00	[2] 680 75	[2] 680 75	51 00	15 00	15 00	604 00
23	Oxford,	1,498 00	1,123 55	1,079 04	78 00	39 00	36 88	1,066 00
24	Plymouth County,	359 25	366 50	366 50	-	10 00	10 00	[1] -
25	Spencer (Farmers' and Mechanics' Association),	[2] 1,700 00	[2] 1,161 00	[2] 1,094 47	-	-	-	815 00
26	Union (Agricultural and Horticultural),	[2] 1,552 00	[2] 1,180 63	[2] 1,166 76	-	-	-	804 00
27	Weymouth (Agricultural and Industrial),	1,155 65	683 84	583 84	-	-	-	679 00
28	Worcester,	[2] 9,553 41	[2] 7,551 40	[2] 7,551 40	-	-	-	5,711 25
29	Worcester East,	3,200 00	2,815 05	2,815 05	32 00	32 00	32 00	2,001 50
30	Worcester Northwest (Agricultural and Mechanical),	1,800 00	1,694 75	1,688 75	-	-	-	[1] -
31	Worcester South,	[2] 3,176 00	[2] 2,540 30	[2] 2,492 40	102 00	64 00	64 00	1,148 00
32	Worcester County West,	[2] 2,181 90	[2] 1,754 51	[2] 1,754 51	60 00	29 00	29 00	1,163 50
		$74,108 96	$55,283 90	$53,514 79	$1,489 45	$534 75	$530 63	$29,031 20

[1] Not reported. [2] Including trotting.

INSTITUTES, FOR THE YEAR ENDING DEC. 31, 1910.

Amount awarded under Head of Farm and Pet Stock.	Amount paid under Head of Farm and Pet Stock.	Amount offered under Head of Field and Garden Crops.	Amount awarded under Head of Field and Garden Crops.	Amount paid under Head of Field and Garden Crops.	Amount offered under Head of Farm and Garden Products.	Amount awarded under Head of Farm and Garden Products.	Amount paid under Head of Farm and Garden Products.	Amount offered under Head of Dairy Products.	Amount awarded under Head of Dairy Products.	
$365 50	$365 50	–	–	–	[1] –	$264 40	$258 90	[1] –	$3 25	1
431 25	334 00	$164 00	–	–	$557 75	363 35	305 85	$10 00	5 00	2
524 50	511 50	–	–	–	115 40	113 90	113 90	10 00	5 00	3
584 00	570 63	–	–	–	78 50	71 75	71 75	12 00	11 00	4
601 50	601 50	–	–	–	254 75	173 25	173 25	63 00	23 00	5
223 25	149 25	197 50	$6 00	$6 00	382 00	136 00	119 25	14 00	4 00	6
1,316 00	1,316 00	–	–	–	500 00	252 10	252 10	21 00	12 00	7
309 25	309 25	–	–	–	250 00	112 25	108 75	6 00	2 00	8
1,179 50	1,105 75	95 00	–	–	241 00	208 25	193 75	40 00	11 00	9
428 25	428 25	17 75	13 75	13 75	70 75	57 45	57 45	4 50	4 50	10
662 45	662 45	45 00	44 50	44 50	77 00	70 50	70 50	4 00	3 00	11
–	–	173 00	84 00	84 00	776 80	371 10	371 10	3 50	2 00	12
264 50	264 50	–	–	–	80 75	55 50	55 50	24 00	6 00	13
1,196 75	1,196 75	276 00	271 00	271 00	391 50	336 00	336 00	38 00	38 00	14
–	–	–	–	–	611 50	528 50	528 50	–	–	15
319 35	319 35	90 50	7 50	2 50	246 00	199 55	193 35	17 50	11 00	16
309 75	309 75	–	–	–	68 25	104 50	104 50	10 00	7 00	17
–	–	–	–	–	8,862 00	5,358 00	[3] 4,333 00	–	–	18
–	–	–	–	–	–	–	–	–	–	19
139 25	103 75	–	–	–	264 75	174 25	159 00	–	–	20
287 60	287 60	67 30	17 85	17 85	22 00	6 50	6 50	–	–	21
349 75	349 75	134 00	–	–	163 00	71 50	71 50	16 00	–	22
802 50	785 26	65 50	62 90	62 22	179 50	109 90	105 04	9 00	9 00	23
90 00	90 00	–	–	–	–	116 50	116 50	–	–	24
386 50	356 50	51 25	25 75	19 25	106 00	86 00	72 00	10 00	10 00	25
462 00	457 50	–	–	–	69 60	57 50	50 75	13 25	5 75	26
325 74	323 49	46 00	–	–	210 00	101 25	96 25	5 50	50	27
3,747 50	3,747 50	–	–	–	497 00	443 00	443 00	22 00	16 00	28
1,650 25	1,650 25	–	–	–	[1] –	871 25	871 25	21 00	8 00	29
1,045 75	1,044 75	–	–	–	[1] –	469 75	469 75	30 00	12 00	30
768 50	732 50	–	–	–	226 00	138 20	131 95	18 00	15 00	31
836 95	836 95	–	–	–	150 50	140 75	140 75	15 00	12 00	32
$19,608 09	$19,210 23	$1,422 80	$533 25	$521 07	$15,452 30	$11,562 70	$10,381 14	$437 25	$236 00	

[3] Awarded in 1909; paid in 1910.

[4] Represented on the Board by special enactment, and makes no returns.

ANALYSIS OF PREMIUMS AND GRATUITIES, MEMBERSHIP AND

	SOCIETIES.	Amount paid under Head of Dairy Products.	Amount offered under Head of Domestic Manufactures.	Amount awarded under Head of Domestic Manufactures.	Amount paid under Head of Domestic Manufactures.	Amount offered under Head of Miscellaneous.	Amount Awarded under Head of Miscellaneous.	Amount paid under Head of Miscellaneous.
1	Amesbury and Salisbury (Agricultural and Horticultural),	$3 25	[1] -	$91 00	$91 00	[1] -	$45 20	$43 80
2	Barnstable County,	5 00	$289 50	305 46	286 90	$179 00	147 99	141 90
3	Blackstone Valley,	5 00	107 25	78 95	78 95	[1] -	42 25	34 25
4	Deerfield Valley,	11 00	104 50	96 30	95 93	[1] -	44 80	44 80
5	Eastern Hampden,	23 00	63 25	61 65	61 30	62 00	38 26	38 26
6	Essex,	4 00	76 50	8 00	5 50	128 00	89 00	88 00
7	Franklin County,	12 00	200 00	82 10	82 10	12 00	6 00	6 00
8	Hampshire,	2 00	68 75	55 00	55 00	239 00	239 00	239 00
9	Hampshire, Franklin and Hampden,	11 00	84 50	49 75	39 00	66 50	44 00	40 25
10	Highland,	4 50	92 35	89 15	89 15	[1] -	12 45	12 45
11	Hillside,	3 00	91 00	81 40	81 40	56 00	50 15	50 15
12	Hingham (Agricultural and Horticultural),	2 00	174 75	148 75	148 75	176 00	55 75	55 75
13	Hoosac Valley,	6 00	230 00	124 30	124 30	76 00	51 00	51 00
14	Housatonic,	38 00	712 75	538 50	538 50	154 00	154 00	-
15	Lenox,	-	-	-	-	-	-	-
16	Marshfield (Agricultural and Horticultural),	11 00	145 00	140 35	139 05	65 00	56 65	56 15
17	Martha's Vineyard,	7 00	68 75	102 00	102 00	[1] -	134 25	134 25
18	Massachusetts Horticultural,	-	-	-	-	-	-	-
19	Massachusetts Society for Promoting Agriculture,[4]	-	-	-	-	-	-	-
20	Middlesex North,	-	80 00	46 50	40 50	14 00	13 15	13 15
21	Middlesex South,	-	84 00	49 90	49 90	60 00	40 75	40 75
22	Nantucket,	-	60 00	75 00	75 00	86 00	40 50	40 50
23	Oxford,	9 00	100 00	100 25	100 25	-	-	-
24	Plymouth County,	-	[1] -	142 75	142 75	-	-	-
25	Spencer (Farmers' and Mechanics' Association),	10 00	52 00	26 00	19 50	[1] -	26 75	19 25
26	Union (Agricultural and Horticultural),	5 75	126 70	105 50	103 00	146 45	157 76	157 76
27	Weymouth (Agricultural and Industrial),	50	165 15	118 65	114 35	50 00	37 70	36 70
28	Worcester,	16 00	121 20	97 50	97 50	131 96	96 50	96 50
29	Worcester East,	8 00	343 05	183 05	183 05	196 50	64 50	64 50
30	Worcester Northwest (Agricultural and Mechanical),	12 00	[1] -	76 00	71 75	[1] -	12 00	12 00
31	Worcester South,	15 00	83 75	74 40	72 15	148 00	130 25	126 85
32	Worcester County West,	12 00	69 05	60 60	60 60	[1] -	21 85	21 85
		$236 00	$3,793 75	$3,208 76	$3,149 13	$2,046 41	$1,852 58	$1,665 82

[1] Not reported. [2] And gratuities. [3] Estimated.

INSTITUTES FOR THE YEAR ENDING DEC. 31, 1910 — *Concluded.*

Amount paid for Trotting.	Number of Persons receiving Premiums.	Number of Persons receiving Gratuities.	Number of Cities and Towns where Premiums were paid.	Amount paid to parties outside the State.	Number of Male Members.	Number of Female Members.	Total Membership.	Number of Institute Sessions held.	Average Number attending Institutes.	
–	[2] 290	–	14	$77 35	202	38	240	6	50	1
$1,360 00	163	214	15	–	218	172	390	3	53	2
–	125	26	14	3 00	301	291	592	3	92	3
540 00	225	–	21	–	946	260	1,206	7	141	4
1,050 00	[2] 130	–	32	195 00	265	175	440	5	113	5
–	60	28	18	–	891	22	913	8	70	6
1,022 50	[1] –	[1] –	23	–	[3] 1,400	[3] 100	[3] 1,500	5	142	7
650 00	164	4	15	–	[1] –	[1] –	609	3	166	8
1,305 00	[2] 250	–	29	–	640	254	894	4	76	9
65 00	161	–	22	–	240	119	359	3	34	10
65 00	275	–	18	–	903	48	951	6	93	11
–	71	168	7	1 25	343	138	481	3	39	12
1,360 00	129	–	9	50 75	376	15	391	2	88	13
3,200 00	470	–	28	161 00	1,721	67	1,788	3	82	14
–	28	–	3	–	113	18	131	–	–	15
1,500 00	96	224	21	–	530	299	829	6	60	16
83 00	[2] 200	–	6	–	90	74	164	3	33	17
–	107	52	72	2,820 50	710	130	840	9	142	18
–	–	–	–	–	–	–	–	–	–	19
–	201	14	15	–	510	240	750	11	225	20
600 00	[1] –	–	–	–	381	219	600	3	145	21
130 00	195	64	1	–	210	394	604	3	14	22
–	[1] –	[1] –	18	152 00	329	272	601	3	80	23
–	[1] –	[1] –	[1] –	–	610	512	1,122	5	53	24
600 00	135	7	16	–	413	412	825	4	119	25
392 00	143	68	27	6 13	666	853	1,519	3	260	26
1,035 00	[1] –	[1] –	15	–	498	14	512	3	67	27
3,070 00	410	40	71	1,391 50	1,506	221	1,727	4	90	28
1,028 25	274	31	40	87 60	129	112	241	5	142	29
1,400 00	[1] –	[1] –	31	16 00	413	221	634	6	92	30
1,175 00	132	57	24	–	641	600	1,241	6	87	31
700 00	[1] –	[1] –	29	–	431	82	513	8	89	32
$22,330 75	4,434	997	654	$4,962 08	16,626	6,372	23,607	143	[5] 106	

[4] Represented on the Board by special enactment, and makes no returns.

[5] General average of attendance.

DIRECTORY

OF THE

Agricultural and Similar Organizations of Massachusetts.

July, 1911.

State Board of Agriculture, 1911.

Members ex Officio.

His Excellency EUGENE N. FOSS.
His Honor LOUIS A. FROTHINGHAM.
Hon. WM. M. OLIN, *Secretary of the Commonwealth.*
KENYON L. BUTTERFIELD, LL.D., *President Massachusetts Agricultural College.*
FREDERICK F. WALKER, *Chief of the Cattle Bureau.*
F. WM. RANE, B. Agr., M.S., *State Forester.*
J. LEWIS ELLSWORTH, *Secretary of the Board.*

Members appointed by the Governor and Council.

	Term expires
CHARLES E. WARD[1] of Buckland,	1911
HENRY M. HOWARD of West Newton,	1912
CHARLES M. GARDNER of Westfield,	1913

Members chosen by the Incorporated Societies.

Amesbury and Salisbury (Agricultural and Horticultural),	J. J. MASON of Amesbury,	1912
Barnstable County,	JOHN BURSLEY of West Barnstable,	1913
Blackstone Valley,	JACOB A. WILLIAMS of Northbridge,	1912
Deerfield Valley,	ERNEST W. PAYNE of Heath,	1914
Eastern Hampden,	O. E. BRADWAY of Monson,	1912
Essex,	FREDERICK A. RUSSELL of Methuen,	1914
Franklin County,	CHARLES P. ALDRICH of Greenfield,	1913
Hampshire,	HOWARD A. PARSONS of Amherst (P. O. North Amherst),	1913
Hampshire, Franklin and Hampden,	FRANK P. NEWKIRK of Easthampton,	1912
Highland,	JOHN T. BRYAN of Middlefield (P. O. Chester, R. F. D.),	1914
Hillside,	HARRY A. FORD of Windsor,	1914
Hingham (Agricultural and Horticultural),	HENRY A. TURNER of Norwell,	1912
Hoosac Valley,	L. J. NORTHUP of Cheshire,	1912
Housatonic,	N. B. TURNER of Great Barrington (P. O. Housatonic),	1912
Lenox Horticultural,	ALFRED H. WINGETT of Lenox,	1914
Marshfield (Agricultural and Hort'l),	WALTER H. FAUNCE of Kingston,	1912
Martha's Vineyard,	JAMES F. ADAMS of West Tisbury,	1913
Massachusetts Horticultural,	WILFRID WHEELER of Concord,	1912
Massachusetts Society for Promoting Agriculture,	N. I. BOWDITCH of Framingham,	1912
Middlesex North,	GEO. W. TRULL of Tewksbury (P. O. Lowell, R. F. D.),	1914
Middlesex South,	JOHN J. ERWIN of Wayland,	1914
Nantucket,	JOHN S. APPLETON of Nantucket,	1912
Oxford,	WALTER A. LOVETT of Oxford,	1913
Plymouth County,	AUGUSTUS PRATT of Middleborough (P. O. North Middleborough),	1914
Spencer (Farmers' and Mech's Ass'n),	WALTER C. BEMIS of Spencer,	1913
Union (Agricultural and Hort'l),	SYLVESTER H. PEEBLES of Blandford,	1913
Weymouth (Agricultural and Ind'l),	THERON L. TIRRELL of Weymouth (P. O. South Weymouth),	1912
Worcester,	B. W. POTTER of Worcester,	1914
Worcester East,	GEO. F. MORSE of Lancaster,	1912
Worcester Northwest (Agricultural and Mechanical),	ALBERT ELLSWORTH of Athol,	1913
Worcester South,	WILLIAM E. PATRICK of Warren,	1913
Worcester County West,	JOHN L. SMITH of Barre,	1914

[1] Successor not yet appointed.

ORGANIZATION OF THE BOARD.

OFFICERS.

President, ... His Excellency EUGENE N. FOSS, *ex officio*.
1st Vice-President, . . JOHN BURSLEY of West Barnstable.
2d Vice-President, . . WILFRID WHEELER of Concord.
Secretary, ... J. LEWIS ELLSWORTH of Worcester.
Office, Room 136, State House, Boston.

COMMITTEES.

Executive Committee.

Messrs. John Bursley of West Barnstable.
O. E. Bradway of Monson.
John J. Mason of Amesbury.
Charles E. Ward of Buckland.
Walter A. Lovett of Oxford.
Charles M. Gardner of Westfield.
Wilfrid Wheeler of Concord.
John L. Smith of Barre.

Committee on Agricultural Societies.

Messrs. O. E. Bradway of Monson.
Albert Ellsworth of Athol.
T. L. Tirrell of South Weymouth.
J. A. Williams of Northbridge.
Ernest W. Payne of Heath.

Committee on Domestic Animals and Sanitation.

Messrs. Walter A. Lovett of Oxford.
F. A. Russell of Methuen.
L. J. Northup of Cheshire.
Harry A. Ford of Windsor.
John T. Bryan of Middlefield.

Committee on Gypsy Moth, Insects and Birds.

Messrs. Wilfrid Wheeler of Concord.
F. A. Russell of Methuen.
B. W. Potter of Worcester.
Walter C. Bemis of Spencer.
Augustus Pratt of North Middleborough.

Committee on Dairy Bureau and Agricultural Products.

Messrs. Charles M. Gardner of Westfield.
Howard A. Parsons of North Amherst.
George W. Trull of Tewksbury.
Walter H. Faunce of Kingston.
S. H. Peebles of Blandford.

Committee on Massachusetts Agricultural College.

Messrs. John Bursley of West Barnstable.
N. B. Turner of Great Barrington.
F. P. Newkirk of Easthampton.
Wm. E. Patrick of Warren.
John J. Erwin of Wayland.

Committee on Experiments and Station Work.

Messrs. John L. Smith of Barre.
N. I. Bowditch of Framingham.
T. L. Tirrell of South Weymouth.
Wilfrid Wheeler of Concord.
Alfred H. Wingett of Lenox.

Committee on Forestry, Roads and Roadside Improvements.

Messrs. J. J. Mason of Amesbury.
F. Wm. Rane of Boston.
John S. Appleton of Nantucket.
H. A. Turner of Norwell.
Chas. P. Aldrich of Greenfield.

Committee on Institutes and Public Meetings.

Messrs. Chas. E. Ward of Buckland.
George F. Morse of Lancaster.
Kenyon L. Butterfield of Amherst.
J. F. Adams of West Tisbury.
H. M. Howard of West Newton.

The secretary is a member, *ex officio*, of each of the above committees.

DAIRY BUREAU.

Messrs. Charles M. Gardner of Westfield, 1911; Howard A. Parsons of North Amherst, 1912; George W. Trull of Tewksbury, 1913.

Executive Officer, ... J. L. Ellsworth.
General Agent, ... P. M. Harwood of Barre.

Office, Room 136, State House.

STATE NURSERY INSPECTOR.

Henry T. Fernald, Ph.D., of Amherst.

STATE ORNITHOLOGIST.

Edward Howe Forbush of Wareham.

STATE INSPECTOR OF APIARIES.

Burton N. Gates, Ph.D., of Amherst.

SPECIALISTS.

Chemist,	Dr. J. B. Lindsey,	Amherst.
Entomologist,	Prof. C. H. Fernald,	Amherst.
Botanist,	Dr. Geo. E. Stone,	Amherst.
Pomologist,	Prof. F. C. Sears,	Amherst
Veterinarian,	Prof. James B. Paige,	Amherst.
Engineer,	Wm. Wheeler,	Concord.

MASSACHUSETTS AGRICULTURAL COLLEGE.

Location, Amherst, Hampshire County.

Agricultural Societies incorporated by Special Act of the Legislature, and represented on the Board of Agriculture.

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Amesbury and Salisbury,[1]	A. Willis Bartlett, Salisbury.	M. H. Sands, Amesbury.	John J. Mason, Amesbury.
Barnstable County,	T. C. Thacher, Yarmouthport.	M. N. Harris, Barnstable.	Henry C. Davis, Cummaquid.
Blackstone Valley,	W. A. L. Bazeley, Uxbridge.	Dr. M. R. Sharpe, Uxbridge.	Chas. A. Barton, Uxbridge.
Deerfield Valley,	Ernest W. Payne, Heath.	S. W. Hawkes, Charlemont.	C. T. Haskins, Charlemont.
Eastern Hampden,	O. E. Bradway, Monson.	L. E. Chandler, Palmer.	W. L. Shaw, Palmer.
Essex,	J. M. Danforth, Lynnfield Center.	Fred A. Smith, Ipswich.	Wm. S. Nichols, Salem.
Franklin County,	George E. Taylor, Jr., Shelburne.	J. H. Murphy, Greenfield.	Frank H. Snow, Greenfield.
Hampshire,	Francis E. Farrar, Amherst.	David H. Keedy, Amherst.	David H. Keedy, Amherst.
Hampshire, Franklin and Hampden,	Clarence E. Hodgkins, Northampton.	C. A. Montgomery, Northampton.	Alvertus J. Morse, Northampton.
Highland,	John W. Crane, Springfield.	John T. Bryan, R. F. D., Chester.	Geo. S. Bell, Middlefield.
Hillside,	Milton P. Howes, Cummington.	Clement F. Burr, Ringville.	Robert L. Streeter, Cummington.
Hingham,[1]	Henry E. Spaulding, Hingham.	William H. Thomas, Hingham.	Reuben Sprague, Hingham.
Hoosac Valley,	Dr. F. D. Stafford, North Adams.	George F. Miller, North Adams.	C. J. Arnold, North Adams.
Housatonic,	Harry Smith, Lee.	Joseph H. Maloney, Great Barrington.	George L. Taylor, Great Barrington.
Lenox Horticultural,	George Foulsham, Lenox.	George Instone, Lenox.	Walter Jack, Lenox.
Marshfield,[1]	Thomas W. Lawson, Boston.	Israel H. Hatch, North Marshfield.	M. Herman Kent, Marshfield.
Martha's Vineyard,	B. T. Hillman, Edgartown.	F. Allen Look, West Tisbury.	George Hunt Luce, West Tisbury.
Massachusetts Horticultural,	Gen. S. M. Weld, Dedham.	William P. Rich, Boston.	Walter Hunnewell, Wellesley.
Massachusetts Society for Promoting Agriculture,	Charles W. Parker, Boston.	Francis H. Appleton, Boston.	R. M. Saltonstall, Newton.
Middlesex North,	George W. Trull, R. F. D., No. I, Lowell.	Andrew Liddell, Lowell.	John A. Weinbeck, Lowell.
Middlesex South,	John P. Bowditch, Framingham.	Peter N. Everett, South Framingham.	George E. Fay, Framingham.
Nantucket,	Herbert G. Worth, Nantucket.	Josiah F. Murphy, Nantucket.	Asa C. Jones, Nantucket.

[1] And horticultural.

AGRICULTURAL SOCIETIES, ETC. — *Concluded.*

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Oxford,	David N. Taft, Oxford.	James E. Darling, Oxford.	George E. Chaffee, Oxford.
Plymouth County,	Augustus Pratt, North Middleborough.	J. Herbert Leonard, Bridgewater.	J. Herbert Leonard, Bridgewater.
Spencer Farmers' and Mechanics' Association,	Arthur Monroe, Spencer.	Geo. H. Ramer, Spencer.	Geo. H. Ramer, Spencer.
Union, [1]	Henry K. Herrick, Blandford.	Enos W. Boise, Blandford.	George O. Millard, Blandford.
Weymouth (Agricultural and Industrial),	Ralph P. Burrell, South Weymouth.	A. Francis Barnes, South Weymouth.	D. Frank Daly, South Weymouth.
Worcester,	Walter D. Ross, Worcester.	Elisha S. Knowles, Worcester.	Leander F. Herrick, Worcester.
Worcester East,	John E. Thayer, Lancaster.	Warren Goodale, Clinton.	John W. Forrester, Clinton.
Worcester Northwest (Ag'l and Mechanical),	Joseph Wilcox, Athol.	Albert Ellsworth, Athol.	Ernest L. Worrick, Athol.
Worcester South,	Herman S. Cheney, Southbridge.	C. V. Corey, Sturbridge.	C. V. Corey, Sturbridge.
Worcester County West,	James A. Rice, Barre.	Daniel H. Rice, Barre.	John S. Rice, Barre.

[1] And horticultural.

Horticultural Societies.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Haverhill,	Haverhill,	Walter Goodrich, Haverhill.	Mrs. William M. Webster, Haverhill.
Hampden County,	Springfield,	- - -	William F. Gale, Springfield.
Houghton,	Lynn,	Frank L. Whipple, Lynn.	Mrs. Nettie L. Day, 20 Webster St., Lynn.
Lenox,	Lenox,	Allan Jenkins, Lenox.	Geo. H. Instone, Lenox.
Massachusetts,	The State,	Stephen M. Weld, Boston.	Wm. P. Rich, Boston.
North Shore,	Manchester,	Wm. Till, Magnolia.	James Salter, Manchester.
Springfield Amateur,	Springfield,	A. J. Griffin, Greene St., Springfield.	J. Alden Davis, 36 Groveland St., Springfield.
Worcester County,	Worcester,	Geo. C. Rice, Worcester.	Adin A. Hixon, Worcester.

Farmers' and Mechanics' Associations.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Bolton,	Bolton,	Legrand F. Brigham, Bolton.	William M. Brigham, Bolton.
Needham,	Needham,	John F. Mills, Needham.	Wm. A. Parks, Needham Heights.
Oakham,	Oakham,	Wayland Angier, Oakham.	M. Idella Angier, Oakham.
Princeton,	Princeton,	J. C. F. Mirick, Princeton.	J. E. Merriam, Princeton.
Westminster,	Westminster,	Chas. F. Knowles, R. F. D., No. 1, Westminster.	G. W. Barnes, Westminster.

Farmers' and Mechanics' Clubs.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Ashburnham,	Ashburnham,	E. J. Forristall, South Ashburnham.	W. E. Jefts, Ashburnham.
Belchertown,	Belchertown,	Harry H. Ward, Belchertown.	Almon L. Pratt, Belchertown.
Groton,	Groton,	Wm. A. Lawrence, Groton.	L. H. Sheedy, Groton.
Holden,	Holden,	E. W. Merrick, Jefferson.	Geo. M. Perry, Holden.
Pepperell,	Pepperell,	H. W. Hutchinson, Pepperell.	Chas. F. Spaulding, Pepperell.
Shirley,	Shirley,	H. S. Hazen, Shirley Center.	M. W. Longley, Shirley Center.
Shrewsbury,	Shrewsbury,	E. A. Bartlett, Shrewsbury.	F. J. Stone, Shrewsbury.

Farmers' Clubs.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Boxborough,	Boxborough,	R. Y. Nelson, Boxborough.	G. W. Burroughs, Boxborough.
Buckland,	Buckland,	Chas. E. Ward, Buckland.	Miss Lura E. Hite, Shelburne Falls.
East Charlemont,	East Charlemont,	W. W. Smith, East Charlemont.	Geo. H. Wheeler, East Charlemont.
Easthampton,	Easthampton,	Geo. Vaugh, Park Hill, Easthampton.	Joel Searle, Easthampton.
Franklin,	Franklin,	E. S. Cook, Franklin.	L. W. Daniels, Franklin.
Halifax,	Halifax,	Jas. T. Thomas, Halifax.	Mrs. Geo. W. Hayward, Halifax.
Medway,	Medway,	- - -	D. H. Holley, Metcalf.
New Braintree,	New Braintree,	Jas. E. Barr, New Braintree.	Chas. S. Lane, New Braintree.
Rowley,	Rowley,	J. D. Dodge, Rowley.	T. P. Hale, Rowley.
South Bristol,	New Bedford,	Herbert Wing, South Dartmouth.	Allen Russell, Jr., Acushnet.
Tatnuck,	Worcester,	Herbert R. Kinney, Worcester.	H. Ward Moore, 28 Amherst St., Worcester.
Upton,	Upton,	Orlando F. Taft, Upton.	Edward B. Newton, Upton.
West Brookfield,	West Brookfield,	S. Newell Cutler, Warren.	Sumner H. Reed, West Brookfield.
Wilbraham,	Wilbraham,	B. F. Green, North Wilbraham.	H. M. Bliss, R. F. D., No. 2, Ludlow.

Poultry Associations.

Athol Poultry and Pet Stock Association,	Athol,	- - -	J. E. Burt, Athol.
Brockton Poultry Association,	Brockton,	M. E. Holmes, Campello.	C. A. Brown, Brockton.
Dalton Poultry, Pigeon and Pet Stock Association,	Dalton,	G. W. Crow, Dalton.	W. H. Griswold, Dalton.
Essex County Poultry Association,	Beverly,	Joseph D. Barnes, Beverly.	Walter R. Bell, Manchester.
Falmouth Poultry Association,	Falmouth,	E. P. Davis, Falmouth.	R. E. Small, Falmouth.
Greenfield Score Card Poultry Club,	Greenfield,	W. E. Weatherwax, Greenfield.	S. H. Stone, Greenfield.
Holyoke Poultry and Pet Stock Association,	Holyoke,	Albert C. Chapin, Holyoke.	Percy M. Alden, Willimansett.
Lawrence Poultry and Pet Stock Association,	Lawrence,	B. D. Todd, Lawrence.	Asa L. Harris, Lawrence.
Milford Poultry Association,	Milford,	Geo. P. Sheldon, Hopedale.	W. H. Pyne, Milford.
North Abington Poultry Association,	North Abington,	Chas. W. Pratt, North Abington.	Jas. H. Dwyer, North Abington.
Northern Berkshire Poultry Association,	North Adams,	W. G. Carter, North Adams.	C. A. Larabee, North Adams.
Plymouth Poultry Association,	Plymouth,	T. Allen Bagnell, Plymouth.	F. C. Chandler, Kingston.
Springfield Poultry Club, Inc.,	Springfield,	Geo. W. Pike, Springfield.	- - -
Springfield Poultry and Pet Stock Association,	Springfield,	E. C. Powell, Longmeadow.	E. S. Evans, Springfield.
West Brookfield Poultry Association,	West Brookfield,	R. H. Buffington, West Brookfield.	E. L. Richardson, West Brookfield.
Worcester Poultry Association,	Worcester,	Walter D. Ross, Worcester.	W. H. Fitton, Worcester.

MISCELLANEOUS.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Bay State Agricultural Society,	The State,	C. Minot Weld, Boston.	N. I. Bowditch, Framingham.
Boston Market Gardeners' Association,	Boston and vicinity,	H. F. Hall, 96 Wallingford Rd., Brighton.	J. P. Estey, Newton Center.
Brockton Agricultural Society,	Brockton,	Charles Howard, Brockton.	Perley G. Flint, Brockton.
Connecticut Valley Breeders' Association,	Western New England,	George E. Taylor, Jr., Shelburne.	O. C. Burt, Easthampton.
Cranberry Growers' Association,	Cape Cod District,	George R. Briggs, R. F. D., Bournedale.	Wm. M. Marsh, Wareham.
Franklin Harvest Club,	Connecticut Valley,	Harry T. Newhall, Conway.	C. B. Lyman, Southampton.
Hampden Harvest Club,	Connecticut Valley,	The members alternately.	Edwin C. Powell, Myrick Bldg., Springfield.
Haverhill Agricultural Society,	Haverhill,	Edward H. George, Groveland.	Leslie K. Morse, Haverhill.
Massachusetts Cattle Owners' Association,	The State,	B. W. Potter, Worcester.	J. L. Harrington, Lunenburg.
Massachusetts Creamery Association,	The State,	W. H. Wright, Easthampton.	A. M. Lyman, Montague.
Massachusetts Forestry Association,	The State,	Nathaniel T. Kidder, Milton.	Irving T. Guild, Boston.
Massachusetts Fruit Growers' Association,	The State,	S. T. Maynard, Northborough.	F. Howard Brown, Hosmer St., Marlborough.
Massachusetts Nurserymen's Association,	The State,	Windsor H. Wyman, North Abington.	A. E. Robinson, Bedford.
Massachusetts Society of Bee-keepers,	The State,	E. C. Britton, Canton.	T. J. Hawkins, Everett.
Massachusetts State Poultry Association,	The State,	Henry D. Smith, Rockland.	J. H. Robinson, Boston.
Stockbridge Club,	Amherst,	R. C. Barrows, M. A. C., Amherst.	R. A. Warner, M. A. C., Amherst.
Ware Agricultural Society,	Ware,	F. F. Gilmore, Ware.	E. P. Lovett, Ware.
Worcester County Harvest Club,	Worcester,	F. P. Knowles, Auburn.	Mrs. D. A. Howe, Worcester.
Worcester County Bee-keepers' Association,	Worcester,	John L. Byard, Marlborough.	C. H. Goodell, Worcester.
Worcester North Agricultural Society,	Fitchburg,	H. O. Mead, Lunenburg.	W. H. Laws, Ashburnham.

MASSACHUSETTS PATRONS OF HUSBANDRY.

Officers of the State Grange, 1911.

Master,	Charles M. Gardner of Westfield.
Overseer,	E. E. Chapman of Ludlow.
Lecturer,	E. F. Richardson of Millis.
Steward,	L. R. Smith of Hadley.
Assistant Steward,	E. H. Gilbert of Stoughton (P. O. address, North Easton).
Chaplain,	Rev. A. H. Wheelock of Marlborough.
Treasurer,	Hon. F. A. Harrington of Worcester.
Secretary,	Wm. N. Howard of South Easton (P. O. address, North Easton).
Gate Keeper,	F. L. Warfield of Buckland.
Ceres,	Mrs. Mary Olds Lakin of Brookfield.
Pomona,	Mrs. Ella D. Rice of Leominster.
Flora,	Mrs. Philomene Cook of Methuen.
Lady Assistant Steward,	S. Mabel Thompson, Westborough, R. F. D. No. 2.

Executive Committee.

George S. Ladd,	Sturbridge.
C. A. Dennen,	Pepperell.
W. C. Jewett,	Worcester.

General Deputies.

N. B. Douglas,	Sherborn.
Elmer D. Howe,	Marlborough.
Warren C. Jewett,	Worcester.
George S. Ladd,	Sturbridge.
C. D. Richardson,	West Brookfield.

Pomona Deputies.

W. E. Patrick,	Warren.
F. N. Boutelle,	North Leominster.
W. T. Moore,	Huntington.

Subordinate Deputies.

George W. Sherman,	Brimfield.
L. H. Cudworth,	Oxford.
W. H. Sawyer,	Winchendon.
W. A. Harlow,	Cummington.
H. N. Jenks,	Adams, R. F. D.
Elbridge Noyes,	Newbury.
T. E. Flarity,	Townsend.
Moses U. Gaskill,	Mendon.
E. B. Hale,	Bernardston.
Hermon W. King,	East Longmeadow.
John Bursley,	West Barnstable.
C. R. Damon,	Williamsburg.
W. T. Herrick,	Westborough.
H. W. Carter,	Millbury.
Chester B. Williams,	Cochituate.

SUBORDINATE DEPUTIES — *Con.*

Walter E. Morris,	Billerica.
Harold M. Shaw,	Great Barrington.
Joseph W. Baldwin,	North Easton.
S. T. Brightman,	Westport.
Horace E. Wallis,	Waltham.
Charles H. Preston,	Danvers.
Dr. M. H. Williams,	Sunderland.
Fred E. Alden,	Worcester.
Norman L. Peavey,	Dracut.

SPECIAL DEPUTIES.

William N. Howard,	North Easton.
J. P. Ranger,	North Brookfield.
M. A. Morse,	Belchertown.
C. H. Shaylor,	Lee.

Massachusetts Patrons of Husbandry — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Pomona Granges.			
Middlesex and Norfolk, No. 1,	John F. Mills, Needham.	Joseph Mason, Waban.	J. H. Baker, Medfield.
Essex County, No. 2,	Albert P. Wadleigh, Church St., Merrimac.	Edward A. H. Grover, Danvers.	Miss Matilda B. Lund, Ward Hill, R. F. D. No. 1.
Middlesex-Worcester, No. 3,	Mrs. L. E. Starr, Pepperell.	Mrs. Annie Greenlief, Townsend Center.	Mrs. Minnie L. F. Knight, Townsend Harbor.
Franklin and Worcester, No. 4,	E. S. Putnam, Wendell Depot.	William L. Wheeler, Templeton.	Ellen M. Conant, North Orange.
Worcester West, No. 5,	Calvin Drury, Princeton.	Mrs. S. Alice Hillman, Hardwick.	Mrs. Rachel S. Titterton, Templeton.
Berkshire County, No. 6,	T. L. Curran, Housatonic.	J. J. Glynn, Dalton.	J. C. Jenks, Adams.
Worcester Central, No. 7,	Edward P. Davidson, Millbury.	Mrs. C. H. Freeman, 4 Genoa St., Worcester.	Mrs. A. E. Grout, Millbury.
Hampshire County, No. 8,	Milton H. Williams, Sunderland.	Mrs. Fannie J. Clary, Williamsburg.	John W. Marsh, Hadley.
Worcester Southwest, No. 9,	W. H. Eccleston, Southbridge.	Miss Jennie S. Gilbert, Fiskdale.	Mrs. Mary Q. Ainsworth, East Brookfield, R. F. D.
Worcester and Norfolk, No. 10,	Frank C. Wood, Mendon.	Moses U. Gaskill, Mendon.	Mrs. Annie E. Gaskill, South Milford.
Borough, No. 11,	F. Howard Brown, Hosmer St., Marlborough.	Mrs. S. Mabel Thompson, Westborough.	Mrs. Maria A. Gilmore, Westborough, R. F. D. No. 2.
Springfield, No. 12,	H. W. King, East Longmeadow.	Mrs. George S. Wood, East Longmeadow.	Mrs. Carrie L. Hayward, Agawam.
Old Colony, No. 13,	Edwin V. Kinsley, Ponkapoag.	J. Herbert Cushing, Middleborough.	Mrs. Alida N. Stevens, Tremont St., South Braintree.
Worcester East, No. 14,	Myron Garfield, Boylston.	Mrs. Ella F. Miller, Leominster.	Mrs. Ida A. Cunningham, Lancaster.
Quaboag, No. 15,	Edwin L. Havens, New Braintree.	Mrs. B. A. Barnes, Brimfield.	Mrs. Carrie E. Webb, West Brookfield.
Middlesex North, No. 16,	S. J. Anthony, Carlisle.	Mrs. Etta Spaulding, 32 Grace St., Lowell.	Mrs. Lulu M. Hutchins, Billerica.
Deerfield Valley, No. 17,	D. P. Bardwell, Bardwell's Ferry.	Mrs. Florence Butler, East Charlemont.	Adelbert J. Larned, Lyonsville.
Western Hampden, No. 18,	E. F. Goodwin, Huntington.	Mrs. Lucy Perkins, Huntington.	Annette Sackett, Westfield.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Connecticut Valley, No. 19,	Charles M. Hemenway, North Leverett.	Mrs. L. O. Clapp, Northfield.	Mrs. Henry B. Barton, Riverside, Gill.
Hillside, No. 20,	H. G. Ely, Cummington.	C. A. Williams, Plainfield.	Mrs. Belle Miner, East Windsor.
Swift River Valley, No. 21,	Sewall V. King, Cooleyville, Box 31.	Mrs. Geneva S. Ballard, Millington, Box 53.	Mrs. Sewall V. King, Cooleyville, Box 31.
Mayflower, No. 22,	LeRoy M. Peterson, Millbrook.	Dr. Flavel S. Thomas, South Hanson.	Winthrop Fillebrown, Bryantville, R. F. D. No. 2.
Middlesex Central, No. 23,	James B. Tuttle, Acton.	Frank Tyler Marston, 20 Fairmont St., Melrose.	Mrs. Maude M. Clark, Sudbury.
Cape Cod, No. 24,	S. Fremont Crocker, Marston's Mills.	Frank E. Howes, Dennis.	Henry C. Davis, Cummaquid.
Subordinate Granges.			
"Guiding Star" of Greenfield,	Miss Martha Sprague, Bernardston Road, Greenfield.	Mrs. Henrietta Snyder, Leyden Road, Greenfield.	Mrs. Agnes Handforth, Greenfield.
Deerfield, No. 2,	Lewis J. Smith, Deerfield.	Mrs. Sarah R. Hawkes, Deerfield.	P. G. Davis, Deerfield.
Northfield, No. 3,	F. H. Montague, Northfield.	Mrs. F. H. Montague, Northfield Farms.	Mrs. T. R. Callender, Northfield.
Groton, No. 7,	Millard S. Sawyer, Groton, R. F. D.	Mrs. Blanche M. Brown, Groton.	Mrs. Mary D. Boynton, Groton, Box 47.
Conway, No. 8,	Wm. D. Allis, Conway, R. F. D.	Mrs. William D. Allis, Conway.	L. T. Hopkins, Conway, R. F. D.
Barre, No. 9,	G. F. Smith, Barre.	Mrs. Edith A. Cochran, Barre.	James M. Washburn, Barre.
Pittsfield, No. 14,	Edwin R. Burdick, 340 First St., Pittsfield.	Miss Myrtie L. Elmer, Pittsfield, Box 1265.	Miss Bessie F. Parkee, Pittsfield, R. F. D. No. 2.
"Hope" of Hadley, No. 15,	Clifford Horton, Hadley.	Mr. J. W. Marsh, Hadley, Box 172.	Mrs. J. W. Marsh, Hadley, Box 172.
Amherst, No. 16,	H. A. Parsons, North Amherst.	Mrs. C. H. Thayer, Amherst.	Miss Mary H. Scott, Amherst.
Cheshire, No. 17,	George M. Purdy, Cheshire.	Jabez C. Jenks, Adams, R. F. D.	Mrs. Maude L. Purdy, Cheshire.
Hinsdale, No. 19,	L. L. Sherman, Hinsdale.	Miss Harriet Tracy, Hinsdale, R. F. D.	T. Augustus Frissell, Hinsdale.
Westfield, No. 20,	Geo. B. Church, 18 Bates St., Westfield.	Mrs. C. M. Gardner, 57 Day Ave., Westfield.	Miss Annette Sackett, 7 Taylor Ave., Westfield.
Lanesborough, No. 21,	C. E. Chadwick, Lanesborough, R. F. D.	Miss E. J. Tillotson, Lanesborough.	Mrs. Ella L. Foster, Lanesborough.

Worcester, No. 22,	Scott T. Pierce, Holden St., Worcester.	Mrs. Scott T. Pierce, Holden St., Worcester.	Mrs. Nancy E. Moore, 92 Summer St., Worcester.
Dalton, No. 23,	John J. Glynn, 1245 East St., Dalton.	Mrs. E. R. Morse, Pittsfield.	Miss Lauretta D. Barton, Dalton.
Blandford, No. 24,	C. R. Ripley, Blandford, R. F. D.	Miss Ethel Blodgett, Chester, R. F. D.	Miss Cordelia G. King, Blandford.
New Lenox, No. 26,	Mrs. Harvey H. Dewey, New Lenox.	Miss Elsie Dunbar, Lenox.	Horatio H. Sears, New Lenox.
Easthampton, No. 27,	D. A. Forbes, West St., Easthampton.	Miss Chella Underwood, Chapman Ave., Easthampton.	Miss Lillian A. Russell, 15 Prospect St., Easthampton.
Richmond, No. 32,	Mrs. Ida B. Coleman, Pittsfield, R. F D.	Mrs. M. W. Coleman, Pittsfield, R. F. D.	Miss Ida H. Barnes, Richmond.
Adams, No. 34,	Mrs. Fannie Sherman, Park St., Adams.	Mrs. Frank Miller, Columbia St., Adams.	Mrs. C. A. Daniels, 18 Orchard St., Adams.
Russell, No. 36,	A. B. Copeland, Russell.	Mrs. H. E. Griffin, Russell.	Mrs. T. H. Rogers, Russell.
Leverett, No. 37,	C. H. Beaman, Leverett.	Miss Stella Ingram, Hillsborough.	F. N. Bourne, Moore's Corner.
Granville, No. 40,	H. S. Hartley, Granville.	Mrs. Clara M. Hartley, Granville.	Mrs. Lillian Goodrich, Granville.
Montgomery, No. 45,	Walter D. Allyn, Montgomery.	Miss Helen Kelso, Montgomery.	Miss Florence Moore, Montgomery.
Southwick, No. 46,	William S. Barnes, Southwick.	Mrs. F. D. Lambson, Southwick.	Mrs. C. A. Griffin, Southwick.
Becket, No. 47,	Mrs. C. E. Lyman, Becket, R. F. D. No. 1.	Mrs. Marie Fairfield, Becket, R. F. D. No. 1.	Arthur H. Capen, Becket, R. F. D. No. 1.
"Highland" of Huntington, No. 48,	W. T. Moore, Huntington.	Mrs. S. C. Wilbur, Huntington.	Miss Lena Gamble, Huntington.
"Granite" of South Worthington, No. 49.	Rufus H. Adams, Ringville.	Miss Harriet Davis, Ringville.	Mrs. Helen L. Drake, Huntington.
"Golden Rule" of Prescott, No. 52,	Charles W. Berry, Greenwich Village, R. F. D.	Mrs. Lilian S. Gross, North Prescott.	Mrs. Fanny G. Thayer, Greenwich Village, R. F. D. No. 1.
Sterling, No. 53,	Rodney Monk, Pratt's Junction.	Harry A. Wiles, Sterling.	Frank P. Elliott, Sterling.
Springfield, No. 54,	E. T. Davis, 157 Lebanon St., Springfield.	Mrs. Eliz. A. Hotchkiss, Agawam.	Mrs. Lillian A. Cornell, 307 Main St., Springfield.
Cummington, No. 56,	W. A. Harlow, Swift River, Cummington.	Mrs. Lida Libenow, Cummington.	Walter E. Ford, Cummington.
Auburn, No. 60,	Everett W. Stone, Auburn.	Charles A. Wood, 22 Hollywood St., Worcester.	Miss Linnie E. Keep, Auburn.
Egremont, No. 63,	Henry M. Brown, Great Barrington, R. F. D. No. 3.	Mrs. Mary H. Dunlop, Great Barrington, R. F. D. No. 3.	William L. Bliss, South Egremont.
"Union" of Belchertown, No. 64,	Myron G. Ward, Belchertown.	Mrs. Ella Ward, Belchertown.	John V. Jewett, Belchertown.
Brimfield, No. 65,	Albert R. Brown, Brimfield.	Mrs. B. A. Barnes, Brimfield.	Mrs. Mary K. Hitchcock, Brimfield.
Charlemont, No. 66,	C. A. Hawkes, Charlemont.	H. E. Warfield, Charlemont.	J. H. Davenport, Charlemont, R. F. D. No. 2.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Hardwick, No. 67,	O. A. Tuttle, Gilbertville.	Mrs. J. S. Hillman, Hardwick.	Mrs. Nelson L. Smith, Hardwick.
Shelburne, No. 68,	C. A. Loomis, Greenfield, Box 94.	Mrs. C. S. Dole, Shelburne.	Mrs. C. A. Loomis, Greenfield, Box 94.
Ashfield, No. 69,	Clinton Wing, Ashfield, R. F. D.	Miss Olive Wing, Ashfield.	Mrs. Joseph Tatro, Shelburne Falls, R. F. D.
Phillipston, No. 70,	D. W. Baker, Athol, R. F. D. No. 3.	Mrs. Ella R. White, Athol. R. F. D. No. 3.	Mrs. Cora A. Dunton, Phillipston.
Leyden, No. 71,	Edwin P. Howes, Jr., Leyden.	Mrs. Helen Hooper, Leyden.	Mrs. Lucy Howes, Leyden.
"Prescott" of Pepperell, No. 73,	Walter Shattuck, East Pepperell.	Miss Sarah B. Tucker, Pepperell.	Miss S. Luella Parker, East Pepperell.
Princeton, No. 74,	Fred P. Hall, Brooks Station.	Raymond J. Gregory, Princeton.	Miss Nellie Davis, Princeton.
Colrain, No. 76,	Seth E. Temple, Shattuckville.	Adelbert J. Larned, Lyonsville.	Miss Alice Bardwell, Shattuckville.
Windsor, No. 77,	Gardner L. Miner, East Windsor.	Mrs. Eliza I. Jacobs, East Windsor.	Mrs. Belle D. Miner, East Windsor.
Holden, No. 78,	Frank C. Hubbard, Jefferson, R. F. D.	Dr. C. W. Stickney, Holden.	Mrs. W. J. Powers, Holden.
Spencer, No. 79,	Arthur Monroe, Spencer.	J. R. Kane, Spencer.	John W. Bigelow, Spencer.
Bernardston, No. 81,	R. H. Cushman, Bernardston.	C. S. Hale, Bernardston.	Mrs. Nellie Reade Hale, Bernardston.
"Manhan" of Southampton, No. 82.	C. S. Hooker, Southampton.	Mrs. C. S. Hooker, Southampton.	Miss Julia Norris, Southampton.
Chesterfield, No. 83,	H. L. Merritt, Chesterfield.	Miss Bessie Baker, Bisbees.	Miss Katherine Quinn, Chesterfield.
Warwick, No. 85,	George A. Witherell, Warwick.	Mrs. Etta M. T. Bass, Warwick.	Miss Jessie M. Rouviere, Warwick.
North Orange, No. 86,	Wm. E. Blackmer, North Orange.	Mrs. Hattie M. Baker, North Orange.	Golan A. Miller, North Orange.
Buckland, No. 87,	H. E. Ward, Buckland.	Frank D. Wiley, Buckland.	Vera B. Elmer, Buckland.
Lee, No. 88,	Charles F. Bradley, Lee.	Mrs. C. E. Hale, Tyringham.	Mrs. H. J. Voght, Lee.
Worthington, No. 90,	Frank H. Burr, Worthington.	Rev. J. D. Willard, Worthington.	Mrs. Helen M. Burr, Worthington.
Charlton, No. 92,	William Casey, Charlton Depot.	Edward M. Bowers, Charlton Depot.	Mrs. Rosa E. Bowers, Charlton Depot.
Grafton, No. 93,	J. Frank Johnson, North Grafton.	Miss Grace Mills, Grafton.	Mrs. Eva M. Sibley, Grafton.
Petersham, No. 95,	George K. Wilder, Petersham, R. F. D.	Maria E. Williams, Petersham.	Ruby J. Stone, Petersham.
Savoy, No. 99,	F. N. Haskins, Savoy.	Mrs. Margaret McCulloch, Savoy.	Mrs. C. A. Maranville, Savoy.
Shrewsbury, No. 101,	Wesley D. Bates, Shrewsbury, Box 44.	Mrs. Charles M. Field, Shrewsbury.	Mrs. M. E. Chamberlin, Shrewsbury, R. F. D.

Stow, No. 103,	Otto H. Geers, West Acton, R. F. D.	Mrs. C. F. Hearsey, Gleasondale.	Mrs. Fannie A. Stevens, Stow.
"Garfield" of North Dana, No. 104,	H. B. Eddy, North Dana.	O. H. Skinner, North Dana.	Miss Celia Whittaker, North Dana, R. F. D.
Marlborough, No. 105,	Clarence V. Lee, Bigelow St., Marlborough, R. F. D.	O. A. Morton, 83 Mechanic St., Marlborough.	Mrs. Elmer D. Howe, Fair View Farm, Marlborough.
West Boylston, No. 106,	William C. Pierce, West Boylston.	Mrs. J. Frank Record, Valley Croft, West Boylston.	Mrs. M. A. Cook, West Boylston, Box 193.
Millbury, No. 107,	H. W. Davidson, Millbury, Box 87.	Miss Florence Bentley, West Millbury.	Edw. P. Davidson, West Millbury, Box 87.
Hudson, No. 108,	Dennis Eldridge, Hudson, R. F. D.	Miss Clare MacKay, Stow, R. F. D.	Mrs. Mary E. Lawrence, 55 Lincoln St., Hudson.
Sutton, No. 109,	Clarence E. Wallace, Sutton, R. F. D. No. 2.	John F. Freeland, Sutton, R. F. D. No. 1.	Oscar F. Stetson, Sutton, R. F. D. No. 1.
Sherborn, No. 110,	Joel H. Stratton, Sherborn, R. F. D.	N. B. Douglas, Sherborn, R. F. D.	Miss A. H. Daniels, Sherborn.
Boylston, No. 111,	Fred C. Stark, Boylston Center, R. F. D.	Abbie D. Flagg, Boylston Center.	Edna B. Garfield, Boylston Center.
East Medway, No. 112,	Rudolph F. King, Millis.	Clarence E. Simpson, Millis.	Edward E. Adams, Millis.
Framingham, No. 113,	Mervin R. Parsons, South Framingham.	Mrs. Flora M. Merrick, 94 Franklin St., South Framingham.	George E. Fay, 35 Winter St., South Framingham.
Medfield, No. 114,	Mrs. Clara A. Clark, Medfield.	T. R. Bailey, Medfield.	Mrs. W. W. Preston, Medfield.
Holliston, No. 115,	Lovell E. Littlefield, Holliston.	Herbert E. Jones, Holliston.	Mrs. Nellie V. Pope, Holliston.
Westborough, No. 116,	B. Howard Fay, Westborough.	Mrs. Maria A. Gilmore, Westborough, R. F. D. No. 2.	Mrs. Julia H. Rogers, Westborough, R. F. D. No. 2, Box 5.
Dover, No. 117,	Lewis B. Paine, Dover.	Mrs. Carrie McClure, Dover.	Mrs. M. B. Chickering, Dover.
Southborough, No. 118,	Aaron W. Hosmer, Southborough.	Mrs. Anna McCloskey, Fayville.	Mrs. Fred Wells, Fayville.
Northborough, No. 119,	Willis E. Wheeler, Northborough.	Mrs. Mary C. Wheeler, Northborough.	Miss Emma M. Cutler, Northborough.
Lancaster, No. 120,	Clifford Cassidy, Lancaster.	J. Fred Brown, South Lancaster.	Mrs. Foster J. Sawyer, Lancaster.
Sudbury, No. 121,	Rev. George H. Clarke, Sudbury Center.	Mrs. S. Josie White, Sudbury.	Mrs. Ida J. Rice, Maynard, R. F. D.
Templeton, No. 122,	Arthur C. Fairbanks, Templeton.	Mrs. E. B. Burnheimer, Templeton.	Mrs. R. S. Titterton, Templeton.
Oxford, No. 123,	James H. Carling, Oxford.	Miss Bertha G. Chaffee, Oxford.	Miss Mable R. Taft, Oxford, Box 157.
Ashland, No. 124,	Herbert Wenzel, Ashland.	Charles E. Burr, Ashland.	Mrs. Emma C. Luce, Ashland.
Upton, No. 125,	Whitman H. Holbrook, West Upton.	Miss Myrtice S. King, Upton.	Mrs. L. Jennie Chapman, West Upton.
Hubbardston, No. 126,	Mrs. Mabel I. Smith, Hubbardston.	Mrs. M. A. McWilliam, Hubbardston.	Miss Grace R. Prentiss, Hubbardston.
Amesbury, No. 127,	Edmond Bartlett, Amesbury, R. F. D. No. 1.	Florence Stephan, 2 Merrimac St., Amesbury.	Charles F. Tibbets, 220 Main St., Amesbury.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
North Andover, No. 128,	Fred D. Whittier, North Andover.	Miss Lucy A. Prescott, North Andover.	Walter A. Hayes, North Andover.
Lincoln, No. 129.	Edward F. Flint, Lincoln.	Mrs. S. R. Snelling, South Lincoln.	H. S. Cousins, South Lincoln.
Gardner, No. 130,	F. L. Curtis, Sr., East Templeton.	Mrs. Minnie Girard, East Broadway, Station A, Gardner.	Mrs. Mabel C. Bolster, 66 Glenwood St., Station A, Gardner.
Boxborough, No. 131,	Arthur W. Nelson, West Acton.	Mrs. A. F. Cunningham, West Acton, R. F. D.	Stephen D. Salmon, West Acton, R. F. D.
North Brookfield, No. 132,	C. D. Richardson, West Brookfield.	Mrs. Mabel S. Peck, North Brookfield.	Mrs. Mary A. Howe, North Brookfield.
Berlin, No. 134,	I. E. Coulson, Berlin.	Mrs. G. F. Matthews, Hudson, R. F. D.	Mrs. Bertha M. Cole, Berlin, R. F. D.
Norfolk, No. 135,	Miss Hattie B. Reed, Norfolk.	Miss Sarah A. Parker, Norfolk.	Mrs. Emma F. Holbrook, Norfolk.
Ipswich, No. 136,	Fred A. Smith, Ipswich, Turner Hill.	George H. Sprague, Ipswich, Turner Hill.	Mrs. Helen M. Moulton, Essex Road, Ipswich.
East Blackstone, No. 137,	Ralph M. Estes, Blackstone, R. F. D.	Mrs. Sabra Bennett, Blackstone, R. F. D.	Mrs. Angelia Hope, Blackstone, R. F. D.
Northampton, No. 138,	Josiah W. Parsons, 128 Bridge St., Northampton.	Mrs. Josiah Parsons, 128 Bridge St., Northampton.	Mrs. Ida A. Fuller, 3 Edward Sq., Northampton.
East Sandwich, No. 139,	Mrs. Florence A. Bursley, West Barnstable.	John F. Carlton, East Sandwich.	Mrs. Rosa S. Armstrong, East Sandwich.
West Boxford, No. 140,	H. Dana Killam, Georgetown, R. F. D. No. 2.	Miss Alma M. Cole, Ward Hill, R. F. D. No. 1.	Miss Matilda B. Lund, Ward Hill, R. F. D. No. 1.
Montague, No. 141,	Charles M. Hemenway, North Leverett.	Mrs. Kate Hayden, Montague.	Mrs. Eva G. Farnsworth, Montague.
Bolton, No. 142,	Gilbert H. Wheeler, Bolton, R. F. D.	Miss Eva Marple, Stow, R. F. D. No. 42.	Mrs. George L. Taylor, Star Route, Hudson.
Mendon, No. 143,	Edwin F. Blood, Mendon.	Mrs. Mabel A. Holbrook, Mendon.	B. W. Sanderson, Mendon.
Franklin, No. 144,	Charles Adams, Franklin.	Lucy E. Tower, Franklin.	Susie Adams, Franklin.
Douglas, No. 145,	Edwin T. Rawson, East Douglas.	Minnie E. Park, Douglas.	Arvilla L. Leonard, Manchaug.
West Newbury, No. 146,	S. Bixby Sargent, Merrimac.	Mrs. Ruth A. Ruddock, Groveland.	Mrs. Harriett M. Ware, West Newbury.
West Springfield, No. 147,	Homer B. Miller, West Springfield, R. F. D. No. 1.	Mrs. Cornelia Fisher, West Springfield, R. F. D. No. 1.	Lillian M. Capron, 15 Elm St., West Springfield.

Harvard, No. 149,	Henry A. Knight, Harvard, R. F. D., Box 7.	Miss Annie Reed, Harvard.	Miss Emeline Knight, Harvard.
Concord, No. 150,	Edwin A. Caldwell, 5 Grove St., Concord.	Mrs. S. Addie Garfield, 18 Hubbard St., Concord.	J. Frank Miller, 18 Grove St., Concord Junction.
East Longmeadow, No. 152,	Frank C. Burton, East Longmeadow.	Rev. C. S. Wilder, East Longmeadow.	Flora D. Burton, East Longmeadow.
Wilbraham, No. 153,	Edgar C. Clark, Ludlow.	Mrs. Ida A. Clark, Ludlow.	Mrs. Juva C. Pease, Ludlow.
Haverhill, No. 154,	Everett E. Dickey, Minot Ave., Haverhill.	Miss Annie Adams, 51 Broadway, Haverhill.	Mrs. Grace A. Merrill, 1231 Broadway, Haverhill.
Methuen, No. 155,	Sydney V. Coburn, 65 Howe St., Methuen.	Hubert E. Gordon, 25 Gage St., Methuen.	Frank A. Gordon, 96 Arnold St., Methuen.
West Bridgewater, No. 156,	Henry M. Morse, West Bridgewater.	H. J. LeLachener, West Bridgewater.	R. F. Wilbur, West Bridgewater.
Granby, No. 157,	Arthur T. Goldthwait, Granby.	Miss Myra F. Chapin, Granby.	Miss Gladys M. Rust, Granby.
"Nemasket" of Middleborough, No. 158.	Leroy C. Decker, North Middleborough.	J. H. Cushing, Middleborough.	Mrs. Annie D. Deane, Middleborough.
Green River of Williamstown, No. 159.	Frank P. Stevens, Blackinton.	Miss Helen Fowler, Williamstown.	Mrs. Jessie Torry, Williamstown.
South Hadley, No. 160,	I. N. Day, South Hadley.	Mrs. Myra N. Forbes, South Hadley.	Mrs. Marion Larock, South Hadley.
"Laurel" of West Newbury, No. 161.	John A. Newhall, 32 Merrimac St., Newburyport.	Mrs. Belle Kennett, West Newbury, R. F. D.	LeRoy D. Lane, West Newbury, R. F. D.
Dartmouth, No. 162,	J. F. Briggs, Dartmouth.	Mrs. F. A. Davoll, Dartmouth.	Mrs. J. F. Briggs, Dartmouth.
Dudley, No. 163,	George B. T. Truell, Dudley, R. F. D. No. 1.	Sallie C. Walker, Dudley, R. F. D. No. 1.	Ethel Bates, Dudley.
Ware, No. 164,	Fred D. Buffington, Ware, R. F. D. No. 1.	Mrs. Angie G. Buffington, Ware, R. F. D. No. 1.	Miss Madora R. Howard, Ware, R. F. D. No. 1.
Hampden, No. 165,	James W. Mulroney, Hampden.	Mrs. Albert F. Ballard, Hampden.	Mrs. Mary A. Sessions, Hampden.
Wellesley, No. 166,	Charles S. Cornwall, Needham Heights.	John F. Mills, Needham.	William A. Parks, Needham Heights.
Rowe, No. 167,	Rev. M. B. Barnard, Rowe.	Wilfred Harris, Rowe.	Mrs. Anna L. Henry, Rowe.
Somerset, No. 168,	Frank E. Hathaway, Pottersville.	Mary D. Eddy, Somerset, R. F. D.	Mary E. Wood, Somerset, R. F. D.
Lunenburg, No. 169,	Arthur W. Rockwood, Lunenburg.	Mrs. Lula M. Francis, Lunenburg.	Thomas Aker, Lunenburg.
New Braintree, No. 170,	J. Arthur Bass, New Braintree.	Julia A. Ross, New Braintree.	Mrs. Kittie C. Pollard, North Brookfield.
Merrimac, No. 171,	Albert P. Wadleigh, Church St., Merrimac.	Mrs. Ella Quimby, Vendome St., Merrimac.	Mrs. Cora L. Wadleigh, Merrimac, Box 149.
Ashby, No. 172,	William S. Green, Ashby.	Mrs. Lora Piper, Ashby.	Mrs. Flora E. Ingerson, Ashby.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Hopkinton, No. 173,	Frank C. Leighton, Hopkinton.	Mrs. Minnie Holcombe, Hopkinton.	Miss Minnie Kilburn, Hopkinton.
Brookfield, No. 174,	Walter B. Mellen, Brookfield.	Mrs. Annie E. Hyde, West Brookfield.	Mrs. Jennie E. Bemis, Brookfield.
Athol, No. 175,	George E. Marshall, 312 Drury Ave., Athol.	Mrs. Mary Cross, 108 Highland Ave., Athol.	Mrs. Minnie Spalding, Sanders St., Athol.
"Millers River" of Orange, No. 176,	Fred E. Cary, Mechanic St., Orange.	Mrs. Nellie Drake, Congress St., Orange.	Miss Josephine Clapp, 23 Howe St., Orange.
Sturbridge, No. 177,	Mrs. Geo. W. Edgerly, Sturbridge.	Harry C. Shepard, Globe Village.	Mrs. Phila P. Holmes, Fiskdale.
Ludlow, No. 179,	William M. Ashwell, Ludlow.	Archer Bennett, Ludlow.	Mrs. Charles E. Chapman, Ludlow.
West Brookfield, No. 180,	John H. Webb, West Brookfield.	Mrs. C. C. Ferguson, West Brookfield.	Miss Florence Benson, West Brookfield.
Westport, No. 181,	C. R. Macomber, South Westport.	Arthur H. Gifford, South Westport, R. F. D.	Charles H. Brightman, Westport, R. F. D.
Southbridge, No. 182,	Mr. Frank E. Snow, 10 Coombs St., Southbridge.	Mrs. E. C. Richardson, 87 Mechanic St., Southbridge.	Mrs. Helen E. Clemence, Clemence Hill, Southbridge.
Andover, No. 183,	George M. Carter, Andover, R. F. D. No. 1.	C. Madeleine Hewes, Porter Road, Andover.	Edw. W. Burtt, Andover, R. F. D.
Topsfield, No. 184,	John Gould, Topsfield.	Mrs. Susie M. Dwinell, Danvers, R. F. D.	Miss Eliz. D. Peabody, Topsfield.
"Milton" of North Attleborough, No. 185.	D. B. Hunt, North Attleborough.	Mrs. T. F. Dean, South Attleborough.	Miss Ruth E. Hunt, North Attleborough.
Fitchburg, No. 186,	Henry E. Rodeimon, Fitchburg, R. F. D.	Mrs. Alice H. Arnold, 191 Elm St., Fitchburg.	Miss Maude E. Lamson, 96 East St., Fitchburg.
Littleton, No. 188,	Richard T. Barrows, Concord Junction, R. F. D.	Mrs. Fannie L. Barrows, Concord Junction.	Miss Augusta W. Smith, Littleton Common.
Warren, No. 189,	Charles E. Wilson, Warren.	Miss I. M. Williams, Warren.	Mrs. Flora B. Patrick, Warren.
Bellingham, No. 190,	Walter L. Bennett, South Milford.	Mrs. Hattie M. Burr, Bellingham.	Mrs. Ada H. Greenwood, Milford, Box 95.
Winchendon, No. 192,	Charles D. Young, Winchendon.	Mrs. E. M. Bartlett, Winchendon.	Charles W. Brooks, Winchendon.
Foxborough, No. 193,	Walter S. Mann, Foxborough, R. F. D.	Edward H. Williams, Foxborough, R. F. D.	Nellie F. Capen, Foxborough, Box 2.
Townsend, No. 194,	Mrs. L. I. Richards, Townsend.	Mrs. Icea M. Cowdry, Townsend.	Mrs. Flora I. Atwood, Townsend.
Royalston, No. 195,	Eri S. Stewart, Athol.	Mrs. C. H. Wilcox, Royalston.	Mrs. Ellen M. Stockwell, Royalston.

Easton, No. 196,	Walter A. Baldwin, North Easton.	Mrs. Lynda P. Howard, North Easton.	Mrs. Emily M. Drew, 11 Grafton St., Brockton.
"Brookville," of Holbrook, No. 197,	William B. Emery, Brookville.	Cora B. Shaw, Howard St., Montello.	Edna G. Bowen, Brookville.
Leominster, No. 198,	James A. Davis, 53 Pleasant St., Leominster.	Ernest D. Hallet, 53 Pleasant St., Leominster.	Miss Bertha E. Hudson, 625 Main St., North Leominster.
Stoughton, No. 199,	Paul S. Jones, 82 Seaver St., Stoughton.	Mrs. Edna F. Tilden, 46 Seaver St., Stoughton.	Mrs. J. M. Spaulding, West Stoughton.
Uxbridge, No. 200,	Howard G. Ramsey, Uxbridge.	Mrs. Kate Thom, Uxbridge.	Mrs. Helen J. Hollis, Uxbridge.
Ashburnham, No. 202,	John L. Livesey, Ashburnham.	Miss Bernice E. Marble, Ashburnham.	Mrs. Sadie M. Fosgate, Ashburnham.
Westminster, No. 203,	Frank W. Derby, Westminster.	Mrs. Mildred L. Nye, Westminster.	Miss Lizzie E. Baker, Westminster, R. F. D. No. 1, Box 40.
Rowley, No. 204,	Harold S. Morong, Rowley, Box 163.	Miss Edna E. Wallis, Rowley, R. F. D. No. 1.	John A. Marshall, Rowley.
"Webster" of Marshfield, No. 205,	Walter I. Seaverns, Marshfield.	Mrs. Lizzie E. Flavell, Marshfield.	Frank T. Harlow, Marshfield.
Tewksbury, No. 207,	Clarence E. Foster, Tewksbury.	G. E. Crosby, Lowell, R. F. D. No. 1.	Mrs. Neil A. Clark, North Billerica, R. F. D. No. 1.
Westford, No. 208,	F. C. Wright, Westford, R. F. D. No. 1.	Miss Martha Grant, Westford, R. F. D. No. 1.	Mrs. F. C. Wright, Westford, R. F. D. No. 1.
Hanson, No. 209,	Dr. A. W. Gorham, North Hanson.	Mrs. Leon F. Estes, South Hanson.	Mrs. Nan S. Harley, South Hanson.
Chicopee, No. 211,	Clinton G. Chapin, 165 Chicopee St., Chicopee.	Miss B. Morehouse, Willimansett.	Mrs. Charles Perry, 262 Chicopee St., Chicopee.
"Oak Hill" of Attleborough, No. 212.	H. L. Clark, Attleborough.	Mrs. E. V. Carpenter, Oak Hill Ave., Attleborough.	Mrs. M. P. Smith, Locust St., Attleborough.
"Massapoag" of Sharon, No. 213,	Sidney P. Hull, Sharon.	Mrs. M. J. Fuller, Sharon, R. F. D.	Mrs. Georgie B. Brown, Sharon.
Walpole, No. 214,	Geo. W. Lowrie, Walpole.	Wm. J. W. Wheeler, Walpole.	Mrs. Carrie C. Snyder, Walpole, Box 372.
Mattapoisett, No. 215,	Dr. Walter E. Blaine, Mattapoisett, Box 251.	Mrs. Etta M. Hiller, East Mattapoisett.	Miss Ella A. Madden, Mattapoisett.
Dracut, No. 216,	Miss Eva C. Blanchard, 688 Pleasant St., Dracut.	Mrs. Clara E. McPhail, Dracut.	S. Howard Chase, 97 18th St., Lowell.
Norton, No. 218,	Howard F. Woodward, Norton.	Harry E. Gardner, Norton.	Miss Nellie H. Lincoln, Norton.
East Princeton, No. 219,	Perley Aldrich, East Princeton.	Calvin A. Drury, Princeton.	Mrs. Alwilda Drury, Princeton.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Sunderland, No. 220,	William P. Abbey, Sunderland.	Ralph B. Brown, Sunderland.	Miss Adaline M. Clark, Sunderland.
"Anawan" of Rehoboth, No. 221,	Frank L. Thomas, Rehoboth.	Mrs. Jennie C. Smith, Rehoboth.	Mrs. Elmie G. Fuller, Attleborough, R. F. D. No. 1.
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Billerica, No. 223,	Mrs. Lulu M. Hutchins, Billerica.	Forrest F. Collier, Billerica.	Josiah C. Folsom, Billerica.
Sheffield, No. 224,	Zacheus H. Cande, Sheffield.	Mrs. A. V. Palmer, Sheffield, R. F. D.	George A. Scott, Sheffield.
Williamsburg, No. 225,	John A. Breckenridge, Williamsburg.	Mrs. R. A. Warner, Williamsburg.	Luther H. Warner, Florence.
West Medway, No. 226,	Ralph W. Hunter, West Medway.	Miss Eva M. Jackson, West Medway.	Mrs. Hattie A. Blake, West Medway.
Heath, No. 227,	H. E. Stetson, North Heath.	Mrs. A. S. Charlton, Heath.	E. P. Dickinson, Heath.
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Cochituate, No. 229,	Sidney Loker, Cochituate.	Warren L. Bishop, Cochituate.	Mrs. Gertrude D. Bishop, Cochituate.
Taunton, No. 230,	Edwin L. Lewis, 15 Fisher St., Taunton.	Mrs. E. L. Lewis, 15 Fisher St., Taunton.	Geo A. Hart, 206 County St., Taunton.
"Ponkapoag" of Canton, No. 231,	Miss Isabelle McIntyre, 168 River St., Mattapan.	Walter W. Shaw, Ponkapoag.	Joseph W. Farwell, Canton Corner.
Plainfield, No. 232,	Charles A. Williams, Plainfield.	Mrs. Charles F. Dunham, Plainfield	Mrs. N. K. Lincoln, Plainfield.
Lexington, No. 233,	L. C. Sturtevant, Lexington.	S. P. Robertson, Lexington.	Mrs. E. M. Hutchinson, Lexington, R. F. D. No. 2.
Newbury, No. 234,	C. Stanley Harrison, 52 East High St., Newburyport.	Miss Ethel L. Chase, Curzon Mill Road, Newburyport.	Miss Marcia E. Little, 4 Green St., Newburyport.
Oakham, No. 235,	Wm. Bullard, Oakham.	Mrs. Ellen Tottingham, Oakham.	Miss Sarah Butler, Oakham.
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Bradford, No. 238,	Howard Kimball, Ward Hill, R. F. D.	Miss Lizzie D. Hunt, 25 Washington Sq., Haverhill.	Mrs. Grace F. Pierce, 4 New St., Bradford.
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Rutland, No. 242,	Harlan P. Bliss, Rutland.	Mrs. Sarah J. Munroe, Rutland.	Mrs. Frances P. Hanff, Rutland.
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Chelmsford, No. 244,	Walter B. Bullock, Chelmsford.	Frank J. Lupien, Chelmsford.	Harlan E. Knowlton, Chelmsford.
Greenwich, No. 245,	C. F. Tyler, Ware, R. F. D. No. 3.	Mrs. Eliz. C. Sawtelle, Greenwich.	Mrs. J. E. Lincoln, Greenwich Village.
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Wendell, No. 248,	C. M. Ballou, Wendell.	Mrs. Mary Glidden, Wendell.	Mrs. Grace Oliver, Wendell.
Baldwinsville, No. 249,	George H. Smith, Otter River.	Alberto W. Small, Baldwinsville.	Mrs. Ernestine Smith, Otter River.
Everett, No. 250,	Earl B. Wheeler, 129 Glendale St., Everett.	Wayland F. Dorothy, Everett.	C. E. Dinslow, 116 High St., Everett.
West Tisbury, No. 251,	James F. Adams, West Tisbury.	Mrs. Hepsa A. Look, West Tisbury.	Frederick G. Vincent, West Tisbury.
"Wachusett" of Leominster, No. 252.	Frank G. Foster, 62 Church St., Leominster.	Mrs. Jennie M. Vinton, Monument Sq., Leominster.	Charles H. Lane, 56 Church St., Leominster.
Halifax, No. 253,	George Estes, Halifax.	Mrs. Wilson G. Harlow, Bridgewater, R. F. D.	Mrs. Nettie Simpson, Halifax, R. F. D. No. 1.
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New Salem, No. 256,	F. D. Coggswell, New Salem.	Mrs. W. J. Whitaker, New Salem.	Miss Hattie M. Bliss, Millington.
Rochester, No. 257,	George T. Parker, Acushnet.	Mrs. Maude G. Barnes, Marion, R. F. D.	A. G. Ashley, Marion, R. F. D.
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Acton, No. 259,	Wm. H. Kingsley, Acton.	Mrs. Nelson H. Tenney, South Acton.	Miss Ella L. Miller, North Acton.
Dennis, No. 260,	Frank B. Howes, Dennis.	Frank E. Howes, Dennis.	Nathan Crowell, East Dennis.
East Charlemont, No. 261,	O. J. Hager, East Charlemont.	Mrs. Florence Butler, East Charlemont.	Miss Inez G. Temple, East Charlemont.
Braintree, No. 262,	George M. Mosher, South Braintree, Box 103.	Dr. J. Wm. Watson, 1010 Washington St., South Braintree.	Mrs. Salome Sandford, 405 Franklin St., South Braintree.
Danvers, No. 263,	Walter H. Brown, West Peabody, R. F. D.	Clarence E. Burnham, 164 Hobart St., Danvers.	Mr. Loring B. Goodale, 90 Center St., Danvers.
"Quinobequin" of Medway, No. 264,	Charles R. Adams, Medway.	Orion T. Mason, Medway.	Mrs. Cynthia C. Albee, Medway.

Massachusetts Patrons of Husbandry — *Concluded.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Great Barrington, No. 265,	Frank Freehan, Great Barrington.	Frank A. Minkler, Great Barrington.	Charles T. Kellogg, Great Barrington.
Peru, No. 266,	Wm. H. Cullitt, Peru.	Mrs. Mary Hadlock, Peru.	C. M. Hathaway, Peru.
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Wakefield, No. 293,	Robert C. Atkinson, 297 Salem St., Wakefield.	Darius Hadley, Salem St., Wakefield.	Mrs. Ida F. Miller, 18 Lawrence St., Wakefield.
Georgetown, No. 294,	J. Winfred Yeaton, Georgetown, R. F. D. No. 1.	Mrs. Clara Illsley, Georgetown, R. F. D. No. 1.	Irving C. Wilkins, Georgetown, R. F. D. No. 1.
Stockbridge, No. 295,	Peter I. Adams, Housatonic.	Charles S. Babcock, Stockbridge.	S. Albert Noble, Stockbridge.

INDEX.

INDEX.

Public Document No. 31

TWENTY-THIRD ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

PART I.,

BEING PART III. OF THE FORTY-EIGHTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1911.

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1911.

Approved by

The State Board of Publication.

TWENTY-THIRD ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

PART I.

DETAILED REPORT OF THE EXPERIMENT STATION.

INTRODUCTION.

In accordance with the provision of the act of the Legislature relative to the publication of the reports of the Massachusetts Agricultural College, the report of the experiment station, which is a department of the college, is presented in two parts. Part I. contains the formal reports of the director, treasurer and heads of departments, and papers of a technical character giving results of experiments carried on in the station. This will be sent to agricultural colleges and experiment stations and to workers in these institutions, as well as to libraries. Part I. will be published also in connection with the report of the Secretary of the State Board of Agriculture, and will reach the general public through that channel. Part II. will contain papers of a popular character, and will be sent to persons on our mailing list.

WM. P. BROOKS,
Director.

CONTENTS.

Part I.

MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

TWENTY-THIRD ANNUAL REPORT.

PART I.

ORGANIZATION.

Committee on Experiment Department.

Station Staff.

WILLIAM P. BROOKS, Ph. D., Director, 28 Northampton Road.
JOSEPH B. LINDSEY, Ph. D., Vice-Director, 47 Lincoln Avenue.
FRED C. KENNEY, Treasurer, Mount Pleasant.
CHARLES R. GREEN, B.Agr., Librarian, Mount Pleasant.

Department of Plant and Animal Chemistry.

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FRED W. MORSE, M.Sc., Research Chemist, 44 Pleasant Street.
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EDWIN F. GASKILL, B.Sc., Second Assistant, North Amherst, Mass.

Department of Horticulture.

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GEORGE H. CHAPMAN, M.Sc., Assistant Botanist, 13 Fearing Street.
SUMNER C. BROOKS, B.Sc., Assistant Botanist, 28 Northampton Road.

Department of Entomology.

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BURTON N. GATES, Ph.D., Apiarist, 42 Lincoln Avenue.
ARTHUR I. BOURNE, B.A., Assistant in Entomology, 66 North Pleasant Street.

Department of Veterinary Science.

JAMES B. PAIGE, B.Sc., D.V.S., Veterinarian, 42 Lincoln Avenue.

Department of Meteorology.

JOHN E. OSTRANDER, A.M., C.E., Meteorologist, 35 North Prospect Street.
CHARLES M. DAMON, Observer, Massachusetts Agricultural College.

Other Officers of the Experiment Station.

Miss ROSE J. BROWN, Secretary to the Director, Draper Hall.
Miss JESSIE V. CROCKER, Stenographer, Department of Botany and Vegetable Pathology, Sunderland, Mass.
Miss HARRIET COBB, Stenographer, Department of Plant and Animal Chemistry, 35 North Pleasant Street.
Miss BRIDIE O'DONNELL, Stenographer, Department of Entomology, Hadley, Mass.
Miss ALICE M. HOWARD, Stenographer, Department of Plant and Animal Chemistry, North Amherst, Mass.

REPORT OF THE DIRECTOR.

Changes in Staff.

The experiment station staff during the past year has suffered the loss of two of its oldest and strongest men: Dr. C. A. Goessmann, who died in September, and Dr. C. H. Fernald, who retired on a Carnegie pension at about the same time.

Dr. Goessmann had been connected with the experiment station from the very first inception of station work in the State, in 1882. He was director of the State Experiment Station until it was combined with the station later organized under the Hatch act, in 1895. Dr. Goessmann, however, although giving up his duties as director at that time, retained active supervision of the inspection of commercial fertilizers and the general work in the fertilizer and soil laboratory until his retirement in 1907. Subsequent to retirement he was retained as consulting chemist, and continued his active interest in the station and its work until almost the end of his life. Goessmann was one of the great pioneers in the work of agricultural investigation. It seems eminently fitting, therefore, to present at this time a brief account of his life and work. Dr. J. B. Lindsey, vice-director and chemist of the station, one of Dr. Goessmann's pupils, peculiarly fitted through long and close association with him to write such an account and estimate, has at my request kindly prepared a tribute which will be found in following pages.

Dr. Charles H. Fernald, head of the entomological department of the college and station, became connected with the station work at the time of organization under the Hatch act, and continued at the head of the entomological department until his retirement, the first of September last. Dr. Fernald's work was of great value to the station. Of him, as of Goessmann, it is largely true that to a considerable extent his work was of a pioneer character. He was one of the earliest station entomologists, and as such he had much to do with the establishment of a general policy for station entomological work. It was in considerable measure due to his influence that the policy that original descriptions of insects should not be published in ordinary station bulletins was adopted. During the early years of his station activities he devoted a large amount of time to the study of the gypsy moth, and the recognition of this insect and the scientific work connected with it were due to his efforts. His work in connection with the gypsy moth greatly strengthened the entomological department of the station, and resulted in making its work better understood and appreciated. Dr. Fernald's bulletin on household insects is believed to have been the first of its kind; but the value of such work was promptly recognized. His monograph papers, which have been published as station bulletins, are constantly quoted as standard works on the subjects of which they treat. He was the first to undertake investigations on cranberry insects, and the work he did in relation to them proved of great value to cranberry growers. His work in systematic and economic entomology has been extensive, and he instituted numerous lines of investigation which have since been greatly extended and developed by others better situated to prosecute them. While Professor Fernald did a very large amount of strong original work, I think it will be generally admitted by those who know him and his influence that his greatest work was in the line of stimulating others by his personality to accomplish what he himself had no opportunity to do.

The death of Dr. Goessmann did not involve important changes in the chemical department as his services during the past few years had been simply advisory, and, owing to failing health, largely nominal during the last year or two.

On the retirement of Dr. C. H. Fernald, his son, Dr. H. T. Fernald, was made head of the entomological department. The retirement of the elder Fernald imposed additional duties on his son, and some reorganization of the department became necessary. Mr. John N. Summers, a graduate assistant, who had been giving one-half his time to the experiment station, retired, and in his place, Mr. A. I. Bourne, B. A., who has had a valuable experience in graduate and investigational work, was made assistant. Mr. Bourne is allowed a certain amount of time for graduate study, but he will give nearly all his attention to the work in the experiment station. His employment relieves Dr. H. T. Fernald of almost all of the routine work of the entomological department, and of the necessity of giving direct personal attention to the experimental work in its simpler phases. This will make it possible for Dr. Fernald to devote a very large proportion of his time to research work in entomology.

In this connection attention should be called to the extremely valuable work which Mrs. C. H. Fernald, with some clerical assistance, carried on for a period of more than twenty years, in editing the index cards with references to entomological literature. The work of Mrs. Fernald has been characterized by extreme accuracy and thoroughness, and up to the present time no less than 50,000 cards, with many times that number of references, have been prepared. A large proportion of the entries on these are in Mrs. Fernald's own hand. Advancing years have led Mrs. Fernald to desire to be relieved of this work, so important to all investigators in all lines of entomology, and arrangements have been completed whereby it will be continued under Dr. H. T. Fernald's supervision by his stenographer and clerk, Miss O'Donnell.

The retirement of Dr. R. D. MacLaurin, referred to in my last annual report, left a vacancy in the research division of the chemical department. This place was filled in January by the temporary appointment of Fred W. Morse, Ph.D., for many years chemist of the New Hampshire Experiment Station. His appointment was made permanent in July. Mr. Morse is devoting himself entirely to research problems connected with the nutrition of crops and the productive capacity of soils.

The staff of the station has been strengthened by the addition of two men; David W. Anderson, B.Sc., has been made graduate assistant in the department of horticulture; Sumner C. Brooks, B.Sc., has been made assistant in the department of botany and plant pathology. The appointment of these men relieves their superiors in these departments of routine work, and will enable them to devote their time in larger measure to research.

The work of the station has been broadened in scope and further strengthened by the appointment of Dr. B. N. Gates, Ph.D., as apiarist. It is the expectation that Dr. Gates will devote about one-quarter of his time, so far as possible consecutively, to research work on problems connected with beekeeping.

Mr. James Alcock replaces Mr. Roy Gaskill in charge of the animals used in feeding and digestion experiments, and Clement L. Perins, B.Sc., has taken the place of Carl D. Kennedy as assistant in the chemical laboratory.

Lines of Work.

There has been no essential change in the character of station work during the year. It covers a field of constantly broadening scope and increases steadily in amount. As heretofore, our efforts may be classed under the following principal heads: general experiments, research, control and dissemination of information.

The relation of the lines of work which come under the last class to the possibility of adequate attention to and of financial support for the experiment and research, for carrying on which the funds for the support of the station which come from the federal government are designed, is so vital that while in logical sequence these lines of work would seem to come last, they will be considered first.

Dissemination of Information.

The principal methods whereby the station now endeavors to serve the public by dissemination of information are by means of its publications, through private correspondence, through lectures by members of its staff and by demonstrations.

Publications. — Our publications are of three kinds, an annual report in two parts, bulletins and circulars. The following tables show the publications of the year 1910 and those still available for distribution: —

Publications during 1910.

Annual report: —

Parts I. and II. 338 pages.

Bulletins: —

No. 132. Inspection of Commercial Feed Stuffs, P. H. Smith and J. C. Reed. 64 pages.

No. 133. Green Crops for Summer Soiling, J. B. Lindsey. 20 pages.
No. 134. The Hay Crop, William P. Brooks. 68 pages.
No. 135. Inspection of Commercial Fertilizers, H. D. Haskins, L. F. Walker and J. F. Merrill. 76 pages.

Meteorological bulletins, 12 numbers. 2 pages.

Circulars:

No. 26. Fertilizers for Potatoes, William P. Brooks. 4 pages.
No. 27. Seeding Mowings, William P. Brooks. 8 pages.
No. 28. Rules relative to Testing Dairy Cows. 8 pages.
No. 29. Chemical Analysis of Soils, William P. Brooks. 4 pages.

Miscellaneous circulars (unnumbered): —

Fertilizers for Corn, William P. Brooks. 2 pages.
Home-mixed Fertilizers, William P. Brooks. 4 pages.
Fertilizers for Turnips, Cabbages and Other Crucifers, William P. Brooks. 2 pages.
Dairymen losing Money on Low-grade Feeds, J. B. Lindsey. 2 pages.
Orchard Experiment, William P. Brooks. 2 pages.
Summer Soiling Crops, P. H. Smith. 1 page.
Balanced Rations for Business Cows, J. B. Lindsey. 2 pages.
Corn for the Silo. 2 pages.

Publications Available for Free Distribution.

Bulletins: —

No. 33. Glossary of Fodder Terms.
No. 68. Fertilizer Analyses.
No. 76. The Imported Elm-leaf Beetle.
No. 83. Fertilizer Analyses.
No. 84. Fertilizer Analyses.
No. 89. Fertilizer Analyses.
No. 90. Fertilizer Analyses.
No. 103. Fertilizer Analyses.
No. 113. Fertilizer Analyses.
No. 115. Cranberry Insects.
No. 121. Seed Separation and Germination.
No. 123. Fungicides, Insecticides and Spraying Directions.
No. 124. Bee Diseases in Massachusetts.
No. 125. Shade Trees.
No. 126. Insects Injurious to Cranberries and how to fight them.
No. 127. Inspection of Commercial Fertilizers, 1908.
No. 130. Meteorological Summary — Twenty Years.
No. 131. Inspection of Commercial Fertilizers, 1909.
No. 132. Inspection of Commercial Feed Stuffs, 1910.
No. 133. Green Crops for Summer Soiling.
No. 134. The Hay Crop.
No. 135. Inspection of Commercial Fertilizers, 1910.

No. 136. Inspection of Commercial Feed Stuffs, 1911.
Technical Bulletin No. 2. The Graft Union.
Technical Bulletin No. 3. The Blossom End Rot of Tomatoes.
Index to bulletins and annual reports of the Hatch Experiment Station previous to June, 1895.
Index to bulletins and annual reports, 1888–1907.
Annual reports: 10th, 11th, 12th, 13th, 14th, 15th, 16th, 17th, 20th, 21st, Part II., 22d, Parts I. and II.

So far as our publications treat primarily of the results of station observation, experiment and research, they are to be looked upon as a necessary and important feature of station activity, — indeed, to be the crowning result of such activity; but the demand for bulletins and circulars of information of a general character, already widespread, is most active, insistent and growing, and the force of circumstances has seemed to compel us to make at least some effort to meet it. To fully do so has been impossible; indeed, must probably be recognized as in the very nature of things always likely to remain so, since nothing less than a complete library covering every conceivable agricultural topic would enable us to meet the demand.

A considerable share of the contents of the popular part of our annual report (Part II.), most of our circulars and some of our bulletins have, however, aimed to furnish information of a more or less general character on topics of immediate interest to the public. These papers have, it is true, been based upon our own observations and experiments in so far as possible, and to that extent are to be regarded as legitimate station publications. To a considerable extent, however, they are of a general character. United States funds cannot be used in their publication, and since the demands for other purposes upon the relatively small appropriation which comes to the station from the State are heavy, and since, further, furnishing this literature is rather extension than experiment, provision to carry the costs should be made in the extension department of the institution.

Circulation of Publications. — In accordance with an act of our Legislature Part I. of our annual report is printed with the report of the secretary of the State Board of Agriculture, and those on the mailing list of that Board will receive this publication. Five thousand copies of Part I. of our annual report also are furnished to the station. These are sent to libraries and directors of agricultural experiment stations, to presidents and libraries of agricultural colleges, to the public libraries of Massachusetts, and all other libraries on our mailing list, to the mailing list of the United States Department of Agriculture and to those on our exchange list. This part of our annual report contains technical monographs giving the results of research work, and a large number of copies are reserved to meet future demands. Part II. of our annual report, which contains the more popular papers, and our bulletins are sent to all those on our general mailing list, to the public libraries of the State, to those on the mailing list of the United States Department of Agriculture likely to be interested, and to experiment stations and agricultural colleges. It is our aim to reserve a considerable number of each publication to meet subsequent demands, but the demand has grown so rapidly that the supply of most, as will be noted from the above list of available publications, has been exhausted. The meteorological bulletins are sent only to agricultural college and experiment station libraries, presidents and directors, to the Department of Agriculture and Office of Experiment Stations, to newspapers and to libraries and individuals who have especially requested them.

Our circulars are printed for use in connection with the correspondence of the station. It is only by the use of such circulars that we are able to give information and advice on the many problems on which we are consulted. These circulars are sent only as above stated or on request. An abstract of all important publications is furnished to the press, and requests for any issued will be met as long as the supply permits.

During the past year the revision of our general mailing list has been completed. As a result, 1,502 names were dropped from the list. The additions of the year have numbered 1,663 names. The total numbers on our general list and on the few special lists are shown by the following: —

Residents of Massachusetts, ...	13,361
Residents of other States, ...	2,381
Residents of foreign countries, ...	223
Newspapers, ...	524

Libraries,	292
Exchanges,	137
Cranberry growers,	1,437
Beekeepers,	2,638
Meteorological,	379

Correspondence. — The correspondence with private individuals who seek information or advice grows constantly and rapidly. During the year 1910 the number of letters of inquiry answered by the members of the station staff was 16,650. Replies to many of these involve investigation, and the demands upon the college and station men giving attention to this work are heavy and growing. There can be no doubt that such work is most helpful; numerous letters of appreciation testify to this fact. The work should be continued, but it is neither experiment nor research. It is rather a branch, and a most important one, of the extension propaganda, and should be provided for in that department.

Lectures and Demonstrations. — The demand for lectures and demonstrations by members of the station staff has much increased during the year. Relatively few of the requests for such services have been accepted. The number of such engagements met during the year has been 48. Work of this kind properly comes under the head of extension service, and yet as it helps in some measure to keep the station men, whose duties are for the most part of a character which keeps them closely confined, in touch with the public and its most vital problems, these opportunities are accepted in so far as is consistent with proper attention to the prosecution of those investigations and studies for which especially the station is maintained.

Future Provision for Extension Work. — The facts stated concerning the various lines of work which have for their object the dissemination of information must have made it apparent that this work now makes very heavy demands upon the time of station men. It already encroaches upon resources which would more properly be devoted to experiment and research. The authorities in Washington charged with the general oversight of the methods of expenditure of United States funds are most zealous, and rightly so, in their efforts to prevent the diversion of these funds from the uses for which they are intended. The funds appropriated to the station by the State are not sufficient to cover this line of work and at the same time to provide funds to pay the costs of other lines of work now in progress which should be continued.

The desired relief may be obtained either by transfer of the lines of work under consideration to the extension department of the institution, or by the appropriation of funds from that department to cover the cost of employing competent secretarial assistants. The latter plan would, for a time at least, seem to have advantages, as with secretarial assistance the members of the station departments whose experience gives them the best foundation for it would be able to direct the work and to exercise a close oversight over it.

General Experiments.

Under this class are included a large number of experiments relative to the following subjects: soil tests with fertilizers, with different crops in rotation; comparisons of different materials which may be used as sources, respectively, of nitrogen, phosphoric acid and potash for different field and garden crops; the results of the use of lime; systems of fertilizing grass lands, both mowings and pastures; comparisons of fertilizers for both tree and bush fruits; different methods of applying manures; variety tests of field and garden crops and of fruits; trials of new crops; determinations of the digestibility of feedstuffs; methods of feeding for milk; systems and methods of management in feeding poultry for eggs; and co-operative work with selected farmers in the trial of crops and systems of fertilizing them. Few of these lines of experiment call for special comment here. Brief reports on some of them will be found under the departments in which they are being prosecuted.

Particular attention is directed to the fact that the plots used in the various experiments, involving the highly varied use of manures and fertilizers, and the many comparisons in progress, become increasingly valuable with the passing years. Many of these plots have been under definite and differing manurial treatment for periods of time ranging from twelve to twenty-one years. They have taught many important lessons. If undisturbed, they will teach many more. They are teaching new lessons yearly as to the ultimate effects of differing treatments.

These facts are pointed out because the development of the institution on its educational side appears to threaten the integrity of important series of plots. They cannot, of course, be moved, nor indeed, in any true sense, can they be replaced. It is urged, therefore, that their value and the extreme undesirability of disturbing them be recognized in all plans for future growth and development.

Co-operative Experiments with Alfalfa. — During the past year thirty-three experiments with alfalfa have been made in ten different counties. Arrangements were completed for one experiment also in each of the counties Barnstable, Bristol and Dukes, but local conditions prevented the carrying out of the plans formed. Northern-grown seed treated with farmogerm for inoculation with nitrogen-fixing bacteria was used. The following extract from the directions sent to co-operating farmers will indicate what is believed to be a satisfactory method of preparing for the crop: —

(1) Plow in spring just as soon as possible after the ground can be worked.

(2) Apply lime at the rate of about 1½ tons to the acre and disk in at once.

(3) About ten days later apply the following mixture per acre: basic slag meal, 1,500 pounds, high-grade sulfate of potash, 400 to 500 pounds, and disk that in.

(4) Thereafter harrow about once in ten to twelve days, until you are ready to sow the seed, which should not be later than about July 27.

(5) When ready to sow the seed, apply per acre: nitrate of soda, 100 pounds, basic slag meal, 300 pounds, mixing them, and harrowing in lightly.

(6) Sow 30 pounds of seed per acre, in showery weather if possible, and cover as you would grass seed.

The fall months were exceptionally dry and therefore somewhat unfavorable, but in most cases the crops made a good start and went into the winter in good condition, having made sufficient growth to afford the needed protection.

Research.

More research work has been done in the station during the past year than in any previous year of its history. The additions to our staff which have made this possible have already been referred to. Work still continues upon the various research problems which have been mentioned in earlier reports,[1] but the studies of Pyralidæ and Tortricidæ which Dr. C. H. Fernald has been conducting have been nearly brought to a conclusion, and the results in part already privately published.[2] The scope of our research work has been broadened during the year by the addition of two new lines of work, *i.e.*, an investigation of the solubility effect of ammonium sulfate on the soil of field A; and color vision in bees. The progress made in most of these lines of investigation has been satisfactory, but there has been some interruption on account of moving the entomological work into the new building, and on account of ill health of members of our staff, apparently due to overwork. In both departments in which such interruption has occurred changes (already referred to) have been made, including the provision of an additional assistant in each, which, it is believed, will make it possible to push the work of investigation more rapidly.

In the later pages of this report will be found a number of valuable technical papers based upon some of the investigations in progress. The more important of these are as follows: —

Studies in Milk Secretion.
The Determination of Arsenic in Insecticides.
The Purification of Insoluble Fatty Acids.
The Soluble Carbohydrates in Asparagus Roots.
Abnormalities of Stump Growth.
Climatic Adaptations of Apple Varieties.

The progress which has been made in our work with asparagus and cranberries, and the greatly increased facilities for

[1] For full list see Part I., twenty-second annual report.

[2] On the Dates of Jacob Hübner's Sammlung europäischer Schmetterlinge and Some of His Other Works, C. H. Fernald, Ph. D., author and publisher; The Genera of the Tortricidæ and their types, C. H. Fernald, Ph.D., author and publisher.

investigation in the interest of cranberry growers, are made the subjects of special comment which follows.

Asparagus Substation, Concord.

The details of the work in progress in the substation, maintained in the interest of asparagus growers in Concord, have been carefully looked after by Mr. Charles W. Prescott, to whom, as heretofore, we are greatly indebted for his lively interest and efficient supervision. The work has already given results of much interest, and is likely, I believe, to prove of great value. It will be remembered that it follows two rather distinct lines: (1) breeding experiments, with the hope of producing a rust-resistant type of asparagus; (2) fertilizer experiments, designed to throw light upon the special plant food requirements of the crop.

Breeding Experiments. — In the breeding work which is done at Concord the station is fortunate in enjoying the co-operation of the Bureau of Plant Industry of the United States Department of Agriculture. Mr. J. B. Norton of the Bureau has been assigned by Dr. B. T. Galloway to look after the asparagus breeding experiments. It is a pleasure to testify to the enthusiasm and faithful attention of Mr. Norton, who has not only most energetically prosecuted the breeding work, but has proved of much assistance in making observations and records on the fertilizer plots.

A very large number of crosses between selected plants have been made, and among these different crosses a few have resulted in offspring which seem to be almost absolutely immune to rust. These plants will be propagated and seed raised from them as rapidly as possible, with the object of producing stock for trial upon a more extended scale. If, however, the plants produced by some of the crosses continue to show the immunity exhibited by the seedlings, and if they have, as may be anticipated, the capacity to transmit their characteristics, a very gratifying forward step has certainly been made, and we may confidently anticipate complete success in attaining the end in view. At as early a date as possible, seed and young plants will be produced in quantities sufficient for trial by growers in different localities.

Fertilizer Experiments. — It remains true, as was stated to be the case in earlier reports concerning these experiments, that the growth and development of the crops, even upon the no fertilizer plots, owing to the very thorough preparation which the soil received, is still remarkably vigorous. Naturally, therefore, the varying fertilizer treatment does not as yet show the differences which may be confidently looked for. A few points, however, seem to be sufficiently well established to deserve mention.

The field contains 40 plots of one-twentieth acre each. The crop of 1910 was rather seriously injured by frost, but it was nevertheless fairly satisfactory as to quantity and quality. The past season was the fourth since the plants were set. The first cutting was made on April 23, the last on June 29. The total yield of all the plots was 9,020 pounds and 6 ounces.

Attention is called to the following conclusions, based upon results, as of possible interest: —

(1) The use of fertilizer made up of a combination of nitrate of soda, acid phosphate and muriate of potash, in addition to an application of manure at the rate of 10 tons per acre, has not materially increased the crop in whatever quantity applied.

(2) The use of nitrate of soda in addition to manure at the rate above named, in quantities ranging between the rate of from 311 pounds to 622 pounds per acre, has not increased the crop.

(3) The use of nitrate of soda in addition to a fairly liberal application of acid phosphate and muriate of potash has somewhat increased the crop, but a quantity in excess of 311 pounds has not resulted in further increase.

Chemical Work on Asparagus Roots. — It is a part of the plan of the experiments with fertilizers to study the effects of varying treatment upon the composition of the roots. This investigation on the chemical side is being carried on by Prof. F. W. Morse, who will in due time report fully upon the results of the analytical work. It was thought that a study of the reserve material stored in the roots in the autumn might offer results of especial interest and importance, and although the investigation is not yet completed, this expectation has been largely realized. The special object in view in the first collection of roots made was to study the effect of the varying use of nitrogen in the form of nitrate of soda upon the reserve material in the roots in the autumn. The following points appear to have been well established by the analyses so far made: —

The amount of nitrogen in the roots in the fall: (1) is increased by application of nitrate of soda; (2) is greater where nitrate was used at the rate of 466 pounds per acre than where it was used at the rate of 311 pounds per acre; (3) is not greater where the nitrate of soda was used at the rate of 622 pounds per acre than where it was used at the rate of 466 pounds per acre.

It is believed, although this has not yet been proved, that the crop of the following season must bear a rather close relation to the amount of reserve material in the roots in the fall. If this be so, and if further investigation gives results in agreement with those already obtained, the conclusion that the use of nitrate of soda among our growers is not infrequently in excess of the most profitable quantity would appear to be justified. This conclusion should, however, for the present be regarded as tentative rather than fully established.

Cranberry Substations.

During the past year our work in the interest of cranberry growers has been put upon a much more satisfactory basis than heretofore, through a special appropriation by the Legislature to provide for the work. The amount of this appropriation was $15,000. A bog containing about 12 acres, lying near Spectacle Pond in East Wareham, with a small amount of adjoining upland, two small buildings and a powerful gasoline engine and pump, were purchased for $12,600. A building to contain screen and storage rooms, living and office rooms for an assistant, and a small laboratory will be erected early this year at a cost of about $2,000. The balance of the appropriation will be used for the purchase of additional upland to provide readier access to the building above referred to, in the making of needed improvements in the pumping machinery and in preparations for experiments.

The cranberry bog purchased is planted with Early Black and the Howe varieties. It lies a little above the usual level of the water in Spectacle Pond, the lift required to flood it usually varying between about 3 and 4 feet. The capacity of the power and pumping machinery is such that the bog can be completely flooded in about six hours. The area of Spectacle Pond is nearly 100 acres, and the supply of water is constant and abundant. Being a "great pond" the waters are under State control. Only one other bog, and that a relatively small one, draws water from the pond, so that there must always be water enough for any possible need for all kinds of experimental work. The bog when purchased was in exceptionally perfect condition. It is one which has the reputation of more than average fruitfulness. The crop last year, as was the case with most of the bogs in the cranberry districts of Massachusetts, was moderate, and the net revenue derived from it was small. It is, however, confidently anticipated that the product of the bog will, over a series of years, be sufficient to produce a considerable net income, which will be used in helping to meet the expenses connected with our experimental work. The crop of the past season brought $1,255 more than the costs of ordinary maintenance, harvesting, packing, etc. The net sum available towards the costs of experimental work, however, was substantially $100 less than this, that being the amount which we were compelled to pay for taxes, since the bog had not been the property of the Commonwealth on the first of May.

It will be remembered that our cranberry work thus far has followed two principal lines of inquiry relating (1) to the fertilizer requirements of the crop; (2) to insects affecting it.

Fertilizer Experiments. — The fertilizer experiments begun four years ago in Red Brook bog at Waquoit have been continued. The bog, however, gave only a very small crop during the past season, — a result which we believe to have been due in large measure to the effects of frost. The variations in yield caused by uneven amount of frost damage were so great that it was impossible to draw conclusions as to the specific effects of the different fertilizer combinations. The fertilizer experiments in the Red Brook bog at Waquoit will be continued during next year, but meanwhile similar experiments will be begun in the Spectacle Pond bog. It is believed that it will be best to discontinue the Waquoit experiments after next year, since they lie at such a distance from the station bog in Wareham as to make proper attention to the work somewhat difficult and expensive.

Insect Work. — Dr. Franklin has devoted himself with great enthusiasm and faithfulness to observations and studies on the insects having a relation either injurious or beneficial to the cranberry industry. He has accumulated a large amount of valuable data, but his work is not advanced to the point where publication seems called for.

Control Work.

Detailed reports concerning the various lines of control work carried on by the station, prepared by the chemists in charge, will be found in the later pages of this report.

Fertilizer Law. — We have found it impossible during the past few years to exercise an efficient control over the trade in fertilizers and to publish the reports without expending an amount exceeding the sum brought in by the analysis or license fees required by our law. The expenditure in 1909 exceeded the amount of the license fees to the amount of nearly $1,000. To provide for this excess expenditure by the use of other station funds seriously reduces the amount available for experimental work. Accordingly, the amount of analytical work in connection with the fertilizer control during the past year has been somewhat restricted, and the size of the bulletin giving the results has been reduced. These reductions, while for the time being necessary, are undesirable, and for this reason, as well as for other important reasons, it has been decided to ask for a revision of our fertilizer law. The preparation of the new draft has required a great deal of study and many conferences with parties affected by the law. The more important of the changes which it provides are an increase in the analysis fee per fertilizer element from $5 to $8, and bringing the various grades of agricultural lime within its scope. The other changes which have been made have been designed to remedy defects from the standpoint of administration which the execution of the old law had disclosed, and to make it more definite and explicit on a number of rather important points. The fertilizer law at present in force requires us to publish the dealer's cash price and the percentage of difference between this price and the commercial valuation of the fertilizer. It is not proposed to retain this provision in the new law, as it is felt that it is on the whole likely to prove misleading to the farmer, almost inevitably unfair to dealers, and from no point of view apparently serves any important use.

Dairy Law. — Much time has been spent during the past year also in studying and rewriting the so-called dairy law. Besides various perfecting changes, the most important modification is to bring milk inspectors and the Babcock machinery and apparatus which they use within the scope of the law. There would seem to be equal reason that steps should be taken to insure accuracy of work on the results of which, if unfavorable, the milk dealer or farmer may be prosecuted for infringement of one of our State laws, as for bringing those testing milk and cream for determining its value within the scope of the law.

Feed Law. — The increasing number of feedstuffs in our markets, and the increased extent to which materials of complex character are purchased and used by our farmers, have greatly increased the amount of work required to exercise effective control over the trade in feedstuffs, and we find it to be impossible at the present time to properly execute the law and to publish the results of our inspection for the sum of money provided by the State legislative appropriation for the purpose. It will be necessary, therefore, in the near future, to ask for a revision of this law. The amount of the appropriation should be moderately increased to provide for the much greater amount of work now required than was necessary when the amount of the appropriation was fixed some eight years ago. In the case of this law, also, practical experience in its execution has made it apparent that some perfecting amendments are necessary in order that it may operate smoothly and effectively.

Inspection of Apiaries.

The great desirability of the passage of a law providing for the inspection of apiaries, with a view to the eradication and control of contagious diseases of bees, was set forth at some length in my last annual report. It seems proper, therefore, in this report to refer to the fact that the Legislature of 1910 passed such an act. The execution of the law, however, was placed with the secretary of the State Board of Agriculture, but the experiment station and college are working in harmony with the secretary. He has named as inspector of apiaries the apiarist of the college and station, Dr. Burton N. Gates, whose appointment has already been referred to.

Buildings.

The new building for the departments of entomology and zoölogy has been completed during the year and has been occupied since September. It is a commodious, fireproof structure, costing $80,000, and paid for by special appropriation. It provides ample accommodations for the experimental work in entomology. The hothouse, a comparatively new and modern building used in connection with the old insectary for experimental work, has been moved on to new foundations and is connected with the new building.

The necessity for increased accommodations for the research chemical work of the station was pointed out in my last annual report, in which it was stated that plans for enlargement and modification of the old building for the purpose of securing the increased accommodations needed were under consideration. Mature study of the problem as to the best means of providing the needed room, in connection with more exact estimates of the cost of so enlarging and modifying our old laboratory as to meet the requirements, has led to the conclusion that it is unwise to make the relatively large expenditure required for such enlargement and modification. It seems clear that the old building, however enlarged and improved, must still fail to be entirely adequate or satisfactory, and that therefore it is wiser at this time to make only the few absolutely necessary changes, involving relatively little expenditure, leaving full provision for our needs until such time as the State shall grant the money needed for a new building, which the growth of our work will render imperative in the very near future.

WM. P. BROOKS,

Director.

REPORT OF THE TREASURER.

ANNUAL REPORT

OF FRED C. KENNEY, TREASURER OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

For the Year ending June 30, 1910.

The United States Appropriations, 1909–10.

	Hatch Fund.	Adams Fund.
Dr.		
To receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1910, under acts of Congress approved March 2, 1887 (Hatch fund), and March 16, 1906 (Adams fund),	$15,000 00	$13,000 00
Cr.		
By salaries,	$13,184 81	$9,918 15
labor,	264 74	817 05
publications,	49 75	–
postage and stationery,	95 12	19 00
freight and express,	–	13 35
heat, light, water and power,	7 43	149 47
chemical supplies,	–	114 41
seeds, plants and sundry supplies,	250 19	496 08
fertilizers,	348 61	95 01
feeding stuffs,	406 48	–
library,	47 44	6 45
tools, implements and machinery,	–	–
furniture and fixtures,	117 00	328 50
scientific apparatus,	123 75	892 02
live stock,	48 00	–
traveling expenses,	56 68	105 51
contingent expenses,	–	–
building and land,	–	45 00
Total,	$15,000 00	$13,000 00

State Appropriation, 1909–10.

To balance on hand July 1, 1909,	$5,538 50	
Cash received from State Treasurer,	13,500 00	
from fertilizer fees,	5,970 00	
from individuals (cranberry contribution),	544 17	
from farm products,	3,208 73	
from miscellaneous sources,	6,387 84	
		$35,149 24
Cash paid for salaries,	$8,434 28	
for labor,	9,447 30	
for publications,	2,313 60	
for postage and stationery,	928 20	
for freight and express,	381 42	
for heat, light, water and supplies,	341 94	
for chemical supplies,	542 26	
for seeds, plants and sundry supplies,	2,348 15	
for fertilizers,	532 83	
for feeding stuffs,	1,468 03	
for library,	188 46	
for tools, implements and machinery,	26 70	
for furniture and fixtures,	240 95	
for scientific apparatus,	1,018 52	
for live stock,	80 38	
for traveling expenses,	2,299 51	
for buildings and land,	358 33	
Balance,	4,198 48	
		$35,149 24

REPORT OF THE AGRICULTURIST.

WM. P. BROOKS.

The work in the department of agriculture during the past year has been of about the usual scope and extent. The problems which are being investigated are for the most part related to questions connected with the maintenance of fertility. Various questions connected with the selection, adaptation and methods of application of manures and fertilizers are being investigated. Most of our experiments have continued for a considerable number of years. Some indication is afforded of the amount of work in progress by the following statements. The number of field plots on the station grounds used in experiments the past year was 356. Our vegetation experiments have involved the use of 352 pots; while as a check upon the work in the open field, and as a method of throwing light upon a few special problems, 167 closed plots have been used.

No attempt will be made in this report to discuss the work in detail. Attention is called, however, to a few of the more striking results.

1. Comparisons of Different Materials as a Source of Nitrogen.

These experiments, which are carried on in Field A, were begun in 1890. The materials under comparison as sources of nitrogen are manure, one plot; nitrate of soda, two plots; dried blood, two plots; and sulfate of ammonia, three plots. Nitrate of soda and dried blood are used on one plot with muriate of potash; on the other with sulfate. The sulfate of ammonia is used on two plots in connection with muriate and on one in connection with sulfate of potash.

The different materials furnishing either nitrogen or potash are used on the several plots in such amounts as to furnish, respectively, equal quantities per plot of nitrogen and of potash; two of the three no-nitrogen plots which serve as checks receive potash in the form of muriate, the other in the form of sulfate, and all the plots in the field receive an equal liberal application of dissolved bone black as a source of phosphoric acid.

The crops grown in the order of their succession have been: oats, rye, soy beans, oats, soy beans, oats, oats, clover, potatoes, soy beans, potatoes, soy beans, potatoes, oats and peas, corn and clover for the last three years. The clover crop of the past year, as was true of the two preceding years, was considerably mixed with grass. The seed was sown early in August, 1909, and just previous to the sowing of the seed one-half of each of the plots in the field received a dressing of lime, at the rate of a ton and one-half to the acre. It was thought that such an application of lime would increase the efficiency of the sulfate of ammonia as a source of nitrogen, and to some extent this expectation appears to have been realized. The differences, however, between the limed and unlimed halves of the plots were relatively small, and the yields on the two halves were not separately determined.

The best crop of the past year was produced where nitrate of soda was used as a source of nitrogen; but the yields on dried blood and on sulfate of ammonia used in connection with sulfate of potash were not much inferior. On the basis of 100 for nitrate of soda, the relative standing of the different nitrogen fertilizers and the no-nitrogen plots as measured by total yield during the past season was as follows: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	93.73
Sulfate of ammonia,	95.53
Barnyard manure,	94.75
No nitrogen,	91.79

The relative standing of the different materials as indicated by total yield for the twenty-one years during which the experiment has continued is as follows: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	94.07
Dried blood,	92.38
Sulfate of ammonia,	86.87
No nitrogen,	71.96

On the basis of increase in crop as compared with the no-nitrogen plots, the average of the twenty-one years shows the following relative standing: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	78.85
Dried blood,	72.82
Sulfate of ammonia,	53.17

Nitrate of soda has given a much larger increase in crop than any of the other materials, and since the pound cost of the nitrogen of nitrate of soda is usually less than the pound cost in any other chemical fertilizer, the superior economy of its use is apparent.

II. Muriate compared with Sulfate of Potash.

Our long-continued experiments comparing muriate with high-grade sulfate as a source of potash have continued on Field B. It will be remembered that the two potash salts are used in such quantities as to furnish equal actual potash per acre. These experiments were begun in 1892. Five pairs of plots are under comparison. From 1892 to 1899 the potash salts were used in quantities (varying in different years, but always in equal amounts on the two members of pairs of plots) ranging from 350 to 400 pounds per acre. Since 1900 the quantity used has been uniform on all plots, and at the rate of 250 pounds per acre annually. Fine ground bone has been annually applied to each plot throughout the entire period of the experiment, and the rate of application is 600 pounds per acre. The season of 1910 is the nineteenth year of these experiments. The crops during that year were potatoes on one pair of plots, oats on one pair, and asparagus, rhubarb and blackberries. The rates of yield per acre on the different potash salts are shown in the following tables: —

	Rate per Acre (Pounds).		
	Asparagus.	Rhubarb.	Blackberries.
Muriate of potash,	5,604	24,587	2,661
Sulfate of potash,	4,143	25,856	2,821

	Rate per Acre.		
	potatoes (bushels).		Oat Hay (Pounds).
	Merchantable.	Small.	
Muriate of potash,	204.6	11.15	3,716
Sulfate of potash,	255.4	13.02	3,345

These figures call for but little comment, as they are in general in full agreement with results previously obtained. The asparagus gives a larger yield on the muriate of potash, which indicates the correctness of the ordinary practice of asparagus growers, who usually employ the muriate as a source of potash.

The rhubarb gives a slightly larger yield on the sulfate, and it was noticed during this year, as it has usually been in previous years, that the proportion of leaf to stalk is greater on the sulfate than on the muriate, the figures for this year on total weight of leaf being at the following rates per acre: —

	Pounds.
Muriate,	18,410
Sulfate,	20,560

No explanation can at present be offered for this difference.

The blackberries gave a larger yield on the sulfate, but the difference is not great. This, however, is in accordance with our observations in the case of most fruits, strawberries alone excepted, that sulfate of potash gives a better yield than muriate.

The difference in yield in potatoes on the two plots amounts to rather over 50 bushels. Such differences have been common in our experiments in earlier years, not only in this field, but in others as well. The difference in character of foliage of the potatoes on the two plots was strikingly evident from a period very early in their appearance above ground. The foliage of the potatoes on the muriate of potash plots was lighter in color, it may be described as a pea green, while that on the sulfate of potash plot was of a much darker shade. An attempt has been made to demonstrate whether there is a difference in the amount of chlorophyl developed in the foliage produced, respectively, by the different potash salts, but the efforts so far made have not demonstrated such a difference. It is perfectly clear, however, that the muriate of potash as compared with sulfate is distinctly unfavorable to the production of starch in the tubers, the percentage of this constituent being almost invariably considerably higher than in the potatoes produced on the muriate.

The yield of oat hay on the muriate is considerably heavier than on the sulfate, and this result seems to be somewhat in harmony with results which we have previously obtained with corn, in the case of which grain the yield of stover on the muriate appears to be usually heavier than on the sulfate under otherwise similar conditions.

III. Nitrogen Fertilizers and Potash Salts for Garden Crops.

Three different nitrogen fertilizers, sulfate of ammonia, nitrate of soda and dried blood, and two potash salts, muriate and high-grade sulfate, each salt being used with each of the nitrogen fertilizers, are under comparison on Field C. In connection with the fertilizers named dissolved bone black was used in liberal amounts, which are the same on all plots. The comparison of these different fertilizers in this field was begun in 1891, but up to 1898 they were used alone. Since that time all plots have received annually a dressing of stable manure, at the rate of 30 tons per acre. The nitrogen fertilizers are used in such quantities as to furnish nitrogen at the rate of 60 pounds per acre, the potash salts in such quantities as to furnish 120 pounds of actual potash per acre, and the dissolved bone black was applied at the rate of 320 pounds per acre. The crops of the past year were asparagus, strawberries and onions.

Yields per Acre.

Plot.	Fertilizers.	Asparagus (Pounds).	Strawberries (Pounds).	Onions (Bushels).	
				Large.	Picklers.
0,	No fertilizer,	3,378	7,012	304.4	53.5
1,	Muriate of potash, Sulfate of ammonia,	3,984	7,661	173.1	39.3
2,	Muriate of potash, Nitrate of soda,	5,057	5,088	258.3	69.0
3,	Muriate of potash, Dried blood,	5,052	6,697	259.2	40.2
4,	Sulfate of potash, Sulfate of ammonia,	3,764	6,087	150.0	34.6
5,	Sulfate of potash, Nitrate of soda,	5,235	5,204	300.6	56.4
6,	Sulfate of potash, Dried blood,	5,417	7,488	253.4	37.9

Attention is called in commenting upon these results to the fact that manure is used on Plot O at the same rate as on the other plots.

Asparagus. — Asparagus has long been recognized as a rank feeding crop, requiring liberal application of manure and fertilizers. It will be noticed that this is the only one of the three crops which appears to have been materially benefited by the use of the fertilizers. The crop on Plot O, on manure alone, is materially smaller than on either of the other two plots. Particular attention is called to the highly unfavorable effect of the combinations containing the sulfate of ammonia. The yields where this fertilizer was used are much below those produced where the other nitrogen fertilizers are employed, and not materially greater than where no fertilizer is used.

Strawberries. — It will be noted that in marked contrast with the results obtained with asparagus the yields of strawberries are highest on plots where sulfate of ammonia is used. A similar result has been obtained in earlier years. The highest yield of all has been produced where muriate of potash is used in connection with sulfate of ammonia, a combination which for most crops has always seemed to be peculiarly unfavorable. Whether a similar result would be obtained in soils less highly enriched is at present a matter of uncertainty, but I desire to point out that in my judgment, based not only upon the yields of strawberries, which are not as large on the best of our plots as are obtained in good practice, but also upon the growth and development of the vines, flowers and fruit, the rate of use of manure and fertilizer in Field C is much too high for the best results. The vines have been over-rank, the fruit has set rather imperfectly and ripened poorly.

Onions. — Comparison of the yields on the different plots shows that none of the fertilizers used in connection with manure have apparently been beneficial. The combination containing sulfate of potash and nitrate of soda has done best; but the most significant point in connection with these results is the distinctly unfavorable effect of the combinations which contain sulfate of ammonia. The yield where this fertilizer is used is much below that on the other plots. The onions where this fertilizer is applied appear to stand practically still for a number of weeks after germination. They become distinctly unhealthy and many die. By midsummer the unfavorable influence disappears, the remaining plants take on a rank growth, the tops are heavy, the necks of the bulbs are thick, and comparatively few well-ripened bulbs are produced. It is probable that a heavy application of lime in connection with the sulfate of ammonia will in large measure, perhaps altogether, correct the faulty conditions which appear to be due to the use of this fertilizer.

IV. Relative Value of Different Potash Salts.

The experiments comparing different potash salts were begun in 1898. The following materials are under comparison: kainit, high-grade sulfate, low-grade sulfate, muriate, nitrate, carbonate and feldspar. There are 40 plots in all. Five have received no potash since the experiments began. Each potash salt is used on five different plots; in other words, there are five series of plots. The crop during the past year was hay (mixed timothy, redtop and clovers). The average yields on each treatment are shown in the following table: —

Average Yield per Acre (Pounds).

	Hay.	Rowen.
No potash, plots 1, 9, 17, 25, 33,	6,240	698
Kainit, plots 2, 10, 18, 26, 34,	6,656	966
High-grade sulfate, plots 3, 11, 19, 27, 35,	6,416	1,866
Low-grade sulfate, plots 4, 12, 20, 28, 36,	6,864	2,058
Muriate, plots 5, 13, 21, 29, 37,	6,976	1,752
Nitrate, plots 6, 14, 22, 30, 38,	7,784	1,916
Carbonate, plots 7, 15, 23, 31, 39,	6,280	1,984
Fine-ground feldspar, plots 8, 16, 24, 32, 40,	6,824	1,256
Average of all potash plots,	6,828	1,685

The various potash salts used are employed in such quantities as to furnish substantially equal actual potash to each plot. In the case of the feldspar, which is very fine ground, the quantity employed on Plot 8 furnishes the same amount of potash as that supplied by the different potash salts. Plot 16 receives the same amount as Plot 8, Plot 24 receives twice as much, Plot 32 three times as much, and Plot 40 four times as much. Particular attention is called to the fact that up to and including 1908 the plots now receiving feldspar had been annually receiving a potash salt which had given results indicating a high degree of availability. It is believed that the crops on these plots are still deriving considerable benefit from the residual potash applied in the earlier years of the experiment.

The following points seem especially worthy of notice: —

(1) The average yield of hay on all the potash plots exceeds the average yield on the no-potash plots by only 600 pounds. The average yield of rowen on the potash plots exceeds the yield on the no-potash plots by about 1,000 pounds. These figures indicate that the grasses, timothy and redtop, which make up the bulk of the first crop, are not dependent in very high degree upon an application of potash, and the much larger increase in the yield of rowen on the potash plots is clearly to be attributed to the fact that clovers make up the greater part of the rowen.

(2) The kainit, while favorable to the grasses, such as timothy and redtop, and therefore giving a first crop nearly equal

to the average for the potash salts, is distinctly inferior to any of the materials supplying potash in its effects upon the rowen. This is undoubtedly due to the large proportion of chlorides which kainit contains.

(3) It will be noticed that the yield of rowen on muriate of potash is considerably less than on either of the sulfates, the nitrate or the carbonate. We have noticed in our experiments that the muriate almost always proves distinctly less favorable to clovers than the sulfates. On the other hand, this salt appears to be highly favorable to the timothy and redtop, as is indicated by the relatively high yield of hay.

(4) The yield of rowen is highest on the low-grade sulfate of potash, and there is a noticeable difference in its favor in the yield of hay also. It is possible that the magnesium contained in this salt is proving of value for the hay crops.

The most marked result of the substitution during the past few years of feldspar for the silicate of potash used in the earlier years of the experiment on Plots 8, 16, 24, 32 and 40 has been the rapid disappearance of clover from these plots. This fact indicates that the claim of the manufacturers that the potash of the feldspar has been rendered available by the treatment to which it has been subjected is not justified by the facts. After two years the clover has disappeared from these plots almost as completely as from the plots to which no potash has been applied throughout the entire period of the experiment.

V. Comparison of Different Phosphates.

Ten of the leading materials which may be used as a source of phosphoric acid have been under comparison in one of our fields since 1897. The different materials are applied to the separate plots in such quantities as to furnish equal amounts of actual phosphoric acid to each. There are three check plots to which no phosphate whatever has been applied during the entire period of the experiment. All the plots receive annually equal and liberal quantities of materials supplying nitrogen and potash in highly available forms. The field has been used for a large variety of crops, the succession having been as follows: corn, cabbages, corn, oats and Hungarian grass (followed by rye plowed under), onions, onions, cabbages, corn, mixed grass and clover three years, cabbages and soy beans. The crop this year was potatoes. The results are shown in the following table: —

Comparison of Phosphates.

Plot.	Fertilizer.	Yield Merchantable Potatoes per Plot (Pounds).	Yield per Plot (Pounds).		Yield Merchantable Potatoes per Acre (Bushels).	Loss or Gain per Acre (Bushels).
			Small.	Rotten.		
1,	No phosphate,	2,148	94	6	286.4	-
2,	Arkansas rock phosphate,	2,170	89	12	289.3	+40.9
3,	South Carolina rock,	1,986	53	23½	264.8	+16.4
4,	Florida soft rock,	1,761	107	24	234.8	—13.6
5,	Phosphatic slag,	1,841	76	18	245.5	—2.9
6,	Tennessee phosphate,	1,773	109	34	236.4	—12.0
7,	No phosphate,	1,831	53	36½	244.1	-
8,	Dissolved bone black,	1,859	90	12½	247.9	—0.5
9,	Raw bone meal,	1,941	140	12	258.8	+10.4
10,	Dissolved bone meal,	1,982	121	15	264.3	+15.9
11,	Steamed bone meal,	1,964	101	11⅓	261.9	+13.5
12,	Acid phosphate,	1,929	120	9½	257.2	+8.8
13,	No phosphate,	1,610	107	11½	214.7	-

The yield, as will be seen, was good on all plots. The average on the three check plots is 244.8 bushels of merchantable potatoes per acre. It will be noticed that the only one of the phosphates used which has given any very considerable increase in merchantable potatoes is the Arkansas rock phosphate, but I am convinced that the superiority of this phosphate is more apparent than real. The field declines somewhat in fertility from Plot 1 to Plot 13. It will be noticed that Plot 1 without phosphate gives a yield of merchantable tubers larger than any of the phosphate plots, with the exception of two, and that the crop on two is practically the same in amount as on one. The superior yield on these two plots is in my judgment merely a consequence of the fact that the soil texture in that part of the field is more favorable to the crop. The conclusions to which I would call particular attention may be stated as follows: —

(1) The potato would appear to be a crop relatively inde-

pendent of a supply of immediately available phosphoric acid. The result with potatoes offers a striking contrast to the result obtained in 1908 with cabbages, with which the crop on some of the best phosphate plots was more than six times greater than that produced on the no-phosphate plots.

(2) Although the phosphate used affected the total yield but little, it was noticed that during the first few weeks of their growth the vines on the plots to which the more available phosphates had been applied (phosphatic slag, dissolved bone black, dissolved bone meal and acid phosphate), made a much more rapid growth than on the other plots. The use of a little phosphoric acid, therefore, in highly available form, seems likely to prove a distinct advantage by pushing the crop more rapidly forward, so that it may better resist attacks of insects or unfavorable conditions which may occur later. It seems likely, further, that where the crop is cultivated for an early market the use of moderate amounts of highly available phosphoric acid may prove beneficial.

(3) The potatoes produced on the plot to which phosphatic slag has been annually applied for so many years were very scabby, although the seed planted was treated with formalin, as was that planted on the other plots also. So serious was this trouble that the market value of the crop was very greatly reduced, and the conclusion appears justified that a free use of phosphatic slag in the same season that land is to be planted with potatoes must in general prove highly undesirable. Slag meal is a strongly alkaline fertilizer, and this is undoubtedly the cause of the very scabby crop produced, since the scab fungus is known to be most troublesome in soils which are alkaline.

VI. Manure Alone compared with Manure and Sulfate of Potash.

This experiment, which occupies what is known as the south corn acre, has been in progress since 1890. The field is divided into four plots of one-fourth acre each. Good barnyard manure from milch cows, at the rate of 6 cords per acre, has been applied annually, with the exception of those years when it was feared so doing would cause the newly seeded grass and clover to lodge, to two of these plots. Manure at the rate of 3 cords per acre, together with high-grade sulfate of potash at the rate of 160 pounds per acre, was applied to the other two plots from 1890 to 1895. Since the latter date the manure has been applied to these plots at the rate of 4 cords per acre in connection with 160 pounds of high-grade sulfate of potash, and whenever, for the reasons above stated, the application of manure has been omitted from the other two plots, both the manure and the potash have been withheld from these plots. The plan of cropping this field for the last twelve years has been corn and hay in rotation in periods of two years for each. During the past season the crop on this field has been hay, and the average yields per acre have been as follows: —

	Pounds.
Manure alone: —	
Hay,	4,480
Rowen,	1,050
Manure and potash: —	
Hay,	4,400
Rowen,	940

The rowen crop of the past season was very small, owing to the marked deficiency in rainfall. The corn crops raised in this field throughout the entire period of the experiment have been very nearly equal under the differing manurial treatments. The hay crops have usually been somewhat larger with the manure alone. The difference during the past season is considerably less than the average.

VII. Average Corn Fertilizer compared with Fertilizer Richer in Potash.

These experiments occupy what is known as the north corn acre. They have been in progress since 1891. This field, like the south corn acre, is divided into four plots of one-fourth acre each. Two of the plots receive a mixture furnishing nitrogen, phosphoric acid and potash in the same proportions in which they are contained in the average corn fertilizers offered in our markets. The other two plots annually receive an application of a home-made mixture, containing much less phosphoric acid and more potash than is applied to the other plots. For the past fifteen years corn and hay, two years each, have regularly alternated. The crop of the past season was hay. Owing to the marked deficiency in rainfall already referred to the rowen crop was almost an absolute failure. The average yields were at the following rates per acre: —

	Pounds.
On the fertilizer rich in phosphoric acid and low in potash: —	
Hay,	3,260
Rowen,	330
On the fertilizer low in phosphoric acid and rich in potash: —	
Hay,	3,500
Rowen,	240

The results of the past season are similar to those which we have usually obtained, except that owing to the protracted drought the production of rowen on the plots receiving the larger proportion of potash is much lower than usual. In an average season the yield of rowen on these plots has invariably been greater than on the others.

VIII. South Acre Soil Test.

The crop raised in the south acre soil test which has continued in this field since 1889 was corn. The succession of crops grown on this field from the beginning of the experiment up to the present time has been as follows: corn, corn, oats, grass and clover, grass and clover, corn (followed by mustard as a catch crop), rye, soy beans, white mustard (plowed in), corn, corn, grass and clover, grass and clover, corn, corn, corn, grass and clover, grass and clover, corn, oats and clover, buckwheat plowed under, corn. During the continuance of the experiment the field has been limed at the rate of a ton to the acre three times. The results of the past season with corn were entirely similar to those which have usually been obtained with that crop. Potash is still the dominant element. The average yield on the no-fertilizer plots, three in number, was at the rate of 4.05 bushels per acre. Muriate of potash alone increases the crop to nearly 23 bushels. Nitrate of soda alone gives a crop of 9 bushels. Dissolved bone black alone gives a yield at the rate of 4.21

bushels. The average increases due to the application of the different fertilizers (used in each case on four plots) were as follows: —

	Bushels per Acre.
Nitrate of soda,	3.2
Bone black,	6.8
Potash,	28.3

If we represent the average increase in grain due to the nitrate at 100, that due to the bone black is 212, that due to the potash 880.9. Similar figures for the stover are: —

	Pounds per Acre.
Nitrate,	186.2
Bone black,	406.5
Potash,	1,922.7

IX. North Acre Soil Test.

The soil test in this field was begun in 1890, and the crops grown since that year in the order of succession have been as follows: potatoes, corn, soy beans, oats, grass and clover, grass and clover, cabbages and turnips, potatoes, onions, onions, onions, potatoes, grass and clover, grass and clover, corn, soy beans, grass and clover, grass and clover, grass and clover. The crop the past year was soy beans, for which the potash appears to be the dominant element. In this field one-half of each of the plots, which are long and narrow, has received three applications of lime, respectively, in 1899, 1904 and 1907. On the limed portion the increases due to the application of single fertilizer materials for the muriate of potash alone was 10.22 bushels per acre; for the nitrate of soda alone, 0.12 bushels; for the dissolved bone black alone, a loss of 4.45 bushels. The muriate of potash in combination with the other fertilizer elements did not give as large an increase in the crop as when used alone. The results will not be discussed in full at this time, but I may add that they are such as to suggest that the soda of the nitrate of soda is to a considerable extent either rendering the natural potash compounds of the soil available, or is itself to some extent taking the place of potash in the economy of the plant.

X. Top-dressing for Hay.

The experiments in the production of hay, by using in rotation as top-dressing barnyard manure, wood ashes and a mixture of bone meal and muriate of potash, have been continued during the past year in the nine-acre field where these experiments have been in progress since 1893. The average yield for the entire area this year was at the rate of 5,853 pounds per acre. The yields on the different materials used in top-dressing were at the following rates per acre: —

	Pounds.
Barnyard manure,	5,641
Fine ground bone and muriate of potash,	6,076
Wood ashes,	5,523

The crops this year were lighter than usual, as a consequence, without doubt, of the marked deficiency in rainfall already referred to. The average yields to date under the different systems of top-dressing have been at the following rates per acre: —

	Pounds.
Barnyard manure,	6,343
Wood ashes,	5,789
Fine ground bone and muriate of potash,	6,159

The average yield of the 9 acres from 1893 to 1910 inclusive has been at the rate of 6,134 pounds per acre. The rates of application per acre are: —

1.	Barnyard manure,	8 tons.
2.	Wood ashes,	1 ton.
3.	Ground bone,	600 pounds.
	Muriate of potash,	200 pounds.

XI. Winter v. Spring Application of Manure.

The experiments in progress for the purpose of testing the relative advantages of applying manure in the winter or in the spring were begun in 1899. There are five pairs of plots. In each pair the manure is applied to one plot some time during the winter. At the same time sufficient manure for the other and of the same quality is placed in a large heap, from which it is spread in the spring. The field in which these experiments are in progress has a decided slope lengthwise of the plots, which lie side by side. The manure which is put on in the winter is applied to the various plots at different times. The crop of the past season was hay, mixed timothy, redtop and clovers. The supply of manure for use in the experiments this year was not as large as usual and Plot 4 was not top-dressed. The results on this plot, therefore, for this season illustrate simply the residual effects of the two systems of applying manure. It must be pointed out, also, that owing to the relatively slow accumulation of manure used in this experiment the quantity available for Plot 3 was not sufficient until the last of March, so that this year the manure was applied both to the north and south half of this plot on the same date, March 31. The results are shown by the following tables.

Yield per Acre (Pounds).

Plot.	North Half. Winter Application.		South Half. Spring Application.	
	Hay.	Rowen.	Hay.	Rowen.
1,	6,312	534	6,925	1,009
2,	6,252	1,049	6,826	950
3,	7,004	811	6,905	1,068
4,	5,857	534	6,114	752
5,	8,904	930	8,528	1,563

Relative Yields (Per Cent.).

Plot.	North Half. Winter Application.		South Half. Spring Application.	
	Hay.	Rowen.	Hay.	Rowen.
1,	100	100	109.7	188.9
2,	100	100	109.2	90.6
3,	100	100	98.6	131.6
4,	100	100	104.4	141.0
5,	100	100	95.8	168.1

Hay and Rowen (combined). — Average Yields.

Plot.	North Half. Winter Application.		South Half. Spring Application.	
	Per Acre (Pounds).	Per Cent.	Per Acre (Pounds).	Per Cent.
1,	6,846	100	7,934	115.9
2,	7,301	100	7,776	106.5
3,	7,815	100	7,973	102.0
4,	6,391	100	6,866	107.4
5,	9,834	100	10,091	102.7

REPORT OF THE CHEMIST.

JOSEPH B. LINDSEY.

This report is intended to give an outline of the work accomplished and in progress in the department of plant and animal chemistry for the year 1910.

1. Correspondence.

There have been substantially 5,000 letters sent out during the year ending Dec. 1, 1910, the estimate being made on the basis of stamps used. The correspondence divides itself into (*a*) answering letters of inquiry, (*b*) the execution of the fertilizer, feed and dairy laws, (*c*) the testing of cows, and (*d*) the ordering of supplies.

2. Numerical Summary of Work in the Chemical Laboratory.

From Dec. 1, 1909, to Dec. 1, 1910, there have been received and examined 101 samples of water, 459 of milk, 2,799 of cream, 151 of feed stuffs, 223 of fertilizers and fertilizer materials, 44 of soils and 48 miscellaneous. In connection with experiments made by this and other departments of the station, there have been examined 247 samples of milk, 115 of cattle feeds and 300 of agricultural plants. There have also been collected and examined 890 samples of fertilizer, in accordance with the requirements of the fertilizer law, and 1,055 samples of cattle feeds, in accordance with the requirements of the feed law. The total for the year has been 6,432. This summary does not include work done by the research division.

In addition to the above, 10 candidates have been examined and given certificates to operate Babcock machines, and 4,047 pieces of Babcock glassware have been tested for accuracy of graduation, of which 41, or 1.01 per cent., were inaccurate.

3. Laboratory Work of the Research Section.

Messrs. Holland and Reed have continued work on the preparation of chemically pure insoluble fatty acids, and on the perfecting of methods for their quantitative determination. Investigations have also been continued relative to the cause of rancidity of fats, and upon the composition and preparation of chemically pure insecticides, particularly Paris green, arsenates of lead and arsenite of lime. Papers entitled "The Purification of Insoluble Fatty Acids" and "The Determination of Arsenic in Insecticides" are presented elsewhere in this report, and likewise in the "Journal of Industrial and Engineering Chemistry."

Mr. Morse has devoted his time to studying the effect of fertility on the chemical composition of asparagus roots, and presents a preliminary paper in this report and in the "Journal of the American Chemical Society" entitled "Soluble Carbohydrates of Asparagus Roots." Chemical analyses showed clearly that there was a marked increase in the total nitrogen in the roots, produced by the addition to the soil of different amounts of nitrate of soda. Low applications of nitrate gave an increase, medium still more, but high applications did not appear to be more effective than medium ones.

The carbohydrates in the reserve material of the roots consisted mainly of a soluble sugar, made up of fructose and glucose, the former decidedly in excess. Nitrogenous fertilizers apparently had no direct effect on the carbohydrates. In general the increase in protein accompanied a lower proportion of total carbohydrates, including fiber. Seventy-six samples of roots were gathered in November to repeat the nitrogen series and to extend the investigations to the effect of phosphorus and potassium.

Mr. Morse has also done some preliminary work in studying the character of the drainage waters from miniature cranberry bogs constructed under the direction of Director Brooks.

At intervals study has also been given to the chemistry of the soils on Field A, in hopes of ascertaining the cause or causes of clover sickness, but no definite results can be reported.

4. Research Work in Animal Nutrition.

Work is in progress to study the effect of lactic and butyric acids upon the digestibility of food. It has been shown that molasses is responsible for a decided digestion depression upon the foodstuffs with which it is fed. It being recognized that such material in the digestive tract is a large yielder of organic acids, it seemed at least possible that it is these acids which check the further action of the micro-organisms, and prevent their attacking the more difficultly digestible fiber, pentosans and gums.

A paper is presented elsewhere in this report attempting to show the protein requirements of dairy animals. Most dairy animals respond to increased amounts of protein over a protein minimum. By minimum is meant the amount required for maintenance plus that required in the milk. An excess of 25 per cent. over the minimum seems to give very satisfactory results, and is sufficient under most conditions.

Two experiments with dairy cows have been completed to note the comparative effects of corn meal, dried beet pulp and dried molasses beet pulp for milk production. Another experiment with corn meal versus ground oats has also been completed. The results have not been worked out.

The complete records of the station herd have been tabulated from 1896 through 1909, giving such data as food cost of milk production, dry and digestible matter required to produce definite amounts of milk, total solids and fat, relation of grain to roughage, etc. The food cost of 5 per cent. milk for 1909 was 3.3 cents per quart.

Tabulations.

There has been prepared and will be found elsewhere in this report the following tabulations: —

1. Analyses of all cattle feeds made in this laboratory through 1910.

2. Important ash constituents in cattle foods.
3. Composition of dairy products.
4. Digestion coefficients obtained from experiments made in the United States.
5. Composition of fertilizer materials and of natural and waste products.
6. Fertilizer constituents of fruit and garden crops.
7. Relative proportion of phosphoric acid, potash and nitrogen in fruit and garden crops.
8. Composition of some Massachusetts soils.

5. Report of the Fertilizer Section.

Mr. H. D. Haskins makes the following report: —

The principal work of this section has had to do with the execution of the fertilizer law of the State. Our experience this season indicated a very active demand for both chemicals and factory-mixed commercial fertilizers. There was a larger number of brands licensed than ever before. The inspection did not include the collection of as large a number of samples as during the previous year, although about the same number of brands were analyzed. It has been necessary to curtail somewhat, in order to keep as nearly as possible within the income derived from the fertilizer analysis fees. The expense of the inspection work has increased from year to year, and necessitates a larger income. It has also become evident that the old law requires many changes in order to make it applicable to present conditions. An attempt to improve the law is now under consideration.

Fertilizers licensed.

During the season of 1910 analysis fees have been paid by 83 manufacturers, importers and dealers, including the various branches of the American Agricultural Chemical Company, upon 465 distinct brands of fertilizer, including agricultural chemicals and by-products. Five more certificates of compliance have been issued, including 34 more brands than during 1909. They may be classed as follows: —

Complete fertilizers,	316
Fertilizers furnishing phosphoric acid and potash,	14
Ground bone, tankage and dry ground fish,	53
Chemicals and organic compounds furnishing nitrogen,	82
Total,	465

Fertilizers collected.

With but few exceptions, representative samples of every brand of fertilizer sold in the State have been secured. The collection work was in charge of Mr. James T. Howard, the regular inspector, assisted by Mr. A. B. Harris. As a general rule an effort has been made to collect samples of the same brand in different parts of the State, and to make one analysis of a composite sample made up of equal weights of the several samples. It is believed that this method will prove more satisfactory than when the results are based upon the analysis of a single sample. In all cases at least 10 per cent. of the number of bags found present were sampled; in cases where only a small amount of any particular brand was found in stock a larger percentage of the bags was sampled (often 50 to 100 per cent.), and in no case were less than five bags sampled without the fact being stated on the guarantee slip which is sent to the station laboratory with every brand of fertilizer sampled. One hundred and fourteen towns were visited, and samples of fertilizers were taken from 291 different agents. Eight hundred and ninety samples were drawn, representing 487 distinct brands. Some of the brands represent private formulas which farmers have had manufactured for their own use. The analyses of such brands were published in the bulletin in a table by themselves.

Fertilizers analyzed.

A total of 612 analyses was made in connection with the inspection of 1910. They may be grouped as follows: —

Complete fertilizers,	418
Fertilizers furnishing potash and phosphoric acid, such as ashes, superphosphates and potash,	21
Ground bones, tankage and fish,	71
Nitrogen compounds,	50
Potash compounds,	32
Phosphoric acid compounds,	20
Total,	612

The analyses were made in accordance with methods adopted by the Association of Official Agricultural Chemists. The analysis of a composite sample was made whenever possible, and in instances where such an analysis has shown a brand to be seriously deficient in one or more elements, a new portion was drawn from each original sample collected and a separate analysis made. This was done to determine whether the shortage was confined to one sample or whether it was general in case of that particular brand.

Twelve samples of lava fertilizer, so called, were analyzed. Although these materials have not been offered for sale in Massachusetts, considerable literature concerning them has been circulated, and it was thought best to have representative samples examined and the results published.

Thirty-two more analyses were made than during the previous year.

Trade Values of Fertilizing Ingredients.

The following table of trade values of fertilizer ingredients was used. It was adopted by the experiment stations of New England, New Jersey and New York at a meeting held in March, 1910. For purposes of comparison the 1909 schedule is also given.

	Cents per Pound.	
	1909.	1910.
Nitrogen: —		
In ammonia salts,	17	16
In nitrates,	16½	16
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	19	20
Organic nitrogen in fine[1] bone and tankage,	19	20
Organic nitrogen in coarse[1] bone and tankage,	14	15
Phosphoric acid: —		
Soluble in water,	4	4½
Soluble in neutral citrate of ammonia solution (reverted phosphoric acid),[2]	3½	4
In fine[1] bone and tankage,	3½	4
In coarse[1] bone and tankage,	3	3½
In cottonseed meal, linseed meal, castor pomace and ashes,	3	3½
Insoluble in neutral citrate of ammonia solution (in mixed fertilizers),	2	2
Potash: —		
As sulfate, free from chlorides,	5	5
As muriate (chlorides),	4¼	4¼
As carbonate,	8	8

[1] Fine and medium bone and tankage are separated by a sieve having circular openings one-fiftieth of an inch in diameter. Valuations of these materials are based upon degree of fineness as well as upon composition.

[2] Dissolved by a neutral solution of ammonium citrate; specific gravity 1 09 in accordance with method adopted by the Association of Official Agricultural Chemists.

These trade values will be found to correspond fairly with the average wholesale quotations of chemicals and raw materials as found in trade publications for the six months preceding March 1, plus about 20 per cent. They represent the average pound cost for cash at retail of the various ingredients as furnished by standard unmixed chemicals and raw materials in large markets in New England and New York for the six months preceding March 1, 1910. The cost of the mineral forms of nitrogen (nitrate of soda and sulfate of ammonia) has been somewhat lower than for the previous year, which has led to a more general use of these forms of nitrogen. Nitrogen from organic sources has been a cent higher than for the season of 1909. The cost of phosphoric acid was one-half cent higher than for the previous season. There was no material change in the cost of the various forms of potash.

Summary of Analyses as compared with Guarantees of Licensed Complete Fertilizers.

Manufacturers.	Number of Brands Analyzed.	Number with All Three Elements equal to Guarantee.	Number equal to Guarantee in Commercial Value.	Number with One Element below Guarantee.	Number with Two Elements below Guarantee.	Number with Three Elements below Guarantee.
W. H. Abbott,	3	1	3	1	1	-
American Agricultural Chemical Company,	78	55	75	19	3	-
Armour Fertilizer Works,	11	11	11	-	-	-
Baltimore Pulverizing Company,	4	-	2	4	-	-
Beach Soap Company,	5	3	5	2	-	-
Berkshire Fertilizer Company,	8	6	8	2	-	-
Bonora Chemical Company,	1	-	1	1	-	-
Bowker Fertilizer Company,	30	21	27	7	2	-
Joseph Breck & Sons Corporation,	3	1	3	2	-	-
Buffalo Fertilizer Company,	8	1	6	6	1	-
Coe-Mortimer Company,	13	6	10	3	3	1
Eastern Chemical Company,	1	1	1	-	-	-
Essex Fertilizer Company,	12	4	10	5	3	-
R. & J. Farquhar & Co.,	3	1	3	2	-	-
The Green Mountain Plant Food Company,	1	1	1	-	-	-

Summary of Analyses as compared with Guarantees of Licensed Complete Fertilizers — Con.

Manufacturers.	Number of Brands Analyzed.	Number with All Three Elements equal to Guarantee.	Number equal to Guarantee in Commercial Value.	Number with One Element below Guarantee.	Number with Two Elements below Guarantee.	Number with Three Elements below Guarantee.
C. W. Hastings,	1	–	1	1	–	–
Lister's Agricultural Chemical Works,	6	3	6	3	–	–
James E. McGovern,	1	–	1	1	–	–
Mapes' Formula and Peruvian Guano Company,	17	6	17	9	2	–
National Fertilizer Company,	14	8	12	3	3	–
New England Fertilizer Company,	6	3	5	2	–	1
Olds & Whipple,	6	4	6	1	1	–
Parmenter & Polsey Fertilizer Company,	8	1	7	4	3	–
R. T. Prentiss,	4	–	1	2	1	1
Pulverized Manure Company,	2	1	2	–	1	–
W. W. Rawson & Co.,	1	1	1	–	–	–
Rogers Manufacturing Company,	9	3	9	5	1	–
Rogers & Hubbard Company,	8	6	8	2	–	–
Ross Bros. Company,	3	2	3	1	–	–
N. Roy & Son,	1	1	1	–	–	–
Sanderson Fertilizer and Chemical Company,	6	5	6	–	1	–
M. L. Shoemaker & Co., Ltd.,	1	1	1	–	–	–
Swifts' Lowell Fertilizer Company,	17	4	15	9	2	2
W. G. Todd,	1	1	1	–	–	–
Whitman & Pratt Rendering Company,	5	–	5	4	1	–
Wilcox Fertilizer Works,	6	5	6	1	–	–
A. H. Wood & Co.,	3	–	3	2	1	–

The above table shows that 306 distinct brands of licensed complete fertilizers have been collected and analyzed.

That 140 brands (45.75 per cent. of the whole number analyzed) fell below the manufacturer's guarantee in one or more elements.

That 104 brands were deficient in one element.

That 30 brands were deficient in two elements.

That 6 brands were deficient in all three elements.

That 24 out of the 306 brands (7.85 per cent. of the whole number) showed a commercial shortage; that is, they did not show the amount and value of the plant food as expressed by the lower guarantee, although the values of any overruns were used to offset shortages.

The deficiencies were divided as follows: —

60 brands were found deficient in nitrogen.
80 brands were found deficient in available phosphoric acid.
71 brands were found deficient in potash.

When the data furnished by the above summary are compared with those of previous years, it is clear that greater care has been exercised on the part of the manufacturers, the guarantees being more generally maintained.

More brands were deficient in potash than during the previous year, a fact which may be due to temporary shortage in the supply of German potash salts in this country and correspondingly higher prices. These conditions were due to German legislation, which prevented the carrying out of contracts with German mine owners held by American fertilizer manufacturers except on payment of heavy production taxes.

Commercial Shortages.

The brands having a commercial shortage were much fewer in number than for 1909, and the amount or value of the shortages was much less, as may be seen from the following table: —

Commercial Shortages in Mixed Complete Fertilizers for 1910, as Compared with the Previous Year.

Commercial Shortages.	Number of Brands.	
	1910.	1909.
Over $4 per ton,	None	1
Between $3 and $4 per ton,	None	2
Between $2 and $3 per ton,	None	5
Between $1 and $2 per ton,	6	14
Under $1 but not less than 25 cents per ton,	18	35

There were a few brands showing rather serious deficiencies in some element of plant food, but which did not suffer a commercial shortage on account of an overrun of some other ingredient. Such brands, of course, may be seriously out of balance, and while not excusable, the manufacturer evidently had no intention to defraud.

Quality of Plant Food.

As a general rule the potash and phosphoric acid were furnished in the forms guaranteed.

It is hoped that methods of analysis may soon be perfected so that it will be possible to indicate the relative availability of the organic nitrogen in mixed fertilizers. The importance of this may, in a measure, be realized when it is remembered that nearly 45 per cent. of the nitrogen used in the complete fertilizers this year was derived from organic sources.

Grades of Fertilizer.

The following table shows the average comparative commercial values, the retail cash prices and the percentages of difference of the licensed complete fertilizers analyzed in Massachusetts during the season of 1909 and 1910, grouped according to commercial valuation. Those having a valuation of $18 or less per ton are called low grade; those having a valuation of between $18 and $24 are called medium grade; and those having a valuation of over $24 are called high grade.

	High Grade.		Medium Grade.		Low Grade.	
	1909.	1910.	1909.	1910.	1909.	1910.
Average ton valuation,	$27 63	$28 81	$20 69	$21 04	$15 32	$15 61
Average cash price,	$39 05	$38 40	$33 85	$33 51	$29 51	$27 80
Average money difference,	$11 42	$9 59	$13 16	$12 47	$14 19	$12 19
Percentage difference,	41.33	33.28	63 61	59.26	92.62	78.03

The percentage of difference column becomes a convenient method of comparing the commercial worth of fertilizers of the same grade and cost, and usually indicates fairly the most economical fertilizer to purchase. It should never be interpreted as representing only the profit which the manufacturer makes on his fertilizer. It must include not only the profit, but all other expenses connected with the manufacture and delivery of the goods, such as grinding, mixing, bagging, transportation, agents' profits, long credits, interest and depreciation of factory plants.

Composition according to Grade. — The following table shows the average composition of the complete commercial fertilizers, according to grade, as sold in the Massachusetts markets during 1910: —

Grade.	Number of Brands.	Per Cent. of Whole Number.	Per Cent. of Nitrogen.	Per Cent. of Phosphoric Acid. Soluble.	Per Cent. of Phosphoric Acid. Reverted.	Per Cent. of Phosphoric Acid. Available.	Per Cent. of Potash.	Pounds of Available Plant Food in 100 Pounds of Fertilizer.
High,	151	44.67	4.22	3.88	3.26	7.14	7.63	18.99
Medium,	120	35.50	2.65	4.86	2.81	7.67	5.06	15.38
Low,	67	19.83	1.77	4.55	2.46	7.01	3.06	11.84

A study of the above tables shows: —

1. That the percentage difference or percentage excess of the selling price over the valuation in the low-grade fertilizer is over twice what it is in the high-grade goods.

2. That with a 38 per cent. advance in price over the low-grade fertilizer, the high-grade furnishes over 84 per cent. increase in commercial value.

3. The average high-grade fertilizers, with a 14.6 per cent. advance in price over the medium-grade goods, furnishes about 23 per cent. more plant food and about 37 per cent. increase in commercial value.

4. That with a 38 per cent. advance in price over the low-grade fertilizer, the high-grade furnishes more than 78 per cent. increase in available plant food.

5. The medium-grade goods cost about 20 per cent. more

than the low-grade goods and furnish over 34 per cent. greater commercial value.

6. That the per cent. of nitrogen and potash is very much higher in the high-grade goods than in the low or medium grade.

7. A ton of the average high-grade fertilizer furnishes about 49 pounds more nitrogen, 2½ pounds more available phosphoric acid and 91 pounds more actual potash than does a ton of the low-grade goods.

8. A ton of the average high-grade fertilizer furnishes about 31 pounds more nitrogen and about 51 pounds more potash than does a ton of the medium-grade goods.

Table showing the Comparative Pound Cost, in Cents, of Nitrogen, Potash and Phosphoric Acid in its Various Forms in the Three Grades of Fertilizer.

Element.	Low-grade Fertilizer.	Medium-grade Fertilizer.	High-grade Fertilizer.
Nitrogen,	35.62	31.85	26.66
Potash (as muriate),	7.57	6.77	5.67
Soluble phosphoric acid,	8.01	7.17	6.00
Reverted phosphoric acid,	7.12	6.37	5.33
Insoluble phosphoric acid,	3.56	3.19	2.67

This table emphasizes the marked increase in the cost of plant food wherever the low and medium grade fertilizers are purchased. It shows that nitrogen has cost 8.96 cents, available phosphoric acid about 2 cents and potash 1.9 cents per pound *more* in the average low-grade fertilizer than in the high-grade goods. It shows that nitrogen has cost 5.19 cents, the available phosphoric acid 1.11 cents and the potash 1.10 cents *more* per pound in the average medium-grade goods than in the average high-grade fertilizer. A comparison with the previous year shows that more high-grade brands have been sold this season than for 1909. There is, however, altogether too large a proportion of low and medium grade brands sold at present (55.33 per cent. of the whole). It is evident that too many purchasers select a fertilizer for its low cost, and without much regard for the plant food which they are getting. The object in buying a fertilizer should be to get the largest amount of plant food in the proper form and proportion for the least money. The high-grade goods approach as near this ideal as is possible in case of factory-mixed fertilizers. It costs just as much to freight, cart and handle the low-grade fertilizers as it does the high grade. Nitrogen and potash in low-grade fertilizers cost from a third to a half more than if obtained from high-grade goods. *The farmer cannot afford to buy low-grade fertilizers.*

Unmixed Fertilizers.

MISCELLANEOUS SUBSTANCES. — *Ground Bone.* — Thirty-nine samples of ground bone have been inspected and analyzed. Nine were found deficient in phosphoric acid and 5 in nitrogen. None of the brands, however, showed a commercial shortage of 50 cents per ton. The average retail cash price for ground bone has been $31.13 per ton, the average valuation $29.75, and the percentage difference 4.64.

Ground Tankage. — Twelve samples of tankage have been analyzed. Four were found deficient in nitrogen and 4 in phosphoric acid. The average retail cash price per ton was $31.82, the average valuation per ton $31.28, and the percentage difference 1.73. Nitrogen in fine tankage has cost on the average 20.34 cents, while nitrogen in coarse tankage has cost 15.25 cents per pound. Two samples have shown a commercial shortage of over 50 cents per ton.

Dissolved Bone. — Two samples of dissolved bone have been analyzed and both were up to the guarantee placed upon them. The average retail cash price per ton has been $29.67, the average valuation $26.17, and the percentage difference 13.37.

Dry Ground Fish. — Twenty-three samples of dry ground fish have been examined, of which 5 were found deficient in nitrogen and 4 in phosphoric acid. The average retail cash price per ton was $39.65, the average valuation $38.89, and the percentage difference 1.95. Nitrogen from dry ground fish has cost on the average 20.39 cents per pound. Two brands have been analyzed, which show a commercial shortage of over 50 cents per ton.

Wood Ashes. — Thirteen samples of wood ashes have been analyzed, of which 1 was deficient in potash and 2 in phosphoric acid, although none of the samples showed a commercial shortage. Three samples put out by H. C. Green & Co., importers, were simply guaranteed "Pure wood ashes." The agent for three cars of these ashes, Ross Bros. Company, Worcester, Mass., stated that the ashes were of such poor quality that no charge would be made for them. Under present conditions of price and quality, the purchase of wood ashes is of questionable economy. They should never be bought without a guarantee of potash, phosphoric acid and lime.

Ground Rock. — The Farmhood Corporation of Boston, Mass., has offered a product called "Farmfood" which is unquestionably a ground mineral. It was guaranteed 2 per cent. phosphoric acid and 5 per cent. potash, both "in bond," meaning presumably associated with silica and not soluble. An analysis reveals the presence of 2.55 per cent. phosphoric acid, of which only .38 per cent. was available (dissolved by neutral citrate of ammonia). Only .56 per cent. of potash was found soluble in boiling water, and only .66 per cent. was found soluble in dilute hydrochloric acid. The commercial value of the product was $1.65 per ton, which would hardly pay cartage.

The New England Mineral Fertilizer Company [1] of Boston, Mass., has put out a product called "New England mineral fertilizer," which is apparently largely ground rock. The material was guaranteed .23 per cent. phosphoric acid and 1.50 per cent. potash. Our analysis showed .18 per cent. phosphoric acid, .10 per cent. water-soluble potash and .35 per cent. potash soluble in dilute hydrochloric acid. The plant food in a ton of this material is valued at 24 cents, although $17 is the advertised price in ton lots. Aside from the guarantee of potash and phosphoric acid, the firm makes a claim for a given percentage of soda, lime, magnesia, iron, sulfur, silica, chlorine and alumina. Although some of these elements are essential to the growth of plants, yet they are found in most soils in sufficient quantities to meet the needs of growing vegetation, so that they

[1] The New England Mineral Fertilizer Company, 19 Exchange Place, Boston, should not be confused with the New England Fertilizer Company, 40 North Market Street, Boston. The latter is an old company which has done business in Massachusetts for many years, and disclaims any connection with the New England Mineral Fertilizer Company.

have no particular significance in this connection. The extravagant claims made by the company for this "New England mineral fertilizer" are overdrawn, and border somewhat upon the ridiculous.

NITROGEN COMPOUNDS. — *Sulfate of Ammonia.* — Two samples of sulfate of ammonia have been analyzed and found well up to the guarantee. The average cost of the pound of nitrogen in this form has been 15.65 cents.

Nitrate of Soda. — Sixteen samples of nitrate of soda have been analyzed and only 1 was found deficient in nitrogen. The average cost of nitrogen per pound in this form has been 16.56 cents.

Dried Blood. — Three samples of this material were examined, 2 of the brands showing a considerable overrun and 1 a slight deficiency in nitrogen, the latter containing, however, considerable phosphoric acid. The average cost of nitrogen from blood has been 20.16 cents per pound.

Castor Pomace. — Six samples of castor pomace have been inspected and the guarantee was maintained in each instance. The average cost of nitrogen in this form has been 22.29 cents per pound.

Cottonseed Meal. — Nineteen samples of cottonseed meal used for fertilizer have been examined. These were licensed by 6 companies doing business in Massachusetts. Nitrogen from cottonseed meal has cost on the average 28.47 cents per pound. Seven out of the 19 samples analyzed showed a commercial shortage amounting to over 50 cents per ton.

POTASH COMPOUNDS. — *Carbonate of Potash.* — Only 1 sample of carbonate of potash was analyzed during the season. It sold so that the pound cost of actual potash was 7.54 cents.

High-grade Sulfate of Potash. — Nine samples of high-grade sulfate of potash have been examined and the potash guarantee was maintained in every instance. The pound of actual potash in this form has cost, on the average, 4.64 cents.

Potash-magnesia Sulfate. — Seven samples of double sulfate of potash and magnesia have been examined, and all have been found well up to the guarantee. The pound cost of actual potash in this form has been 5.46 cents.

Muriate of Potash. — Eleven samples of muriate of potash have been examined, and only 1 deficiency was found. The pound of actual potash as muriate or chloride has cost on the average 4.06 cents.

Kainit. — Two samples of kainit have been analyzed and found well up to the guarantee. The pound of actual potash from kainit has cost 4.21 cents.

Phosphoric Acid Compounds. — *Dissolved Bone Black.* — Three samples of dissolved bone black have been examined. Two of these were found somewhat low in available phosphoric acid, although only 1 showed a commercial shortage of over 50 cents per ton. The pound of available phosphoric acid from this source has cost, on the average, 5.91 cents.

Acid Phosphate. — Ten samples of acid phosphate have been examined, all but 3 being found well up to the minimum guarantee. No commercial shortages of over 50 cents per ton were noticed. The pound of available phosphoric acid from acid phosphate has cost 5.76 cents.

Basic Slag Phosphate. — Five samples have been analyzed, and the phosphoric acid ran low in 2 instances. There were no commercial shortages of over 50 cents per ton. The pound of available phosphoric acid (by Wagner's method) from basic slag has cost, on the average, 5.01 cents.

The complete results of the fertilizer inspection may be found in Bulletin 135.

Miscellaneous Work.

During the early part of the year some two months were devoted to the detailed mineral analysis of asparagus roots, in connection with fertilizer experiments carried on by the agricultural department. There has also been examined a number of cases of abnormal soils due to over-fertilization; such conditions are found particularly in greenhouse and tobacco soils, and in the latter case is confined to soils possessing an impervious subsoil, which will not permit of the free circulation of soluble saline materials.

In addition to the above work the fertilizer section has analyzed home mixtures, chemicals, by-products, soils, insecticides, etc., for farmers and farmers' organizations. We have insisted that all such material be taken according to furnished directions, which is more likely to insure representative samples, without which an analysis is of little value. In case of soils, but few complete detailed analyses have been made, and those only when abnormal conditions pointed to malnutrition or over-fertilization. In many cases tests were made to determine the relative amount of organic matter present and the acidity. Advice as to the use of fertilizer on any particular soil has been based more particularly upon the general character of the soil, previous manurial treatment, crop rotation, cultivation, and upon the crop to be grown.

In the analysis of by-products, refuse salts and materials used as fertilizers, the report has included the relative commercial value of the material and the best method of utilizing the same. During the year 300 miscellaneous analyses were made for citizens of the State and for the various departments of the experiment station. They may be grouped as follows: —

Fertilizers and by-products used as fertilizers,	223
Soils,	44
Miscellaneous materials,	33
Total,	300

As in the past, co-operative work was done in connection with the study of new methods of analysis for the Association of Official Agricultural Chemists. Much time and study were also given to perfecting a suitable method to determine the relative availability of nitrogen from organic sources in mixed fertilizers. Tests were also made on 80 brands of fertilizer selected from the 1910 official collection, to ascertain the efficiency of the improved alkaline-permanganate method in detecting the presence of low-grade organic ammoniates.

6. Report of the Feed and Dairy Section.

Mr. P. H. Smith reports: —

The Feed Law.

During the past year 1,055 samples of feedstuffs have been collected by Mr. James T. Howard, official inspector. These samples have been analyzed and are soon to be published, together with the necessary comments.

Analytical Work. — The analytical work has consisted of protein and fat determinations on all samples, a fiber estimation in many cases and a microscopic examination when further information seemed desirable. A protein and fat guarantee are required by law. It is felt, however, that the protein and fiber content of a feedstuff are a much better index of its true value. Protein is the most valuable constituent, while fiber is of least value, and it is a fact that any feedstuff which contains a relatively high fiber percentage is quite apt to contain some inferior by-product. For this reason more fiber determinations have been made this year than ever before.

Compliance with the Law. — Fewer violations of the law have been noted than in previous years. Reputable manufacturers and dealers are coming to believe that the statute works no hardship in honest products. The time is not far distant when to neglect to brand a feedstuff will make the purchaser suspicious of its merits. In the future, violations of the feedstuffs law will be placed in our attorney's hands for settlement. In several instances this has already been done, and one case, where goods were not guaranteed, has been taken into court. The dealer entered a plea of guilty and the case was placed on file. It is not the intention of those having the enforcement of the law in charge to be overbearing in regard to this matter, but any law which is not enforced soon becomes inoperative. The benefits of the law are so obvious as to render it unwise to allow it to become a dead letter.

New Law. — At the time the present law was passed it was not possible to secure the requirement of a fiber guarantee. Since that time other States have enacted statutes which not only require a protein, fat and fiber guarantee on all feedstuffs, but in addition a statement of composition in the case of all compounded feeds. It is believed that Massachusetts should enact a law requiring every package of feedstuff sold or offered for sale to have attached the following information: —

1. The number of net pounds in the contents of the package.

2. Name, brand or trademark.

3. Name and principal address of the manufacturer or jobber responsible for placing the commodity on the market.

4. Its chemical analysis expressed in the following terms:

(*a*) minimum percentage of crude protein; (*b*) minimum percentage of crude fat; (*c*) maximum percentage of crude fiber.

5. If a compounded or mixed feed, the specific name of each ingredient therein.

A revision of the present statute is now under consideration which will include the above requirements, together with such changes as have from time to time suggested themselves.

Definitions. — At present there is more or less confusion between different States and different sections of the country in regard to names of commercial feedstuffs. A feedstuff which is recognized by one name in the west may be known by an entirely different name in the east. Again, manufacturers of low-grade goods often attach names which are misleading or at best mean nothing. The National Association of Feed Control Officials is considering uniform definitions for the different commercial feedstuffs. Such a group of definitions, if adopted by the feed control officials of the different States, will be of great benefit to the retailer and manufacturer.

Weight of Sacked Feeds. — There is a growing tendency on the part of some manufacturers to state the gross weight of a package instead of the weight of the contents. Others state both net and gross weights. The State law calls for the weight of the contents of the package. Purchasers who buy sacked feeds should see that they are getting full weight. The difference between gross and net weight will amount to about 1 pound per sack.

Co-operation. — It is a difficult matter to enforce the provisions of the feedstuffs law without the co-operation of both retailers and consumers. Consumers should refuse to buy goods which are not guaranteed, and retailers should refuse to handle goods which are received without a guarantee.

The Dairy Law.

The work required by this act is divided into three natural subdivisions: (1) the examination of candidates, (2) the testing of glassware, and (3) the inspection of machines.

(1) *Examination of Candidates.* — During the past year 10 candidates were examined for proficiency in the Babcock test.

All candidates are refused a certificate who fail to show proficiency in manipulation or who do not have a good working knowledge of the principles underlying the test. Eight candidates passed the examination at the first trial, and 2 certificates were withheld until further proficiency was acquired. The idea has been prevalent that the experiment station gives instruction in Babcock testing. Such is not the case; all candidates must, before presenting themselves for examination, have acquired a thorough knowledge of the test.

(2) *Examination of Glassware.* — During the past year 4,047 pieces of glassware were examined, of which 41 pieces, or 1.01 per cent., were inaccurate. This is the lowest percentage of inaccuracy found during the ten years that the law has been in force. Following is the summary of the work for the entire period: —

YEAR.	Number of Pieces tested.	Number of Pieces condemned.	Percentage condemned.
1901,	5,041	291	5.77
1902,	2,341	56	2.40
1903,	2,240	57	2.54
1904,	2,026	200	9.87
1905,	1,665	197	11.83
1906,	2,457	763	31.05
1907,	3,082	204	6.62
1908,	2,713	33	1.22
1909,	4,071	43	1.06
1910,	4,047	41	1.01
Totals,	29,686	1,885	6.34[1]

The passage of this law has prevented 1,885 pieces of inaccurately graduated glassware, representing 6.34 per cent. of the entire number tested, from coming into use.

(3) *Inspection of Babcock Machines.* — Since the 1909 inspection 1 creamery has suspended operations. During the present inspection, recently completed, 28 places were visited, of which 15 were creameries, 12 milk depots and 1 a chemical laboratory. Ten of the creameries were co-operative and 5

[1] Average.

were proprietary. The 12 milk depots were in every case proprietary. Twenty-eight machines were examined, 2 of which were condemned, but on second inspection a few weeks later they were found to have been put in good condition. Those in use are 10 Facile, 6 Agos, 5 Electrical, 4 Grand Prize, 2 Wizard, 1 unknown. The glassware was, as a whole, clean, and with two exceptions Massachusetts tested. Where untested glassware was found in use, the provisions of the law were made plain, and it is not expected that there will be a repetition of the offense. Unless machines are set on firm foundation and the bearings kept well oiled, the required speed cannot be maintained economically, and machines will not give satisfaction. The Babcock machine should be as carefully looked after as the cream separator in order to give efficient service.

The creameries and milk depots where machines were inspected are as follows: —

1. Creameries.

Location.	Name.	President or Manager.
1. Amherst,	Amherst,	W. A. Pease, manager.
2. Amherst,	Fort River,[1]	E. A. King, proprietor.
3. Ashfield,	Ashfield Co-operative,	Wm. Hunter, manager.
4. Belchertown,	Belchertown Co-operative,	M. G. Ward, manager.
5. Brimfield,	Crystal Brook,	F. N. Lawrence, proprietor.
6. Cummington,	Cummington Co-operative,	D. C. Morey, manager.
7. Egremont,	Egremont Co-operative,	E. A. Tyrrell, manager.
8. Easthampton,	Hampton Co-operative,	W. S. Wilcox, manager.
9. Heath,	Cold Spring,	F. E. Stetson, manager.
10. Hinsdale,	Hinsdale Creamery Company,	W. C. Solomon, proprietor.
11. Monterey,	Berkshire Hills Creamery,	F. A. Campbell, manager.
12. New Salem,	New Salem Co-operative,	W. A. Moore, president.
13. North Brookfield,	North Brookfield,	H. A. Richardson, proprietor.
14. Northfield,	Northfield Co-operative,	C. C. Stearns, manager.
15. Shelburne,	Shelburne Co-operative,	I. L. Barnard, manager.
16. Wyben Springs,	Wyben Springs Co-operative,	H. C. Kelso, manager.

[1] Pays by test. Testing done at Massachusetts Agricultural Experiment Station.

2. *Milk Depots.*

Location.	Name.	Manager.
1. Boston,	D. W. Whiting & Sons,	Geo. Whiting.
2. Boston,	H. P. Hood & Sons,	W. N. Brown.
3. Boston,	Boston Dairy Company,	W. A. Graustein.
4. Boston,	Boston Jersey Creamery,	T. P. Grant.
5. Boston,	Walker-Gordon Laboratory,	G. Franklin.
6. Boston,	Oak Grove Farm,	C. L. Alden.
7. Cambridge,	C. Brigham Company,	J. R. Blair.
8. Cheshire,	Ormsby Farms,	W. E. Penniman.
9. Dorchester,	Elm Farm Milk Company,	J. K. Knapp.
10. Sheffield,	Willow Brook Dairy,	L. C. Smith.
11. Southboro,	Deerfoot Farm Dairy,	S. H. Howes.
12. Springfield,	Tait Bros.,	W. A. Pease.
13. Springfield,	Emerson Laboratory,	H. C. Emerson.

Milk, Cream and Feeds sent for Free Examination.

During the past year the experiment station has analyzed a large number of samples of dairy products and feedstuffs sent for examination. Such work, where the results are of general interest, is a legitimate part of the station work. The station will not, however, act as a private chemist for manufacturers. Correspondence is solicited before samples are shipped, as in many cases the required information can be furnished without resorting to a chemical analysis, which will save shipping expenses to the applicant and the expense of a costly analysis to the experiment station. Upon application, full instructions for sampling and directions for shipping will be furnished, which will often obviate the necessity of sending another sample for analysis in place of one improperly taken.

Analysis of Drinking Water.

During the past year 101 samples of drinking water have been analyzed for residents of the State. The greater part of these were farm supplies where pollution was suspected. On reporting an analysis, suggestions are in all cases made as to improving the supply when necessary. Parties wishing for water analysis should observe the following points: —

1. Application should be made for analysis.

2. A fee of $3 is charged for each analysis, payable with the application.

3. Only samples of water received in experiment station containers are analyzed (containers sent on application).

4. The experiment station does not make bacteriological examinations.

5. The experiment station does not undertake a mineral examination of waters for medicinal properties.

Miscellaneous Work.

In addition to the work already described, this section has conducted investigations and made other analyses as follows: —

1. It has co-operated with the Association of Official Agricultural Chemists in a study of the methods for the determination of acidity in gluten feeds.

2. It has co-operated with the officials of the New England Corn Exposition in making analysis of corn in connection with the awarding of prizes.

3. It has co-operated with the Bowker Fertilizer Company in making analyses of corn in connection with the awarding of prizes.

4. It has arranged and furnished exhibits and speakers in co-operation with the extension department for (*a*) the better farming special; (*b*) the better farming trolley special; (*c*) an exhibit for several of the Massachusetts fairs; (*d*) an exhibit for the New England Corn Show.

5. It has conducted an investigation in connection with cases of alleged arsenic poisoning of horses through eating sulfured oats, with negative results.

6. In connection with the experimental work of this and other departments of the experiment station, this section has made analyses of 247 samples of milk, 115 samples of cattle feeds and 300 samples of agricultural plants.

Testing of Pure-bred Cows.

The work of testing cows for the various cattle associations continues to increase. Such work is a tax upon the time of the head of this section, and, owing to the uncertainty of steady employment, it is often difficult to secure men to do the work. Two men are now employed permanently in connection with the Jersey, Guernsey and Ayrshire tests. The rules of the above associations require the presence of a supervisor once each month for two consecutive days at the farms where animals are on test. The milk yields noted by the supervisors at their monthly visits are used in checking the records reported by the owners to the several cattle clubs. The Babcock tests obtained at that time are likewise reported, and used as a basis for computing the butter fat yield for each month. Up to June 1, 1910, the supervisors were only required to spend one day in testing Guernsey cows. At the annual meeting of the American Guernsey Cattle Club, in May, 1910, the rules were changed so as to require a two-day monthly test. While this practically doubles the work for this breed, it is felt that a two-day basis is much more accurate in computing tests.

During the past year 1 214-day test and 44 yearly tests with Guernsey cows, 10 7-day and 88 yearly tests with Jersey cows, and a number of yearly tests with Ayrshire cows have been completed.

The Holstein-Friesian tests usually cover periods of from 7 to 30 days, and require the presence of a supervisor during the entire test. During the past year 16 different men have been employed at different times in conducting these tests, which give rather irregular employment during the winter months. On account of the uncertainty of the work such men are difficult to obtain, but thus far it has not been necessary for the experiment station to refuse an application. For the Holstein-Friesian association 112 7-day, 5 14-day, 11 30-day, and one semi-official year test have been completed.

There are now on test for yearly records 96 Jersey, 28 Guernsey and 8 Ayrshire cows.

REPORT OF THE BOTANIST.

G. E. STONE.

The routine and research work of the botanists and assistants for the past year followed similar lines to those of other years, except that perhaps the routine work has had a tendency to increase, leaving less time for research work. This has been remedied to a considerable extent, however, by the addition of Mr. Sumner C. Brooks as laboratory assistant. Mr. Brooks was graduated from the class of 1910, and his appointment as assistant relieves Mr. Chapman of much routine work and gives him time for research, for which he is well fitted. Miss J. V. Crocker has, as usual, been of much service in attending to the correspondence and records, and has given valuable assistance in the seed testing. Much assistance has, as formerly, been obtained from the undergraduate students, and Mr. E. A. Larrabee and Mr. Ray E. Torrey have devoted all their spare time to the department, and were employed during the whole summer vacation.

Diseases More or Less Common during the Year.

The season of 1910 opened unusually early, as is shown by the meteorological records and by the blossoming of trees, shrubs and flowers. The season was, on the whole, rather dry, and crops suffered to some extent from drought, a condition which was emphasized by the severe droughts of the two preceding years.

The peach leaf curl, which naturally follows a cold and rainy period, was quite common. Some frost occurred in May, and in some localities it was reported in June. The effects of this showed on asparagus, and frost blisters were common on apple foliage. An unusually large amount of apple foliage was sent in to this department for examination in early summer. This was affected not only with frost blisters, but considerable injury was caused by a mite, the effect being in many cases similar. An early outbreak of apple scab was also noticed on apple foliage.

Strawberries were of poor quality, and considerable rot of the fruit occurred, owing to excessive rainfall. The foliage of rock maples and oaks was affected to an unusual extent with Glœosporium. In many sections maples in general were affected with this fungus, causing a browning of the leaf and much defoliation, and many inquiries were received concerning this trouble.

Some of the diseases which were more common are as follows: hollyhock rust, sweet pea trouble, apple rust, hawthorne rust, quince rust, black rot of grapes, crown gall, sycamore blight, blossom end rot of tomatoes, pear blight and pear scab, corn smut and maple leaf spot (Rhytisma). Considerable interest is also manifest in the chestnut disease, which is becoming more noticeable in this State.

The following is a list of the less common diseases reported during the year: ash rust, bean rust, rose rust, pea mildew, rose mildew, currant Anthracnose, Anthracnose of melon, rust on strawberry leaves, cherry leaf spot (Cylindrosporium), potato rot, horse chestnut blight (Phyllosticta), apple scab, cane blight of raspberries (Coniothyrium), blackberry Anthracnose and cherry leaf blight (Cercospora). Besides these may be mentioned troubles with which no organisms are associated, namely, frost blisters, frost effect on asparagus, sun scald and sun scorch, malnutrition of cucumbers and aster yellows.

REPORT OF THE ENTOMOLOGIST.

H. T. FERNALD.

The year 1910 has been marked by numerous changes in this department. The resignation of Prof. C. H. Fernald in June, as station entomologist, marks the first change in the head of this portion of the station work since the department was established in 1888. The resignation, at the same time, of Mr. J. N. Summers from his connection with the station, and the poor health of the writer during the early part of the year, necessarily seriously affected the work accomplished, and the time taken in the fall by moving into new quarters has practically prevented anything besides routine work.

The development of a new line of investigation has been made possible by the appointment of Dr. B. N. Gates as station apiarist. Dr. Gates's work will be, at least for the present, entirely under the Adams fund.

Mr. Arthur I. Bourne has been appointed assistant in entomology, and is, in general, in charge of the correspondence and of considerable of the experimental work. His appointment will enable the head of the department to devote more time to the larger problems relating to insects in this State, both in general and in connection with Adams fund projects, than has heretofore been the case.

It has proved to be impossible to obtain an orchard near the station in which to continue the observations on the size and importance of the different broods of the codling moth. The movement for better fruit in Massachusetts has been nowhere more evident than in Amherst, and the results, though most desirable in general, have been disastrous for the continuation of this series of observations, which must now be discontinued. A long delay in moving the greenhouse to its new site, and in making it ready for use, has prevented taking up this year the experiments on the resistance of muskmelons to fumigation. These can be resumed during 1911, however.

Further tests of methods of controlling wire worms attacking seed corn have been continued on Mr. Whitcomb's farm. The results of the tests already made were referred to in the last report, and were also published in the "Journal of Economic Entomology" for August, 1909. It was distinctly stated in the latter publication that these methods were still in the experimental stage, but that it seemed desirable to test them on a larger scale in different parts of the country. Several of the agricultural papers suggested this to their readers, and the reports received as to results varied from excellent to failure, by preventing germination. A few cases of failure have been investigated, and in every case so far appear to have been due to the use of coal tar instead of gas tar, or to giving the corn such a heavy coating of the tar as to, of itself, prevent germination. On the whole, the treatment can hardly be considered as having been fairly tested in all cases.

One objection to the method is that the seed must be treated first with tar and then with the Paris green. During the past season it has been attempted to avoid this, while obtaining equally good results, by the use of arsenate of lead. The particular brand used in these experiments was disparene, which comes in paste form. This was diluted till about as thick as paint. Then the corn was added and the whole thoroughly stirred. The corn was then spread out till dry.

Unfortunately, wire worms proved to be few in the fields where the treated corn was planted, so that the value of the test was restricted to a determination of the effect of the treatment on the germination of the seed. From this standpoint, however, it was a success, having no injurious effect whatever. Plans have already been made to continue this work another season, and fields badly infested with wire worms are to be made use of, so far as these can be found.

Dates of the hatching of the young of the oyster-shell scale, the scurfy scale and the pine-leaf scale have been continued as far as possible. The object of this has been stated in previous reports, and it need only be added here that the observations should be continued for several years, if averages of value are to be obtained.

Nearly ten years ago a study of the Marguerite fly, a pest too familiar to many florists, was begun, but was soon dropped for lack of material. More having been obtained, this investigation has been resumed, and it is hoped that the entire life history of the fly may now be learned, together with effective methods for its control.

Observations on the distribution limits of insect pests in Massachusetts have been continued as opportunity has offered, and some interesting facts on this subject have been obtained. Work of this kind must, from its very nature, be fragmentary for a long time, and for years the gathering and preservation of the observations made are all which it will be possible to accomplish. As the time required for this is but a few moments per week, or even per month, however, the results are well worth the trouble.

Investigations on the importance of the Sphecidæ as parasites have been continued, and a number of additions to our knowledge of the group have resulted. The subject is a large one, however, and the amount of time available for this purpose has been much less than could be desired. Experiments with insecticides have been almost at a standstill from their entomological side, waiting for pure materials of known composition to be provided by the chemical department. Some of these have been satisfactorily obtained during the fall and the tests of them can be begun in the spring of 1911. The chemical results of this work will be reported upon by that department.

CHARLES ANTHONY GOESSMANN.

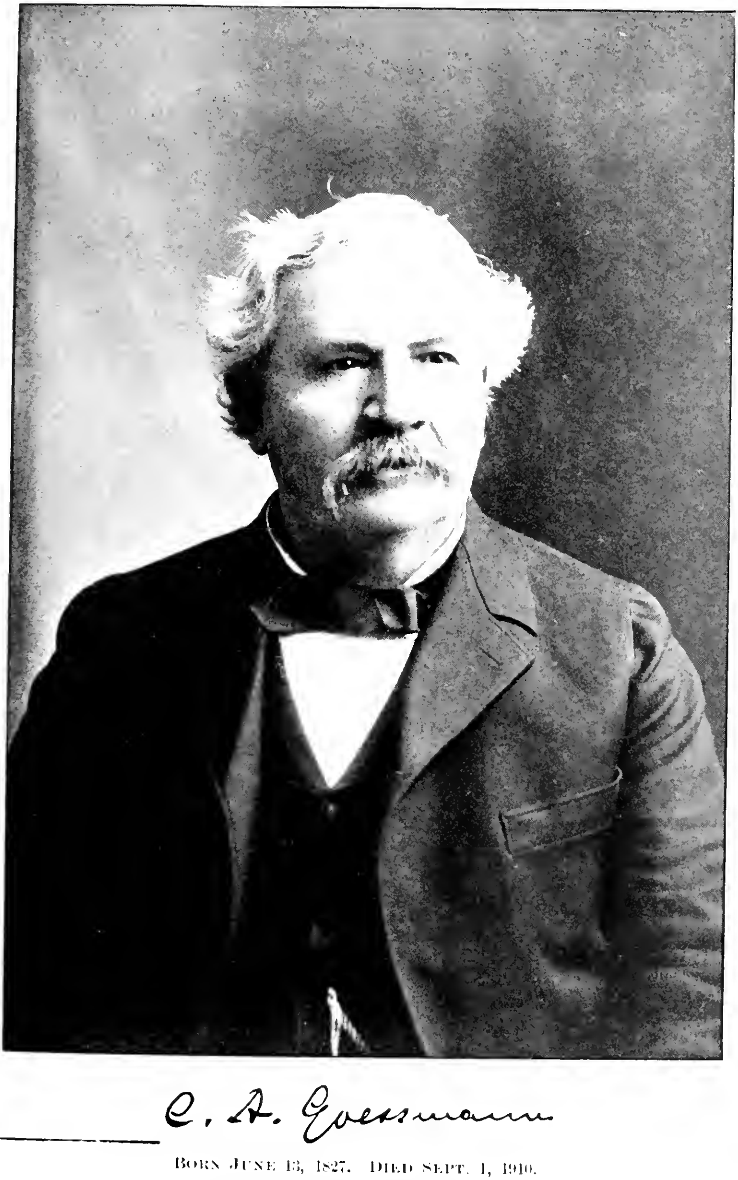
Charles Anthony Goessmann, chemist, investigator, teacher and philosopher, passed to the higher life Sept. 1, 1910.

Karl Anton Gössmann was born in Naumburg, in the Grand Duchy of Hesse, Germany, June 13, 1827. He was the son of Dr. Heinrich Gössmann, who was a fellow student of the noted chemist Frederich Wöhler. When the boy was seven or eight years of age the family moved to Fritzlar in Hesse and here young Gössmann spent his boyhood days. His father wished his son to become a pharmacist, and he received training in pharmacy previous to his becoming a university student. He entered the university of Göttingen in 1850, and studied chemistry, botany, physics, geology and mineralogy. He received the degree of Doctor of Philosophy in 1851 for a dissertation on the "Constituents of the Cantharides." Wöhler early recognized the ability and industry of the young chemist, and made him assistant in his laboratory, and upon the appointment of Limprecht to a professorship, Gössmann became a privatdocent and Wöhler's first assistant. He assumed charge of the chemical laboratory, and lectured on organic and technical chemistry as well as to students of pharmacy. His American students during the period were Chandler, Marsh, Joy, Nason, Caldwell and Pugh.

During his stay at Göttingen he received a number of flattering offers from other institutions, and made the acquaintance of Schönbein, the chemical physicist who discovered gun cotton and ozone; of Schrötter, noted for his researches in phosphorus; of A. W. von Hoffmann and of the celebrated French chemist Sainte Clair Deville.

In 1857 Gössmann left Göttingen on leave of absence, and visited the universities and a number of manufacturing establishments in Germany, Austria, France and England, and then journeyed to the United States upon invitation from Eastwich Brothers in order to become scientific director of their large sugar refineries. It was his intention eventually to return to Germany and teach technical chemistry, but he became so interested in the new country, and observed such a wide field of future usefulness for the technical chemist, that he decided to make the United States his permanent home.

After completing his work at Philadelphia he went to Cuba in order to study the methods of handling sugar then in vogue. On returning to the United States he was engaged as chemist by the Onondaga Salt Company of Syracuse, a position which he retained until 1869.



C. A. Goessmann

BORN JUNE 13, 1827. DIED SEPT. 1, 1910.

[Brief sketch of life, page 80.]

While in its employ, he visited and examined the salt springs in Canada, Michigan and Louisiana. During the latter part of this Syracuse period he spent a portion of each year as professor of chemistry and physics at the Rensselaer Polytechnic Institute at Troy, and he was invited to occupy the position permanently.

In 1868, at the earnest solicitation of his friend, the late Col. William S. Clark, he accepted the professorship of chemistry at the Massachusetts Agricultural College, and held it continuously until his retirement in June, 1907. He was placed at the head of the Massachusetts Experiment Station, a private enterprise started in 1878, and was instrumental in securing the establishment of the Massachusetts State Agricultural Experiment Station in 1882, being made its director and chemist, — positions which he held until it was merged with the Hatch Experiment Station by act of the Legislature in 1895.

Professor Goessmann served as chemist to the Massachusetts State Board of Agriculture from 1873 until his retirement, and for many years also acted as associate analyst of the Massachusetts State Board of Health. He became the first president of the Association of Official Agricultural Chemists, and was a charter member of the American Chemical Society, which he also served as president and vice-president. He was a member of the German society of naturalists and physicians, of the Physico-Medical Society of Erlangen University, a fellow of the American Association for the Advancement of Science, and a member of the Massachusetts Horticultural Society and of the Massachusetts Meteorological Society.

In 1889 Amherst College conferred upon him the degree of Doctor of Laws.

In this connection space forbids any extended reference to his work. Briefly it may be classified into four periods: —

1. The Göttingen Period of Seven Years, 1850–57.

In addition to his work as teacher in the university he found time to make and publish the results of twenty-five distinct investigations, all of which may be found in the "Annalen der Chemie u. Pharmacie." Among the most important of these papers may be mentioned the discovery of arachidic and hypogæic acids in the peanut oil, the constituents of the cantharides, the composition of cocoa oil and the constitution of leucine. This latter paper was considered of so much importance that it drew forth a letter of commendation from Wöhler to Dumas and secured for Gössmann membership in the Physico-Medical Society of the University of Erlangen, an honor which he highly prized.

2. The American Period of Eleven Years previous to the Massachusetts Agricultural College, 1858–69.

He made a number of contributions to the "American Journal of Science" on the chemistry of brine and salt, and while in the employ of the salt company at Syracuse devised a process for the removal of calcium and magnesium chlorides from salt which was of inestimable value to the salt industry of the United States. He also contributed papers to the "London Chemical News" on sugar refining.

3. The Massachusetts First Period, 1869–86.

During this period, in addition to teaching, Professor Goessmann made a study of the agricultural conditions in the State, was a frequent contributor to the agricultural press, and gave numerous lectures before the State Board of Agriculture.

His more prominent investigations may be briefly referred to under the following headings: —

(*a*) *Beets for Sugar, and Sugar Beets as an Agricultural Enterprise.* — He carried on investigations with the sugar beet both in the field and laboratory, and demonstrated the feasibility of growing beets for sugar in certain sections of Massachusetts, and concluded that, with the proper education of the farmer and capitalist, the production of sugar from the beet should prove a profitable American industry. (Reports of the Massachusetts Agricultural College, 1871, 1872, 1873, 1874, 1876.)

(*b*) *The Value of Early Amber Sorghum as a Sugar-producing Plant.* — His study of the plant as a possible source of sugar led him to conclude that "the presence of a large amount of grape sugar in all the later stages of growth . . . is a serious feature in the composition of the juice, impairing greatly the chances for a copious separation of the cane sugar by simple modes of treatment." *This prophesy has been literally fulfilled,* in spite of the later efforts to utilize this plant as a commercial source of sugar.

(*c*) *Reclamation of Salt Marshes.* — Goessmann made a thorough investigation of the condition of the marshes in southeastern Massachusetts, and embodied his results in a number of valuable papers before the Massachusetts State Board of Agriculture. His studies included the chemical conditions of the soils, and he recommended diking when necessary, suitable fertilizers and especially thorough drainage and cultivation. (Reports of the Massachusetts State Board of Agriculture, 1874, 1875, 1876.)

(*d*) *The Application of Chemistry to Fruit Culture.* — His studies were devoted particularly to the composition of the ash of different fruits, and to the influence of the various forms of mineral fertility upon yield and quality. He emphasized the need of a thorough study of the functions of the several mineral elements in plant growth, a subject still calling for much careful investigation. He proved to his own satisfaction that muriate of potash promoted particularly the growth and improved the quality of fruit; and, further, that an increase of potash was accompanied by a corresponding decrease in lime and phosphorus. He called attention to the fact that the young branches of peach trees affected with "yellows" contained excessive amounts of lime and phosphoric acid, and that a judicious pruning, together with liberal applications of muriate of potash, restored the affected trees to a vigorous growth, which contained normal amounts of potash, lime and phosphoric acid. (Twenty-seventh and thirty-second reports of the Massachusetts State Board of Agriculture.)

(*e*) *The Chemical Composition of Different Varieties of Corn, and the Preservation of Corn in Silos.* — Goessmann gave considerable attention to the value of corn for cattle, and in a comprehensive paper published numerous analyses of different varieties of the entire corn plant, as well as of the stalks, ears and cobs. About 1880 attention was being given to the method of preserving corn in the silo, and the claim was made by Dr. J. M. Bailey and others that corn thus preserved (ensilage) did not suffer loss by the process, but was actually superior in feeding value to the original product. Goessmann in two admirable papers explained and discussed the principles of animal nutrition founded upon the researches of German investigators, showed the place of corn in the animal economy, pointed out the changes that took place during the process of fermentation, and made clear the relative merits of the dry and preserved corn. His statements concerning the relative value of silage and dry corn, made in 1880, hold true at the present time. (Reports of the Massachusetts State Board of Agriculture, 1879–80, 1880, 1881.)

(*f*) *The Inspection of Commercial Fertilizers.* — Goessmann was instrumental in securing the passage of a law authorizing the inspection of commercial fertilizers, which became operative Oct. 1, 1873, and as State Inspector of Fertilizers under the new law he made a preliminary report the same year. (Twenty-first report of the Massachusetts State Board of Agriculture.) It is believed that this was the first law enacted in the United States requiring an official inspection of fertilizers. He found many of the materials offered to be of uncertain composition, and to vary greatly in price; "these same articles cost the farmers . . . about one-half the amount more than they ought to". His work along this line from year to year corrected most of these abuses, and was unquestionably of great pecuniary value to the farmers of the State and nation.

4. The Massachusetts Second Period, 1886–1907.

The Massachusetts State Agricultural Experiment Station was established by act of the State Legislature, and Goessmann was made director and chemist. The yearly grant of $5,000 was soon increased to $10,000, and in 1885–86 a new chemical laboratory was completed. He relinquished most of his college work, and devoted his energies to a thorough organization of the station.

The chief lines of work pursued by the station under his guidance are mentioned under the following general headings: —

1. The free analyses of fertilizers, refuse materials suitable for fertilizing purposes, coarse and concentrated feeds and drinking waters.

2. Experiments with dairy cows to test the relative feeding values of home-grown fodders and of commercial feedstuffs.

3. Feeding experiments with soiling crops, and the introduction and testing of new fodder crops.

4. Experiments with pigs to determine the rations best suited for pork production.

5. Feeding experiments with steers and sheep to determine the cost of beef and mutton, and to study the rations best suited for such purposes.

6. Field experiments to determine the nitrogen-acquiring power of the legumes.

7. Field experiments to study the best fertilizer combinations for market-garden crops.

8. Field experiments to ascertain the relative values of different forms of phosphoric acid.

9. Fertilizers best suited for permanent grass lands.

10. The effects of various forms of plant food in modifying the quality of the product.

11. Compilation of tables of analyses of fertilizers, cattle feeds, dairy products and fruits made at the station.

He devoted himself to the executive work of the station, and carefully supervised all of the experimental work as well. While not a rapid worker, he succeeded in accomplishing a great deal because of his steady and long-continued application. Since 1886 practically all of his papers were published in the annual reports of the experiment station.

After the merging of the State and Hatch stations, in 1895, advancing years made it necessary for him to relinquish many of his responsibilities. He continued, however, until his retirement to supervise the inspection of fertilizers and the general work in the fertilizer and soil laboratory.

Aside from his services as investigator and teacher, it is important to remember that he inspired in others a zeal for further study and accomplishment. There are to be found among his pupils presidents of colleges and schools of agriculture, directors of experiment stations, research and technical chemists, teachers, as well as workers in many lines of industry having a direct bearing upon agriculture.

Professor Goessmann possessed a wonderfully retentive memory, and being a great reader he was especially well informed on a wide variety of topics. He was a good conversationalist, and if interested in a subject poured forth a torrent of information, interspersed with opinions of his own. He had a genial disposition, a winning personality, and when he was amused his smile of appreciation was not soon to be forgotten. One did not need to be long associated with him to feel his influence for good and to realize that he was much more than an ordinary man. In fact, his very presence seemed to exhale a sort of spiritual essence which lifted one to a higher level of thought and feeling.

Goessmann was indeed a pioneer in the cause of agricultural investigation in the United States, or, as one of his students expressed it, he was a foundation builder. He was a leader, and pointed the way to a fuller understanding of the principles of science as applied to agriculture. Every experiment station worker, every tiller of the soil, and in fact every citizen in our great country, either directly or indirectly, has been benefited by this man who has recently passed into the Great Beyond.

J. B. LINDSEY.

STUDIES IN MILK SECRETION.

BY J. B. LINDSEY.

The Effect of Protein upon the Production and Composition of Milk.

Investigations and observations indicate that milk is not a simple fluid secreted directly by the blood, but a complex substance resulting from the activity of the milk cells. The cells and milk glands take from the blood and lymph vessels substances suited to their purposes, and by chemical and physiological processes convert them into a different substance, namely, milk. Milk, therefore, consists for the most part of reconstructed cell substance, and it is not possible, by any system of feeding, to produce very great modification in its composition. The composition of milk depends principally upon the breed and individuality of the cow, stage of lactation and development of the milk cells.

G. Kuhn,[1] M. Fleischer [1] and E. Wolff,[2] during the years 1868 to 1876, studied the additions to the different basal rations of increasing amounts of protein upon the composition of the milk, and noted only very slight variations. They observed that of all the milk components the percentage of fat was the most influenced by the food supply. N. J. Fjord and F. Friis,[3] as a result of experiments by the group method with 1,152 cows, concluded that the protein was practically without influence in varying the proportions of the several milk ingredients. W. H. Jordan [4] has conducted a number of trials, and failed to note any specific influence of the protein in

[1] Landw. Versuchsstationen 12 Bd., 1869; Journal für Landw., 1874.

[2] Die Versuchsstationen Hohenheim, Berlin, 1870; Résumé in Die Ernahrung der Landw. Nützthiere, E. Wolff, 1876.

[3] Beretning fra den Klg. Veterinær. og Landbohoiskole Lab. for landokonomiske Forsog. Kopenhagen, 1892; Résumé in Centralblatt f. Agricultur Chemie, 22 Jahrg., 1893. s. 604.

[4] Maine Experiment Station, reports for 1885–86, 1886–87; New York Experiment Station, Bulletin 197, 1906.

varying the proportion of the milk constituents. Armsby,[1] as well as Whitcher and Wood,[2] has drawn similar conclusions. Morgan *et als.* conclude from numerous investigations that protein is without specific influence in the formation of milk fat.[3] Kellner,[4] in summing up the results of numerous experiments, especially of German origin, says "in so far as it is possible by means of food to effect the action of the milk glands, the protein of the several food groups exerts a very pronounced influence. This influence is especially noticeable in increasing the *quantity* of the milk. Only after the long-continued feeding of a ration known to be deficient in protein does the water content of the milk increase, and the dry matter and fat show a noticeable decrease."

This station from time to time has conducted a number of experiments to observe the influence of different amounts of protein in increasing the quantity of milk, to note the protein requirements of dairy animals and also to study its influence in modifying the proportions of the several milk ingredients. Some of these results have been published in reports of the station. It is proposed to briefly summarize the results already given publicity, and to describe somewhat in detail our more recent observations.

Experiment I.[5] *— 1895.*

This experiment was undertaken with six cows by the reversal method. The animals were from five to ten years of age, had all calved in the early autumn, and none had been served when the experiment began.

Weighing Animals. — The animals were weighed once before feeding and watering at the beginning and end of each half of the trial, and once each week during the continuance of the experiment. It would have been better to have weighed each animal for three consecutive days at the beginning and

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[1] Wisconsin Experiment Station, reports for 1885-86, New Hampshire Experiment Station, Bulletin 90, pp. 12-14; Bulletin 18, p. 13.

[2] *Ibid.*

[3] Landw. Vers. Stat., 62 (1905), nos. 4, 5; pp. 251-286; Abs. Experiment Station Record Vol. 17, p. 286.

[4] Die Ernährung d. Landw. Nützthiere, erste Auflage, p.519; also, fünfte Auflage, p. 539.

[5] Ninth report of the Hatch Experiment Station, pp. 100-125.

end of the experiment; the weights, however, were probably sufficient to give an accurate *average weight* of each animal.

Sampling and Testing the Milk. — A composite sample of each cow's milk was made for five consecutive days, and preserved with bichromate of potash. Great care was used to secure representative samples. The total solids and fat were determined by approved gravimetric methods.

Dates of the Experiment.

Dates.	Days.	High Protein.	Low Protein.
Oct. 24 through Nov. 18, 1895, ...	26	Cows I., IV., VI.	Cows II., III., V.
Nov. 28 through Dec. 23, 1895, ...	26	Cows II., III., V.	Cows I., IV., VI.

At least a week elapsed after the animals were placed upon full rations before the experiment proper began.

Average Daily Rations fed to the Six Cows (Pounds).

Character of Ration.	Wheat Bran.	Chicago Gluten Meal.	Corn Meal.	Hay.	Sugar Beets.
High protein, ...	3	5.83	–	15.17	12
Low protein, ...	3	–	5.83	16.17	12

Each of the cows received 3 pounds of bran and 12 pounds of beets daily. One of the cows, Ada, received only 5 pounds of corn or gluten meal per day, while the others received each 6 pounds. The amount of hay fed differed slightly in the case of individual cows, depending upon their ability to utilize it. The hay was of good quality, containing 9.73 per cent. of crude protein; the bran 19.20 per cent.; the gluten meal 42.73 per cent., and the corn meal 11.36 per cent., all on a dry-matter basis.

It will be seen that the basal ration consisted of hay, beets and bran, and that the variable factor was the corn or gluten meal.

Average Weight of Animals and Average Digestible Nutrients in Daily Rations (Pounds).

Character of Ration.	Weight of Animal.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Fat.	Fiber and Extract Matter.	Total.	
High protein,	941	3.07	.59	10.23	14.06	1:3.86
Low protein,	938	1.46	.52	12.45	14.43	1:9.43

Three of the cows varied in weight from 800 to 900 pounds, and three others from 1,000 to 1,060 pounds. During the high-protein period the cows gained in total 101 pounds, and during the low-protein period there was a total loss of 64 pounds. The average weight of the herd during each of the two halves of the experiment was substantially the same.

The figures for digestible nutrients were secured from actual analysis of the feedstuffs used, together with average digestion coefficients, actual digestion tests not being made. The total digestible nutrients consumed was the same in case of each of the halves of the experiment, the difference being in the excess of digestible protein and the corresponding deficit of carbohydrates. The high-protein ration had evidently too narrow a ratio, and the low-protein ration too wide a ratio for the best results.

Protein Balance (Pounds).

Character of Ration.	Cows.	Protein digested.	Protein required for Maintenance.	Protein contained in Milk (N. x 6.25).	Protein Excess over Maintenance and Milk Requirements.
High protein,	Ada,	69.16	14.56	20.31	34.29
	Una,	79.56	16.38	18.66	44.52
	Bessie,	81.12	15.60	26.03	39.49
	Beauty,	84.24	18.98	22.28	42.98
	Red,	82.16	19.24	24.26	38.66
	Spot,	82.16	17.94	28.00	36.22
Low protein,	Ada,	33.54	14.56	17.84	1.14
	Una,	36.40	16.12	17.84	2.44
	Bessie,	37.96	15.60	22.51	—.15
	Beauty,	40.82	18.98	17.92	3.92
	Red,	39.00	18.72	22.08	—1.80
	Spot,	39.00	18.20	20.72	.08
Total high,	-	478.40	102.70	139.54	236.16
Total low,	-	226.72	102.18	118.91	5.63
Average per cow, high,	-	79.73	17.12	23.26	39.36
Average per cow, low,	-	37.79	17.03	19.82	.94

[1] Calculated by allowing .7 of a pound digestible crude protein per day per 1,000 pounds live weight.

In this experiment the percentage of protein in the milk was not determined, and the average figures secured for the experiment immediately following were employed. Calculations show that in the high-protein period there was a surplus of nearly 100 (97.5) per cent. of digestible protein over that required for maintenance and milk production, while in the low-protein period the total digestible protein consumed and the amount required were about equal.

Influence of Protein on the Milk Yield.

Herd Results in Pounds.

Character of Ration.	Average Weight of Cow.	Yield of Milk.	Protein digested.	Protein required for Maintenance and Milk.	Protein Excess over that required for Maintenance and Milk.	Percentage Excess.
High protein,	941	4,241 5	478 40	242 24	236.16	97 5
Low protein,	938	3,695 5	226.72	221.09	5.63	2.3

It is quite evident that the ration with the large excess of digestible protein exerted a marked influence on the milk-secreting organs, causing an increase of approximately 15 per cent. in the milk yield. The average daily milk product per cow during the high-protein period was 27.2 pounds, and during the low-protein period 23.7 pounds, and it therefore may be said that both rations produced a fair yield. The period was too short to note the effect of the larger amount of protein on the general condition of the animal; it is believed, however, that if such an amount had been fed for a long period of time, the result would have been over-stimulation, indigestion and a refusal to eat the large amount of gluten meal.

Effect of the Rations on the Composition of the Milk (Per Cent.).

Character of Ration.	Total Solids.	Fat.	Solids not Fat.
High protein,	13.67	4 51	9 16
Low protein,	13 45	4 28	9 17

Composite samples of each cow's milk were secured for five days of each week. These composites were averaged, and this average represented the composition of the milk of each cow for the period. The average percentage produced by each cow was multipled by the pounds of milk she produced, thus securing the weight of total solid matter and fat yield by each animal in the herd. These totals were added and the amount divided by the total amount of milk given by the herd, and the quotient represents the average percentage of total solids and of fat, as stated in the table.

The results indicate that during the low-protein period, the cows produced milk containing .23 per cent. less fat than in the period when the high protein was fed. The difference is not pronounced and may be considered within the limit of a reasonable experimental error.

Experiment II.[1]

This experiment immediately succeeded experiment I. and was conducted with the same cows, excepting that cow II. (Una) was replaced by Guernsey. The general plan of the experiment, methods of caring for the cows, feeding and sampling of milk were all identical with the preceding experiment.

Dates of the Experiment.

Dates.	Days.	High Protein.	Low Protein.
Jan. 27 through Feb. 16, 1896,	21	Cows I., II., VI.	Cows III., IV., V.
Feb. 29 through March 20, 1896,	21	Cows III., IV., V.	Cows I., II., VI.

It will be seen that each period lasted twenty-one days, with a preliminary feeding of seven or more days.

Average Daily Rations fed to the Six Cows (Pounds).

Character of Ration.	Wheat Bran.	Chicago Gluten Meal.	Linseed Meal.	Corn Meal.	Hay.	Millet and Soy Bean Silage.
High protein,	2.83	3.00	1.92	–	10.33	28.33
Low protein,	1.92	–	–	5.83	10.33	28.33

[1] Ninth annual report of the Hatch Experiment Station, pp. 100-125.

The bran contained 18.87 per cent., the Chicago gluten 39.75 per cent., the old-process linseed meal 41.99 per cent. and the corn meal 11.36 per cent. of protein in dry matter. The silage was a mixture of barnyard millet and soy beans, the latter being quite well podded; it contained about 81 per cent. of water and 12 per cent. of protein in dry matter. Each animal received from 9 to 11 pounds of hay, 20 to 30 pounds of silage, during each half of the experiment. In the high-protein ration from 2 to 3 pounds of bran were fed, 3 pounds of gluten and 1.5 to 2 pounds of linseed meal. In the low-protein ration 1.5 to 2 pounds of bran were given and 5 to 6 pounds of corn meal. The above table shows the averages. The cows ate their rations clean in every case.

Average Weight of Animals and Average Digestible Nutrients fed daily (Pounds).

Character of Ration.	Weight of Animals.	Protein.	Fat.	Fiber and Extract Matter.	Total.	Nutritive Ratio.
High protein, . .	899	2.85	.65	9.96	13.46	1:4.04
Low protein, . .	900	1.45	.54	11.44	13.42	1:8.85

The individual weight of the individual cows varied from 763 to 1,004 pounds. The cows changed very slightly in weight during each half of the experiment.

The digestible nutrients were calculated from the analyses of the feed, with the aid of average digestion coefficients. The high-protein ration contained substantially twice as much digestible protein as the low-protein ration. The fat varied but slightly, and the difference in the amount of carbohydrate matter depended naturally upon the different amounts of protein fed. The total nutrients consumed in two rations were the same.

Protein Balance (Pounds).

Periods of Twenty-one Days.

Character of Ration.	Cows.	Protein digested.	Protein required for Maintenance.	Protein contained in Milk (N x 6.25).	Protein Excess over Maintenance and Milk Requirement.
High protein,	Ada,	50.61	11.21	15.42	23.98
	Guernsey,	60.61	12.60	19.52	28.49
	Bessie,	61.53	12.18	18.98	30.37
	Beauty,	62.58	14.41	16.22	31.95
	Red,	62.58	14.91	17.37	30.30
	Spot,	62.58	13.86	20.29	28.43
Low protein,	Ada,	25.20	11.34	12.83	1.03
	Guernsey,	31.50	12.30	16.36	2.84
	Bessie,	30.24	12.09	15.90	2.25
	Beauty,	31.29	14.07	15.08	2.14
	Red,	31.29	14.70	16.05	.54
	Spot,	32.55	13.84	16.65	2.06
Total high,	-	360.49	79.17	107.80	173.52
Total low,	-	182.07	78.34	92.87	10.86
Average per cow, high,	-	60.08	13.19	17.97	28.75
Average per cow, low,	-	30.34	13.06	15.48	1.81

Influence of Protein on Milk Yield.

Herd Results in Pounds.

Character of Ration.	Average Weight of Cows.	Yield of Milk.	Daily Yield of Milk per Cow.	Protein digested.	Protein required for Maintenance and in Milk.	Protein Excess over that required for Maintenance and Milk.	Percentage Excess.
High protein,	899	3,261.0	25.82	360.49	186.97	173.52	92.8
Low protein,	900	2,877.0	22.73	182.02	171.21	10.86	5.1

It will be seen that on the high-protein ration the cows received 92.8 per cent. more digestible crude protein than was required for maintenance and for the milk produced, while in low-protein ration the excess was only 5 per cent., the amount digested and the amount fed being substantially equal.

The figures show that for a period of twenty-one days, while not changing in weight, the herd produced 13.3 per cent. more milk on the high-protein diet, showing very distinctly the influence of the excess of protein. This experiment exactly confirms the experiment immediately preceding.

Composition of the Herd Milk (Per Cent.).

Character of Ration.	Total Solids.	Fat.	Solids not Fat.	Nitrogen.	Protein Equivalent.
High protein,	13.82	4 83	8.99	.526	3.28
Low protein,	14 10	5 02	9.08	.518	3.23

The samples were taken and averages secured in the same way as in the previous experiment. Here we have a direct reversal of the results, the low-protein ration showing a trifle higher average fat percentage than the high-protein ration. This may also be regarded as within the limit of error. The percentage of nitrogen in the milk produced during each half of the experiment is substantially the same, and this in spite of the fact that the low-protein ration contained but 1.45 pounds of digestible protein, and the high-protein ration 2.85 pounds.

Experiment III.[1]

This experiment was one of a series designed to study the effect of food stuffs upon the composition of milk and of butter fat. Only that portion of the experiment is here published which shows the influence of protein upon the yield and composition of the milk. It was planned on the group system, five cows composing each group. The first two periods of the experiment only are needed in this connection.

Duration of Experiment.

Periods.	Dates of Experiment.	Length in Weeks.
First period: both herds standard ration,	Nov. 17, through Dec. 7, 1900,	3
Second period: { Herd I., standard ration, / Herd II., cottonseed ration, }	Jan. 5, through Feb. 8, 1901,	5

[1] See résumé in fourteenth report of the Hatch Experiment Station, pp. 162–168.

Average Daily Rations (Pounds).

First period: both herds, standard grain ration.

Herds.	Standard Grain Ration.	Cotton-seed Meal.	First-cut Hay.	Rowen.
Herd I.,	9	-	8-12	10
Herd II.,	9	-	8-12	10

Second period: Herd I., standard ration; Herd II., cottonseed ration.

Herds.	Standard Grain Ration.	Cotton-seed Meal.	First-cut Hay.	Rowen.
Herd I.,	9	-	8-12	10
Herd II.,	5	3	8-12	10

The standard ration consisted of 3 pounds of wheat bran, 5 pounds of ground oats and ½ pound each of cottonseed and gluten meals. The cottonseed meal contained some 9 per cent. of oil and 54.54 per cent. of protein in dry matter.

Average Dry and Digestible Nutrients in Daily Rations (Pounds).

First period: both herds, standard grain ration.

Herds.	Dry Matter.	Protein.	Fiber and Extract Matter.	Fat.	Total.	Nutritive Ratio.
Herd I.,	26.15	2.44	12.81	.68	15.95	1:5.8
Herd II.,	26.97	2.49	13.25	.69	16.42	1:5.9

Second period: Herd I., standard grain ration; Herd II., cottonseed ration.

Herds.	Dry Matter.	Protein.	Fiber and Extract Matter.	Fat.	Total.	Nutritive Ratio.
Herd I.,	25.00	2.34	12.27	.66	15.27	1:5.8
Herd II.,	25.69	3.20	11.62	.73	15.55	1:4.1

The digestibility of the standard grain mixture was ascertained by actual experiment. Average coefficients were used for the other feeds. Both herds received substantially the same amounts of protein and total digestible nutrients in the first period. Each herd averaged in live weight about 950 pounds. In the first period the amount of digestible protein was ample to enable the cows to do good work. In the second period Herd II. received .86 of a pound more of digestible protein than did Herd I.

Total and Average Daily Yield of Milk (Pounds).

Herds.	Total Herd Yield.	Average Daily Yield.
First period: both herds, standard grain ration.		
Herd I.,	2,332.5	22.2
Herd II.,	2,405.3	22.9
Second period: Herd I., standard ration; Herd II., cottonseed meal ration.		
Herd I.,	3,856.3	21.9
Herd II.,	3,898.1	22.2

In the first period Herd II. produced 3.1 per cent. more milk than Herd I., and in the second period 1 per cent. more. It would appear, therefore, that the amount of protein fed in the first period was ample, and that the increase given to Herd II. in the second period was not needed and did not increase the milk flow. In the first period Herd I. gained 6 pounds in live weight, and Herd II., 83 pounds. In the second period Herd I. lost 87 pounds, and Herd. II., 73 pounds.

Average Composition of the Herd Milk (Per Cent.).

Herds.	Total Solids.	Fat.	Solids not Fat.	Nitrogen.	Protein Equivalent.	Ash.
First period: both herds, standard grain ration.						
Herd I.,	14.15	5.00	9.15	.538	3.36	.73
Herd II.,	14.27	4.93	9.31	.546	3.41	.72
Second period: Herd I., standard ration; Herd II., cottonseed meal ration.						
Herd I.,	14.16	5.06	9.10	.550	3.44	.73
Herd II.,	14.30	4.98	9.32	.562	3.51	.71

The analyses for the first period represent the average of 3 separate samples, each covering a period of five days; those for the second period represent the average of 5 separate samples, each covering a period of five days. Each five-day composite represented the average composition of the herd milk for one week. The separate analysis of each cow's milk was not made.

In the first period the milk of the two herds showed itself to be practically identical in composition. In the second period the substitution of 3 pounds of cottonseed meal for 4 pounds of the standard ration, thereby increasing the digestible protein in the ration .86 of a pound, had no effect whatever in varying the proportions of the milk. It is well to remember in this connection that nearly a month intervened between the first and second periods [1], and that the period itself covered five weeks. It is possible that, if the standard ration had contained a pound less of digestible protein daily, some difference may have been observed in the composition of the milk produced by the two herds in the second period.

Influence of Protein on the Milk Yield (Pounds).

Herd Results, Second Period.

Character of Ration.	Average Weight of Cow.	Total Yield of Milk.	Protein digested.	Protein required for Maintenance.	Protein in Milk.	Protein Excess over that required for Maintenance and Milk.	Percentage Excess.
Standard,	946	3,856.3	409.5	115.5	132.6	161.4	65.0
Cottonseed meal,	939	3,898.1	560.0	115.5	136.8	307.7	122.0

In so far as this experiment throws any light on the protein requirements, it indicates that Herd I. was receiving ample protein (65 per cent. above the minimum requirement), and that the addition of more protein (122 per cent. above the minimum) was without any noticeable influence upon the milk yield.

Experiment IV.

This experiment was completed during the winter of 1897–98, although the results have not been published. It was conducted on the reversal method, with twelve mature grade Jersey cows, all of which had freshened the previous summer and autumn.

Weighing Animals. — Each animal was weighed for three

[1] This excessive lapse of time was due to some of the cows not being in best of condition.

consecutive days, before feeding in the afternoon, at the beginning and end of each half of the experiment.

Weighing and Sampling the Milk. — The weight of each milking was taken on a spring balance sensitive to 1 ounce, and the weights preserved on prepared record sheets. The milk was sampled for five consecutive days by the usual method, as described in accounts of the many feeding experiments given in previous reports. It was preserved with bichromate of potash and analyzed by gravimetric methods.

Character of Feeds. — The feeds used were all of good quality and of average composition. The hay was composed largely of Kentucky blue grass, sweet vernal grass and a liberal admixture of clover.

Dates of the Experiment.

First Half.

Dates.	Weeks.	High-protein Cows.	Low-protein Cows.
Nov. 13, 1897 to Jan. 14, 1898,	9	Guernsey, Midget, Susie, Beauty, Sadie, Alice.	Bessie, Mary, Mildred, Nina, Blossom, Jennie.

Second Half.

Dates.	Weeks.	High-protein Cows.	Low-protein Cows.
Jan. 24 to March 27, 1898, .	9	Bessie, Mary, Mildred, Nina, Blossom, Jennie.	Guernsey, Midget, Susie, Beauty, Sadie, Alice.

It will be observed that ten days were allowed for changing the feeds given the animals.

Average Daily Rations fed to Each Cow (Pounds).

Character of Ration.	Wheat Bran.	Gluten Feed.	Corn Meal.	English Hay.	Corn Silage.
High protein, ...	3	5.5	–	10 9	25.7
Low protein, ...	3	1 5	4	11.0	25.7

It will be seen that the two rations were practically identical, excepting that 4 pounds of corn meal were substituted for a like amount of gluten feed. Different cows received from 10 to 12 pounds of hay and from 20 to 30 pounds of silage. Each animal received exactly the same amount of grain daily.

Average Dry and Digestible Nutrients in Daily Rations (Pounds).

Character of Ration.	Dry Matter.	Digestible Organic Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total Nutrients.	
High protein,	24.17	2.10	13.00	.50	15.60	1:6.7
Low protein,	24.24	1.67	13.70	.53	15.90	1:8.9

The herd averaged about 900 pounds in weight. The amount of dry matter and of total digestible nutrients fed in each ration was substantially the same; the high-protein ration contained about .4 of a pound more digestible protein than the low-protein ration. The excess over the low-protein ration is not marked and is very much less than that fed in experiments I. and II., previously mentioned.

Herd Gain in Live Weight (Pounds).

Character of Ration.	Gain or Loss.
High protein,	+353
Low protein,	+223

Both rations caused a gain in weight, the excess being in favor of the high-protein ration. This may have been expected, as the low-protein ration had rather too wide a ratio to be productive of the best results.

Protein Balance (Pounds).

Herd Results; Periods of Sixty-three Days.

Character of Ration.	Protein digested.	Protein required for Maintenance.	Protein contained in Milk (N. x 6.25).	Protein Excess over Maintenance and Milk Requirements.
High protein,	1,587.6	476.28	591.76	519.6
Low protein,	1,262.5	476.28	563.23	223.0

Influence of Protein on Milk Yield.

Herd Results in Pounds.

Character of Ration.	Average Weight of Cow.	Yield of Milk.	Daily Yield of Milk Per Cow.	Protein digested.	Protein Excess over that required for Maintenance and Milk.	Percentage Excess.
High protein, . .	900	16,257	21.5	1,587.6	519.6	48.6
Low protein, . .	900	15,347	20.3	1,262.5	223.0	21.4

The average amount of digestible protein fed daily per cow in the high-protein ration — 2.10 pounds — could not be considered excessive, although it was 48.6 per cent. more than was required for milk and maintenance. The average amount of digestible protein fed daily per cow in the low-protein ration was 1.67 pounds, which was 21.4 per cent. above that necessary for milk and maintenance. The high-protein ration, being 48.6 per cent. in excess of the protein minimum, produced 5.9 per cent. more milk than did a ration made up of similar feedstuffs which was 21.4 per cent. in excess of the minimum. Such a difference in an experiment extending over a period of sixty-three days is believed to be too pronounced to be attributed to an experimental error, and is evidently the result of the increased amount of protein fed. In this connection it may be remarked that if the practical feeder purchased all of his grain, it would be to his advantage to buy gluten feed rather than corn meal. If he produces his own corn, the feeding of one-third bran, one-half corn and cob meal and one-sixth gluten feed would be advisable.

Composition of the Herd Milk (Per Cent.).

Character of Ration.	Total Solids.	Fat.	Solids not Fat.	Nitrogen.	Protein Equivalent (N. x 6.25).	Ash.
High protein, . .	14.55	5 11	9.41	.58	3.64	.75
Low protein, . .	14.44	5 01	9.43	.59	3.67	.74

Samples of milk from each cow were taken weekly for five consecutive days, and tested for total solids and for fat. The average percentage produced by each cow for the nine weeks was multiplied by the amount of milk produced during the same period, and the amounts of total solids and of fat produced by the entire herd on each of the two rations calculated. These amounts, divided by the total milk yield, gave the average percentages of total solids and fat produced by each herd for the entire period.

The product of each milking of the six cows receiving the two different rations was also mixed, and composite five-day samples tested for total solids, fat, nitrogen and ash. In case of total solids and fat the average results varied less than .1 per cent. from those secured by the other method. The average results stated in the table above represent those secured by the last-described method.

It will be seen that the two rations produced milk of substantially the same composition. While the excess of protein appeared to have noticeably influenced the amount of the milk produced, it was without influence on its composition.

Experiment V. — 1898.

This experiment was conducted on the same plan as experiment IV., and the conditions were substantially the same. Nine cows only were used, being divided into herds of five and four.

Dates of the Experiment.

First Half.

Dates.	Days.	High-protein Cows.	Low-protein Cows.
April 4 to April 29, 1898, .	26	Blossom, Jennie, Bessie, Mary, Mildred.	Beauty, Alice, Guernsey, Midget.

Second Half.

Dates.	Days.	High-protein Cows.	Low-protein Cows.
May 8 to June 2, 1898, . .	26	Beauty, Alice, Guernsey, Midget.	Blossom, Jennie, Bessie, Mary, Mildred.

Nine days elapsed between halves, and the halves themselves lasted twenty-six days each. The "cow balance" was hardly satisfactory in this experiment, five cows receiving one ration at the same time four were receiving the other, and *vice versa*. These were the only animals at the time that were in suitable condition.

Average Daily Rations fed to the Nine Cows (Pounds).

Character of Ration.	Wheat Bran.	Gluten Feed.	Corn Meal.	English Hay.	Rowen.
High protein,	3	5	-	9 3	9.3
Low protein,	3	1	4	9.3	9.4

These two rations differ only in that 4 pounds of corn meal took the place of a like amount of gluten feed.

Average Dry and Digestible Nutrients in Daily Rations (Pounds).

Character of Ration.	Dry Matter.	Digestible Organic Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total Nutrients.	
High protein,	23.62	2.41	11.97	.43	14.81	1:5.4
Low protein,	23.44	1.96	12.39	.44	14.79	1:6.8

In the so-called low-protein ration the herd received substantially 2 pounds of digestible protein daily; in the high-protein ration this was increased .4 of a pound. The total digestible nutrients fed were the same in each case. The cows averaged 970 to 960 pounds in live weight during the two halves of the experiment. In the low-protein ration the amount of protein fed was sufficient to give satisfactory results.

Herd Gain in Live Weight (Pounds).

Character of Ration.	Gain or Loss.
High protein,	+76
Low protein,	+115

Protein Balance (Pounds).

Herd Results; Periods of Twenty-six Days.

Character of Ration.	Protein digested.	Protein required for Maintenance.	Protein contained in Milk.	Protein Excess over Maintenance and Milk Requirements.
High protein,	563.9	156.8	184 4	222 7
Low protein,	458 6	155.5	174 8	128 3

Influence of Protein on Milk Yield.

Herd Results in Pounds.

Character of Ration.	Average Weight of Cow.	Yield of Milk.	Daily Yield of Milk Per Cow.	Protein digested.	Protein Excess over that required for Maintenance and Milk.	Percentage Excess.
High protein,	960	4,693 5	20 06	563.9	222.7	65.3
Low protein,	950	4,370.6	18.68	458.6	128.3	39.0

The average amount of digestible protein fed daily to each cow in the high-protein ration was 2.41 pounds, and the excess over that required for milk and maintenance was 65.3 per cent. In the low-protein ration each cow received 1.96 pounds daily, and an average excess of 39 per cent. above requirements.

During the high-protein feeding the herd produced 7.4 per cent. more milk than when it received the low-protein ration, showing the influence of the larger amount. Whether all of the milk increase was due to the extra protein consumed is uncertain. The low-protein ration naturally had a wider ratio, and evidently was rather better suited to fattening than to milk production, and was indicated by the increase in live weight.

Composition of the Herd Milk (Per Cent.).

Character of Ration.	Total Solids.	Fat.	Solids not Fat.	Nitrogen.	Protein Equivalent (N x 6.25).	Ash.
High protein,	14 83	5 00	9 84	.63	3 93	.74
Low protein,	14 90	5 07	9 82	.66	4 00	.76

The above figures represent the average of five-day composite samples of the milk produced by the herd of nine cows while on the two different rations. Samples of *each cow's* milk were also tested five days in each week for total solids and fat. The average of the two herds by this method varied less than .1 per cent. from the above figures. It is, therefore, evident that the difference in the amount of protein in the ration did not vary the fat, solids not fat, nitrogen or ash content of the milk.

Experiment VI. — 1905–06.

This experiment, hitherto not reported, was carried out by the group method, six cows constituting each of two groups.

The object of the experiment was to note the effect of a ration low in digestible protein, — the amount required in the milk plus that for maintenance, — as compared with one containing approximately ½ pound in excess. The effect of the two rations was to be noted (*a*) on the condition of the animals; (*b*) on the yield of milk, milk solids, fat and nitrogen; (*c*) on the relative shrinkage; (*d*) on the composition of the milk.

Plan of the Experiment. — The twelve cows were divided as evenly as possible into two groups. The first few weeks both groups received the low-protein ration in order to establish a basis for comparison. The record of the milk yield and its composition is reported for the last week of this preliminary period. At the beginning of the period proper, Group II. received the high-protein ration, and Group I. continued on that low in protein.

History of the Cows.

Name.	Breed.	Age (Years).	Last Calf dropped.	Days with Calf, Beginning of Test.
Blanche,	Grade Guernsey,	10	October, 1905	57
Daisy,	Grade Jersey,	7	August, 1905	79
Fancy,	Grade Jersey,	6	August, 1905	79
Gladys,	Pure Jersey,	3	December, 1905	–
Maude,	Grade Guernsey,	2	December, 1905	18
May,	Grade Jersey	10	July, 1905	68
Betty,	Grade Jersey,	2	November, 1905	–
Dora,	Grade Jersey,	12	August, 1905	–
May Rio,	Pure Jersey,	3	October, 1905	64
Molly,	Grade Jersey,	10	July, 1905	–
Red H.,	Grade Jersey,	10	November, 1905	20
Samantha,	Grade Jersey,	3	August, 1905	51

Weighing Cows. — Each cow was weighed for three consecutive days at the beginning and end of the period proper, before watering and feeding in the afternoon. These weights were also taken twice during the intervening time.

Sampling Feeds. — Samples of hay and silage were taken at the beginning of the period, and every two weeks thereafter. In case of the hay, forkfuls were taken here and there from the entire amount to be fed for the day, run through a feed cutter, subsampled, the final sample brought to the laboratory in glass-stoppered bottles, dry-matter determinations made at once and the sample saved for a composite. The silage was similarly sampled, excepting that it was not run through the cutter. The grain was sampled daily, preserved in glass-stoppered bottles, and at the end of the period analyzed.

Sampling Milk. — The milk of each cow was sampled for five consecutive days in each week by the usual method, and the composite tested for fat, total solids, nitrogen and ash.

Dates of the Experiment.

Preliminary Period.

Herd.	Character of Ration.	Dates.	Weeks.	Cows.
I.,	Low protein,	January 27 through February 2.	1	Blanche, Daisy, Fancy, Gladys, Maude, May.
II.,	High protein,	January 27 through February 2.	1	Betty, Dora, May Rio, Molly, Red II., Samantha.

Period Proper.

Herd.	Character of Ration.	Dates.	Weeks.	Cows.
I.,	Low protein,	February 10 through April 27.	11	Blanche, Daisy, Fancy, Gladys, Maude, May.
II.,	High protein,	February 10 through April 27.	11	Betty, Dora, May Rio, Molly, Red II., Samantha.

Average Daily Rations consumed by the Two Herds (Pounds).

Preliminary Period.

Herd.	Character of Ration.	English Hay.	Corn Silage.	Wheat Bran.	Corn Meal.	Gluten Meal.
I.,	Low protein,	12 6	22 5	3 4	3 3	–
II.,	Low protein,	12 6	22 2	3 4	3 3	–

Period Proper.

Herd.	Character of Ration.	English Hay.	Corn Silage.	Wheat Bran.	Corn Meal.	Gluten Meal.
I.,	Low protein,	12 6	22 2	3 4	3 3	–
II.,	High protein,	13 0	21 0	3 7	1 2	2 2

The amount of hay fed to the different cows varied from 11 to 15 pounds; silage, from 20 to 30 pounds; bran, from 3 to 4.5 pounds; corn meal, from 3 to 4.5 pounds, and gluten meal, from 2 to 3 pounds daily.

Average Amounts of Dry and Digestible Matter consumed by Each Cow daily (Pounds).

Preliminary Period.

Herd.	Character of Ration.	Dry Matter.	Protein.	Fiber.	Extract Matter.	Fat.	Total.	Nutritive Ratio.
I.,	Low protein,	21.75	1.22	3.58	8.39	.42	13.61	1:10.6
II.,	Low protein,	22.51	1.27	3.63	8.68	.43	14.02	1:10.4

Period Proper.

Herd.	Character of Ration.	Dry Matter.	Protein.	Fiber.	Extract Matter.	Fat.	Total.	Nutritive Ratio.
I.,	Low protein,	21.70	1.22	3.58	8.37	.41	13.58	1:10.5
II.,	High protein,	22.18	1.76	3.60	8.14	.41	13.91	1: 7.2

Herd I. averaged 912 pounds and Herd II. 903 pounds in live weight. On the basis of 1,000 pounds live weight, Herd I. would be receiving 1.34 pounds of digestible protein and 14.9 pounds total digestible matter, and Herd II., 1.95 pounds digestible protein and 15.4 pounds of total digestible matter daily in the period proper. The digestible matter was calculated from actual analyses of the feeds, and average digestion coefficients. It seems probable that the results are a trifle low, and that more material was actually digested than the calculations show, for the animals appeared well nourished, Herd I. gaining 225 pounds, and Herd II., 215 pounds during the eleven weeks of the period proper. The low-protein ration was evidently somewhat deficient in protein and too wide. The high-protein ration must have satisfied the protein requirements, and on the basis of 1,000 pounds live weight, it contained .6 of a pound more of digestible protein daily than did the other ration.

Weight of Animals at Beginning and End of Experiment (Pounds).

Herd.	Period.	Blanche.	Daisy.	Fancy.	Gladys.	Maude.	May.	Betty.	Dora.	May Rio.	Molly.	Red H.	Samantha.	Gain or Loss.
I.,	Beginning,	1,167	837	835	732	778	1,010	-	-	-	-	-	-	-
	End,	1,230	892	865	707	813	1,077	-	-	-	-	-	-	+225
II.,	Beginning,	-	-	-	-	-	-	672	843	758	1,018	1,007	1,013	-
	End,	-	-	-	-	-	-	712	877	808	1,088	1,063	978	+215

Judging from the above weights it would appear that both herds were well nourished and able to add slightly to their live weight.

Crude Protein Balance (Pounds).

Preliminary Period: One Week.

Character of Ration.	Protein digested.	Protein for Maintenance.	Protein for Milk.	Protein Deficit.	Percentage Deficit.
Low protein, Herd I.,	51.3	30.4	27.18	—6.28	—11.0
High protein, Herd II.,	53.3	30.4	28.66	—5.76	—9.7

Crude Protein Balance (Pounds).

Period Proper, Eleven Weeks.

Herd.	Character of Ration.	Cows.	Protein digested.	Protein required for Maintenance.	Protein required in Milk (N. x 6.25).	Excess over Maintenance and Milk Requirements.	Percentage Excess.
II.,	High protein,	Betty,	118.58	37.30	45.87	35.41	42.6
		Dora,	124.74	46.35	53.55	24.84	24.9
		May Rio,	128.59	42.20	49.82	36.57	39.7
		Molly,	133.21	56.76	52.48	23.97	21.1
		Red H.,	174.02	55.79	70.01	48.22	38.3
		Samantha,	133.21	53.68	56.54	22.99	20.9
I.,	Low protein,	Blanche,	104.72	64.68	43.55	—4.51	—4.2
		Daisy,	99.79	46.62	44.20	6.97	7.7
		Fancy,	92.40	45.82	49.49	—2.91	—3.1
		Gladys,	93.90	38.81	50.88	4.21	4.7
		Maude,	77.77	42.85	34.98	—.06	±
		May,	96.25	56.27	49.49	—9.51	—9.0

Influence of Protein on Milk Production (Pounds).

Preliminary period: both herds, low-protein ration.

Ration.	Average Weight of Cow.	Digestible Protein consumed daily per Cow.	Percentage Deficit or Excess Protein over Requirements.	Total Milk Yield.	Daily Average Yield.	Yield of Solids.	Yield of Fat.	Yield of Protein (N. x 6.25).
Low,	-	1.22	—11.0	747.8	17.80	108.95	37.97	27.18
Low,	-	1.27	—9.7	821.3	19.55	115.66	40.67	28.66
Percentage excess, Herd IV. over Herd I.	-	-	-	9.8	-	6.20	7.00	5.50

Period proper: Herd I., low protein; Herd II., high protein.

Ration.	Average Weight of Cow.	Digestible Protein consumed daily per Cow.	Percentage Deficit or Excess Protein over Requirements.	Total Milk Yield.	Daily Average Yield.	Yield of Solids.	Yield of Fat.	Yield of Protein (N. x 6.25).
Low,	912	1.22	±	7,415.6	16.05	1,102.10	398.90	272.60
High,	903	1.76	31.3	8,906.5	19.28	1,294.80	473.00	328.30
Percentage increase, high over low.	-	-	-	20.1	-	17.50	18.60	20.00

It was hardly possible, with the cows at our disposal, to select two herds of six each that would produce substantially equal amounts of milk. It will be seen, therefore, that Herd II. in the preliminary period was producing nearly 10 per cent. more milk and from 5.5 to 7 per cent. more protein and fat than Herd I.

In the second or period proper, covering eleven weeks, this percentage was increased from 9.8 to 20 in case of the milk; substantially similar increases were also noted in case of the milk ingredients. Otherwise expressed, Herd II., receiving the high-protein ration, nearly maintained its flow during the second period, while each cow in Herd I. showed an average daily decrease of 1.75 pounds, or practically 10 per cent.

In the preliminary period both herds were receiving from 10 to 11 per cent. less protein than was actually needed for maintenance and milk. In the second period the low-protein herd had approximately reached a balance between income and outgo, while the high-protein herd was receiving 31.3 per cent. of crude protein in excess of requirements. The effect of this extra protein may be clearly seen in maintaining the flow of milk. It would be of interest to know whether it would have maintained its influence throughout the entire milking period. The herd receiving the shortage of protein was obliged to adjust itself to the low-protein diet. It was able to increase somewhat in live weight (fat?), but its milk flow was of necessity noticeably checked. It is quite probable that some cows of pronounced ability as milkers would not shrink as rapidly as others on a low-protein diet, but for a time would have taken the needed protein from that stored in the body.

Effect of Protein on Average Composition of the Milk (Per Cent.).

Herds.	Period.	Character of Ration.	Total Solids.	Fat.	Solids not Fat.	Protein.
I.,	I.,	Low protein,	14.57	5.08	9.49	3.63
I.,	II.,	Low protein,	14.86	5.38	9.48	3.69
Increase,	-	-	.29	.30	±	06
II.,	I.,	Low protein,	14.08	4.95	9.13	3.49
II.,	II.,	High protein,	14.54	5.31	9.23	3.69
Increase,	-	-	.46	.36	.10	.20

The above average figures were secured by taking the average of the weekly analysis of the milk produced by each cow and multiplying it by the pounds of milk produced, the result being the pounds of the several ingredients produced by each cow. These were added, and gave the total milk and milk ingredients produced by each herd. The total ingredients divided by the total milk produced gave the average percentages. The fact that the milk produced by each herd did not show the same composition in the preliminary period prevents a direct comparison. It will be observed, however, that in case of Herd I. the milk in the second period changed but little in composition from that produced in the first period, the principal difference being a slight increase in the fat, due evidently to the advance in lactation. Herd II. produced milk also with only slight variations in the two periods. The fat increased .36 of 1 per cent., being about the same increase as with Herd I. The protein showed rather more of an increase than in case of Herd I., and this may possibly be attributed to the influence of the extra protein in the food. It must be remembered that Herd I. received a ration deficient in protein, and the increased amount given to Herd II. may have had a slight effect upon the milk protein. With this exception it is safe to state that the protein was entirely without influence upon the composition of the milk.

Experiment VII. — 1907–08.

This experiment was conducted with six cows, the only ones available at the time, and was by the group method.

The object of the experiment was primarily to note the effect of rations low and high in protein (a) upon the condition of the animals, (b) upon the yield of milk, and (c) upon the relative milk shrinkage.

The plan of the experiment consisted in dividing six cows into two herds of three each, which were known as Herds D and E. The first ten days were regarded as preliminary, to accustom the two herds to their distinct rations. Herd D received the low-protein ration and Herd E the one high in protein.

Weighing Cows. — Each of the cows was weighed for three consecutive days at the beginning and end of the experiment, and every fourth week during its progress. They were weighed in the afternoon before being fed or watered.

Sampling Feeds. — The hay was sampled in the usual way at the beginning of the experiment, and every two weeks thereafter. The grain was sampled daily and preserved in glass-stoppered bottles, and eventually tested for dry matter and for the ordinary ingredients.

Character of Feeds. — The hay was a mixture of grasses, the finer varieties, such as Kentucky blue grass, predominating. It contained a noticeable admixture of clover.

Sampling Milk. — The cows were milked twice daily, and the single milking of each cow in each herd was poured into a common receptacle, mixed and the herd mixture sampled. This method was continued for five consecutive days, each single sample composited, and eventually tested for solids, fat and nitrogen. It will therefore be seen that herd samples only were analyzed, and not the product of individual cows.

History of Cows.

HERD.	Cows.	Breed.	Age (Years).	Last Calf dropped.	Days with Calf at Beginning of Trial.
D,	Samantha,	Jersey-Holstein,	4	September 3	8
	May Rio,	Pure Jersey,	4	September 12	-
	Daisy,	Grade Jersey,	8	August 23	-
E,	Fancy,	Grade Jersey,	7	September 1	-
	Gladys,	Pure Jersey,	4	October 7	-
	Red III.,	Grade Jersey,	2	October 27	-

Duration of the Experiment.

HERD.	Character of Ration.	Dates.	Number of Weeks.	Cows.
D,	Low protein,	Nov. 23, 1907, through May 8, 1908.	24	Samantha, May Rio, Daisy.
E,	High protein,	Nov. 23, 1907, through May 8, 1908.	24	Fancy, Gladys, Red III.

Rations consumed daily by Each Cow (Pounds).

HERD.	Character of Ration.	Cows.	Hay.	Wheat Bran.	Corn Meal.	Gluten Feed.
D,	Low protein,	Samantha,	22	3.40	4.50	-
		May Rio,	20	3.00	4.00	-
		Daisy,	20	3.00	4.00	-
E,	High protein,	Gladys,	20	3.00	-	3.90
		Fancy,	22	3.40	-	4.60
		Red III.,	16	2.50	-	3.40
Average, Herd D,	-	-	20.7	3.13	4.16	-
Average, Herd E,	-	-	19.3	2.97	-	3.97

The difference in the two rations consisted in the substitution of corn meal for gluten feed. The latter, as is well known, is a by-product of the former, hence the general character of the two variables was the same, and particularly the protein.

Digestible Matter in Daily Rations (Pounds).

Herd.	Character of Ration.	Cows.	Digestible Nutrients. Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
D,	Low protein,	Samantha,	1.44	.48	14 27	16.19	1:10.7
		May Rio,	1.29	.43	12.87	14 59	1:10.6
		Daisy,	1 29	.43	12 87	14 59	1:10.6
E,	High protein,	Gladys,	1.88	.38	12.23	14.49	1:6.9
		Fancy,	2.14	.43	13 65	16.22	1:6.8
		Red III.,	1.58	.31	9.97	11.86	1:6 6
Average, Herd D,	–	–	1.34	.45	13.34	15.12	1:10.6
Average, Herd E,	–	–	1.87	.37	11.95	14.19	1:6.7

The above figures were secured from the actual analyses of the feeds and average digestive coefficients. It is clear that Herd D received a ration with a very wide nutritive ratio, while Herd E received a ration with a medium ratio.

Average Weight of Cows at Beginning and End of Period (Pounds).

	Herd D.			Herd E.		
	Daisy.	May Rio.	Samantha.	Fancy.	Gladys.	Red III.
Beginning,	920	898	1,003	973	810	680
End,	923	907	1,063	1,013	818	782
	Total gain, Herd D, 69 pounds.			Total gain, Herd E, 150 pounds.		

Herd E made a larger gain than Herd D, but this appears to be due largely to the gain made by Red III., a heifer with first calf.

Crude Protein Balance (Pounds).

Herd.	Character of Ration.	Average Weight.	Protein digested (N. x 6.25).	(Protein required for Maintenance (N. x 6.25.)	Protein required for Milk (N. x 6.25).	Protein Excess or Deficit.	Percentage Excess or Deficit.
D,	Low protein,	935	675.36	328 00	351.50	—4 14	—.6
E,	High protein,	832	912.48	291 75	389.37	261.36	38.4

The total protein digested was calculated from the amount digested daily multiplied by the number of days of the experiment. The protein for maintenance was calculated from the average weight of each herd, allowing .7 of a pound of digestible protein per 1,000 pounds live weight. The protein in the milk was calculated from the actual analysis of the milk. It is admitted that the above results are only approximate, being secured partly from average figures, and on the basis of crude in place of true protein. They indicate, however, that Herd D was receiving a ration rather deficient in protein, and that Herd E was receiving at least 38.4 per cent. over that required for maintenance and milk.

Milk Yield and Milk Shrinkage.

Herd.	Character of Ration.	Milk produced and Shrinkage.			
		Total Yield (Pounds).	First Week (Pounds).	Last Week (Pounds).	Per Cent. Shrinkage.
D, ...	Low protein, .	9,287.1	446.3	368.8	17.4
E, ...	High protein, .	11,161 5	514.5	401.6	21.9

In spite of the fact that the three cows comprising Herd D received hardly sufficient protein for maintenance and milk produced, they did not shrink as much during a period of twenty-four weeks as did the three cows in Herd E, which received substantially 38 per cent. protein in excess of supposed requirements. Such a result can only be explained on the ground that the animals were too few in number to give accurate results by the group method, and that individuality rather than food appeared to be the controlling factor. See also Experiment VIII.

Experiment VIII. — 1908–09.

This experiment was planned primarily to study the protein requirements of dairy animals. It will not show the effect of protein upon the chemical composition of the milk.

Plan of the Experiment. — Inasmuch as the cows in the herd calved at different times, the experiment was planned with pairs of cows, *i.e.*, each pair of cows, when ready, was started, one on a diet approximately sufficient to furnish protein for maintenance plus that contained in the milk, and the other on a diet containing some ½ pound more protein daily than the maintenance and milk requirements.

Duration of the Experiment. — The experiment was planned to continue substantially through a milking period, or until the animals were so far advanced in lactation as to cease to respond to the influence of food.

Weighing the Cows. — Each animal was weighed for three consecutive days at the beginning of the period, and for three days each two weeks thereafter.

Sampling Feeds. — The hay fed was sampled at the beginning of the period for each pair of cows, and each two weeks thereafter. The samples were placed in glass-stoppered bottles, taken to the laboratory and dry-matter determinations made at once. The method of sampling has been described in preceding experiments.

Each kind of grain was sampled daily during the process of weighing out, and the composite samples preserved in glass-stoppered bottles. Dry-matter determinations were made once each month, and the monthly samples composited.

Character of Feeds. — It was intended to procure one lot of hay of the same quality sufficient to last during the entire experiment. Owing to several unfortunate circumstances this was not possible. Three different lots were secured, and composite samples of each analyzed. The digestibility was not determined, but approximate coefficients applied, depending upon the analysis and general appearance of the hay. The several grains were procured in large amounts and average digestion coefficient applied.

Sampling Milk. — The milk of each cow was sampled for five consecutive days at the beginning of the period, and each two weeks thereafter. It was tested for total solids, for fat by the Babcock method in duplicate, and for nitrogen by the Kjeldahl method.

History of the Cows.

Pairs.	Cows.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield at Beginning of Experiment. Pounds.
I.,	Minnie,	Grade Holstein,	8	September 12,	26.0
	Mary,	Grade Holstein,	10	September 5,	26.0
II.,	Samantha,	Jersey-Holstein,	6	August 27,	26.0
	Chub,	Grade Holstein,	10	September 1,	20.0
III.,	Betty,	High-grade Jersey,	4	September 25,	26.3
	May Rio,	Pure Jersey,	6	October 13,	27.5
IV.,	Daisy,	High-grade Jersey,	11	October 22,	28.7
	Cecile,	Pure Jersey,	4	October 10,	25.7
V.,	Red III.,	High-grade Jersey,	2	October 30,	29.0
	Betty II.,	High-grade Jersey,	2	–	–

Duration of Experiment.

Cows.	Preliminary Period began.	Period Proper.	Number of Days.
Minnie,	October 10,	October 17 through April 30,	196
Mary,	October 10,	October 17 through April 30,	196
Samantha,	October 10,	October 17 through May 28,	224
Chub,	October 10,	October 17 through May 28,	224
Betty,	October 24,	November 14 through June 11,	210
May Rio,	October 24,	November 14 through June 11,	210
Daisy,	October 31,	November 14 through May 28,	196
Cecile,	October 31,	November 14 through May 28,	196
Red III.,	November 28,	December 12 through June 11,	182
Betty II.,	December 17,	December 26 through June 11,	168

Rations consumed daily by Each Cow (Pounds).

Character of Ration.	Number of Days.	Cows.	Hay.	Wheat Bran.	Corn Meal.	Gluten Feed.
High protein,	196	Mary,	21.4	3.0	-	3.93
	224	Chub,	17.6	3.0	-	3.51
	210	Betty,	19.4	3.0	.80	3.87
	196	Cecile,	17.0	3.0	.43	3.48
	168	Betty II.,	16.4	3 0	1.00	3.00
Low protein,	196	Minnie,	20.0	3.0	3.51	.51
	224	Samantha,	22.0	3.9	3.90	-
	210	May Rio,	19.6	3.0	4.80	-
	196	Daisy,	19.3	3.0	4.00	.44
	182	Red III.,	19.5	3.0	4.00	.41
Average, high protein,	-	-	18.4	3.0	.74	3.56
Average, low protein,	-	-	20.1	3.2	4.10	.45

The substantial difference in the rations of the two lots of cows consisted in the fact that the high-protein cows received the gluten feed and the low-protein cows the corn meal.

Dry and Digestible Matter in Daily Rations (Pounds).

Character of Ration.	Cows.	Dry Matter.	Digestible. Protein.	Digestible. Fat.	Digestible. Carbohydrates.	Digestible. Total.	Nutritive Ratio.
High protein,	Mary,	25.1	2.05	.55	12.26	14.86	1:6.57
	Chub,	21.3	1.79	.38	10.41	12.58	1:6.28
	Betty,	23.9	1.95	.43	12.04	14.42	1:6.66
	Cecile,	21.1	1.74	.38	11.06	13.18	1:6.84
	Betty II.,	20 7	1.61	.38	10.32	12.31	1:6.93
Low protein,	Minnie,	23.8	1.47	.42	12.23	14.12	1:8.95
	Samantha,	26.0	1 41	.43	12.90	14.77	1:9.62
	May Rio,	24 2	1.36	.44	12 70	14 50	1:10 51
	Daisy,	22 7	1.34	.39	11.61	13.34	1:9.30
	Red III.,	23.7	1 36	.41	12.63	14.40	1:9.95
Average, high protein,	-	22 4	1.83	.42	11.22	13.47	1:6.65
Average, low protein.	-	24 1	1.39	.42	12.41	14.27	1:9.61

It will be seen that the cows receiving the larger amount of protein did not receive by .8 of a pound as much total digestible matter as the low-protein cows. The amount of food fed daily to each cow was gauged partly by the appetite of the animal. The high-protein cows received only .44 of a pound more digestible protein than the other herd.

Influence of Rations on Weight (Pounds).

Character of Ration.	Cows.	Average Weight.	Weight at Beginning.	Weight at End.	Total Gain or Loss.
High protein,	Mary,	1,074	1,047	1,102	+55
	Chub,	1,011	955	1,067	+112
	Betty,	869	843	895	+52
	Cecile,	805	783	827	+44
	Betty II.,	743	742	745	+03
Low protein,	Minnie,	971	923	1,018	+95
	Samantha,	1,068	995	1,142	+147
	May Rio,	826	825	827	+02
	Daisy,	830	798	862	+64
	Red III.,	837	807	867	+60
Herd average, high,	–	900	874	927	+266
Herd average, low,	–	906	869	943	+368

The cows receiving the low-protein ration gained rather more in weight than the other herd; whether this was due to the character of the ration, or whether it simply depended upon the individuality of the animal, it is difficult to say.

True[1] Protein Balance (Pounds).

Character of Ration.	Cows.	True Protein digested.	Protein required for Maintenance.	Protein found in Milk. (N. x 6.25).	Excess over Maintenance and Milk Requirements.	Percentage Excess.
High protein,	Mary,	350 97	147 35	143 10	60 52	20 8
	Chub,	368 24	158 52	124 71	85 01	30 0
	Betty,	380 61	127 74	156 35	96 52	34 0
	Cecile,	316 38	110 45	136 07	69 86	28 3
	Betty II.,	256.82	87 37	114 69	54 75	27 1
Low protein,	Minnie,	277 15	133 22	143 73	00.20	+
	Samantha,	320.40	167 46	168 14	—15.20	—4 5
	May Rio,	284 48	121.42	136 07	26.99	10 5
	Daisy,	259 20	113 87	140 52	4.80	1 9
	Red III.,	247 13	106.63	119 58	20.92	9 2

The high-protein cows received an average of 28 per cent. of protein over maintenance and milk requirements, while in case of the low-protein cows the percentage varied from an actual shortage of 4.5 per cent. to a surplus of 10.5 per cent.

[1] Amines were determined and deducted from the total protein, the above results being expressed as true albuminoids.

Milk Yield and Milk Shrinkage (Pounds).

Character of Ration.	Cows.	Milk produced and Shrinkage.					Total Solids produced and Per Cent. Shrinkage.				
		Total.	First Two Weeks.	Last Two Weeks.	Per Cent. Shrinkage.	Weekly Shrinkage (Per Cent.).	Total.	First Two Weeks.	Last Two Weeks.	Per Cent. Shrinkage.	Weekly Shrinkage (Per Cent.).
High protein,	Mary,	4,224.7	341 4	173.6	49 2	2 0	567.3	44.3	25.7	42.0	1.7
	Chub,	3,684.1	263.6	173.4	34 6	1.2	483.5	33.1	22.7	31.4	1.1
	Betty,	4,086.0	343.4	208.4	39.3	1.5	599.6	49 9	29.7	40.5	1.6
	Cecile,	3,677.1	306.4	206.4	32.6	1.3	533.5	43.6	29.7	31.8	1.3
	Betty II.,	3,235.3	286 0	234.8	17.6	.89	430 2	39.6	30.1	24.0	1.2
Low protein,	Minnie,	4,183.3	329 1	251 6	23 6	1.0	457.5	42.2	33 5	20.7	.9
	Samantha,	4,370.0	305 5	231.9	24.1	.86	673.0	46 0	34 4	25.1	.9
	May Rio,	4,323 0	368.7	228 6	38 0	1.50	627.7	53.1	33.1	37.7	1.5
	Daisy,	3,643.5	352.9	202 4	42 6	1.8	545 9	50.1	30 0	40 2	1.7
	Red III.,	3,720.3	357 5	210 4	41 1	1.9	502.9	48.0	28 4	40 8	1.9
Average, high,		-	-	-	34 7	1.4	-	-	-	34 0	1.4
Average, low,		-	-	-	33 9	1.4	-	-	-	32.9	1.4

Influence of Protein on Milk Shrinkage (Average Results).

Character of Ration.	Weight of Cow (Pounds).	Digestible Protein consumed daily per Cow (Pounds).	Percentage Excess of Protein over Requirements.	Total Shrinkage (Per Cent.).	Weekly Shrinkage (Per Cent.).
High protein,	900	1.83	22	34.7	1.4
Low protein,	906	1.39	3	33.9	1.4

The average amount of digestible protein consumed daily by each of the high-protein cows (1.83 pounds) was not quite as high as intended, hence the difference between the low and high protein rations was not particularly pronounced. Nevertheless, one would expect if the conditions were reasonably satisfactory that the low-protein cows would have shrunk in their milk yield (over an average of two hundred days) rather more than the high-protein cows. Such, however, was not the case, the shrinkage of both herds being substantially identical. The only explanation that can be offered is the undue influence of individuality and the small number of cows in each group. For example, Mary shrunk 49 per cent. during the experiment, it being characteristic of this animal to dry off quite rapidly after she had been four months with calf; Daisy also had such a tendency. The individuality of each animal, as well as its age and condition, all have a pronounced influence, especially when the experiment is extended over a long period of time, and in order to arrive at the truth a large number of animals must be used with as near similar conditions as it is possible to secure. Is it probable that if an animal receives sufficient protein to supply the daily demands of her body (maintenance) and of the milk produced, she will not shrink in her yield *during a milking period* any more than when she is receiving 25 to 50 per cent. protein in excess of the actual requirements? In other words, is it not possible that the excess protein acts as a stimulus for a time, after which the individuality of the animal becomes the more pronounced factor?

Conclusions.

The following general conclusions may be drawn from the experiments reported: —

1. A large excess of digestible protein (1.5 pounds, or 100 per cent.) above the protein minimum increased the flow of milk some 15 per cent. in experiments extending over periods of four weeks.

2. No particular difference was noted in the milk yield in case of two herds of cows receiving the same amount of total digestible matter, one receiving 65 per cent. and the other 122 per cent. of digestible protein above the protein minimum. Such a result indicates, at least, that the former excess was sufficient.

3. A 50 per cent. excess of digestible protein daily above the protein minimum in an experiment by the reversal method, extending over a period of nine weeks, produced some 5.9 per cent. more milk than did a ration with 21 per cent. excess protein.

4. Under similar conditions an excess, above the minimum, of 65 per cent. digestible protein produced 7.4 per cent. more milk than did an excess of 39 per cent. (experiment covered twenty-six days).

5. In experiment VI., extending over a period of eleven weeks with twelve cows, by the group method, an excess of .54 of a pound of protein, or 31.3 per cent., over the protein minimum, produced an apparent increase of 10 per cent. in the milk yield.

In experiment VIII., extending over periods of twenty-four to thirty weeks with ten cows, by the group method, the cows receiving the protein minimum did not shrink any more than those receiving each .44 of a pound, or 28 per cent., protein above the minimum.

6. The group method of experimentation is best suited for conducting experiments where a relatively large number of animals — twenty or more — is available. With a less number the influence of individuality is altogether too pronounced.

7. An excess of 30 per cent. of digestible crude protein above the protein minimum (equal to 1.80 pounds of protein per

day) will be productive of satisfactory results in case of cows weighing 900 pounds and producing daily 12 quarts of 4 per cent. milk.[1]

An excess of 50 per cent. of digestible crude protein above the protein minimum is believed to be ample for all ordinary requirements.

8. Protein in excess of the above suggested amounts may temporarily increase the milk yield, but it seems probable that in many cases the influence of individuality is likely to be more pronounced than the effect of the protein consumed.

9. Under the usual conditions, varying amounts of protein appear to be without influence upon the composition of the milk.

[1] Armsby, in Farmers' Bulletin No. 346, United States Department of Agriculture, expresses substantially the same idea in allowing .05 of a pound of digestible true protein for each pound of average milk, in addition to the maintenance requirement of .5 of a pound of digestible true protein per 1,000 pounds live weight. It is possible that animals can even do very good work with .04 of a pound of protein for each pound of milk.

THE DETERMINATION OF ARSENIC IN INSECTICIDES.

BY E. B. HOLLAND.

During the past three years the writer [1] has given considerable time to the study of arsenical insecticides, with special reference to their manufacture, composition and use, — the main object of which was to provide the entomological department of this station with chemicals of known composition, suitable for an extended investigation to determine their effect in practical application under varying climatic and atmospheric conditions.

For more than a decade the analysis of arsenicals has received marked attention because of the high value of a number of these salts as insecticides. The sale of inferior, adulterated or imitation products lacking in efficiency, or causing severe injury to foliage, has rendered necessary a certain amount of supervision by the agricultural experiment stations of the country. In several States special laws have been enacted to regulate the sale and to provide for an inspection of such materials. Arsenic as trioxide or pentoxide is the active constituent of these compounds, and various methods of several distinct types and numerous modifications have been proposed for its determination. Some of the methods are applicable to arsenous acid and others to arsenic acid.

Methods.

As the work planned by the entomological department would require many analyses, it was desirable that the methods adopted should be reasonably short and simple, though accuracy would be the controlling factor. The literature on the determination of arsenic was reviewed at some length. The results, while somewhat overwhelming, can be roughly summarized under gravimetric methods, volumetric methods and processes for the elimination of substances liable to affect the determination. A

[1] Assisted by Dr. R. D. MacLaurin, Prof. S. F. Howard, C. D. Kennedy and J. C. Reed.

classification of this character is open to criticism, but will serve the purpose intended.

The gravimetric methods include the hydrogen sulfide precipitation of arsenous acid [1] weighable as arsenous sulfide after removal of the excess sulfur; the Neher modification [2] of the Bunsen method,[3] precipitating arsenic acid with hydrogen sulfide, weighable as arsenic sulfide; the modified Levol method, precipitating arsenic acid with "magnesia mixture," weighable as magnesium pyro-arsenate; and the Werther method,[4] precipitating arsenic acid with uranyl acetate, weighable as uranyl pyro-arsenate. The inherent faults of the sulfide methods render them impracticable. The modified Levol method, the most prominent of the gravimetric, is complicated, tedious and tends towards low results. All of these methods are time consumers, and none of them appear to have met with favor, having of late been almost entirely superseded by volumetric.

The volumetric methods include the Kessler method,[5] oxidizing arsenous acid with potassium bichromate and titrating the excess chromic acid with standard ferrous sulfate, using potassium ferri-cyanide to determine the end point; the permanganate method, titrating arsenous acid with standard potassium permanganate to a rose color; the Mohr method, titrating arsenous acid with standard iodine in the presence of sodium bicarbonate, using starch paste as indicator; the Bunsen method,[6] based on the difference in amount of chlorine evolved from hydrochloric acid by a given weight of potassium bichromate in the presence of arsenous acid, the gas being conducted into potassium iodide and the free iodine titrated with standard sodium thiosulfate, using starch paste as indicator; the Kriekhaus method,[7] reducing arsenic acid to arsenous with hydrochloric acid and potassium iodide, and titrating the free iodine with standard thiosulfate; the Bennett modification [8] of the Pierce method,[9] precipitating arsenic acid with silver nitrate and titrating the silver in the precipitate with potassium sulphocyanate, according to Volhard; [10] and the Böeker method,[11] titrating arsenic acid with

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[1] Fresenius, Quan. Chem. Anal.
[2] Ztschr. Analyt. Chem., 32, 45 (1893).
[3] Ann. Chem. Pharm., 192, 305.
[4] Jour. Prakt. Chem., 43, 346 (1848).
[5] Poggend. Ann., 118, 17, Series 4 (1863).
[6] Ann. Chem. Pharm., 86, 290.
[7] Engin. and Min. Jour., 90, 357. See Sutton for earlier references.
[8] Jour. Amer. Chem. Soc., 21, 431 (1899).
[9] Proc. Col. Sci. Soc., Vol. 1.
[10] Liebig's Ann. Chem., 190, 1 (1878).
[11] Ann. Chem. Pharm., 117, 195.

standard uranyl nitrate, using potassium ferrocyanide to determine the end point. The Kessler and Bödeker methods are objectionable in their requirement of an "outside" indicator. The Bunsen and Bennett methods are lengthy, and demand very careful manipulation. The permanganate titration is not as sensitive as the iodine, and the Krickhaus method offers no advantages in its application to arsenic acid over a similar reduction and titration with iodine. In other words, the iodine titration method (Mohr) seemed to us rather superior to any other in point of accuracy, manipulation and time, and was adopted for the work in view.

There are a number of processes that are noted more particularly as a means of eliminating impurities likely to effect the arsenic determination, among which may be mentioned the distillation processes of Fischer,[1] Piloty and Stock,[2] Stead,[3] and Jannasch and Seidel,[4] using hydrochloric acid in connection with reducing substances such as ferrous salts, hydrogen sulfide, and potassium bromide and hydrazine hydrochloride. The above list of methods is far from complete, but attention has been called to practically every type applicable to commercial products.

Iodine Method (Mohr).

As previously stated, the iodine method appeared to offer the greatest advantages, and was selected. A clear understanding of the character and limitations of the reaction underlying the method is necessary at the outset. Iodine is an indirect oxidizer, acting on the elements of water with the formation of hydriodic acid and the liberation of oxygen.

$$As_2O_3 + 4\ I + 2\ H_2O = As_2O_5 + 4\ HI.$$

The oxidation cannot be conducted in an acid or neutral solution because of the reversible action of the hydriodic acid. If the latter is neutralized with sodium bicarbonate as rapidly as produced, the reaction will proceed to completion. Caustic alkali or carbonate cannot be employed, as they absorb iodine, the former being especially active. The reaction between starch

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[1] Ztschr. Analyt. Chem., 21, 266 (1882).
[2] Ber. Deut. Chem. Gesell., 30, 1649 (1897).
[3] Sutton, Vol. Anal., Edit. 9, 159 (1904).
[4] Ber. Deut. Chem. Gesell., 43, 1218 (1910).

and iodine in the presence of hydriodic acid or soluble iodide is one of the most sensitive in analytical chemistry, forming the characteristic blue iodide of starch. A more delicate indicator could not be desired. Since the method was first applied to the analysis of arsenicals numerous modifications have been devised to insure complete solution of the arsenic, to prevent oxidation, to eliminate or render innocuous substances that might effect the titration, and to enlarge its field of application so as to readily include the arsenates. The Association of Official Agricultural Chemists began work on insecticides in 1899 and has rendered valuable service.

New Processes.

The introduction of the Thorn Smith process [1] marked a turning point in the analysis of arsenicals. It was intended particularly for Paris green, and is the official method for that substance. Solution of the arsenic is effected by boiling the sample with a slight excess of sodium hydrate, which readily unites with the free arsenous acid, and also with the combined after displacing the copper. In presence of a reducing substance like sodium arsenite, the copper is precipitated as cuprous oxide and a portion of the arsenous acid oxidized to arsenic. This oxidation necessitates a subsequent reduction of the filtrate with hydrochloric acid and potassium iodide (hydriodic acid), and the removal of the excess iodine with thiosulfate. The solution is neutralized with dry sodium carbonate, an excess of sodium bicarbonate added, and titrated with iodine. The process is accurate, though the double titration is objectionable.

Avery and Beans devised a very ingenious process [2] noted for its simplicity. The Paris green is pulverized, solution effected with concentrated hydrochloric acid in the cold, neutralized with sodium carbonate, the precipitated copper redissolved with sodium potassium tartrate and titrated as usual. The copper held by the alkaline tartrate colors the solution but does not effect the titration. Hydrochloric acid, however, is a poor solvent for free arsenic, and unreliable, which constitutes a very serious objection to the process. Avery noted this error and advised [3] that samples showing a tendency to separate white

[1] Jour. Amer. Chem. Soc., 21, 769 (1899).
[2] Jour. Amer. Chem. Soc., 23, 485 (1901).
[3] Jour. Amer. Chem. Soc., 25, 1096 (1903).

arsenic should be treated with N/2 hydrochloric acid, 5 to 10 cubic centimeters for each .1 of a gram, and boiled gently. In case arsenic remains undissolved, a cold saturated solution of sodium acetate, 3 grams salt for each .1 of a gram of substance, is added, and boiling continued until solution is effected. By another modification [1] suggested by Avery, and reported by Thatcher,[2] 1 gram sample is boiled five minutes with 25 cubic centimeters of sodium acetate solution (1–2), dissolving the free arsenic which is removed by filtration. The residue is dissolved in dilute hydrochloric acid and both solutions titrated.

Haywood attempted, in several ways,[3] to modify the original Avery-Beans process so as to insure solution of the free arsenic. After treating the sample with a slight excess of hydrochloric acid at laboratory temperature, sodium carbonate was added and the solution boiled. In another case sodium bicarbonate was employed, but the results were unsatisfactory in both instances, due to more or less reduction of copper and accompanying oxidation of arsenous acid. Accurate results were secured, however, by filtering off the hydrochloric acid solution and boiling the residue with 5 grams of sodium bicarbonate, titrating both solutions.

Haywood proposed still another modification [4] which might be considered a simplified Avery-Thatcher process; [5] .4 of a gram sample is boiled ten minutes with 25 cubic centimeters sodium acetate solution (1–2) to dissolve free arsenic, and concentrated hydrochloric acid carefully added until solution is effected. After neutralizing with a solution of sodium carbonate, avoiding an excess, alkaline tartrate and sodium bicarbonate are added and titrated as usual.

The Avery, Avery-Thatcher and Avery-Haywood processes employ the same reagents, differing only in their application. The co-operative investigation [6] of the association in 1904 showed that the three above modifications, together with the Haywood, gave closely agreeing results, with little, if any, advantage in the

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[1] Optional official method, Assoc. Off. Agr. Chem.

[2] Proc. Assoc. Off. Agr. Chem., 20, 196 (1903).

[3] Jour. Amer. Chem. Soc., 25, 963 (1903).

[4] Proc. Assoc. Off. Agr. Chem., 20, 197 (1903). Optional official method of the association.

[5] *Loco citato.*

[6] Proc. Assoc. Off. Agr. Chem., 21, 98 (1904).

two-solution processes over the one. In 1905 the results [1] with the Avery-Thatcher and Avery-Haywood modifications were not as satisfactory though the average difference was not excessive.

In weighing the merits of the Thorn Smith process and various modifications of the Avery-Beans, with apparently little choice as to accuracy, the Avery or Avery-Haywood process, with one titration of a single solution, certainly appeals to chemists in "control" work from the standpoint of manipulation, possible mechanical losses and time. This does not warrant any less care in conducting the analysis, but, if anything, demands greater attention. The essential features of the Avery-Haywood process have been employed at the Massachusetts station for the work on arsenites, though considerably modified as to detail.

Practice at Massachusetts Station.

Having adopted Thatcher's suggestion [2] as to ratio of sample to acetate solution, 1 to 25, and finding 25 cubic centimeters rather inadequate for proper boiling and agitation, double quantity of each is taken. To prevent slight loss of sample in transferring to flask, due to both adhesion and dusting, boats of folded filter paper are employed, and found very serviceable, particularly for Paris green and arsenic for standard solution. After boiling the solution five minutes with acetate, the directions call for the careful addition of concentrated hydrochloric acid until solution is effected. Such a procedure in our hands gave extremely variable results and generally a low test for arsenic. This error necessitated several weeks of experimenting, and was found to be due to the addition of *concentrated* acid, dilute acid (1–3) giving uniform results in practically every instance, and a higher test. Probably this has been one of the sources of trouble with the chemists reporting on association samples by the above process in past years. Neutralizing with sodium carbonate, in dry form or concentrated solution, will introduce an error if added in excess. The use of sodium bicarbonate is preferable for the purpose as the latter salt does not absorb iodine and eliminates an unnecessary reagent. As con-

[1] Proc. Assoc. Off. Agr. Chem., 22, 27 (1905).

[2] Proc. Assoc. Off. Agr. Chem., 21, 99 (1904).

centration has a certain influence on titration, it is advisable to maintain approximately the same volume in every case. The tendency of some solutions to become muddy on titration can often be relieved by additional bicarbonate, though the conditions involved seem to have no appreciable influence on the results. The quality of all reagents employed in the determination should be proved by blank tests, which should not exceed .10 of a cubic centimeter iodine solution for the amounts employed. Some lots of bicarbonate have been found unfit for such work. Due recognition should be given the blank in calculating results.

Considerable trouble is often experienced in determining insoluble matter with hydrochloric acid, due to the splitting off of white arsenic, especially with Paris green. To offset the difficulty it was found advisable to combine the determination with that of preparing the arsenic solution by simply filtering off the residue. The points noted above may be briefly summarized: —

Transfer 2 grams of finely ground sample, together with 50 cubic centimeters of sodium acetate (1–2), to a 500 cubic centimeter graduated flask, and boil five minutes. Cool under tap, add about 60 cubic centimeters of hydrochloric acid (1–3), and shake until solution is effected. Make to volume and filter. Pipette 25 or 50 cubic centimeters into an Erlenmeyer flask, neutralize with dry sodium bicarbonate, add 25 cubic centimeters of sodium potassium tartrate [1] (1–10), to redissolve precipitated copper, approximately 3 grams of sodium bicarbonate, water sufficient to make a volume of 100 cubic centimeters, 2 cubic centimeters starch paste (1–200), and titrate with N/20 iodine to a permanent blue color. Toward the end of the reaction cork the flask and shake vigorously, to insure proper end point. Calculate results as arsenous oxide. The residue in the graduated flask is brought onto the filter, well washed, calcined in a porcelain crucible and weighed as insoluble matter.

The above process has given excellent results with copper aceto-arsenite, copper arsenite and calcium arsenite. Sodium acetate does not prevent hydrolysis of copper and calcium arsenites, as in the case of Paris green, but serves to take up free

[1] Used only with the copper arsenites.

arsenic. The presence of such impurities as cuprous and ferrous compounds, sulfurous and nitrous acids or other oxidizable substances is a source of error by the iodine titration method.

Iodine Method for Arsenates.

The increasing use of lead arsenate as an insecticide resulted in a demand for a rapid volumetric method for the determination of the arsenic acid. The Gooch and Browning process,[1] as modified by Haywood,[2] serves to readily reduce arsenic acid to arsenous, in which form the iodine titration method is applicable. The process in our hands did not at first prove satisfactory, but eventually yielded concordant results after minor changes. As the differences are largely a matter of detail, not involving principle, only the modified process will be given.

Transfer 2 grams of finely ground sample, together with 60 cubic centimeters of nitric acid (1–3), to a 500 cubic centimeter graduated flask; bring to boil, cool, make to volume and filter. Pipette 50 or 100 cubic centimeters into a 150 cubic centimeter Jena Griffin beaker, add 10 cubic centimeters of sulfuric acid (2–1), evaporate, heat in an air bath at 150–200° C. to expel last traces of moisture, and then on asbestos board, to the appearance of dense white fumes, to insure complete removal of nitric acid. Add a small quantity of water, and when cold, filter through a sugar tube under suction into a 300 cubic centimeter Erlenmeyer flask, and wash to about 150 cubic centimeters. Add 10 cubic centimeters of potassium iodide (165–1,000) and boil until *free iodine is expelled*, — solution practically colorless, — with the reduction of arsenic to arsenous acid.

$$As_2O_5 + 4\ HI = As_2O_3 + 4\ I + 2\ H_2O.$$

Dilute, cool immediately, neutralize approximately three-quarters of the free acid with 20 per cent. sodium hydrate solution, add starch paste, and if any free iodine remains, add dilute (N/50) thiosulfate carefully, with vigorous shaking, to the absence of blue color.

$$2\ I + 2\ Na_2S_2O_3 = Na_2S_4O_6 + 2\ NaI.$$

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[1] Amer. Jour. Sci., 40, 66 (1890).

[2] Proc. Assoc. Off. Agr. Chem., 23, 165 (1906). Provisional method of the association.

Make up to about 150 cubic centimeters, add excess of sodium bicarbonate and titrate as usual with N/20 iodine, reporting as arsenic oxide. The residue in the graduated flask is brought onto the filter, washed, calcined and weighed as insoluble matter.

Care should be taken to have sufficient sulfuric acid to cover the bottom of the beaker when heated on asbestos. A decided excess of acid is also necessary when boiling with potassium iodide to insure vigorous action and rapid volatilization of iodine. Undue concentration should be avoided. If free iodine persists add more water and continue the boiling. The use of caustic soda is permissible under the conditions described. The hydrate is a much more convenient and rapid agent than the carbonate. Practically no difference was noted in the titration when the lead sulfate was allowed to remain, but the data at hand do not cover a sufficient number of samples to warrant a statement that this will always hold true.

The iodine method, as modified for arsenites and arsenates, has been given a careful study, and proved repeatedly, in the work at the Massachusetts station, to yield excellent results in the analysis of the insecticides mentioned, if reasonable attention is paid in following the details. While no radical changes in the method have been recommended, this article is offered in hopes that some of the points noted may prove of assistance to other analysts working along similar lines.

PURIFICATION OF INSOLUBLE FATTY ACIDS.

BY E. B. HOLLAND.

Workers in oils and fats experience the same difficulty in obtaining chemically pure products as investigators in other lines of organic chemistry. The best insoluble fatty acids on the market — judging from our experience — are unsatisfactory in both physical characteristics and neutralization number. In general appearance the acids that are offered resemble granulated curd, though varying in color from white to yellow, and contain considerable dust and dirt. The molecular weight, as measured by titration in an alcoholic solution, may deviate from the theoretical by 10 to 15 points. These statements apply to chemicals marked " C. P." and bearing the name of a reputable manufacturer or dealer.

The writer required stearic, palmitic, myristic, lauric and oleic acids for certain tests, and, finding it impossible to purchase them of the desired quality, was forced to undertake a study of various methods for their purification. As the character of the unsaturated acids is so unlike that of the saturated, only treatment of the latter will be considered at this time. The methods that seemed the best adapted for the purpose were (*a*) distillation of the fatty acids in vacuo, (*b*) crystallization from alcohol, and (*c*) distillation of the ethyl esters in vacuo, and all were given extended trial.

A. Distillation of the Fatty Acids in Vacuo.

Direct distillation under reduced pressure was successfully employed a few years ago by Partheil and Ferie,[1] starting with Kahlbaum's best acids. Upon careful test the writer found that the method possessed certain objectionable features which render it rather impracticable for ordinary use. If it was merely a

[1] Arch. Pharm., 241, 545 (1903).

question of distillation of the acids the process would be less difficult, but for fractionation, using a Bruehl or similar type apparatus, it proved almost impossible, in case of the higher acids, to prevent solidification in the side neck (outflow tube). The danger arising from a plugged apparatus at the high temperature involved has also to be taken into account. An attempt was made to heat the tube and keep the acids liquid by means of a hot-water jacket, also by an electrically heated asbestos covering, but neither process fully met the requirements of the case. The slow distribution of heat in vacuo is, of course, one of the obstacles in the way. For the distillation of solids of high melting point Bredt and A. van der Maaren-Jansen[1] devised an elaborate piece of apparatus having a flask and receiver of special construction, and an overflow tube heated by electricity, but it is hardly suited for a general laboratory or for handling any considerable quantity of material.

There are two other conditions necessary for a successful distillation of fatty acids, namely, absence of moisture and a current of hydrogen or carbon dioxide to prevent bumping and to lessen decomposition. Overlapping of the acids in different fractions cannot be obviated entirely, and if an unsaturated acid was present in the original, it will probably appear in nearly every fraction.

Students under the direction of Professor Burrows of the University of Vermont have applied this process for a partial separation of the insoluble acids of several oils with a fair measure of success. With all due allowance for the possibilities of the method in the production of pure saturated fatty acids, the inherent difficulties render it inadvisable in most instances.

B. Crystallization from Alcohol.

Crystallization in this connection is practically limited in its application to the removal of a small amount of impurities, especially unsaturated acids. It can hardly be considered other than a supplementary treatment, though excellent for that purpose, to follow either of the distillation methods. Dry neutral alcohol suitable for such work can be prepared by distillation after treatment with caustic lime. In dissolving the acids care

[1] Liebig's Ann. Chem., 354, 367 (1909).

should be taken to avoid heating to a higher temperature than is required for solution, or to prolong the heating unduly, as it will cause the formation of esters. Several minutes' boiling of the different fatty acids in alcohol caused the following loss in neutralization number: —

Stearic acid,	1.70
Palmitic acid,	.56
Myristic acid,	2.24
Lauric acid,	.89
Oleic acid,	.28

Esterification undoubtedly causes a serious error by this process of purification. Under more careful treatment the change is not as rapid as shown above, but is evidently cumulative and may even exceed the figures given. Further study may warrant the substitution of a more stable solvent, such as acetone. For the filtration a water or ice jacketed funnel is almost necessary, particularly for the acids of low melting point, and suction is a time saver. Repeated crystallization is needed to bring out the true crystalline structure and silvery luster of the leaflet. Vacuum drying at a low temperature is one of the most efficient means for removing adhering alcohol and traces of moisture without injuring the structure. Crystallization as a whole is wasteful of acids and solvent unless both are recovered, but is essential for the production of a superior product.

C. Distillation of the Ethyl Esters in Vacuo.

As ethyl esters distill freely in vacuo, the process admits of a more ready application, and to products of a greater range of purity, than does a distillation of the acids. After considerable experimenting it was found that the esters are easily prepared by heating in an open flask equal parts (100 grams) of fatty acids and alcohol, together with a small quantity (10 cubic centimeters) of concentrated hydrochloric acid, using capillary tubes to prevent bumping. The reaction requires about thirty minutes, after which the excess of hydrochloric acid can be removed with a separatory funnel. The distillation is conducted in a 500 cubic centimeter "low" side neck flask, with a small (8 inch) Liebig condenser and a large size Bruehl fractionation apparatus. Heat is furnished by means of a linseed oil bath, and suction by a pump of any type, using a mercury manometer to prove constancy of vacuum. The neck of the flask from the shoulder to an inch or more above the side tube should be wound with asbestos paper to prevent cracking, due to sudden changes of temperature. The condenser should be kept full of water, without circulation, to serve as a hot-water jacket. The vacuum should be as high as the flask will safely withstand, but above all uniform, otherwise the fractions are of questionable value. The temperature range of an ester also varies with the distance between surface of liquid and side tube. At least one redistillation of like fractions is necessary.

As the esters are very stable, more difficulty was experienced in finding some means for their quantitative decomposition than in any other portion of the work. Heating with mineral acids hydrolizes the fatty acids very slowly, even under pressure. If, however, the esters are first saponified [1] by heating over a naked flame with twice their volume of glycerol and an excess of caustic potash until all the alcohol is expelled, and then the resulting soap dissolved in water and heated on a water bath with a slight excess of sulfuric acid, the separation is readily accomplished. This plan was suggested by the Leffmann-Beam saponification for volatile acids, and after extended trial proved the most thorough and rapid means for decomposing the esters. The resulting acid should be washed in a separatory funnel with boiling water until clear, and the cake allowed to drain. As previously stated, several crystallizations are necessary if a crystalline product of satisfactory melting point and neutralization number is to be secured. When crude acids are employed it is also advisable to crystallize at the outset to exclude a major part of the unsaturated acids, which otherwise would prove troublesome.

To summarize: saturated fatty acids may be purified by distillation of the acids or their ethyl esters. The latter method is less hazardous and easier to manipulate, although more steps are required. Crystallization is a finishing rather than an initial process of purification.

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[1] Observing the usual precautions given for the determination of insoluble fatty acids, Massachusetts Agricultural Experiment Station, twenty-first report, p. 130 (1909).

THE SOLUBLE CARBOHYDRATES IN ASPARAGUS ROOTS.

BY FRED W. MORSE.

This paper is a simple statement of progress in a study of the composition of the asparagus plant, and is part of an investigation of the fertilizer requirements of asparagus now being conducted at this agricultural experiment station.

The nutrition of asparagus shoots in early spring necessarily depends on the material stored in the roots, since the mode of growth of the young shoots up to the time of cutting for the table renders assimilation from the atmosphere nearly impossible. Hence, roots were selected as the first portion of the plant to be studied.

A search of the literature of asparagus failed to show anything about the composition of the roots beyond a few scattering ash analyses and a brief article by Vines [1] on the reserve proteins.

Very recently, however, Wichers and Tollens [2] have reported an extensive study of asparagus roots, and called attention to similar work by Tanret,[3] brief abstracts of whose articles had been overlooked.

Since the work has been wholly independent of that just mentioned, it is believed that this report of progress will be of value at this time.

All the material for the work here reported was prepared in other divisions of the department, and consisted of finely pulverized samples of individual root systems. All of the plant below the surface had been dug up, freed from earth and dried

[1] Proc. Royal Soc., 52, 130–132; Abstr. Jour. Chem. Soc., 64, 431.

[2] Jour. f. Landwirth., 58, 101–116.

[3] Bul. Soc. Chem. (4), 5, 889, 893; Compt. Rend., 149, 48–50; Abstr. Jour. Chem. Soc. (1909), Abstr., 634; Chem. Abstr., 3, 2677.

at about 50° C. The roots were secured in November of the second year after setting, when translocation from the tops was believed to be complete. For subsequent study of the effects of different fertilizers the individual samples were separately analyzed; but for this report detailed results are unnecessary.

The average proximate composition of the dry matter of 16 roots was as follows: —

	Per Cent.
Protein (nitrogen x 6.25),	11.03
Fat,	1.00
Fiber,	15.39
Nitrogen-free extract,	66.34
Ash,[1]	6.24

The proximate composition showed clearly that the soluble non-nitrogenous matter included most of the reserve material of the roots.

The methods of the Association of Official Agricultural Chemists [2] for sugars, starch, pentosans and galactans were employed for estimating the different carbohydrates in the reserve material.

An examination of 25 roots showed 12 to contain no reducing sugars, while most of the others had only traces present; therefore reducing sugars were not estimated, but were reckoned with total sugars. The latter were especially abundant, and ranged from 26.4 per cent. to 50.8 per cent., only two samples containing less than 35 per cent. calculated to dry matter.

Pentosans were determined in 16 samples, and ranged from 7.32 per cent. to 10.68 per cent. in the dry matter. Galactans were determined in 4 individual samples and in a composite sample, but were insignificant in amount, averaging only 1.04 per cent.

In the estimation of starch by the diastase method, it was found that there was no more glucose obtained than was accountable from the diastatic extract. Subsequent examination revealed starch in only microscopic traces. Six different samples, after having undergone the diastase treatment as for starch,

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[1] Ash determinations were made in the fertilizer division of the department.

[2] Bulletin No. 107, Bureau of Chemistry, United States Department of Agriculture, pp. 38–56.

were filtered and washed, and the residues then subjected to two hours' boiling under reflux condensers, with 100 cubic centimeters of HCl of approximately 6 per cent. After cooling the solutions they were nearly neutralized with NaOH, and made up to 250 cubic centimeters. The reducing sugars were then determined by Fehling's solution and the weights of copper calculated to glucose. The 6 samples averaged 8.6 per cent. of glucose by this hydrolysis; but since the same samples averaged 8.67 per cent. of pentosans, reckoned from furfurol-phloroglucid, it is improbable that there are any hydrolizable carbohydrates unaccounted for by the usual analytical methods.

From these different analyses it was found that the dry matter of 16 roots contained —

	Per Cent.
Sugars calculated as invert sugar,	41.43
Pentosans,	8.78
Galactans,	1.04

The carbohydrate forming over 40 per cent. of the dry matter was at first assumed to be sucrose. The analytical procedure had shown it to be soluble in cold water and inactive to Fehling's solution until hydrolized, which was easily accomplished by dilute acids. Repeated attempts to recover sucrose by means of strontium hydrate [1] resulted in securing only very small quantities of a straw-colored syrup which could not be crystallized, but did not reduce Fehling's solution.

Methyl alcohol was found to extract considerable quantities of the sugar from the roots, which suggested raffinose; but no mucic acid could be obtained by oxidation with nitric acid, although a parallel test with lactose under the same conditions yielded it in abundance.

Osazones were prepared from both methyl alcohol and water extracts, before and also after inversion. The characteristic yellow, crystalline precipitate was easily obtained in every case. Five such precipitates had their melting points determined, and they ranged between 203 ° and 210 °, and were accompanied by an evolution of gas. Glucosazone was evidently the only one formed.

[1] E. Schulze, Zeitschr. Physiol. Chem., 20, 513–515.

About 100 grams of roots were extracted by cold water and the extract concentrated on the water bath to a thick, black, tenacious syrup, which was strongly reducing to Fehling's solution. Heat and probably acid salts had brought about a nearly complete hydrolysis during the evaporation. This extract failed to yield mucic acid, but oxalic acid was readily formed.

Portions of the syrup were subjected to distillation with HCl of 1.06 specific gravity, and yielded a small quantity of furfurol. The furfurol-phlorogluciol, after being dried and weighed, was found to lose about two-thirds of its weight by solution in hot 93 per cent. alcohol, indicating that it was largely methyl-furfurol.

The action of polarized light was observed upon freshly prepared water extracts of two different roots, and upon three syrups which had been fractionated by strontium hydrate. The solutions were clarified by lead subacetate, and the readings were made in a Schmidt and Haensch triple shade saccharimeter through a 200 millimeter tube. The solutions were then inverted and again polarized, together with two solutions of the dense water extract above mentioned.

Subsequent to the readings, the actual strength of sugar in each solution was determined with Fehling's solution. The solutions were necessarily dilute, because the roots on moistening swelled to a large volume and small charges had to be used. The three syrups were small in amount, as before mentioned, and the black syrup from the water extract was difficult to clarify to a point where light would pass through it.

Polarization before Hydrolysis.

	Sugar in 100 Cubic Centimeters (Grams).	Saccharimeter Reading.	Specific Rotatory Power (Degrees).
Root 34,	1.738	+0.5	+5.0
Root 40,	2.259	—1.4	—10.0
Syrup A,	2.623	+2.88	+18.9
Syrup B,	2.775	—1 6	—10.0
Syrup C,	.858	zero	zero

Polarization after Hydrolysis.

	Invert Sugar in 100 Cubic Centimeters (Grams).	Saccharimeter Reading.	Specific Rotatory Power (Degrees).
Root 34,	.893	—2.33	—45
Root 40,	1.189	—4.10	—59
Syrup A,	1.381	—3.45	—49
Syrup B,	1.461	—5.25	—62
Syrup C,	.452	—1.30	—49
Extract 1,	.936	—3.00	—55
Extract 2,	2.350	—7.80	—57

The action on polarized light both before and after inversion excludes the possibility of the carbohydrate being pure sucrose, while the failure to secure it with strontium hydrate renders its absence probable.

Fructose was clearly demonstrated by the osazone and the negative optical activity, also by fine reactions with resorcin and hydrochloric acid. Glucose is indicated by the osazone and the fact that the specific rotatory power of the inverted solutions is not high enough for pure fructose. Fructose clearly predominates over the glucose, and the non-reducing property before hydrolysis indicates some condensation product formed between them. The behavior of individual root extracts does not point to any fixed proportion of the two sugars.

These results are, on the whole, in close agreement with those of Wichers and Tollens. There was, however, a marked difference in the behavior of the water extract of the roots, which contained the sugar-like carbohydrate. Wichers and Tollens used boiling water, and state that only a portion of this carbohydrate was soluble in water when extractions were made on the water bath. Their solutions also reduced Fehling's solution before hydrolysis.

My extractions were all made with water at 20° C., and until hydrolized, had either no reducing action or precipitated no more than traces of copper.

This difference in solubility and reducing action is doubtless due to the stage of development of the roots, since Wichers and Tollens worked upon roots gathered in April and July instead of in November.

Tanret isolated two distinct crystalline carbohydrates from the root sap, one of which had a rotation of — 35.1 and the other + 30.3. Syrups A and B fractionated with strontium hydrate showed opposite rotations before inversion, but lack of material has given no opportunity to confirm further his observations.

Grateful acknowledgment is made of suggestions received from Dr. Joseph B. Lindsey during the progress of this investigation.

SEED WORK, 1910.

BY G. E. STONE.

The seed work for 1910 includes seed germination, separation and the testing for purity. The number of samples of seed sent in for germination exceeded that of 1909, the total number being 296. This germination work seems to be on the increase from year to year, and a great many more varieties of seed are tested for germination than has been the case in the past. Of the total number of samples sent in this year, 152 were miscellaneous seeds, a trifle over 50 per cent. of the total number. The number of samples of onion seed sent in was a little less than in 1909, and tobacco averaged about the same. The average germination of the tobacco seed, 95 per cent., was slightly better than usual. The lowest germination of any sample of tobacco seed sent in was 89 per cent. On the whole, onion seed last year did not seem to be up to the previous year's standard, as the average germination of all samples was only 77.4 per cent., as against 82.2 per cent. in 1909. The germination of the tobacco seed, with a lowest percentage of 89, tends to prove the theory that large seeds produce large plants; therefore in succeeding years better crops are obtained, and, as a result, better seed.

TABLE 1. — *Records of Seed Germination, 1910.*

Kind of Seed.	Number of Samples.	Average Per Cent.	Per Cent. of Germination.	
			Highest.	Lowest.
Onion,	75	77.4	100.0	3.0
Tobacco,	7	95.0	99.0	89.0
Lettuce,	41	77.7	100.0	15.0
Cucumber,	10	93.7	99.0	85.0
Alfalfa,	4	98.2	100.0	97.0
Clover,	4	93.0	97.0	88.0
Red clover,	3	100.0	99.5	98.5
Miscellaneous,	152	66.0	100.0	-
Total,	296	-	-	-

The work in seed separation for 1910 was carried on as usual, and although a smaller number of samples was separated than in 1909, the total amount of seed separated, 1,552 pounds, was greater. Of this, 1,183 pounds were onion seed. The principal varieties of seed separated were onion, tobacco and lettuce. The separation of onion seed also tends to show that the seed was not as good this year as it was in 1909, as the average percentage of good seed was only 88.7 per cent., while the amount of discarded seed was slightly larger than in 1909. As in years past, several growers have requested that this station test the germination of seed both before and after separation, and the results this year resemble those of previous seasons so closely that they will not be inserted in this report. In the case of the separation of lettuce seed, the grower sending the seed often requests that a certain amount, sometimes in excess of the actual need, be taken out. This, however, is believed to be a good practice in the case of lettuce or tobacco seed, as it is certain that better germination results from removing more than is absolutely necessary. Table 2 shows the records of seed separation for 1910.

TABLE 2. — *Records of Seed Separation, 1910.*

KIND OF SEED.	Number of Samples.	Weight (Pounds).	Per Cent. of Good Seed.	Per Cent. of Discarded Seed.
Onion,	40	1,183.82	88.7	11.3
Tobacco,	62	44.96	89.6	10.4
Lettuce,	13	323.45	74.4	25.6
Total,	115	1,552.23	-	-

No effort has been made on the part of the station as yet to establish and maintain a seed-control laboratory for the purpose of testing the purity of seed, and therefore in the past year the number of samples of seed sent in for examination as to their purity has been small. In all, some 30 samples have been examined; mostly clovers and grasses, but as this work takes considerable time, no grass mixtures have been examined for purity.

The station is always glad to receive samples of seed for germination, and it is believed that if the farmer would send his seed in for examination for purity also, he would very often save himself a great deal of trouble and expense, as much of the seed sold in this State is full of weed seeds. It is believed that there should be a seed-control act in Massachusetts, as has been stated in our previous reports, and the sooner this comes the better the farmer will be served by the seedsmen, since they are perfectly willing to handle good seed if it is what the farmer wants and demands.

All samples of seed to be germinated or separated should be addressed to G. E. Stone, Massachusetts Agricultural Experiment Station, Amherst, Mass., and the express or freight on these seeds should be prepaid.

AN OUTBREAK OF RUSTS.

BY G. E. STONE.

For the past three years certain rusts have increased materially in this State as well as in other sections of the United States. The rust on the apple, which has been scarcely noticeable for years, at least on our cultivated fruit trees, has become quite common the last three seasons. It was particularly prevalent three years ago, and quite a little of it has been noticed on apple leaves the past two years. The hawthorne (Crataegus), a plant closely related to the apple, has shown a much greater tendency to rust in the period above mentioned than formerly, and some anxiety has been felt by nurserymen who have had to contend with this in their nurseries.

The ash rust, which is supposed to have as one of its hosts the grass known as Spartina, has occurred much more commonly than usual during this period. It is to be found on young growths of ash trees, distorting the twigs. There have also been severe outbreaks of the bean rust lately, although this has given little trouble in former years; and the hollyhock, rose and quince rusts have been much more common than formerly.

SWEET PEA TROUBLES.

BY G. E. STONE.

One of the most unsatisfactory types of troubles with which the pathologist has to deal is that having no specific organism as its primary cause. It is especially difficult to diagnose such diseases where the conditions of growing the plants are almost entirely unknown, and this is the case with most of the miserable, sickly looking sweet pea plants sent into the laboratory for diagnosis. There may be well-defined troubles associated with sweet peas, but from 90 to 100 per cent. of them may be prevented if the grower has even an elementary knowledge of the conditions required by this plant.

When sweet peas are planted in poor soil, without care or preparation, unfavorable results may be looked for. That such is too often the case is evident from an examination of the material which is sent in for examination. To obtain a good crop of sweet peas unusual care should be given to preparation. A light soil is better than a heavy, compact soil. It is impossible to grow this crop without a good depth of garden loam, and, if this is not available, it must be secured by deep trenching and heavy manuring. Most skillful gardeners maintain that the best results are obtained by having a soil which the sweet pea roots can penetrate deeply, and in which they can develop luxuriantly. A trench 1½ to 2 feet deep and the same width, filled with manure and loam, is usually sufficient. If a good depth of root development is desired, it is best to sow the seeds in trenches 4 to 6 inches below the surface, and as the plants mature the soil can be gradually hoed around the stems. The many specimens which we receive from growers testify to the poor conditions in which the plants have been grown, there being little root or stem development, and often tubercles on the roots are lacking. Proper conditions count very much in growing sweet peas, and when these are given, many so-called "diseases" peculiar to this plant disappear.

A SPINACH DISEASE NEW TO MASSACHUSETTS.

BY HARRY M. JENNISON, B.S.

Early in the spring of 1910 the writer's attention was attracted to a plot of winter spinach growing on the college grounds which had been practically ruined by a fungus causing a spotting of the leaves. The olivaceous color of the spots on the diseased leaves suggested the possible presence of a Cladosporium as the causal organism, but upon microscopical examination the fungus was determined to be *Heterosporium variable*, Cke. This organism is closely related to that causing the *Heterosporium* disease of cultivated carnations, known as "fairy ring."

It was supposed that a disease which could so completely devastate this crop would have been extensively reported, but upon thorough search of the literature only a few references to this particular spotting of spinach could be found. In 1905 Clinton [1] reports having collected in the open market in New Haven, Conn., specimens of spinach leaves affected with the above-mentioned fungus, and he refers to it as "leaf mold." Halsted [2] in his investigations on the fungi attacking the spinach plant does not include *Heterosporium* in his list. Since 1908 Reed [3] has been studying its occurrence and injurious effects in the truck crop regions of Virginia, where it causes large losses annually to the truck farmers of that State. At Amherst the disease was found infecting winter spinach, growing on two widely separated plots. Immediately adjacent to one of these was a considerable area set with young spinach

[1] Clinton, G. P., Connecticut Agricultural Experiment Station, report for 1905, Part V., p. 275.

[2] Halstead, B. D., New Jersey Agricultural Experiment Station Bulletin No. 70, 1890.

[3] Reed, H. S., in Virginia Agricultural Experiment Station circular No. 7, revised edition, p. 80, 1910.

Showing *Heterosporium* Disease of Spinach.

plants for the late spring crop. Careful examination, however, failed to reveal any indications of this disease on the young plants. As has been suggested, this fact seems to indicate that the causal organism is not a true parasite, and that it cannot infect healthy, vigorous plants, being more probably one that is capable of infecting its host only after the latter has become weakened by adverse climatic conditions, or injuries produced by other causes.

Further observations upon this interesting phase unfortunately could not be made, but in a recent text-book on the "Diseases of Economic Plants"[1] the following statement is found: "The disease does not seem capable of attacking healthy, vigorous plants, but usually follows injuries produced by other agencies."

The first indications of the presence of the disease are subcircular areas of dead tissue from 1/8 to 1/4 of an inch in diameter and brownish in color. (See cut.) These spots soon become more noticeable by the development of a greenish-black felt of fungous mycelium, bearing conidiophores and conidia, on both the upper and lower sides of the leaf. The spots are frequently more numerous toward the apex of the leaf, and by the time the fungus felt is well developed, the intervening leaf tissue is yellowed and presents a sickly appearance. Often the leaf is so badly infected that the diseased areas coalesce, leaving very little of the leaf tissue visible.

The market value of the crop is lessened if the leaves are at all spotted, and when badly diseased it is not salable. Even if the whole plant does not collapse from the effects of the fungus, it is greatly injured, and trimming off the injured leaves necessitates extra labor and expense at harvest time.

Since the disease is new to this locality, and there have been such limited opportunities to study it and the factors responsible for it, it is impracticable to offer any remedies at present. If the disease is sporadic, and caused by adverse conditions, the proper remedy would be to find out what those conditions are and remedy them. On general lines, however, it would be well

[1] Reed, in Stevens & Hall's "Diseases of Economic Plants, — Heterosporiose," p. 288, 1910.

to employ sanitary methods in growing the crop, to use seed from healthy and vigorous plants, and try to prevent injuries from insects, etc.

ADDITIONAL REFERENCES.

Reed, Science, n. s., Vol. 31, p. 638, 1910.
Cooke, Grevielea, Vol. 5, p. 123, 1877.
Tubeuf & Smith, "Diseases of Plants," p. 516, 1897.
"Market Gardener's Journal" (Louisville, Ky.), Vol. 7, No. 5, 1910.

ABNORMALITIES OF STUMP GROWTHS.

BY GEORGE H. CHAPMAN.[1]

For the past few years there have been called to our attention on stump land and burned-over wood lots various malformations and abnormalities of the leaves of sprouts growing from the stumps; and in connection with other physiological work being done in the laboratory,[2] these conditions were studied, with the idea of discovering, if possible, the cause and relationship to other physiological diseases, such as those arising from malnutrition; also mosaic disease, overfeeding and œdema.

These diseases are all different in character, but it might be well to give a brief description of them at this point.

Overfeeding, particularly with nitrates, may be recognized by a slight increase in size of leaf, the color being darker and the leaf stiffer in texture. The cells of the leaf, with the exception of the bundles, are normal in form and are larger, but the bundles are distorted, and this causes a distortion of the leaf, due to the form of the bundles. The leaf is usually somewhat larger than normal, and the distortion curves the edges of the leaf downward, *i.e.*, rolls them toward the under side.

All investigators agree that the mosaic disease is purely a physiological one, but there seems to be much doubt as to whether it is infectious or contagious in character, or both. There seems to be some difference in opinion, also, as to the direct cause of the disease. In tomatoes it is always produced when the vines are heavily pruned, and in the work here it has been shown that it is connected in no way with methods of transplanting the young plants, and only results from subsequent pruning.

It has been found that tobacco is much more susceptible un-

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[1] Presented as part work for degree of M.Sc.

[2] Dept. of Veg. Phys. and Path., Mass. Agr. Exp. Sta.

der conditions which tend to produce the disease than is the tomato.

In the case of tobacco, A. F. Woods[1] found that when a plant was grown in soil containing small roots of diseased plants the disease occurred in a short or long period of time, as the case might be. In our observations on the tomato we have been unable to verify this statement, as in no case has the disease appeared when normal plants were grown in soil which contained roots of plants which had been badly diseased, and in the growing of tomatoes year after year in the station greenhouses there has never been the slightest evidence of infection arising from the soil.

In the case of the tomatoes grown under glass, the disease did not make its appearance when the plants were left normal, but occurred when the plants were pruned. These conditions held true for soils in which there were diseased roots as well as for those in which tomatoes had not previously been grown.

The appearance of mosaic disease has been described by many investigators, and nearly all have described it in a similar manner, but more particularly with reference to tobacco than to the tomato. The general characteristics of the disease are the same for both plants, but some difference is found in its appearance in extreme cases on the tomato, as will be noted from the following description.

In the first stages of the disease the leaf presents a mottled appearance, being divided into larger or smaller areas of light and dark green patches. At this point, however, no swelling of the areas is noticeable, but as the disease progresses the darker portions grow more rapidly, while the light-green areas do not grow so rapidly, and leaf distortion is brought about. In the case of tomato, the light-green areas become yellowish as the disease progresses, and in badly affected plants become finally a purplish red color. This purplish coloration is found principally on plants which are exposed to strong light, but does not always occur, as it has been found that sometimes, even in badly infested plants, the disease may reach its maximum without showing any reddish coloration whatever. The reddish

[1] U. S. Dept. Agr., Bur. of Plant Ind., Bul. No. 18.

appearance is noticeable only on the upper surface of the leaf, and appears to extend only through the palisade cells. As yet no investigation has been made with reference to its character, but from its appearance under the microscope it is thought that it may be due to the breaking down of the chlorophyll granules as a result of the diseased condition of the leaf.

Under all conditions of disease, however, the leaves are much distorted and stiff, and often very badly curled, usually with the edges rolled up over the leaf, and never possessing the flexibility of healthy, normal leaves.

Œdema is perhaps the least liable to be confounded with other physiological troubles as its appearance is more strongly characteristic. Only a brief description will be given here, as this trouble does not enter into the discussion in this paper. Usually the leaves, as a whole, hang pendent, but the leaflets curl strongly upward; on close examination it is found that the veins, midrib and surface of the leaf show elevated more or less frosty areas, somewhat resembling the masses of conidia of some of the Erysyphæ; although in mild cases this condition is not striking, but the leaves usually have a more or less pearly luster at some stage of its development. The epidermal cells are very much enlarged in these areas and turgid, and the chlorophyll-bearing cells are also greatly changed. For a detailed description and discussion of this trouble no better work can be found than that of G. F. Atkinson.[1]

It can be seen from these brief descriptions that unless care were exercised it might be easy to confound these troubles, especially in the case of the first two. Keeping this in mind we will pass on to a more detailed description of the malformation of stump growth subsequent to the burning off or cutting down of large trees.

The malformation appears to be worst in the first two or three seasons' growth, the sprouts outgrowing the trouble as their age increases. From our observations this trouble appears to occur in two distinct forms: first, as an abnormal growth of stem and leaves, they sometimes reaching a size five to ten times that of normal young plants of the same species. This form of the

[1] N. Y. (Cornell Univ.) Agr. Exp Sta., Bul. No. 53, "Œdema of Tomato."

leaf was especially noticeable in such sprouts as ash, poplar and plane tree, and sometimes occurred also on chestnut and oak, although it may be mentioned that they were occasionally very much distorted.

When the leaves were simply abnormally large it was found that the structure of the cells and their relative positions were analogous to a healthy, normal leaf, but that they were relatively much larger, and were of a stiffer texture than the normal specimens.

Very often it was found that the cell contents, especially the coloring matter, were brought into undue prominence, richly colored red leaves being of frequent occurrence. Occasionally, also, leaves having a decided yellow color, but otherwise appearing strong and healthy, were observed. This excessive coloration was evidently due to the abnormal deposition of pigment or activity of colored cell sap. When the leaves were green, the color seemed to be deeper than that of normal specimens.

The second form of the malformation has much the appearance of that caused by overfeeding, or excessive use of nitrates; *i.e.*, a severe distortion of leaves, but in this case accompanied by excessive production, usually smaller in size than the normal, but thickly clustered. Distorted leaves did not usually show much abnormal coloration, but occasionally a reddish or yellowish color was observable.

Usually the leaves were much more numerous and very badly distorted, the veins and ribs being especially twisted in various ways. The texture of the leaf was very stiff, much more so than in the case of the abnormally large leaves, the tissue having hardly any elasticity, and breaking easily, with a crackling sound. Plates I. and II. (Figs. 1, 2 and 3) show the two forms of this trouble better than mere description.

There is a remarkable dearth of literature bearing on this specific trouble, although much has been written in a general way on somewhat similar physiological troubles, but dealing principally with field crops and forced plants. In the reports of the various experiment stations will be found more or less literature on physiological troubles, and Woods,[1] Suzuke,[2] Stur-

[1] U. S. Dept. Agr., Bur. Plant Ind., Bul. No. 18.

[2] Bul. Col. Agr., Tokyo, Vol. IV., repts. for 1900.

FIG. 1.—Chestnut (*Castanea dentata*), showing Diseased (Left) and Healthy (Right) Shoots.

FIG. 2.—Red Oak (*Quercus rubra*), showing Diseased (Left) and Healthy (Right) Shoots.

PLATE I.

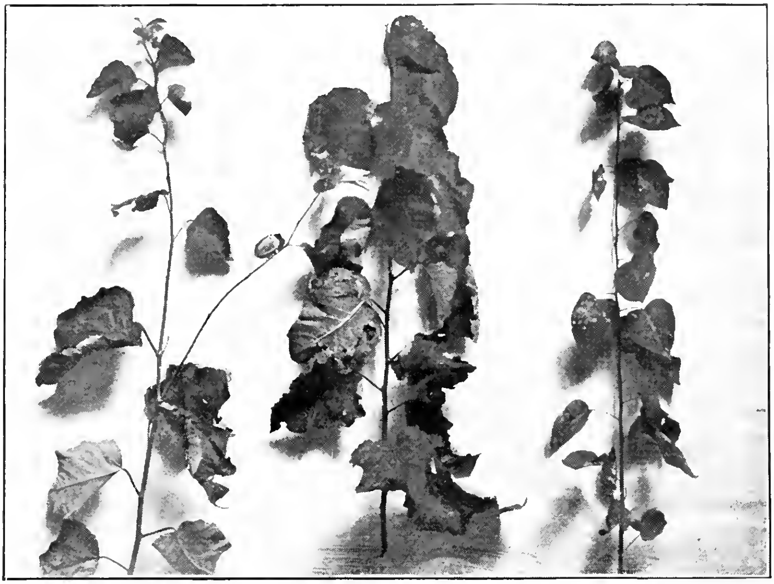

FIG. 3. — Poplar (*Populus grandidentata*), showing Diseased (Right) and Healthy (Left) Shoots.

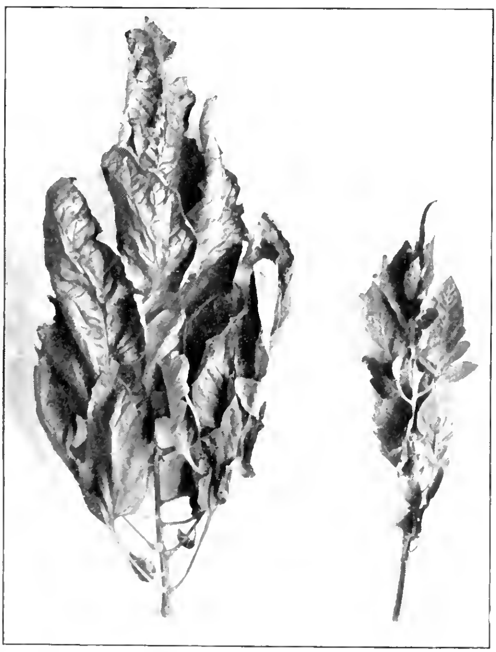

FIG. 4. — Mosaic Disease on Tomato.

FIG. 5. — White Oak, showing Diseased Shoot.

PLATE II.

PLATE III.

FIG. 1.—Mature pycnidia, showing a few unicellular hyaline spores and orifice from which they have been expelled.

FIG. 2.—Nearly mature pycnidia, with attached *Alternaria* spores.

FIG. 3.—Mycelium threads giving rise to *Alternaria* spores and an immature pycnidium.

FIG. 4.—Common type of *Alternaria*.

FIG. 5.—Conidial form of *Cladosporium* developed from microsclerotia found on gummy excretions.

All from camera lucida drawings.

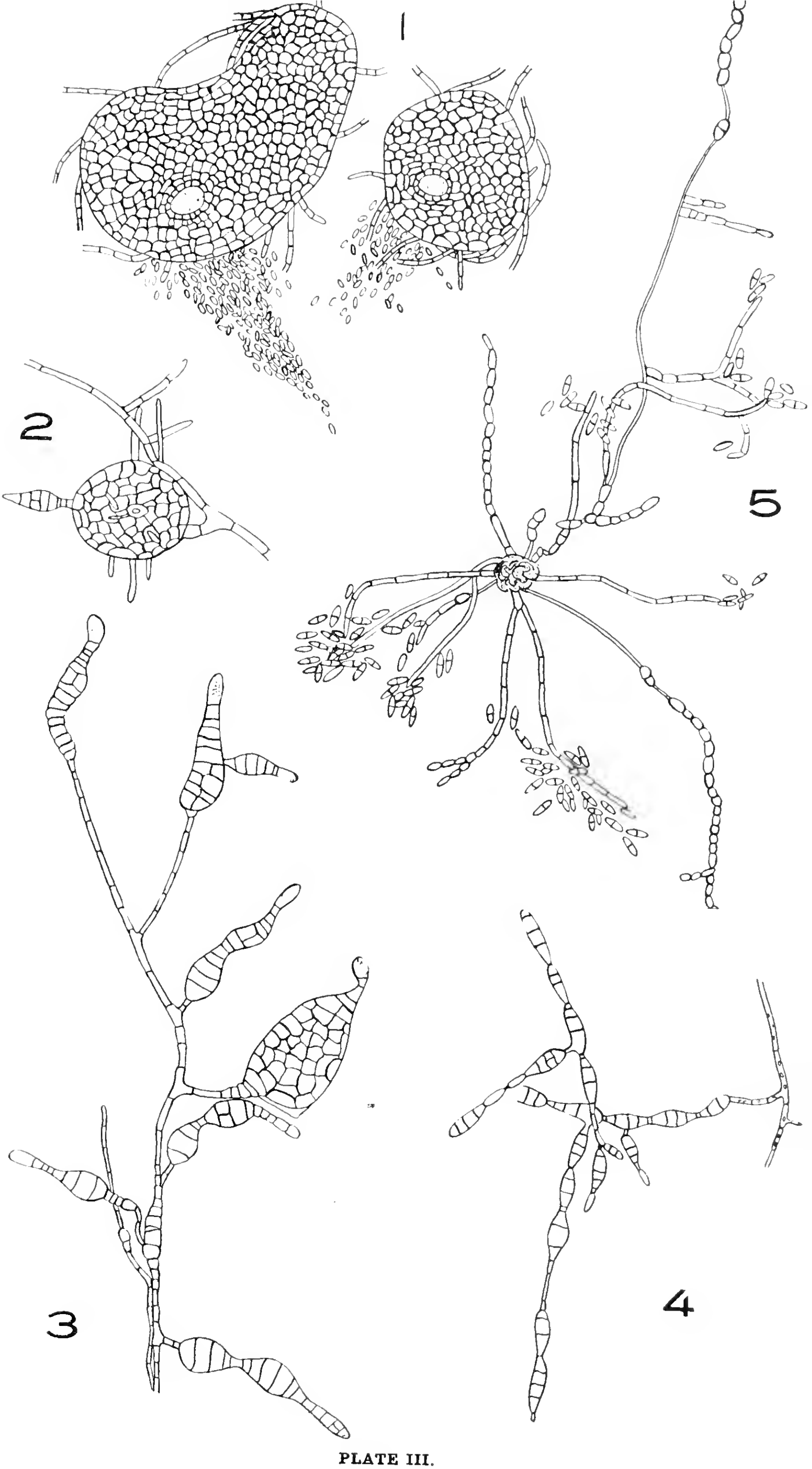

PLATE III.

gis,[1] Czapek,[2] Stone,[3] Atkinson [4] and others have dealt with various physiological troubles more in detail.

From our observations and experiments in the field and greenhouse we have come to the conclusion that it is a well-developed form of malnutrition, using malnutrition in its broadest meaning, *i.e.*, to include any physiological trouble which is caused by an excess or lack of any one or more nutritive substances necessary for the normal metabolism of a plant, and is allied to the phenomena exhibited in a severe case of overfeeding.

Logically it is what one would expect when a large tree is suddenly cut off or the top killed, and practically all transpiration, respiration, or, in short, all photosynthesis and leaf metabolism, is suddenly arrested. We have a violent disruption of the normal metabolism of the tree. The balance between root absorption, photosynthesis, etc., and the metabolic processes of the leaves is suddenly broken, and we have the roots, which are still alive, attempting to do their normal work without the aid of the leaves; starch formation is arrested and carbon assimilation cannot take place. In the roots there remains a great reserve store of food and during the winter no root pressure. As most woods are cut in the fall and winter, the trees are dormant, and forest fires also occur largely in fall and spring during this dormant period. Now, when spring comes and circulation starts, the adventitious buds are called upon to produce new shoots for the utilization of the reserve food in the roots. This they try to do in the manner we have described, by producing abnormally large leaves or a great number of small and distorted leaves. This distortion will be discussed later.

Of the trees which have come under our observation, maples, oaks and chestnuts seem to be the most susceptible to leaf distortion, while such trees as the ash, poplar and plane usually have abnormally large leaves with very little distortion. However, in some cases both conditions are observable.

The theory which has been advanced above as to the cause of the disease has been borne out by experiments carried on in the

[1] Conn. Agr. Exp. Sta., 1898, and others.

[2] Biochemie der Pflanzen (general).

[3] Mass. Agr. Exp. Sta. reports.

[4] N. Y. (Cornell Univ.) Agr. Exp. Sta., Bul. No. 53.

field and laboratory. The results of these experiments will be discussed later in the paper.

Relation to Mosaic Disease.

It was at first thought that there might be some relation between the so-called "mosaic disease" and this, but from our observations we have been able to find only a superficial relationship, *i.e.*, as regards the distortion of the leaf in its first stages. Other investigators,[1] as has been previously mentioned, have proved that the "mosaic disease" can be communicated from one plant to another by inoculating a healthy plant with the juice of a diseased plant, and that the new growth subsequent to the inoculation will come diseased in nearly every case. This is not so in the case of sprout growth, however, as in no instance were we able to bring about a diseased condition of normal plants by inoculating them with juice taken from diseased leaves. As it was impossible to carry on these inoculation experiments in the laboratory, the work was done in the field, and observations taken from time to time.

Experiments in Inoculation.

In order to prove that, unlike mosaic disease, this malformation could not be communicated from a diseased sprout to a healthy one, the following experiments were made. Two series of ten inoculations each were made; in one case diseased tissue was inserted at the base of the terminal bud of normal, healthy sprouts; in the second series the terminal buds of healthy sprouts were inoculated with the filtered juice from diseased plants. In all cases a healthy plant was inoculated with the tissue or juice of a malformed plant of the same kind, *i.e.*, a maple was inoculated with juice from a diseased maple shoot, etc. In not one case could we find that the trouble was either contagious or infectious in character. The results of these inoculations are given in Table I., and from these results it is evident that the disease cannot be communicated from one plant to another.

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[1] A. F. Woods, U. S. Dept. Agr., Bur. Plant Ind., Bul. No. 18.

TABLE 1.

SERIES A. — *Showing Results of Inoculation of Healthy Young Growth with Tissues from Malformed Plants.*

PLANT.	Number inoculated.	Number diseased.	Remarks.
Maple (*Acer rubrum*),	10	None.	The terminal bud died in two cases, but this was due to mechanical injury.
Chestnut (*Castanea dentata*),	10	None.	
Oak (*Quercus alba*),	8	None.	
Poplar (*Populus tremuloides*),	10	None.	The terminal bud died in three cases, but this was due to mechanical injury.

SERIES B. — *Filtered Juice used for Inoculation.*

PLANT.	Number inoculated.	Number diseased.	Remarks.
Maple (*Acer rubrum*),	14	None.	
Chestnut (*Castanea dentata*, Borkh.),	11	None.	
Oak (*Quercus alba*),	10	None.	Inoculated twice two weeks apart with juice.
Poplar (*Populus tremuloides*),	10	None.	
Ash (*Fraxinus Americana*),	5	None.	

The appearance of the leaves of "mosaic" plants is usually different from that of diseased shoots in the case under discussion. In mosaic these are flattened areas of cells which are lighter in color than the normal areas, and which are also smaller in size, growing more slowly than the normal cells, this causing a general unevenness or distortion of the leaf.

On the other hand, in the trouble under discussion, where abnormality occurs, the tissue of the leaf itself is not so much distorted as the vessels and veins. These are usually curved more or less, and thus distort the leaf. The leaf, also, is always of a healthy dark-green color, and shows no division of color into light and dark areas. Plate II. (Figs. 4 and 5) shows a typical mosaic leaf and some from affected sprout growth.

The cause of mosaic is not exactly known, but it has been produced repeatedly by severe pruning in the case of tomatoes, tobacco and other allied plants. It occurs on tobacco, also, without pruning in the field, due to some functional disarrangement in all probability; but in the case of tomato we have not been able to find a case in which the disease occurred on a plant which was allowed to grow normally, that is, without pruning. Plants in the field are also not so susceptible to it, and it is rather difficult to conceive just why it is that under similar conditions, but with different plants, we sometimes get the characteristic mosaic disease and sometimes only a condition such as the one under discussion.

Relation of Root Area to Intensity of Disease.

In the course of our experiments it was observed that in the same locality, with the same kinds of trees, there was a marked difference in the intensity or severity of the malformation. It was thought that the size of the original tree and its corresponding root area might bear some relation to the severity of the disease. Rough estimates were made of several root systems from which first-year sprouts were growing which were diseased, and in general it was found that the larger the root area the more distortion of the leaves. This seemed to be the general rule, but from the limited number of observations we were able to make it would be unwise to make a positive statement as to the absolute truth of this observation.

When young trees had been cut down or killed by burning, there was not such severe distortion, but more of a tendency to produce abnormally large leaves. As a result of our observations it may be stated that there is a relationship existing between the amount of active root surface and the severity of the trouble along the lines we have pointed out.

It has been stated elsewhere in this article that the severity of the disease diminishes from year to year as the plant grows older, and it would be natural to expect such a recovery for two reasons: first, the shoot is larger the second year than the first, thus having more leaf surface to effect transpiration, respiration, carbon assimilation, etc.; and secondly, some part of the root system, owing to lack of food (available), which the first year's leaves have been unable to supply, has died from general weakening; thus the second year, and so on from year to year, we have a general attempt to balance up the root system and the leaf system. It is believed that this view is in accordance with the truth, although no specific work has been done here to prove it other than general observations.

Chemical Tests of Abnormal Leaves.

In view of the fact that physiological diseases in general are principally caused by derangement of the function of some organ of a plant, as a result of poor nutrition (lack or excess of some necessary plant food), it was thought that it would be well to obtain, in a general way, an idea as to the presence and absence of certain substances in the leaves of diseased plants. Owing to pressure of other work it was necessary to use dried specimens for examination. The specimens, however, were not over one or two months old when the examinations were made, therefore no great change of constituents could have taken place, with the exception of loss of water, and this was not of any importance. A complete analysis was not made of the leaves, but comparative tests were made, comparing the substance in healthy leaves with the same amount of diseased leaves. The substances tested for were principally nitrates, enzymes and starch.

As Woods [1] in his bulletin on mosaic disease advances the theory that it is caused by an excessive amount and increased activity of oxidizing enzymes, such as oxidase and peroxidase, equal amounts of leaves from healthy and diseased leaves were tested to see if there was any increase or decrease in the relative amounts present. It was found that in general there was usually present in diseased leaves a slightly larger amount than in the healthy leaves, but it was not necessarily so, as in five cases out of eighteen there was less present; but this may possibly have been due to individual variation in the leaf itself, as the method of taking equal weights of leaves for examination has some drawbacks, but no better method has as yet suggested itself.

It was found that catalase, another enzyme which was discov-

[1] *Loc. cit.*

ered in connection with tobacco by Loew,[1] was present in both healthy and diseased leaves in comparatively small amounts, but that there was practically no difference in the amounts present. Twenty samples of healthy and diseased leaves were tested, and below will be found a table containing the averages of these tests. The comparative amounts present were represented by the oxygen developed from a standard solution of hydrogen peroxide, which contained 3 per cent. H_2O_2.

TABLE II. — *Amount of Oxygen developed from Healthy and Abnormal Leaves.*

[Averages of twenty samples.]

	Number of Samples.	Amount of Oxygen developed.	Time.
Abnormal,	20	118.5	30 min.
Healthy,	20	114.0	30 min.

The samples were shaken during the test, as this has been found to increase the amount of oxygen developed.

Fifteen grams of leaves were used in each case.

Individual variations were found in most cases between leaves of different kinds, but not sufficient to warrant distinctive mention.

Thus, in respect to the amount of catalase present we find that there is a difference between this disease and mosaic, for in the case of mosaic disease there is less catalase present in the diseased leaves than in the healthy ones.[2]

Colorimetric tests of healthy and diseased leaves were made to determine the relative amounts of nitrates present, and it was found that in the case of diseased leaves a deeper color was obtained than in the case of healthy specimens. The test for nitrates used was the well-known diphenylamine reaction. Only approximate results were obtained, but sufficient to show that nitrates were more abundant in diseased leaves than in normal specimens. This tends to confirm the idea that this disease is more a form of malnutrition or overfeeding than a specific trouble, such as "mosaic."

Aside from the direct work on the disease it was observed in some few cases that diseased leaves were more liable to the

[1] U. S. Dept. Agr., Report No. 68. [2] Mass. Agr. Exp. Sta. report, 1908.

attacks of leaf-sucking insects, such as aphis, etc., as in a few instances specimens of diseased shoots were obtained which showed the effects of these insects, and some aphides were found also. No insects were observed, however, on healthy shoots, or to so great an extent on shoots which had only a slight indication of the disease in question. It appears from our observations that the disease renders the shoot more liable to the attacks of insects on account of its weakened condition, in some respects it being far more normal; also, the attacks of insects intensify the disease by taking from the leaf a large amount of proteids and sugars. The effects of insects have been noted by various authorities, among which may be mentioned Woods [1] and Suzuki.[2] More specific and interesting facts on this point might be brought out by further observations and detailed study in conjunction with entomologists, but this is without the scope of the present paper. It is, however, true that insects seem to prefer a diseased leaf to a healthy one under these conditions.

More purely chemical work would undoubtedly be of great interest in connection with this interesting disease, and no doubt will find a place in a future report, but it is thought that enough has been done with the disease to bring out several new points in regard to it.

Conclusions.

(1) The abnormal condition of leaves, shown by severe distortion and increase in number, and also sometimes in size, may be classed under the malnutrition diseases, due to functional derangement, as no fungi or bacteria have been found associated with it. It must therefore be due to internal conditions, such as an abnormal metabolism.

(2) It is allied to those pathological conditions which may be brought about by excessive use of nitrates or overfeeding.

(3) It is not allied to mosaic disease, which it somewhat resembles, as this is capable of transmission from one plant to another, and in no case have we been able to bring this result about by inoculation with tissue of malformed leaves.

(4) From our observations it is not of a permanent character,

[1] U. S. Dept. Agr., Bur. Plant Ind., Bul. No. 18.
[2] Gen. Bul. Col. Agr., Tokyo, Vol. IV., No. 4.

as the shoot will outgrow it in from three to five years, and does not seem to suffer any serious ill effects from the trouble.

(5) It is caused by a sudden disruption of the metabolic processes of the tree, all leaf activity being suspended; and there being no normal relationship between root metabolism and leaf metabolism, the new shoot is unable to properly bring into available form the food supplied for the nourishment of the tree. In other words, there is an attempt on the part of the leaves to correlate their functions with a root area many times larger, and consequently a pathological condition is set up within the tissue, due, as has before been said, to imperfect metabolism.

PEACH AND PLUM TROUBLES.

BY RAYMOND DEAN WHITMARSH, B.S.

Many diseases of the plum and peach have been known and described for years. Standing probably first among the most serious of the fungi are "brown or fruit rot," or *Monilia* (*Sclerotinia fructigena* (Pers.) Schroet.), and scab (*Cladosporium carpophyllum*, Thümen). These fungous troubles have been very noticeable in the peach and plum orchards at the college during the past year or two.

The writer began investigations early in January, 1909, mainly to determine the cause of so much gum flow on the peach, almost every tree being affected to a greater or less extent. In connection with this study nearly every phase of the above diseases as they are described by various writers was noted, and a brief résumé of their characteristics and methods of treatment is given here, with observations on "gummosis" of the peach.

This paper has been prepared under the supervision of Dr. G. E. Stone of the Massachusetts Agricultural College, and to him I wish to express my heartiest thanks for his many suggestions, criticism of manuscript and verification of observations.

Brown Rot or Fruit Rot, Monilia (*Sclerotinia fructigena* (Pers.) Schroet.).

Distribution and Host Plants. — This disease is reported by Saccardo as being found in Germany, France, Austria, Italy, Belgium, Great Britain and the United States, where it is known as *Monilia fructigena*, one of the "imperfect fungi." Tubeuf and Smith speak of the disease as being very common in the United States and Great Britain. It was first described in the United States by Dr. C. H. Peck in 1881; since that time a great many investigators have been at work on it. Finally, Prof. J. B. S. Norton in 1902 succeeded in giving us its life history in full, having found the ascospore stage. Within the United States, at least, the greatest damage is caused to the stone fruits.

Symptoms (on Fruit). — The first indications of the disease on the fruit are brown spots of a leathery appearance, which enlarge rapidly, and after the mycelium has become mature, the conidiophores break through the epidermis and give to the spots a downy, dirty, grayish-brown color, due to the great quantity of conidia produced by the fungus. The fruit then shrinks and withers to a thin, tough pellicle. In this "mummied" condition it hangs on the trees over winter or falls to the ground, where the fungus remains dormant until the right conditions of moisture and temperature cause it to become active and attack its host the following spring. The dormant or sclerotium form of this fungus occurs where the "mummied" fruit has laid on the ground over winter, covered by a thin layer of soil. These sclerotia give rise to apothecia, which are funnel-shaped, resembling small toadstools. The asci line, the cup-shaped portion of the apothecia and each ascus, contains eight ascospores. So far as I know this has not been found by any of the Massachusetts Experiment Station staff. The fungus will attack the fruit at different stages of its growth, but it makes the greatest headway on fruit that is almost mature. If the fruit has been attacked by the curculio, or injured in any way, the fungus readily takes advantage of the injury to get in its deadly work. It might be said, however, that although it attacks the fruit most readily where it has been injured, it will also attack the perfect fruit should the humidity and the temperature of the atmosphere be right. In the case of plums the fungus may have been working for some time within the tissue without being outwardly noticeable. This fact has put many shippers to great disadvantage and caused them much loss.

On Flowers. — The fungus usually first attacks the flowers just after the petals fall, but it has been known to attack them previous to that time. The first indication that the fungus is present is a slight brown discoloration on some part of the flowers. This rapidly spreads until it affects the whole flower, and frequently extends into the pedicles. These diseased flowers often remain on the tree several weeks, until a heavy rain or damp weather comes, when they begin to fall, and as they are very sticky, owing to their decaying condition, they adhere very effectively to leaves and fruit, and serve as a new place of infection. They may remain in these new locations for some time before they are washed to the ground. When the fungus from the flower penetrates the pedicle, we have what is commonly called "twig blight."

On the Twigs. — One form in which the fungus attacks the twigs is commonly known as twig blight, and it is apparently a result of the early attacks on the blossoms. I have noticed it attacking both the peach and plum, but more often the former. The fungus penetrates the pedicle and into the tissues of the twig, causing a flow of gum. This fungus often works around the entire stem, cutting off all source of nourishment from the distal portion of the twig, causing it to die. The gummy portions and girdling resemble quite closely the symptoms of another disease, known as canker. In summer and early fall, as well as in spring, we often find this blighting of twigs, the source of infection being the fungus from the decaying fruit. This bores through the pedicle and then ramifies through the stem, often girdling it, as in the case of the blight, where the source of infection was the flowers. The injury in both cases nearly always is confined to a point near the attachment of the fruit or flowers. When the girdling is complete the leaves beyond the point of attack dry up and die.

Another form in which I have noticed it might be called the "brown spotting of twigs." This phase of the disease has been described by Dr. G. E. Stone of the Massachusetts Agricultural College. The spotting occurs on the new shoots, and was not noticed except in the case of the peach. These spots may be single, or several may come together, forming a more or less irregular mass. In these spots we find *Monilia,* which presents similar characteristics to the one found on the fruit. The principal distinction between this and the common *Monilia* of the fruit consists in the smaller spores of the former. Numerous cultures and comparisons made of the two types of *Monilia* — that on the fruit and on the stem, made by Dr. Stone — show that the spores of the one on the twig are always smaller when grown in any media than those of that on the fruit, and the two species react quite differently chemically when grown in solutions on different media.[1]

On the Leaves. — In wet weather, especially, one often notices spots on the leaves. These are found on both the upper and lower surfaces, but are generally most conspicuous on the upper. During wet, warm weather, if one examines these spots carefully he will find here and there small grayish masses of powder, which are in reality the conidia of the "brown rot" fungus.

Spores. — The spores, more or less oval shaped, are one celled, and their contents are quite noticeably granular. These spores germinate readily in water, producing a mycelium whose contents are granular, as in the case of the spores. The mycelium is broken up here and there by cross walls. The spores are produced in chains by a sort of budding, the last one of the chain being the newest one. When grown on culture media (prune agar) these spores form much longer chains than on the fruits out of doors.

Means of Spore Dispersal. — The influencing factors in the spreading of this fungous disease are wind, rain, insects (especially plum curculio), etc. Many minor ways in which the spores are disseminated might be enumerated, but the three above-named methods are probably by far the most influencing.

Methods of Control. — I would suggest the following ways in which to lessen the attacks of this disease. Destroy all "mummied" fruit which hangs on the trees or has fallen to the ground. Cut off and burn all twigs that are infected with the fungus mycelium. Keep the trees pruned, so that there will be a free circulation of air and plenty of light, because a tree which is crowded with cross limbs and has in consequence too much foliage acts as a convenient forcing house for "brown

[1] Dr. Stone has observed this species on the twig for many years in Massachusetts, the twig sometimes being very badly spotted. *Monilia* is also sometimes associated with *Cladosporium*, but the *Monilia* by far predominates. Where lime and sulphur has been used as a spring spray these spots have been entirely absent, with a much better annual growth of the twig as a result. (See Nineteenth Annual Report, Massachusetts Agricultural Experiment Station, p. 166.)

rot." Thin the fruits so that they do not at least come in contact with one another. By using the above precautions and applying the following spray mixtures for "brown rot," "scab" and "plum curculio" I believe that the fungus can be almost entirely controlled. For the Elberta, Belle, Reeves, and other varieties of peaches of about the same ripening season, the following is advised: (1) about the time the calyces of shucks are shedding, spray with arsenate of lead at the rate of 2 pounds to 50 gallons of water. In order to reduce the caustic properties of the poison, add milk of lime made from slaking 2 pounds of stone lime. The date of this treatment is too early for scab, and ordinarily no serious outbreaks of brown rot occur so early, so that the lime sulphur may be omitted with reasonable safety; but during warm, rainy springs, especially in the south, the lime sulphur will doubtless be necessary in this application. (2) Two or three weeks later, or about one month after the petals drop, spray with self-boiled lime sulphur; 8 pounds of lime, 8 pounds of sulphur and 2 pounds of arsenate of lead to each 50 gallons of water. (3) About a month before the fruit ripens, spray with the self-boiled lime sulphur, omitting the poison.

For earlier maturing varieties, such as Waddell, Carmen and Hiley, the first two treatments outlined above would probably be sufficient ordinarily, but in very wet seasons varieties susceptible to rot would doubtless require three treatments. Late varieties, such as Smock and Salway, having a longer season, would not be thoroughly protected by three applications. In view of the results obtained on midseason varieties it seems likely that three treatments will ordinarily be sufficient for the late varieties.

Black Spot or Scab (*Cladosporium carpophyllum*, Thüm.).

History and Distribution. — This fungus was first noticed in 1876 by Von Thümen of Austria, who was at that time botanist to the Austrian Experiment Station. In the year following, 1877, he described the fungus, giving it the above name. Since that time it has been met with quite commonly in this country. In Saccardo's "Sylloge Fungorum" we find a copy of Von

Thümen's description, which mentions only that it was found in the locality of Klosternenburg, where the Austrian Experiment Station was located.

On the Fruit. — Small, round, blackish spots on the skin of the fruit are the first indications of the disease. These spots usually appear when the fruit is about two-thirds grown, most frequently on the upper side of the fruit, and if the spots are very numerous they will, as they grow, coalesce and form a large, irregular, diseased area. When the fruit is thus attacked it becomes one-sided, due to the fact that a corky layer of cells is formed by the fruit under the diseased area as a protective layer. This corky layer is incapable of further growth, and hence we get, as a result, the ill-formed fruit. The corky layers are often ruptured, leaving deep cracks, which furnish an ideal place for the growth of the spores of *Monilia*, which are always ready to take advantage of such injuries. Hence we often find both troubles on the same specimen. This disease attacks the fruit much in the same way as the scab of apple and pear. Its attacks are generally most noticeable on the late varieties of fruits, and it thrives most luxuriantly during damp weather.

On the Leaves. — This fungus causes a shot hole appearance of the leaves. The first indications one has of the disease upon the leaves are scattering brown spots. These spots, as a rule, spread over the leaf, and as the fungus matures the tissues dry up and the diseased portion falls out, leaving a circular opening. This fungus seems to prefer the part of the leaf between the veins. The spores of the fungus attacking the leaf agree with those growing on the fruit, with the possible exception that they are somewhat smaller, but no doubt this slight variation is due to the environment rather than being a specific character.

On the Twigs. — Sturgis gives an account of this fungus attacking the peach twigs. He states that the twigs are marked more or less abundantly with circular spots, somewhat resembling in appearance the "birds' eye rot" of grapes (*Spaceloma ampelinum*, DeBary). Frequently the spots join together and cover the twig so thoroughly as to destroy the pinkish-brown color of the bark. Although not having seen this phase of the disease, it apparently resembles in outward appearance very much the spotting that I described as due to the brown rot fungus.[1]

Peach Leaf Curl (*Exoascus deformans* (Berk.) Fuckel).

This disease is found commonly in Massachusetts, and, as a matter of fact, more inquiries are sent to the station in regard to this trouble than any other peach disease. It is found in almost all parts of the world where the peach is grown to any extent, and has been seen by the writer in great quantities in the large orchards along the shores of Lake Erie.

It attacks the leaf buds just as they begin to open in the spring, also the tender shoots, flowers and young fruit, but is not so noticeable as on the leaves. The leaves become very much swollen, wrinkled and curled, and a little later take on the appearance of a moldy gray covering. In the earlier stages of the disease the leaves often show red or pinkish blotches, but they turn a brownish color as they grow older and fall to the ground. Cold and damp, or rainy, weather in the spring greatly favors this disease, and in fact determines the degree of severity of the attack. It often defoliates the trees to such an extent that they are not able to lay up sufficient material for their needs, or ripen the wood properly, so that when winter comes the trees are often found to be much weakened. In some cases the disease has been so severe that the trees were not able to endure the cold of winter, and consequently were winter killed.

It was previously thought that infection took place only by perennial mycelia, but this theory has gradually been discarded. Infection may take place by perennial mycelia, but most writers and observers now agree that infection is due almost entirely to the spores, which live over winter on the bark of trees and in other places.

The Elberta peach is one of the most susceptible varieties to the attacks of this fungus, but all varieties seem to be more or

[1] For other points of interest in regard to the fungus not given in this paper see Arthur's and Chester's writings.

less subject to the disease. Trees injured by other agencies, and consequently weakened, seem to be more susceptible to attack than healthy, vigorous trees.

It will be readily seen that it is probably useless to spray the trees after the leaves become infected, but since the spores live over winter on the bark, the trees should be sprayed in the spring, while the spores are still dormant.

It is generally accepted by all the largest and best growers that the lime sulphur wash, used for the control of San José scale, is by far the best remedy for this trouble, although some prefer Bordeaux and others copper sulphate solution, where the scale is not present. Since there is nearly always danger from scale infestation, however, it seems wiser to use the lime and sulphur, which is undoubtedly of great fungicidal value, as well as one of the best remedies for the scale.

The spray should be applied to the trees from one to two weeks before the buds open, if possible on a quiet day when the atmosphere is free from moisture.

If the above directions are followed, this treatment should suffice for the leaf curl and the San José scale. For this spray mixture use 10 pounds of good fresh stone lime and 15 pounds of sulphur to each 50 gallons of water. Make up the above spray solution as recommended by Quaintance.

Heat in a cooking barrel or vessel about one-third of the total quantity of water required. When the water is hot, add all the lime and at once add all the sulphur, which previously should have been made into a thick paste with water. After the lime has slaked, about another third of the water should be added, preferably hot, and the cooking should be continued for one hour, when the final dilution may be made, using either hot or cold water, as is most convenient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in kettles. If cooked by steam, no stirring will be necessary. After the wash has been prepared it must be well strained as it is being run into the spray pump or tank. The wash may be cooked in large kettles, or, preferably, by steam in barrels or tanks.

Plum Pockets (*Exoascus Pruni*, Fuckel).

The organism causing the disease known as "plum pockets" is closely related to that causing peach leaf curl, although not occurring on the peach. It was previously thought that the source of infection was only through the hibernating mycelium in the twigs and branches, but from what can be learned in regard to this more investigation seems to be needed on this point. A short time after the young fruit forms, it becomes yellowish, much swollen and stoneless.

These hollow, dropsical-like plums are often streaked with red at first, but after a time they take on a moldy, grayish appearance, similar to the peach leaf curl, and soon fall to the ground. This moldy covering is composed of sacs (asci) which contain the spores.

The attacks of this parasite are generally local, possibly only one tree in a large orchard being affected, and the treatment given for peach leaf curl would probably suffice here.

Black Knot (*Plowrightia morbosa* (Schw.) Sacc.).

One often notices in small family orchards containing a variety of trees, where little care is given them, that some of the plum trees show signs of a disease known as black knot. The knots often extend entirely around the limbs, and as a consequence the more distal parts of the limbs receive but little nourishment, and finally die.

Black knot, if given no treatment, usually destroys the value of the tree within a year or two, even if it does not kill the tree in that time. Almost all varieties of plums are subject to this disease. The first noticeable indication of the disease in the spring is the enlargement of limbs and branches affected. The bark then breaks open, and this new surface soon becomes covered with a moldy, green-like substance which contains the spores. This is followed by black knots containing spores which become mature before the next spring. The spores evidently obtain a foothold on their host through cracks or injuries caused by various agencies. It is therefore essential in the care of an orchard that one should be careful not to bruise or injure the trees.

The wind is probably the greatest agent for conveying the spores from tree to tree. Remedial measures consist in pruning off the knots and burning, and it has been advised that they be cut out when young, and the exposed area coated with paint. Observations and experiments have shown that early spring spraying materially lessens the infection.

Plum Leaf Spot or Shot Hole (*Cylindrosporium Padi*, Karst).

This disease causes spots on the leaves somewhat circular in outline, which often become joined. These affected parts usually have a reddish outline, and finally the diseased tissue turns dark brown and falls out. The leaves turn a yellowish color and often begin to fall in July, but the most severe defoliation usually occurs in August and early in September. The great loss from this disease is caused by defoliation before the tree stores up sufficient starch and ripens its wood enough to enable it to stand the cold of winter. Continual attacks very much weaken the tree and eventually kill it, but if lime sulphur is used thoroughly, little trouble will be experienced from this disease. This same disease also affects the cherry.

Peach Shot Hole (*Cercospora circumscissa*, Sacc.).

The effects of this disease resemble those caused by *Cylindrosporium* of the plum. The diseased spots fall out, and the small branches are also attacked, often causing a great number of the young shoots to die. Spray with lime sulphur, as for peach leaf curl.

Shot Hole Effect caused by improperly mixed Bordeaux.

When improperly mixed Bordeaux is used for a summer spray, we invariably find the leaves badly riddled with holes, due to the burning of the tissues. One can readily distinguish this type of shot hole from those previously described, for the leaves which come out on the new shoots remain unaffected, whereas, if the trouble had been due to a fungus, the new leaves would also become affected. Bordeaux is not, therefore, always safe to use on mature foliage, even at reduced strengths, for it has often been known to cause trouble when used at only half strength.

Gummosis of the Peach.

For the past two years there has been an abundance of gum flow in the college peach orchard. This has been found to the greatest extent on the early varieties, and owing to the poor condition of many of the trees it has seemed best to destroy them. The following gum disease which I am about to describe resembles almost identically in most of its life history the gummosis of *Prunus Japonica*, described by Masseé as due to *Cladosporium epiphyllum*, Fr. In this case (gummosis of peach) I believe the species to be *Cladosporium carpophylum*, Thüm. Masseé mentions in his paper a species of *Macrosporium* that is often found in connection with this gum flow, but he is unable to find any genetic connection between the two fungi. Instead of finding a *Macrosporium* fungus in connection with the gummosis of peach, I have, with very few exceptions, found a species of *Alternaria* [1] or *Alternaria* form, which is apparently something new, as the fungus, in addition to the ordinary alternaria spores, bears pycnidia bodies containing many minute hyline spores. These in turn give rise to *Alternaria* spores and more pycnidia. I could not, however, establish any genetic connection between this form of *Alternaria* and the *Cladosporium*.

Probable Cause of Gummosis.

On the trunks and large branches the gum flow is evidently due to borers, frost cracks and sun scald, and a copious flow of gum at any place of injury is generally found. These places serve as a refuge for the spores of *Cladosporium* and *Alternaria*, and we find some form of *Penicillium* inhabiting the same mass. But whatever the original cause of the flow, it is certain that these forms of *Cladosporium* and *Alternaria* take a hand in

[1] The organism which we term *Alternaria* here may possibly be an undeveloped form of some other type, such as *Pleospora*, etc.

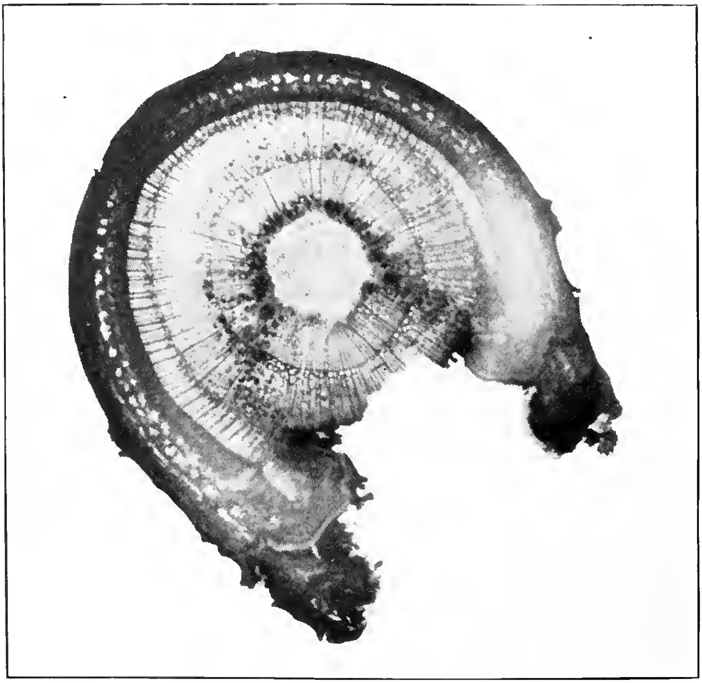
stimulating the host to a more abundant flow. The mycelium of these fungi penetrate every portion of the gum, and their fungous threads may be seen even penetrating the host itself.

On the Fruit-bearing Wood.

The gum flow is almost without exception found at the base of the pedicle bearing diseased fruit. These gummy masses may be confined to a small area in the region of the pedicle, or may extend some little distance below and above the pedicle, sometimes becoming so bad as to entirely girdle the branch, thus killing the entire distal portion. When this happens it is best to cut the diseased member off some two or three inches below the gummy area. I believe this gum flow is first caused on these small branches by the brown rot fungus, which is, without an exception, found on the fruit attached to the diseased pedicle. But as soon as this fungus causes the flow of gum the *Cladosporium* and *Alternaria* come in, as in the case of the injuries on the trunks and large branches. After the above fungi, *Cladosporium* and *Alternaria*, get a foothold, it would seem that the brown rot fungus is less noticeable. *Monilia* is often to be found in these gummy masses, but in masses containing *Cladosporium* and *Alternaria* this fungus has been found very sparingly. These masses become soft during the damp spring weather, and are usually washed to the ground by rains.

Appearance of Cladosporium and Alternaria under the Above Environment.

At first the gummy mass is light in color, but after it remains on the tree some time it becomes browned and blackened. On sectioning one of these masses it is found that the darkened area is near the surface, due to the formation of dark, thick-walled cells, while farther in the mycelium becomes gradually lighter in color, until nearly colorless at the center. On inoculating branches of peach trees with the conidial form of *Cladosporium* grown on prune agar it was found that some little time afterwards a greenish growth of *Cladosporium* appeared. After the spores had disappeared there soon appeared small, tear-like drops, which, as the season advanced, grew larger and darker



Showing a Cross-section of a Three-year-old Peach Twig affected with "Gummosis."

in color. On examination in the fall these masses were found to contain mycelium and spores similar to those found in other gummy masses in the orchard. These chains of dark spores produce many thick-walled spores, or micro-sclerotia, as described by Masseé, and these thick-walled spores, or micro-sclerotia, in turn give rise to many small hyline conidia, while another form of the micro-sclerotia gives rise to a mycelium which bears numerous conidia. In the gummy mass one finds present many pycnidia of a brown color, similar in color to the micro-sclerotia, and from their situation, color, etc., one would take them for different stages of the same fungus. However, on isolating these pycnidial bodies, which were filled with myriads of minute hyline spores, and growing them on pure cultures, I was unable to get any connection between the two; but I found that the minute hyline spores without exception gave rise to other pycnidia and *Alternaria* spores; the *Alternaria* spores, growing on the same mycelium as the pycnidia, in turn gave rise to pycnidia and *Alternaria* spores.

Histological Changes Accompanying Gummosis.

The cut facing this page represents a cross-section of a diseased twig of a peach tree, showing two well-developed annular rings and a third partly developed. This twig was probably attacked by the brown rot fungus, together with *Cladosporium* and a form of *Alternaria.*

This section, which is a typical one, shows that the disease did not destroy the cambium ring until the fall of the second year, but the disease may have made its appearance even a year earlier. The noticeable feature in this illustration is that the last layer of wood formed was very much thinner towards the uninjured side of the twig than the injured side, and this ring of wood is not complete near the area where gummosis had set in. There is also a noticeable thickening of the incomplete rings of wood near the point of injury, a fact due probably to the difference in tension occurring in the stem produced by the injury from gummosis. The cambium, at the margin of the diseased area where it has attempted to heal over, is also much thicker than at the opposite side of the twig, where the tension is different.

Microscopical examinations of sections also showed that considerable healing of the wound caused by gummosis took place. The callus forming as a result of this healing developed ridges along the side of the wound. The cavity of the wound was entirely filled with gum, which contained *Cladosporium* and a form of *Alternaria*.

Suggestions in Regard to the Treatment of Gummosis.

In very bad cases of gummosis it would be best to destroy the tree, since it is of little value and may possibly furnish an ideal place for the development of undesirable organisms. Branches may be cut off a few inches below the affected areas. Since this disease undoubtedly originates from the practice of leaving "mummied" fruit attached to the tree, it is best to remove and destroy them. It is even a question whether "mummied" fruit should be left on the ground. Practically all cases of infection from gummosis have occurred where the "mummied" fruit was left on the tree, and came in contact with the limb or branch.

Care should also be exercised in pruning, and this should be done in winter or early spring. A clean, sloping cut should be made, and large wounds should be covered with paint or coal-tar. This treatment will prevent infection from the wounds.

The practice of good sanitation and systematic spraying of peach trees, together with cultivation and feeding, will undoubtedly hold this disease in check.

Directions for making Summer Spray Mixture.

Essentials.

In making the self-boiled lime sulphur plus arsenate of lead, as recommended for the summer sprayings, the first essentials are to have good stone lime, a perfect mixture of the ingredients, and two men to attend to the mixing. After being mixed it is necessary that the mixture be kept well agitated while in the tank, for if not it will settle, no matter how well made. To accomplish this it is suggested that those using a power outfit employ an agitator of the propellor type, as most others will allow a little settling; and where this occurs an even mixture of the spraying materials is not obtained.

Directions.

The following method has been found to work out satisfactorily in making 250-gallon quantities. First, weigh out 40 pounds each of good stone lime and flour of sulphur. Take the above quantity of lime and place in the bottom of a barrel (one holding 50 gallons is a convenient size to use when not making over 300 gallons at a time); then pour on water slowly and evenly. A good way to do this is to use a fine spray from a nozzle. As soon as the lime begins to slake have the sulphur sifted over the lime, adding just enough water while doing this to keep the lime from burning. By the time the sulphur is added the lime has become very active, and requires one person's attention to stir the mixture while another adds the water just fast enough to keep the mixture from burning. Water should be added cautiously to obtain the best results in slaking.

If the above directions are followed there will first be a thick, pasty substance which gradually becomes thinner as more water is added. The lime ought to keep the mixture well heated for several minutes, but as soon as it becomes well slaked water should be added. If allowed to cook too long the sulphur will go into solution and combine with the lime to form sulphides, and this form is harmful to the foliage. Weigh out 10 pounds of arsenate of lead, add water, and stir until thoroughly mixed; then strain through a sieve (20 to 30 mesh to an inch is satisfactory) either into the spray tank or barrel containing the lime-sulphur mixture. On the addition of the arsenate of lead to the lime sulphur, a dark-colored mixture is obtained. If the mixture has been properly made there will be very few settlings, and very little, if any, sulphur floating on the surface. The ingredients of this mixture ought not to settle for nearly half an hour. The above mixture should be strained into the spray tank and the tank filled with water. The solution is then ready to be sprayed on the trees.

Concentrated Lime-sulphur Solution.

The inconvenience experienced in preparing the lime-sulphur wash by cooking with steam or in open kettles at home has been one of the principal objections to this spray. Certain manufacturers have therefore put on the market concentrated solutions of lime-sulphur wash which have only to be diluted with water for use. These commercial washes have proved to be about as effective in controlling the scale as the well-cooked lime-sulphur wash, and, although somewhat more expensive, have been adopted by many commercial orchardists in preference to the home-prepared spray. They are especially useful for the smaller orchardist, whose interests do not warrant the construction of a cooking plant. In other ways, too, they possess advantages; for instance, those using the commercial washes may always have on hand a stock solution, so that the spray may be quickly prepared and advantage taken of favorable weather conditions. These preparations should usually be used at the rate of 1 gallon to 10 gallons of water.

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CLIMATIC ADAPTATIONS OF APPLE VARIETIES.

BY J. K. SHAW.

I. INTRODUCTION.

The conditions of soil, climate and culture under which our many varieties of fruit succeed are little understood. Most of the publications dealing with varieties concern themselves with histories and technical descriptions, and but very little with the conditions under which the planting of this or that variety is to be recommended. As a result of this lack of information a given variety is planted under widely varying conditions, under some of which it does well and under others it does poorly.

At the present time fruit growing, more especially the growing of apples, is entering a new era. The increased demand resulting from the lessened production during the past decade; improved methods of culture, especially a better understanding of the combating of insects and diseases, and better business methods have stirred up growers all over the apple regions to a renewed interest in the business. This movement has had its origin in the Pacific coast and intermountain regions, but will soon, if it has not already, become general over a large portion of North America.

This movement will result in more or less change in the relative importance of commercial varieties, some becoming less esteemed and others gaining in favor. The consumer will come to prefer varieties of better quality and those better suited to various purposes. The same is true within a variety, where specimens grown to more perfect development will receive preference.

To attain the highest degree of success it will be more necessary than in the past for each grower to choose those varieties which he can grow, under his conditions of soil and climate, to their highest perfection. A mistaken choice will be a serious thing, and one that will require valuable time and much expense to correct.

The present paper is the result of a study, carried on for the past four years, of the effect of varying climatic conditions on varieties, and an attempt is here made to lay down certain principles as to the climatic adaptations of varieties. Questions of soil and culture are given only incidental consideration. For the former there has not been sufficient opportunity, and a consideration of the latter would lead into the whole field of orchard management. Many samples of different varieties, grown under widely varying conditions, have been examined pomologically, and some of them chemically, and a study made of the pomological and meteorological literature available.

This paper does not make specific recommendations of varieties for any section of the country or for the country in general. That is more or less a local problem into which enter questions not considered here. Among them are those of soil, market demands, methods of culture to be followed, the individual preferences of the grower and many others. If the conclusions of this paper are sound, they should aid in such choice, for many varieties that might otherwise be considered are excluded as not being suited to the climatic conditions of the locality under consideration, while from those that are adapted climatically, the ones best suited to soil and other conditions may be singled out.

The subject under consideration is a large one. To understand at all fully the relations of apple variation to climate will require prolonged study and experiment. This paper is, in a large degree, introductory, and may contain errors and omissions which should be corrected. The writer will greatly appreciate any suggestions as to corrections or additions that should be made.

The work has been done as Adams fund research, and at the same time in partial fulfillment of the requirements for the degree of Doctor of Philosophy from the Massachusetts Agricultural College. It has been done under the direction of Prof. F. C. Sears, to whom the thanks of the writer are extended for

advice and criticism, and to Prof. F. A. Waugh as well, who has given many helpful suggestions. The chemical work has been under the direction of Dr. Charles Wellington, and assistance in the analytical work has been rendered by Mr. E. L. Winn and Mr. B. Ostrolenk of the senior class in the college. Many experiment station horticulturists and fruit growers in many sections of the country have aided by giving information and by furnishing samples of apples. It is impossible to name them all here, but their many favors are here acknowledged and hearty appreciation extended.

II. THE CAUSES OF VARIETAL VARIATION.

The causes of the great differences in apple varieties may be grouped under three heads: those arising from (1) cultural conditions, (2) differences in soil types, (3) differences in climate.

Cultural Variations.

The methods pursued in the growing and in the care of the trees have great influence on the character of the fruit. It is affected in every way, in size, form, color, keeping quality, shipping quality and dessert quality. These variations have been given only incidental investigation of such phases as relate directly to the climatic differences that have been the special object of study. A few of these may, however, be given passing attention at this point.

Every orchardist growing any number of trees is aware that there are great differences in the individuality of the trees, even when grown in the same orchard and under apparently identical conditions of climate and soil. One tree may be very productive and its neighbor only moderately so. The apples may differ in many of their characters. Further along in this paper some data are presented bearing on this question (see page 191). These individual differences have been ascribed to various causes, the principal ones of which are, perhaps, those of bud variations or varietal "strains," and that of the influence of the stock.

The method of handling the soil has great influence on the fruit, especially whether the orchard is in sod or is cultivated.

This has been shown in various bulletins from different experiment stations. The Baldwin seems especially influenced by conditions of orchard culture, and other varieties more or less so.

Certain experiments at this station [1] have shown marked effects from the use of different fertilizers. This question has been little investigated, but no doubt great variation in fruit may be produced by the fertilizer used on the land. Differences in pruning also have their effects. A tree kept with an open top will admit an abundance of sunshine, resulting in a higher colored fruit; in many other ways the effect of pruning may be shown in the character of the fruit.

Many fruit growers have discovered, to their grief, that Bordeaux mixture has a decided effect on many varieties, by producing russeting. On the other hand, the lime-sulphur preparation has frequently been found to render the appearance of the fruit better than when not sprayed at all.

Soil Variation.

It has been shown that the nature of the soil has great effect on the character of the fruit. Red apples are likely to be higher colored on sandy soils than on clayey soils. Not enough is known regarding this question to make any very definite generalizations on the subject. H. J. Wilder has determined the soil adaptations of various varieties, and shown that different varieties have decided preferences as to soils.[2] The question of the adaptation of varieties to soils is much complicated by the question of stocks already alluded to. No doubt varieties have soil preferences which are general to the variety, and not seriously modified by differences in stock. Nevertheless, the writer is satisfied that much greater uniformity would be found in the adaptation of varieties to soils were they grown on their own roots.

Climatic Variation.

In a broad way, the limits of apple growing are governed by climatic conditions. The apple is a fruit of a temperate climate, and does not flourish in the far north nor in the warmer

[1] Report, Massachusetts Experiment Station, 22, Part II., p. 10.

[2] Proceedings American Pomological Society, 31, p. 138 (1909).

sections of the temperate zones. The apple adapts itself under cultivation to a considerable range of rainfall, and in districts of deficient precipitation irrigation is practiced. Therefore, the question of rainfall has comparatively little weight in the general cultivation of the apple. Sunshine has considerable effect, but it is not a limiting factor anywhere in the apple belt. The great climatic factor which limits the distribution of apples in general, and of the different varieties in particular, is temperature.

Over the greater part of the North American continent the northern limit of successful apple growing is fixed by the minimum winter temperature. Different varieties of the common apple vary greatly in their ability to withstand minimum winter temperatures, and the condition of the tree, particularly as regards moisture content at the time minimum temperatures occur, has great influence in determining whether the tree survives. Very few, if any, varieties will withstand a temperature much below —40° F. without being killed back more or less. In many cases a considerably less severe temperature is fatal to even the hardiest varieties. With the possible exception of the extreme northern Pacific coast, under conditions of a maritime climate, there is nowhere in North America a region where certain varieties will not produce fruit in summer, provided they can withstand the cold of winter. In other words, the summers are warm enough to mature fruit of short-season varieties, provided the winters do not kill the tree before it has reached the bearing age.

The apple does not succeed in the southern portions of North America, although fruit may be produced in every State of the Union, and probably in portions of Mexico. The difficulty in the way of the southern extension of apple growing seems to be largely the heat during the summer. The trees fail to grow during hot periods in the growing season, and fail to set, or at least to mature fruit. The latter is especially true of winter sorts, and many varieties grown in the south are short-season ones, which are able to mature fruit before the hot periods of July and August arrive.

The Mean Summer Temperature.

For this work we have used as a measure of the summer heat an average monthly mean for the growing season. This has been taken as comprising the months of March to September inclusive. The monthly means for these seven months, as given in publications of the United States Weather Bureau and Canadian Meteorological Service, are averaged. This gives, for points within the apple-growing regions of North America, temperatures varying from about 52° to about 70° or 72°. Summer means have been computed for a great number of stations, and from these the isotherms given in Fig. 16 are drawn. This map is intended principally for study in connection with the matter given later in this paper, but it may be proper to explain it at this point, and to discuss the variations in the summer mean that occur and the causes thereof. In common with other questions of temperature, the summer mean for a given section is determined by a number of considerations. Among these are the following: (1) latitude, (2) elevation, (3) site and aspect, (4) soil, (5) culture, (6) prevailing winds, (7) sunshine.

The first two require no explanation. Temperatures vary inversely with the latitude and altitude, but, owing to the influence of the other features mentioned, no ratio can be laid down that is of any value.

With regard to slope, little need be said. The summer mean on a north slope may be several degrees lower than that of a corresponding southerly slope, though we have been unable to find any data showing the amount of difference. Slope must be considered in estimating the probable temperature of an orchard site.

Soils containing a large proportion of sand will not only be warmer than clayey soils, but will also influence the air temperature in the orchard to a considerable degree.

Hedrick found that the soil in a tilled orchard was from 1.1° to 2.3° warmer than a corresponding plat in sod.[1] This must have an influence on the air temperature in the orchard.

Prevailing winds influence the summer mean. These are de-

[1] Bulletin 314, New York Experiment Station.

termined by mountain ranges and other topographic features, by the temperatures of bodies of water over which the air may have passed, and perhaps by other considerations.

The prevalence of a large proportion of sunshine will operate to raise the temperature in the orchard. The effect on the protoplasm of the tree will, owing to the heat absorptive powers of the dark colored bark, be even greater. This has been shown by Whitten. He also found that in peaches the color of the bark modifies in a marked manner the thermal effect of the sun.[1] The temperatures on which this work is based were presumably all taken in the regulation shelters of the Weather Bureau, where this effect would be less than in the orchard. The probable amount of sunshine should be taken into consideration in estimating the summer mean of an orchard.

III. THE DEVELOPMENT OF THE APPLE.

For convenience in discussion, the life history of the apple (fruit) may be somewhat arbitrarily divided into four periods: (1) that of growth, which extends from the blossom to the attainment of full size; (2) that of ripening, which covers the period from the termination of the first until the apple is picked from the tree; (3) that of "after ripening," extending from picking until the apple is in perfect eating condition; and (4) that of decay, covering the subsequent deterioration and breaking down of the fruit. Various fungous diseases may enter in during these periods and terminate the life of the apple at any time. These are not considered in this discussion. The second and third periods are scarcely differentiated in summer apples, these being ordinarily fit for immediate consumption on picking. In winter apples, on the other hand, there is a distinct period of ripening following the picking of the fruit.

Inasmuch as the discussion of these periods of growth will be largely from a chemical standpoint, it may be well to consider briefly the chemical composition of apples before discussing their development.

Apples vary widely in chemical composition, according to variety, stage of development and conditions of growth. They

[1] Report American Pomological Society, 26, p. 47 (1900).

contain ordinarily from 80 to 88 per cent. of water, most winter varieties when maturing averaging perhaps about 84 per cent., the remainder of the fruit comprising the total solids. The solids consist of the following substances: first, starch, of which there may be 3 or 4 per cent., in growing apples; second, sugars, of which there may be from 5 to 12 per cent., averaging perhaps 8 or 10 per cent. The total sugars are made up of at least three distinct compounds: sucrose, of which we may find from none to 6 per cent.; and a mixture of dextrose and levulose, of which there may be from 5 to 10 per cent. These two latter sugars are separated in the laboratory with some difficulty, and comparatively few figures are available to show their relative proportions, but it is evident that the levulose in apples is in excess of the dextrose, a condition not usually found in plant substances where these two sugars occur together. Of organic acid we may find from .12 to 1.50 per cent., presumably as some form of malic acid.

The foregoing solids are all soluble in water. The insoluble solids are largely of a carbohydrate nature, and consist of cellulose and pentosans for the most part. In the chemical work reported in this paper determinations of the total insoluble dry matter have been made and given as insoluble solids, and consist of those portions of the apple not dissolved by hot water under the conditions prescribed in the method of the Official Association of Agricultural Chemists.[1]

Apples, particularly in the green state, contain small amounts of tannin. In the work here reported no determinations of this have been made, but a few analyses are available from other sources, giving the percentage present. The characteristic flavor and aroma of apples are due for the most part to certain esters or flavoring oils. These exist in the apple in very minute quantities, and though they are of great importance in determining the value and quality of the fruit, no attempt to determine the amount has ever been made, so far as the knowledge of the writer goes. Indeed, it is probable that, owing to the minute quantities present, their determination would be extremely dif-

[1] United States Department of Agriculture, Bureau of Chemistry, Bulletin 107, revised.

ficult, if not absolutely impossible. We can judge of their presence and abundance only by the taste and the aroma of the fruit.

Returning now to a consideration of the changes in the fruit during the four periods of development already mentioned, we find them taking place somewhat as follows. During the period of growth the amount of total solids of course increases greatly. This increase may continue into the ripening period, but after that there is a relative loss of total solids. The percentage, also, of total solids increases during the period of growth and during at least a part of the ripening period, but after that its changes are much dependent upon conditions. The percentage of acid in the fruit is largest in the early stages of growth, and decreases more or less steadily during the entire history of the fruit. The percentage of starch increases during the early part of the growth, and at varying points, under different conditions, it begins to decrease, and disappears during the ripening process. The sucrose increases pretty steadily until the period of after ripening is complete, and then more or less rapidly decreases, and frequently entirely disappears in the process of decay. The point of maximum of sucrose content may be taken as the point of full maturity of the fruit, with a fair degree of accuracy in most cases. The reducing sugars, dextrose and levulose, increase during the period of growth, and may or may not increase slightly during ripening. In the later periods of ripening and decay they in most cases tend to increase, at least until the final stages of decay.

Comparatively little can be said regarding the behavior of the insoluble solids during the periods of growth and ripening. During the periods of after ripening and decay they pretty steadily decrease. Probably they are at their maximum during the early stages of ripening. The stage of development of the insoluble solids of the apple is of great account in determining the quality and condition of the fruit; they compose for the most part the cell walls of the fruit. During the later stages of development of the fruit the middle lamellæ of the cell walls seem to soften, perhaps through the action of some enzym. This results in a comparatively easy separation of the individual cells from each other and in the mealy taste found in the overripe apple.[1]

Comparatively little is known of the behavior of the flavoring oils, but it is evident that they do not develop very noticeably until the period of ripening. It would seem, however, that they develop during the later stages of the ripening period and through the period of after ripening, and tend to disappear as the stage of decay progresses.

Little, also, is known regarding the behavior of the tannin of the fruit, but it is probably highest during the late stages of growth. It may be connected with the development of color in red apples, and inasmuch as it seems to disappear during the ripening stage, when the apple is taking on color, it may be that it contributes in some way to the formation of pigment in the epidermal cells of the fruit.

IV. THE PERFECTLY DEVELOPED APPLE.

In the course of investigation herein reported, the writer has made a somewhat careful study of some twenty varieties of apples, chosen from among the more prominent and widely distributed sorts. From five to fifty or more samples of each variety have been received from many different localities scattered over the entire apple-producing portions of North America. These apples have been carefully examined and their characteristics noted, and from two to twenty samples of each variety have been subjected to chemical examination. In the case of the Ben Davis variety, during the past four years nearly two hundred samples have been received, and fifty or more of these have been given a more or less complete chemical examination. These samples have varied widely in physical appearance and chemical composition. These variations are dealt with in a later division of this paper. The study of these varieties, added to other general observations, has enabled the writer to form a fairly definite conception of them, when developed to their highest perfection in appearance, quality and chemical composition. The point of perfect development is taken as that where

[1] Bureau of Chemistry, Bulletin 94, p. 92.

the after-ripening stage is complete and before any signs of deterioration appear. A variety in this condition is at the point of highest dessert quality. Especial consideration will be given in this discussion to the question of high quality in each variety.

Before entering into this discussion, it may be well to consider the relation between chemical composition and quality. In the first place, it may be said that quality is used with several different meanings. It may refer to the dessert quality of the fruit or to its value for kitchen purposes. The apple of high dessert quality is different from the apple of high kitchen quality. We also speak of the shipping quality of fruit, and high shipping quality is in a measure opposed to high kitchen, and even more to high dessert quality. The apple which ships well will usually be a fair keeper, but these two qualities are by no means coincident. The chemical determinations which throw the most light on quality are those of the sugars and acid and of the insoluble solids, the latter being of greater importance than is usually considered to be the case.

The apple of high dessert quality is low in its content of insoluble solids, this signifying a tender flesh and probably thin-walled cells. It is high in sugars, more particularly sucrose. The amount of acid is proportional to the quantity of sugars; the higher the content of sugars the higher must be the content of acid, in order to bring an agreeable blending of these two constituents. If a large proportion of the sugars is sucrose, the proportion of acid needs to be larger than if the proportion of sucrose is low, in order to give the same quality. The ratio of acid to total sugars most favorable to high dessert quality will vary greatly with individual tastes. Some prefer a sweet apple, and, on the other hand, many like a fairly acid fruit. If the sugars are in the proportion approximately of two-thirds reducing sugars to one-third sucrose, the following may be taken as a fair estimate of the varying ratio of total sugars to acid for different flavored fruits. These ratios will not hold for fruits that have entered into the stage of physiological decay.

	Total Sugars to Acid as Malic.
Sweet apples,	1 : .010 to .025
Mild sub-acid,	1 : .025 to .035
Sub-acid,	1 : .035 to .045
Acid,	1 : .045 to .060
Very acid,	1 : .060 to .085

It has been said that a low percentage of insoluble solids is necessary for high quality in dessert fruits. For cooking purposes this is of minor importance, and the ratio of sugars to acid is narrowed; that is, the relative amount of acid should be larger than in dessert fruits.

Apples of good shipping quality have invariably a high percentage of insoluble solids, and as this is opposed to high dessert quality, it follows that we should not expect to find the highest table quality and highest shipping quality in the same fruit. Most varieties that keep well have a relatively high proportion of their sugars in the form of sucrose. It appears that an apple in order to keep well must be well nourished, and have stored up a large amount of soluble solids, principally in the shape of sugars. Table 1 shows the averages of a number of analyses of most of the varieties that have been examined. In these averages only analyses of normal, well-grown and well-ripened fruit have been included.

TABLE 1. — *Average Analyses of Varieties (Per Cent.).*

	Number of Analyses.	Total Solids.	Insoluble Solids.	Soluble Solids.	Reducing Sugars.	Sucrose.	Total Sugars.	Acid as Malic.	Ratio, Total Sugars to Acid.
Wealthy,	3	13.84	2.11	11.73	7.40	1.71	9.11	.59	1: .055
Maiden Blush,	3	14.59	2.66	11.93	4.80	3.14	7.94	.63	1: .079
Fameuse,	5	15.09	2.64	12.45	7.72	1.38	9.10	.39	1: .043
McIntosh,	6	14.48	2.32	12.16	7.21	1.91	9.12	.38	1: .042
Jonathan,	10	15.19	2.38	12.81	8.28	1.65	9.93	.42	1: .042
Grimes,	11	17.88	2.70	15.18	8.77	4.30	13.60	.45	1: .035
King,	2	16.48	2.45	14.03	8.43	2.39	10.82	.38	1: .035
Rhode Island Greening,	4	15.82	2.89	12.93	6.10	3.27	9.37	.59	1: .063
Northern Spy,	10	14.93	2.39	11.54	8.00	2.22	10.22	.44	1: .043
Baldwin,	9	16.19	2.71	13.48	5.74	3.91	9.65	.55	1: .057
Esopus,	2	17.79	2.67	15.12	7.00	3.66	10.66	.56	1: .053
Yellow Newton,	2	16.48	2.75	13.73	7.59	3.07	10.66	.47	1: .044
Winesap,	7	17.42	2.71	14.71	10.02	2.20	12.22	.47	1: .038
Stayman Winesap,	3	15.83	2.78	13.05	8.11	3.44	11.55	.52	1: .045
Rome Beauty,	3	15.72	2.89	12.83	6.77	3.16	9.93	.41	1: .041
Smith Cider,	2	17.37	3.30	14.07	7.54	2.37	9.91	.51	1: .051
Roxbury Russet,	4	18.73	2.82	15.91	7.43	4.85	12.28	.59	1: .048
York Imperial,	7	14.69	2.69	12.00	7.96	3.04	11.00	.39	1: .035
Ben Davis,	11	15.66	3.07	12.59	6.91	2.95	9.86	.44	1: .045

We may now proceed to the discussion of each of these varieties, and will endeavor to set forth the appearance and quality of these varieties when grown to their highest perfection. The conditions under which perfection is attained, and the effect of unfavorable conditions, are discussed in detail in a later section of this paper. These descriptions are not intended to be complete descriptions of the variety, but should be read in connection with a technical description, if one is not already familiar with the general appearance of the variety.

Wealthy. — Well-grown Wealthies should be about 75 to 80 millimeters in diameter and well colored over the entire surface. The color should be a deep, rich red, distributed in the form of stripes and splashes, deepening to a blush on the sunny side. Poor color is a sign of imperfect development in this fruit. The apple should be very symmetrical in form and appearance. It is altogether a handsome fruit when well grown. The chemical analysis shows that the variety is low in total solids, a condition that we find in most summer and early fall varieties. It is low in all the constituent solids except acid. This high ratio of acid to sugar makes it a good cooking apple, but its low content of insoluble solids makes it acceptable for the table, in spite of its rather low content of sugars.

Maiden Blush. — The well-grown Maiden Blush is of about the same size as the Wealthy, of a clear waxen yellow color, with a generous bright red blush on the sunny side. It is fairly high in solids, and, for a fall apple, is especially high in sucrose. The total sugars are, however, rather low, and the insoluble solids and acid high. Its chemical analysis indicates it to be a good cooking apple and fairly good for table use for those preferring an acid fruit.

Fameuse. — Fameuse should attain a diameter of at least 70 millimeters, and a deep red, almost crimson color, over nearly its entire surface. Its chemical analysis shows its excellent table quality, although the percentage of insoluble solids is somewhat high. The relation of sugars to acid is good. It is remarkably low in sucrose and not particularly high in total sugars.

McIntosh. — The McIntosh should grow a little larger than the Fameuse, reaching about 80 millimeters. The color should be a deep, rich crimson, a little lighter on the shady side and showing sometimes rather obscure splashes and stripes. This variety is one of the most highly esteemed as a dessert fruit. The low content of insoluble solids is in accordance with this estimate, though it does not express fully the excellent texture of this variety. Neither does the analysis give indication of its agreeable aroma and flavor. The content of sugars is good for a variety of its season and the ratio of acid is excellent. The analysis in many ways closely resembles that of the Fameuse, thus indicating the relationship considered to exist between the two varieties.

Jonathan.— This is a favorite table apple of high quality. It should attain a diameter of 70 to 75 millimeters and be of a deep rich straw yellow, almost completely covered with a deep, rich crimson blush. It is a very handsome apple when well grown. Its tender flesh is indicated by its low content of insoluble solids. It is only fairly high in sugars even for a variety of its season, and on this account lacks the richness of flavor of the Grimes and Roxbury Russet. Its ratio of sugars to acid places it among the sub-acid varieties.

Grimes. — Grimes when well grown should reach a size of 75 to 80 millimeters or more, and should be, when ripe, a clear waxen yellow, and may be covered with a slight russeting over the entire surface. When grown in dry climates this russeting may appear in only a slight degree or not at all, a condition which perhaps adds to the good appearance of the fruit. The Grimes is remarkable for its high content of total solids, largely in the form of sugars, and of these a large proportion is in the form of sucrose. The last fact, together with its rather low content of acid, accounts for the almost sweet taste of this variety.

King. — The King when well grown should be not less than 80 to 85 millimeters in diameter, and may be quite variable in form, but should be colored over its entire surface with a deep, rich red, somewhat splashed and mottled. Inasmuch as only two samples of this variety were analyzed, less dependence can be put on the figures given than could be if a larger number had been examined. Its high quality is shown in its analysis, but it is due to no one constituent. The King is good in every respect. It is a more acid apple than the Grimes, although the ratio of sugars to acid is the same. This is due to the fact that a smaller proportion of the sugars is in the form of sucrose.

Rhode Island Greening. — The Rhode Island Greening should reach a size of about 85 millimeters and possess a clear, greenish-yellow skin. It may show a faint red blush on the sunny side, although this character may not appear in fruit that is otherwise well developed. It is generally considered a variety of excellent cooking quality, and this is shown in its high ratio of acid to sugars and in its relatively high sucrose content, while its high content of insoluble solids does not detract from its value for this purpose.

Northern Spy. — The Northern Spy is reputed to be one of the highest quality of winter varieties. It should reach a size of 80 to 85 millimeters, and be well covered with bright red stripes and splashes. Spies of poor color are frequently, though not always, of inferior quality, depending on the nature and cause of the inferiority. The low content of insoluble solids of the Spy is in accordance with its well-known tenderness of flesh and the readiness with which it bruises.

Baldwin. — The Baldwin should reach a size of 75 to 80 millimeters, and be of even deeper color and more evenly distributed. It is a better shipping apple than the Spy, but hardly as good for the table. This condition of affairs is indicated in its higher percentage of insoluble solids. It is also higher in sucrose and in the ratio of acids to sugar.

Esopus. — This variety should reach a diameter of 75 millimeters at least, and the skin should be a deep, rich straw yellow, almost completely covered with deep, rather dull red splashes and stripes. This, like the Jonathan, often appears with a poor color, indicative of imperfect development. The Esopus stands among the best as an all-round high quality variety, and its chemical analysis is in accord with this. It is about medium in its content of insoluble solids, indicating that it is sufficiently firm of flesh to ship and cook well, but not enough to seriously injure its table quality. It is about medium in sugars and the relative amount of sucrose is fairly high. Its ratio of sugars to acid places it among the more acid table fruits and less acid cooking varieties.

Yellow Newtown. — The Yellow Newtown should be from 80 to 85 millimeters in diameter, of a clear, greenish-yellow color, sometimes slightly blushed on the sunny side, and may often show over a considerable portion of the surface a grayish scarf skin characteristic of the variety. Its analysis indicates it to be of somewhat firmer flesh than the Esopus and somewhat less acid; otherwise, it is very similar in its constitution.

Winesap. — The Winesap should be about 75 millimeters in diameter, and should be deeply colored, although the color is hardly as dark as that of Jonathan. It should, however, when well grown, show little or no signs of the ground color of the fruit. Its analysis places it in the highest class. It is rather high in insoluble solids, but very high in sugars, being exceeded only by the Roxbury and Grimes. However, a smaller portion of the sugar is in the form of sucrose than in either of the other two sorts.

Stayman Winesap. — This variety is quite similar to the Winesap. It should reach a little larger size and is not quite as red in color. The ratio of acid to sugars is somewhat higher, but this excess of acid is obscured by the higher amount of sucrose, so the acidity of the apple is about the same to the taste.

Rome Beauty. — As only three samples of this variety have been examined we do not feel like venturing on any very positive statements in regard to it. It would seem to reach a size of 80 millimeters and a color somewhat less marked than other red varieties. It shows a relatively high proportion of sucrose, but is only fair in the amount of total sugars. It is rather high in insoluble solids to be a good table fruit, and altogether the analysis is not indicative of very high quality.

Smith Cider. — The same remarks concerning the study of the Rome Beauty will apply to this variety. Very few samples have been examined, and how typical the analysis given is, the writer does not feel confident. It is remarkably high in insoluble solids, but whether this characteristic is constant or not will require further study to determine.

Roxbury Russet. — The Roxbury Russet should reach a size of 75 to 80 millimeters. The amount of russeting is dependent on climate. A moist atmosphere during the early stages of growth seems to contribute to the increase of russeting. Its analysis shows a high content of sugar, a large proportion of which is in the form of sucrose. It is also high in acid, but in view of the amount and form of the sugars it is not particularly acid to the taste. It is high in insoluble solids, indicating firmness of flesh and good shipping qualities. Altogether, it is one of the high quality varieties, as indicated by its chemical composition.

York Imperial. — The York Imperial should reach a size of about 80 millimeters, and be of a clear waxen yellow, partially overlaid with a pinkish red. Sometimes this over color deepens to a moderately dark red, but this is not necessary to the attainment of high color and pleasing appearance. Its analysis indicates its sub-acid flavor, and it shows as low a ratio of acids to sugars as any of the varieties here reported.

Ben Davis. — The Ben Davis should attain a diameter of 75 millimeters, and fairly deep red color over almost its entire surface. Partial coloration in this variety is a sure sign of imperfect development. It enjoys the reputation of being one of the best varieties to ship and keep, and one of the poorest for both kitchen and table uses. This opinion is supported by its chemical analysis. It is especially high in insoluble solids and low in everything else, although the proportion of sugar in the form of sucrose is fairly high. The total sugars, however, are low for a winter variety. Its serious deficiency as a table fruit is its high insoluble solids content, and as a kitchen fruit its low ratio of acids to sugar.

V. THE INDIVIDUALITY OF THE TREE.

The question of the individuality of the tree has already been mentioned (see page 179). The careful measurements that have been made of the apples from several Ben Davis and Baldwin trees for the past three years afford some interesting data on this point. The trees are on nearly level land at the top of a slope. The soil is a uniform gravelly, clay loam, and the trees are of the same age, and vary only a little in size. In the years 1908–10, every apple borne to maturity by these trees has been measured, as described in the last report of this station,[1] and the results for the individual trees are presented in Table 2.

[1] Report Massachusetts Experiment Station, 1910, p. 198.

TABLE 2. — *Apples from Different Trees.*

	Number of Apples.	Size.			Form.		
		Mean.	Standard Deviation.	Coefficient of Variability.	Mean.	Standard Deviation.	Coefficient of Variability.
Davis.							
Tree 2: —							
1908,	864	71.02 ± .14	6.16 ± .10	8.67 ± .14	1.1422 ± .0014	.0576 ± .0009	3.04 ± .08
1909,	251	70.89 ± .22	5.40 ± .16	7.62 ± .18	1.1248 ± .0024	.0553 ± .0017	4.91 ± .15
1910,	425	73.15 ± .19	5.69 ± .13	7.78 ± .15	1.1159 ± .0016	.0516 ± .0012	4.62 ± .12
Tree 3: —							
1908,	567	68.80 ± .15	5.31 ± .11	7.72 ± .16	1.1399 ± .0016	.0543 ± .0011	4.73 ± .09
1909,	343	68.48 ± .19	5.24 ± .13	7.65 ± .22	1.1297 ± .0020	.0553 ± .0014	4.89 ± .19
1910,	449	72.27 ± .19	6.01 ± .13	8.32 ± .22	1.1322 ± .0015	.0488 ± .0011	4.31 ± .11
Tree 5: —							
1908,	469	68.35 ± .13	5.55 ± .08	8.12 ± .13	1.1666 ± .0019	.0626 ± .0013	3.76 ± .08
1909,	155	68.32 ± .27	4.96 ± .18	7.26 ± .33	1.1295 ± .0028	.0519 ± .0019	4.59 ± .19
1910,	369	75.53 ± .21	5.88 ± .15	8.00 ± .22	1.1151 ± .0018	.0512 ± .0013	4.59 ± .12
Tree 7: —							
1908,	423	72.80 ± .18	6.45 ± .13	8.86 ± .17	1.1716 ± .0019	.0578 ± .0013	3.37 ± .07
1909,	431	70.37 ± .17	5.12 ± .12	7.28 ± .19	1.1486 ± .0017	.0511 ± .0012	4.45 ± .11
1910,	587	75.12 ± .19	6.85 ± .14	9.12 ± .21	1.1333 ± .0014	.0516 ± .0010	4.55 ± .09
Tree 8: —							
1909,	686	70.45 ± .13	4.93 ± .09	7.00 ± .13	1.1310 ± .0013	.0494 ± .0010	4.37 ± .09
1910,	1,093	72.57 ± .09	6.16 ± .06	8.52 ± .10	1.1211 ± .0007	.0481 ± .0005	4.29 ± .05
Baldwin.							
Tree 2: —							
1909,	321	78.62 ± .21	5.59 ± .15	7.11 ± .23	1.1615 ± .0022	.0579 ± .0015	4.98 ± .13
1910,	287	78.84 ± .23	5.86 ± .16	7.43 ± .27	1.1745 ± .0021	.0536 ± .0015	4.56 ± .15
Tree 4: —							
1909,	621	74.39 ± .14	5.01 ± .10	6.73 ± .15	1.1848 ± .0014	.0523 ± .0010	4.41 ± .10
1919,	189	76.90 ± .27	5.57 ± .19	7.24 ± .30	1.1834 ± .0027	.0553 ± .0019	4.67 ± .17
Tree 5: —							
1909,	319	77.66 ± .21	5.66 ± .15	7.29 ± .22	1.1790 ± .0024	.0644 ± .0017	5.46 ± .16
1910,	546	77.71 ± .15	5.20 ± .11	6.69 ± .15	1.1888 ± .0018	.0622 ± .0013	5.23 ± .12

A study of this table shows some positive signs of individuality in the trees in the characters of size, form and productiveness. Size is of course considerably affected by the number of apples borne, though not as much as usual in this case, as the trees have not matured a very heavy crop during the period of observation. The marked seasonal fluctuation in size will be considered later. We can say that Ben Davis trees 7 and 2 show a tendency to bear large apples and trees 3 and 5 a tendency to bear smaller fruit, though in 1910 tree 5 bore the largest fruit of any, but at the same time the crop was lightest of all. Among the three Baldwins, the rank has been the same each year, in spite of the fluctuations in productiveness. In variability there are no constant differences. In the Ben Davis there seems to be a relation between variability and number of apples produced, the greater the number of apples the greater the standard deviation and coefficient of variability, — a relation that is to be expected.

In form, the situation is much the same. Ben Davis tree 7, which produced the largest apples, has invariably borne the flattest ones, usually by a considerable margin. Tree 2 shows a fairly constant character of producing more elongated apples than its fellows. In the Baldwins, also, there are signs of slight differences between the trees.

The variation in number of apples borne by the different trees is great. Ben Davis tree 8 has averaged about three times as many apples as tree 5, and they have been larger. A part of this difference is due to the fact that tree 8 is somewhat larger than tree 5, but the difference in size is not enough to account for all the difference in productiveness.

Productiveness is one of the most important qualities of a variety or individual tree. If the tree does not produce at least a fair crop of fruit, all other valuable qualities it may possess lose their attractiveness to the commercial grower, while great productiveness covers a multitude of deficiencies. Other investigations, and common observations as well, have shown very marked differences in the bearing ability of different trees.[1] In our opinion, these differences, as well as any others which may occur, are generally due to one or more of four influences:

[1] See Macoun, Report Central Experiment Farm for 1903, p. 102.

(1) differences in soil, (2) differences in aspect or exposure, (3) some inherent quality of the tree, (4) the influence of stock.[1]

That the first two of these cause difference no one will dispute, but there are many variations which can hardly be explained by differences in soil or site. It has been assumed by many that variations in productiveness arise from within the tree, and are transmissible. We know of no direct evidence to support this view. Inheritable variation in color and form has appeared in certain varieties. The Collamer, Banks and possibly Gano apples are instances of the former, and a probable case of the latter has been reported by the writer.[2] Whether the slight differences in form and size reported here are transmissible by bud is by no means certain. We are of the opinion that they are not, for it seems possible to explain these and the other variations in productiveness, not attributed to soil and site by reference to a different cause.

Waugh has shown that in plums different stocks produce marked modification in the trees grown on them.[3] Apple stocks do not differ as widely as do the plum stocks, above referred to, but the observed differences are also less marked. Every apple tree of a named variety is growing on a stock of a different, unnamed variety, *i.e.*, a seedling. These seedlings differ to a considerable degree. May not the slight differences observed between individual trees of a variety, growing under apparently similar conditions, be largely due to the influence of the seedling root? We know of no direct evidence to support this view, but to us it seems a more promising theory than that of individuality of the different buds.

If this supposition is true, it is probable that the production of the most desirable trees of a given variety would be favored by growing on a particular known root; thus the Baldwin grown on roots of Spy, Wealthy or Siberian Crab might be an especially desirable tree, while if grown on Tolman or King [4] it might be less desirable. Different soils and localities might be

[1] There are, of course, large seasonal fluctuations in productiveness due to conditions peculiar to the different years. These are not considered in this discussion.

[2] See Report Massachusetts Experiment Station, 22, Part II., p. 187.

[3] Report Massachusetts Experiment Station, 21, Part II., p. 174.

[4] The varieties mentioned are random selections for illustration. There is no reason to believe that they would influence the Baldwin as indicated.

suited by different stocks. We know of no experiments to learn what are the preferences of different varieties or soils, but it appears to be a desirable and promising line of investigation.

VI. THE MODIFYING EFFECT OF CLIMATE ON THE DEVELOPMENT OF THE APPLE.

On Form.

In the last report of this station [1] the question of the variation in form of the Ben Davis was dealt with to some extent, but without arriving at any very definite conclusion as to the cause, further than that it was climatic and closely related to the nearness of large bodies of water. Since this report was written, two years' further work have been completed, which serve to emphasize the conclusions mentioned above, and to show, further, that there are large seasonal fluctuations in the index of form. The following figures from a few selected stations will illustrate this: —

Table 3. — *Seasonal Variation in Form.*

	Number of Apples.	Mean Index of Form.	Standard Deviation.	Coefficient of Variability.
Charlottetown, P. E. I.: —				
1907,	74	1.0511±.0049	.0619±.0034	5.88±.31
1908,	122	1.1250±.0052	.0858±.0037	7.63±.33
1910,	135	1.0557±.0043	.0744±.0031	7.05±.29
Abbotsford, Quebec: —				
1907,	151	1.1788±.0039	.0735±.0028	6.23±.24
1908,	129	1.1739±.0041	.0683±.0029	5.82±.23
1909,	184	1.1986±.0031	.0628±.0022	5.24±.21
1910,	115	1.1356±.0029	.0455±.0021	4.01±.18
Isle la Motte, Vt.: —				
1907,	203	1.1547±.0024	.0735±.0024	6.28±.27
1908,	170	1.1406±.0027	.0526±.0029	3.74±.15
1909,	148	1.1475±.0033	.0590±.0023	5.14±.24
Amherst, Mass.: —				
1907,	284	1.1656±.0023	.0581±.0017	4.98±.14
1908,	2,321	1.1515±.0008	.0589±.0006	5.29±.05
1909,	1,866	1.1338±.0009	.0527±.0006	4.65±.06
1910,	2,914	1.1238±.0007	.0504±.0004	4.48±.04
Storrs, Conn.: —				
1907,	147	1.1557±.0030	.0534±.0021	4.62±.18
1908,	131	1.1423±.0041	.0689±.0029	6.03±.21
1909,	146	1.1330±.0035	.0622±.0025	5.49±.24
Marblehead, Mass.: —				
1908,	192	1.1021±.0029	.0598±.0021	5.42±.18
1910,	176	1.0982±.0033	.0651±.0023	5.93±.22
Sandwich, Mass.: —				
1908,	162	1.1281±.0021	.0407±.0015	3.67±.14
1909,	143	1.1167±.0036	.0654±.0025	5.86±.24

[1] Report Massachusetts Experiment Station, 22, p. 191 (1909). The reader is referred to this paper for the methods used in measuring and studying this variation in form.

This has led to a study of the differences in the climatic conditions in the different years. The apple during its early stages of growth, following blossoming, is relatively more elongated than is the mature fruit. During the later periods of growth it enlarges in cross diameter relatively more. A study of the temperature during the latter part of the summer failed to show any differences corresponding to the variations in form. An examination of the daily mean temperatures for a period at and following the blossoming period gave more positive re-

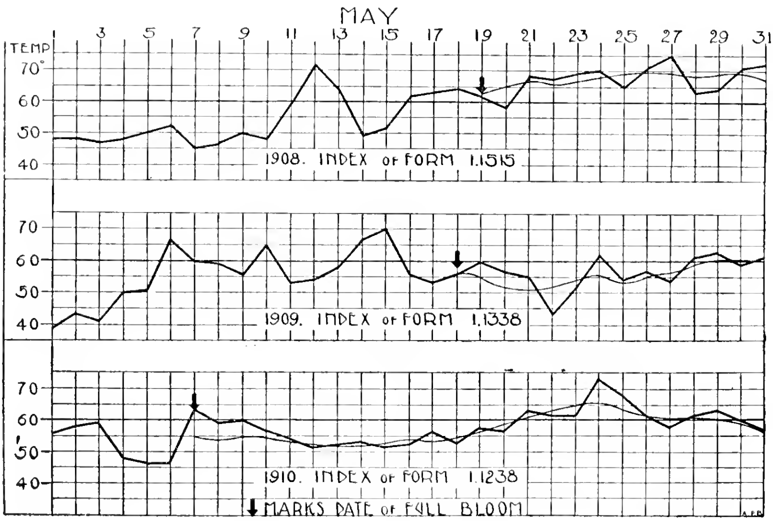

Fig. 1.

sults. At Amherst the apples measured in the last four years have been successively more and more elongated. The temperatures during the blossoming season for the last three years are shown in Fig. 1. The date of full bloom and index of form are also shown. We do not know the date of full bloom in 1907. An examination of this chart shows that the temperature for a period of two or three weeks following blossoming has been lower each year, in agreement with the greater elongation of the fruit.

We have data for a number of other stations, and all show a similar correspondence of temperature and form. Fig. 2 shows conditions in the Lake Champlain valley, the apples being from Isle la Motte, Vt., and temperature data from Burlington. We

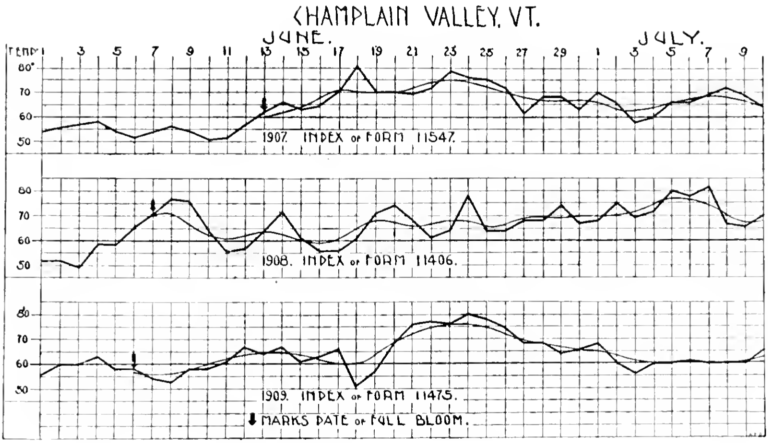

Fig. 2.

do not know the date of bloom in 1908, but it was probably not far from June 8. In Fig. 3 the temperature data are from

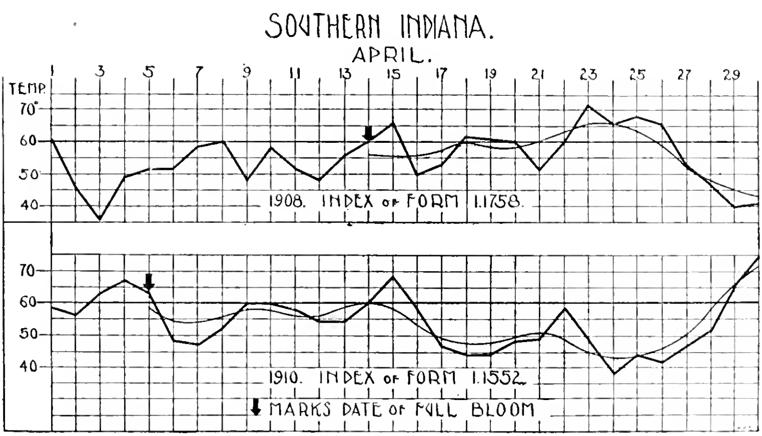

Fig. 3.

Salem, Ind., and the apples from Mitchell; in Fig. 4 both apples and temperature data are from Bentonville, Ark.

An examination of these charts shows a reasonably close agreement with that for Amherst. A period of cool weather, probably during a space of two or three weeks, results in greater elongation of the fruit, presumably through a prolongation of the period of relatively greater axial elongation before referred to.

This theory explains not only the seasonal variations but the greater elongation in the vicinity of large bodies of water, for the fact that in such locations the weather is relatively cool during the spring needs no discussion. In this connection we have observed that the seasonal fluctuation in form is less near

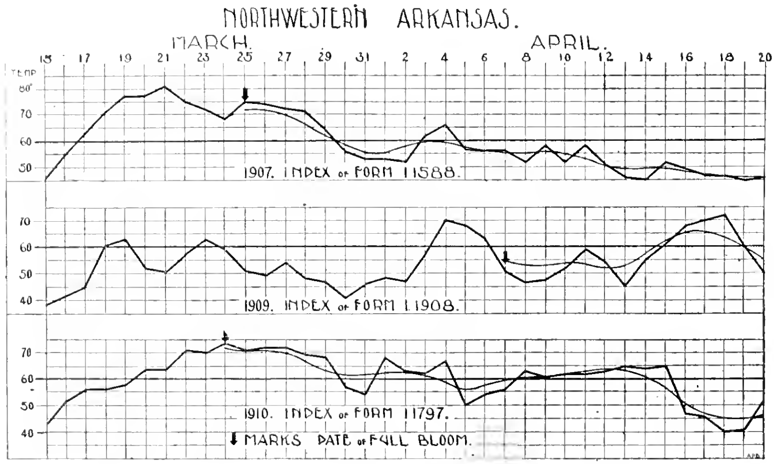

Fig. 4.

the great lakes and the ocean than at a distance from them, this showing the influence on the form of the apple of the equalizing effect on the temperature of the large bodies of water.

In gathering the apples from the trees under observation in Amherst, they have been divided into four lots, by bisecting the tree with a perpendicular plane running east and west, and again with a horizontal plane about midway of the head of the tree. This divides the tree into quarters designated upper south, lower south, upper north and lower north. The sections of each tree have approximately equal amounts of bearing wood. From the first these different portions of the tree have shown differences in form which have been meaningless and confusing until the theory of the temperature following blossoming was proposed. If this is the correct solution we ought to expect the upper south portions of the tree, owing largely to its exposure to the warmth of the sun, to give the flattest apples, and the lower north to give the most elongated ones, with the other two portions intermediate. The calculations for the three years 1908–10 are shown in Table 4.

TABLE 4. — *Variation in Form in Different Parts of the Tree.*

	Number of Apples.	Mean Index of Form.	Standard Deviation.	Coefficient of Variability.
Ben Davis.				
Upper south: —				
1908,	518	1.1643 ± .0017	.0593 ± .0012	3.61 ± .07
1909,	552	1.1390 ± .0015	.0520 ± .0011	4.57 ± .10
1910,	707	1.1299 ± .0013	.0500 ± .0009	4.43 ± .09
Lower south: —				
1908,	714	1.1512 ± .0015	.0619 ± .0011	4.19 ± .07
1909,	379	1.1302 ± .0018	.0516 ± .0012	4.57 ± .12
1910,	893	1.1249 ± .0011	.0189 ± .0009	4.35 ± .08
Upper north: —				
1908,	414	1.1553 ± .0020	.0607 ± .0014	3.91 ± .08
1909,	305	1.1333 ± .0020	.0509 ± .0014	4.40 ± .14
1910,	576	1.1216 ± .0016	.0544 ± .0010	4.85 ± .10
Lower north: —				
1908,	676	1.1406 ± .0016	.0644 ± .0011	4.58 ± .07
1909,	287	1.1338 ± .0021	.0529 ± .0015	4.67 ± .14
1910,	869	1.1171 ± .0012	.0505 ± .0008	4.52 ± .08
Baldwin.				
Upper south: —				
1909,	467	1.1877 ± .0019	.0606 ± .0013	5.10 ± .13
1910,	235	1.1955 ± .0024	.0537 ± .0016	4.49 ± .16
Lower south: —				
1909,	290	1.1688 ± .0020	.0500 ± .0014	4.28 ± .14
1910,	137	1.1792 ± .0031	.0536 ± .0022	4.57 ± .20
Upper north: —				
1909,	327	1.1809 ± .0020	.0548 ± .0014	4.64 ± .13
1910,	168	1.1792 ± .0030	.0575 ± .0021	4.88 ± .18
Lower north: —				
1909,	177	1.1586 ± .0026	.0522 ± .0019	4.51 ± .18
1910,	86	1.1717 ± .0044	.0602 ± .0031	5.14 ± .31

The relative rank of the different parts of the trees of the Ben Davis is as follows: —

	1908.	1909.	1910.
1. Most flattened,	Upper south.	Upper south.	Upper south.
2,	Upper north.	Lower north.	Lower south.
3,	Lower south.	Upper north.	Upper north.
4. Most elongated,	Lower north.	Lower south.	Lower north.

It is seen that the upper south quarter of the tree yielded the flattest apples each year, and usually by a considerable margin, while the most elongated fruit comes from the lower portion of the tree, and, in two of the years under consideration, on the north side. On the whole the figures for the different parts of the tree support the theory already presented that the elongation is due to relatively cold weather, and gives support to the idea that the heat of the sun has much to do with the temperature of the tree itself and probably the development of the fruit.

In the Baldwins the relative rank is as follows for both years: upper south, upper north, lower south, lower north.

On Size.

The size of an apple is determined by several factors. Each variety has its individuality in this respect. Culture is important, an abundance of nitrogenous fertilizers and an abundant supply of moisture being favorable to the attainment of large size. An excessively heavy crop prevents the development of full size of the individuals, but a light crop does not seem favorable to any larger fruit than a moderate one. Young trees usually bear larger fruit than mature ones, while in very old trees the fruit is commonly inferior in size. The differences due to age are probably in considerable degree at least due to the influences already mentioned.

Aside from these influences the summer temperature seems to have considerable influence. Some evidence on this point was presented in an earlier paper.[1] Table 4 (page 203) gives further data on this point.

The mean summer temperatures at Amherst were as follows: 1908, 58.8°; 1909, 56.7°; 1910, 58.9°.

The size of the apples is in a general way in accordance with these temperatures.

In 1910 the apples were much larger than in 1908, while the temperature was practically the same. This may be due to increased amounts of fertilizer which have been applied. The orchard was limed in the spring of 1909, and this may have had

[1] Report Massachusetts Experiment Station, 22, pp. 204, 211 (1909).

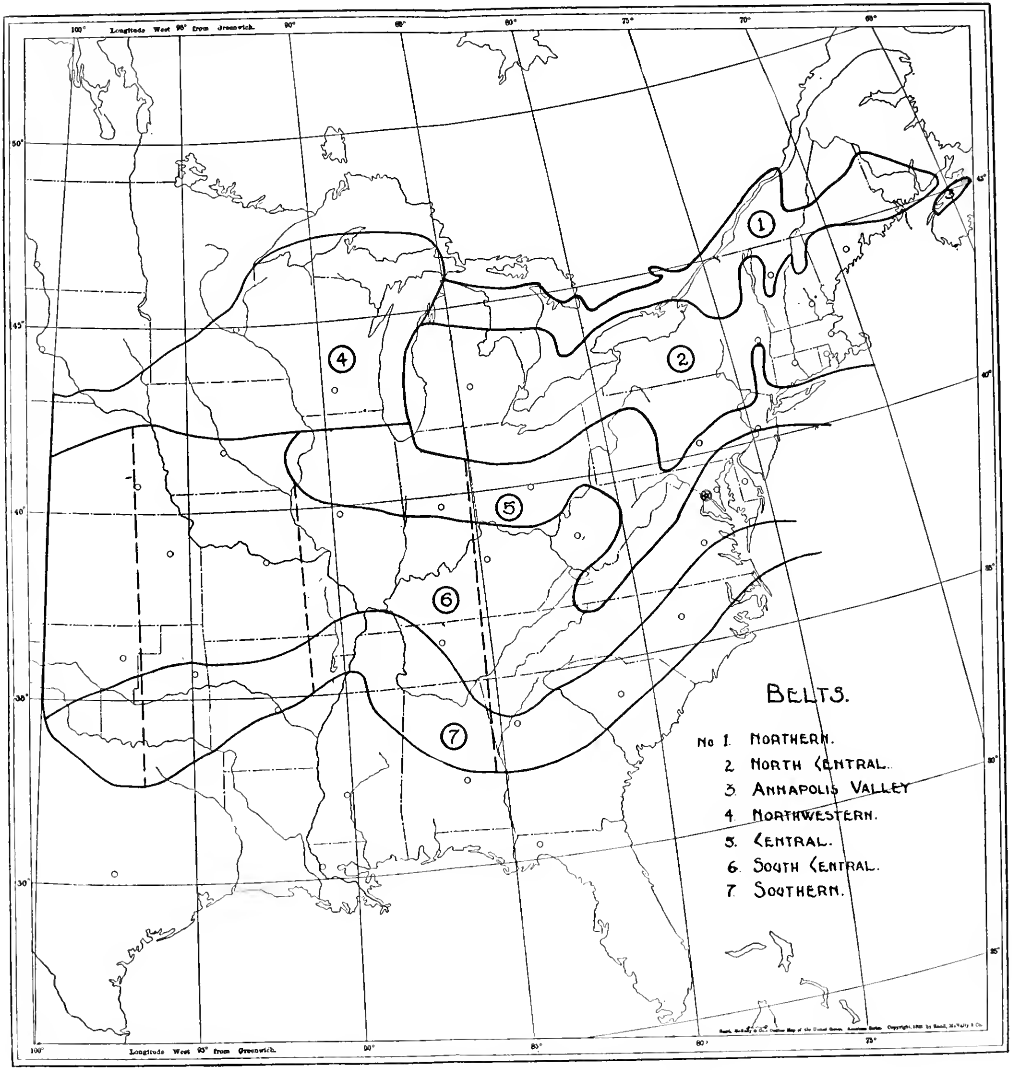

FIG. 5.—APPLE BELTS OF NORTH AMERICA.

an effect by liberating increased amounts of plant food. It does not seem possible to account for the increased size by temperature conditions.

Data from other localities similar to that previously published might be presented, but inasmuch as they show no new features, it is deemed unnecessary to do so.

On General Development.

The question of variation in form and size having been especially considered, we may now proceed to a consideration of the differences in the general development of different varieties, with more particular reference to color, keeping quality and table quality. These are the characters of paramount importance in determining the commercial value of a lot of apples. In order to discuss these questions we have found it convenient to divide the country into belts.

Apple Belts of North America.

We find in pomological writings frequent mention of different apple "belts," such as the Baldwin belt or the Ben Davis belt. This term is understood to designate a certain area over which the variety named is the leading one grown. We find many other varieties referred to a given belt, as the Northern Spy and Rhode Island Greening, which are referred to the Baldwin belt. In connection with the work herein reported, and for convenience in the discussions, the writer presents the division of North America into apple belts, shown in Fig. 5.

1. The northern belt, in which the Fameuse is the most characteristic sort.

2. The north central belt, perhaps the most recognized of any. It is characterized by the Baldwin, Northern Spy, Rhode Island Greening, Hubbardston and many others. It comprises the oldest and in some ways best understood portion of the apple region of North America.

3. The Annapolis valley, in which we find varieties similar to the second belt, but where the season is shorter and many of the varieties of the second belt do not mature well.

4. The northwestern belt, comprising the States of Minnesota and Wisconsin and adjacent territory; somewhat like the Baldwin belt to the east, but having winters too severe for many of the varieties of that belt. It is characterized by the Oldenburg, Wealthy, Hibernal, Northwestern Greening and many others.

5. The central belt, which is of less importance. There is no one variety that predominates over the whole of this territory. In eastern sections we find the Yellow Newtown, Smith Cider and Fallawater, and west of the mountains the Rome Beauty.

6. The south central belt, one of the largest and most important. There are three varieties that are quite generally spread over this belt, the Ben Davis, Winesap and York Imperial. The Grimes is quite general and important in the western part, also the Jonathan.

7. The southern belt, which extends to the southern limit of apple growing, and is characterized by the Yates, Terry, Shockley and Horse as leading varieties.

The figure shows these belts somewhat roughly. They depend on latitude and altitude more than anything else. Inasmuch as the altitude along the Appalachian Mountains is variable, it is impossible to show the belts with entire accuracy. Each belt will dip further south than is indicated in the higher elevations of this region. Some varieties are found generally distributed through the entire range of its belt from east to west. Others do not extend the entire length. The western portion of the territory covered has a smaller precipitation, and this may affect some varieties. More important than this, however, are the higher summer temperatures which prevail, and which cannot be successfully withstood by some varieties grown in the east. Other varieties succeed even better in this warmer summer climate than they do in the cooler and more humid east. The dotted lines in the figure show a possible division of the belts, but such division is not very definite nor of great value. No attempt is made to map the Rocky Mountain and Pacific Coast apple region, owing to the fact that the distribution of varieties there is governed largely by elevation, and would be very difficult to map, especially on so small a scale as the figure shows.

Distribution of Varieties.

A few varieties, most of them well known and of rather general distribution, have been selected for a special study in connection with this work. We may now proceed to a discussion of the distribution and some of the characteristics of these varieties.

Oldenburg. — This variety extends over almost the entire apple-growing region of North America. We find it recom-

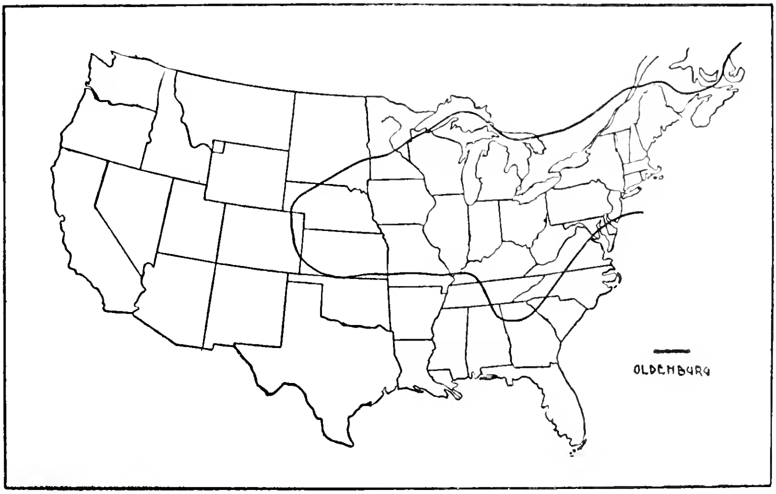

FIG. 6.[1]

mended as a commercial variety in some region of every apple belt shown in Fig. 5, with the possible exception of the southern. The two principal reasons for the wide distribution of this variety are its extreme hardiness, which enables it to withstand the severe winters of the far north, and the short season of maturity, which enables it in the south to ripen before the hot periods of July and August. In addition to this it is an early, regular and fairly abundant bearer, and not particularly subject to disease and insect injuries, and the fruit stands handling quite well.

[1] Figs. 6 to 14 are intended to show the territory over which the various varieties have been recommended as desirable commercial sorts. The places of origin of each variety, so far as known, is indicated by a cross.

Wealthy. — The Wealthy is a fall apple of rather wide distribution. It is growing in favor, especially as a filler in new orchards, and its territory of cultivation is spreading. It originated in Minnesota, and finds its highest favor in the northwestern belt. It also succeeds perfectly over a greater part at least of the north central belt. It is cultivated somewhat in New Jersey, but does not find favor south of there. It will mature a little farther north than the Baldwin, and is not subject to winter-killing as is the Baldwin in severe winter temper-

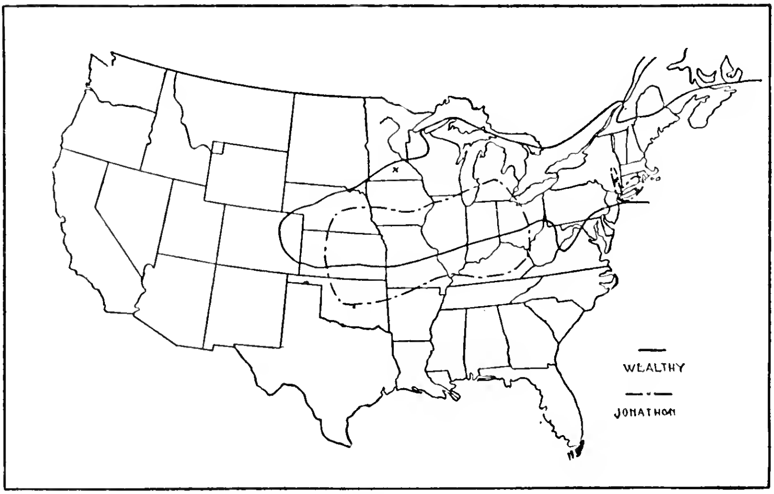

FIG. 7.

atures. It is found in greatest perfection through southern New Hampshire and Massachusetts, and along a line passing west just south of Lake Ontario and through the Province of Ontario, south central Michigan and southern Wisconsin.

Wolf River. — The Wolf River is reputed to be a seedling of the Alexander, one of the Russian varieties, and it may serve as a type of this class of apples. It is of Wisconsin origin and has attained high favor in that State. It appears to succeed best in the central and northern parts of the northwestern belt, in the northern part of the north central belt and the southern part of the northern belt. When grown too far south it does not keep well, is apt to become mealy and tasteless and is of general inferior quality. The Russian varieties as a class are reputed to be of poor quality. They are not of the highest quality, but much of their reputation for inferiority results, in our opinion, from their being grown too far south. As a class they belong to the northern frontier of apple growing, and when grown there, many of them are equal to the better varieties of the more southern apple regions.

Maiden Blush.— This variety is a fall sort, originating in Burlington, N. J., in which State it has attained its highest

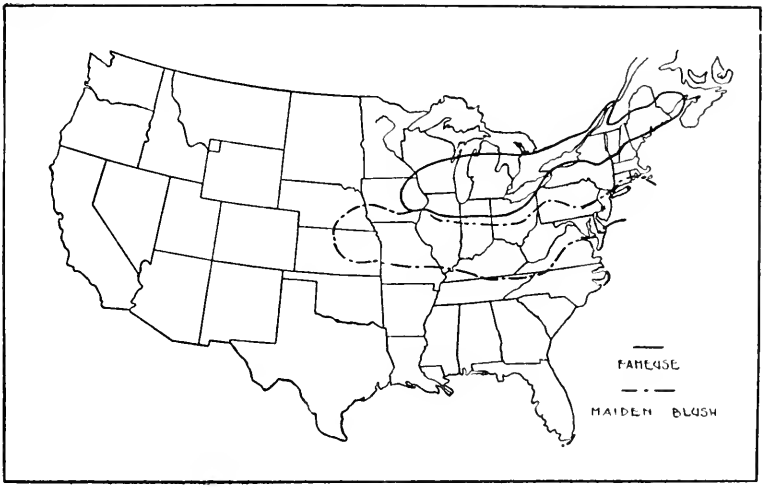

FIG. 8.

favor. It is grown with success as far north as Long Island and southern Connecticut, and west through southern Indiana and central and southern Illinois. It does not withstand the dry climate of the plains as well as some others, but reaches as far west as eastern Nebraska and Kansas. It is cultivated successfully south into the mountains of Virginia. Gould says: —

On Cecil sandy loam, at 900 to 1,000 feet elevation, it is inclined to rot severely, but on the more clayey soil of the Piedmont regions it does well. Its season of ripening varies considerably, ranging from summer to early fall. In the middle Piedmont orchards it would probably ripen in August or early September. At one point in North Carolina having an altitude of 3,500 to 4,000 feet, with rather less friable loam, some very fine specimens have been seen the middle of October.[1]

[1] Bureau of Plant Industry Bulletin 135; p. 38.

It will be seen that the Maiden's Blush belongs to the central belt and the northern part of the south central belt.

Fameuse. — The Fameuse is one of the most northern of commercial apples. It is grown in most parts of the northern belt, also in northern Indiana and Illinois and in southern Michigan, though in these regions the variety does not attain the quality of the St. Lawrence and Champlain valleys. It becomes a fall apple, and is of poor color and inferior flavor. Specimens received from Prince Edward Island were dull red and green, and small in size, while those from southern Quebec were very good specimens of the variety.

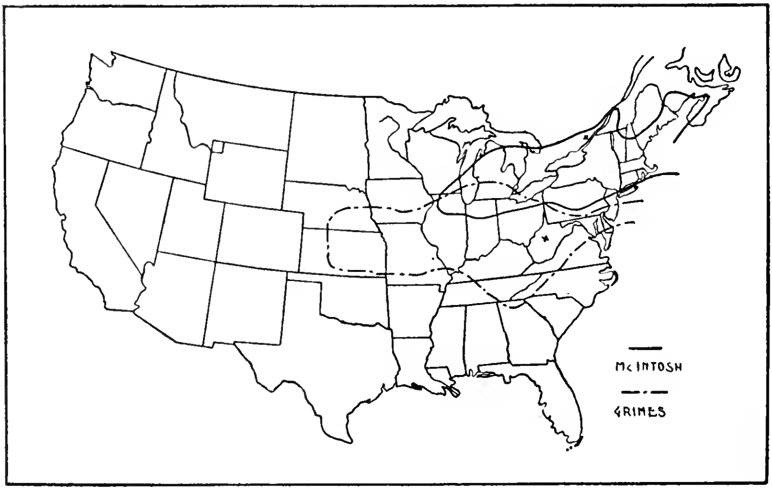

FIG. 9.

McIntosh. — The McIntosh is similar to the Fameuse and succeeds in similar territory. It does well further south, however, being at its best in south central New England and western New York. While it has been known a long time, it has not attained great favor as a commercial variety until recently, probably on account of its susceptibility to the apple scab, which has heretofore been difficult to control in a satisfactory manner. It is now gaining rapidly in popularity, and the territory of its culture is spreading. It is not grown to any extent west of Michigan, excepting in the far northwest. Throughout the Baldwin belt it is a fall apple, and south of this it becomes a late summer or early fall variety, and is inferior in flavor and color to those grown farther north. Beach says: —

It is adapted to a wider range of localities than is the Famense. . . . In western New York it cannot be expected to keep much later than October in ordinary storage without considerable loss, but in cold storage it may be held until December or January. When grown in more northern or elevated regions it is often held in good condition until mid-winter or later.[1]

Jonathan. — This variety had its origin in the Hudson valley, where it is now grown to a considerable extent, as well as in Long Island and southern Connecticut. It is a favorite in the south central belt west of the mountains and in favored portions of southwestern Michigan. It is at its best in central Illinois, northern Missouri and eastern Kansas and Nebraska. In Virginia and North Carolina it seems to succeed best at elevations of 1,200 to 1,500 feet or more. It has received considerable favor in the intermountain and pacific northwest apple regions, where conditions are similar to those in the regions already mentioned. It requires good care and a fairly rich soil in order to develop to its best. It should receive more attention from growers in regions where it succeeds well. It loses its sucrose in storage more readily than most varieties, after which, while still of good desert quality, it lacks the richness possessed by apples high in sucrose. It is necessary to harvest this variety at the proper time of maturity. If allowed to hang too long on the tree, especially if the weather is warm, it develops the defects of overripe apples, and will not keep well.

Grimes. — Grimes is an old Virginia apple which has spread very generally over the south central belt. It is well known over nearly all of this territory, especially in the western portion of it. Its culture extends west to central Nebraska and eastern Kansas. In the northern portion of this belt it is a late fall and early winter apple; in the southern portion it is more strictly a fall variety. It is grown to some degree north of the territory indicated, being found frequently in southern Michigan. In its more northern locations it is smaller than in

[1] Apples of New York, Vol. I, p. 133.

the south and more acid, the latter being a quality that is appreciated by some, inasmuch as in the south the variety has a mild subacid flavor. Gould says: —

> An orchard twelve to fifteen years old in Bedford County, Va., on Porters clay, at 1,500 feet elevation, with southeast exposure, produces fruit of unusual excellence, notable for its good size, fine yellow color, crispness of texture, and rich, spicy flavor. This orchard has had hardly fair care. The fruit of this variety from it reaches edible maturity early in October, but possesses good keeping qualities for the variety. On the same farm, at a point having somewhat lower elevation and a looser type of soil, it matures considerably earlier, and is not of such excellent flavor as from the location above mentioned. Produced at elevations of 2,000 feet in the upper sections of the Blue Ridge region, it may be kept under fairly favorable conditions until early winter. . . . At points south of Virginia, at the elevations of the Piedmont region, it is inclined to drop prematurely, but when grown at points having not less than 1,500 feet altitude it is highly prized in its season. One grower in the southwestern part of North Carolina has this variety at 2,500 to 2,800 feet elevation, and also at an altitude 400 to 600 feet higher. It is his experience that the fruit grown at the latter elevation will keep two months longer than that from the lower level. The fruit is also finer in appearance and more satisfactory in every way at the greater elevation. For best keeping qualities it should not be allowed to become too mature before picking.[1]

Favorable reports on it have been received from certain localities in New York, but in general as grown in this State it does not develop in size, color or quality as well as it does in more southern latitudes, and there is a high percentage of loss from drops and culls.[2]

Tompkins King. — The King is a variety found over a limited portion of the north central belt. It is a standard apple in western New York, and is grown in southern Ontario and to some extent in Michigan. It is also a favorite variety in Annapolis valley in Nova Scotia, where it succeeds to a high degree. The tree is weak, and requires high cultivation and good care. It is scarcely known west of Lake Michigan, and is met with scatteringly as far as Virginia, where it is found in the higher levels of the Blue Ridge. The tree is

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[1] Bureau of Plant Industry, Bulletin 135, p. 36.

[2] Beach, Apples of New York, Vol. 1, p. 154.

evidently not able to withstand the hot dry summers of the middle west.

Esopus. — This is an old variety, but one that has never been very largely cultivated. This may be partially accounted for by the fact that the tree is not particularly vigorous nor especially productive, and is somewhat susceptible to diseases. The apple is of superior quality, being much better than the Baldwin, which it considerably resembles. It has been grown somewhat in the Champlain and Mohawk valleys. It is an apple of limited cultivation for the Baldwin belt. Gould says, regarding its behavior in Virginia and North Carolina: —

At lower levels it usually drops prematurely, and even on Porters black loam at 2,000 feet elevation it often rots and drops seriously. At 3,000 to 3,500 feet altitude in North Carolina, on a rather loose loamy soil with porous subsoil containing more or less red clay, it develops more satisfactorily, keeps well into the winter, and does not manifest in any marked degree the defects observed at the lower levels.[1]

It has recently attained high favor with the growers in certain portions of the Pacific northwest. In our opinion this variety is deserving of wider cultivation inasmuch as it is an excellent variety for all purposes. In fact, so far as the fruit goes we believe that none of the better known varieties of commercial apples answers so well the requirements of a general purpose market apple. When well grown it is of good size and attractive appearance, and is adapted for both dessert use and cooking. It is also a reasonably good shipping apple. It requires the better care and higher cultivation which orchards are destined to receive in the near future.

Rhode Island Greening. — The distribution of the Rhode Island Greening is very similar to that of the Baldwin, but is perhaps adapted to somewhat wider range of conditions; being a green apple it does not call for conditions adapted to the production of good color necessary for the Baldwin. It attains better size and appearance than the Baldwin when grown towards the northern limit of its culture. It is possibly somewhat hardier in tree. It is grown all through the north central

[1] Bureau of Plant Industry, Bulletin 135, p. 34.

belt, and extends somewhat further south in the higher elevations. In the south it becomes a fall apple, and is apt to ripen prematurely and drop and sometimes to decay on the trees.

Northern Spy. — This is a variety of the Baldwin belt, and its distribution is very similar to that variety, although less general. It is at its best in the Champlain valley and in western New York. Some excellent specimens have been seen from southern New England, but they do not keep as well as those from farther north. It seems to be somewhat capricious as to soils and culture, and in localities of ill success it is not always possible to determine the cause of the difficulty. When grown

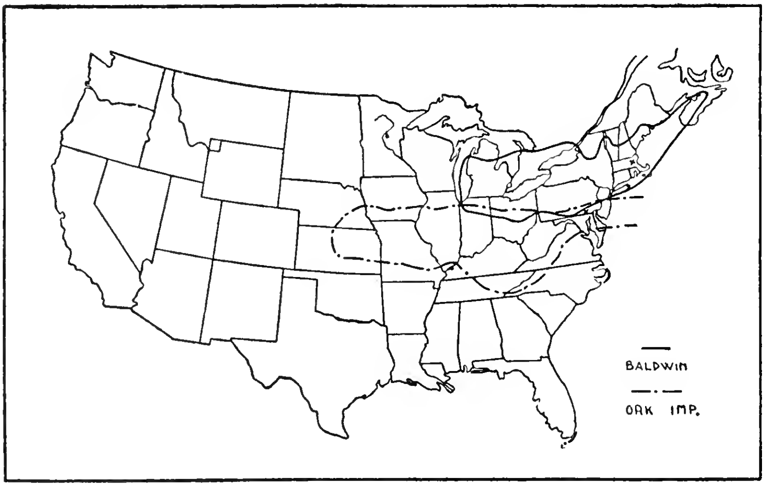

FIG. 10.

in the south it rots badly and drops, nor does it attain the high color and quality that characterize it in its more northern home.

Baldwin. — The Baldwin is the standard winter apple of the northeastern United States. It is distributed all over the north central belt, and is so nearly confined to it as to lend its name to that zone. It is also grown to a considerable extent in the Annapolis valley and very sparingly in the central belt, although it rarely attains any commercial standing in this region. It is not grown west of Lake Michigan, owing to the extremes of maximum and minimum temperatures which there prevail. In the northwestern belt the winters are too severe and the trees winter-kill; while south of this region the summers are so warm that the variety ripens prematurely and is apt to rot and drop. These same remarks will apply to many other varieties of the Baldwin belt, most of them being too tender to withstand the winters west of Lake Michigan. The Wealthy, which is very well adapted to the Baldwin belt, is an exception to this, and grows to perfection in both regions. We have observed the Baldwin for several years in an orchard growing on the higher elevations of the Green Mountains. Here it occasionally matures pretty well. In other years it is small, dull

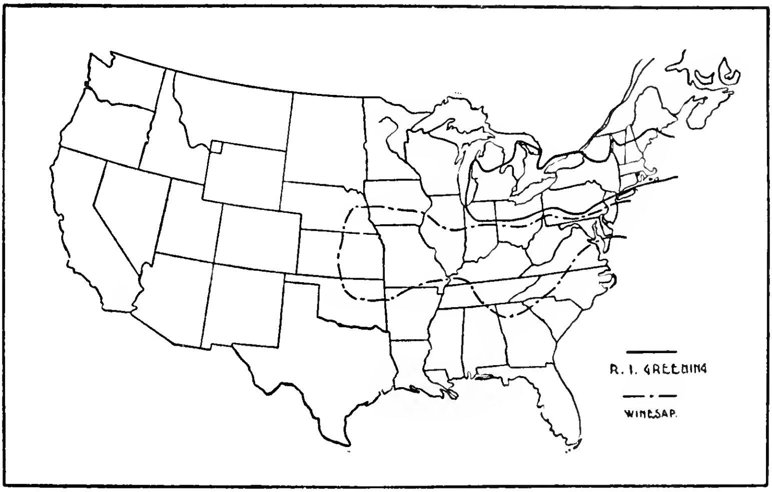

FIG. 11.

green and red in color, and of acid, astringent flavor, indicating that the variety has not had sufficient heat to mature properly. In the Champlain valley, while a standard market apple, it in most seasons fails to reach the size, color and quality that it does in western New York and south central New England. The same applies to its growth in Maine. One may observe in traveling northward through that State increasing signs of immaturity. In Massachusetts 1,000 to 1,200 feet is about the limit of certain full maturity.

Winesap. — The Winesap is a variety that has been known for a long time and has been tested over a wide area. It belongs to the south central belt, being grown from southern New Jersey, Virginia and North Carolina west through the Ohio valley to southern Nebraska. It reaches as far south as Georgia on the higher elevations. It reaches the highest favor in the eastern section of this belt, being of secondary importance west of the Allegheny Mountains. When grown in southern New England it is somewhat inferior in size, of doubtful color and flavor, although it keeps better than when grown in many places in its native region. It has found very little favor north of Pennsylvania and New Jersey. Specimens from Arkansas

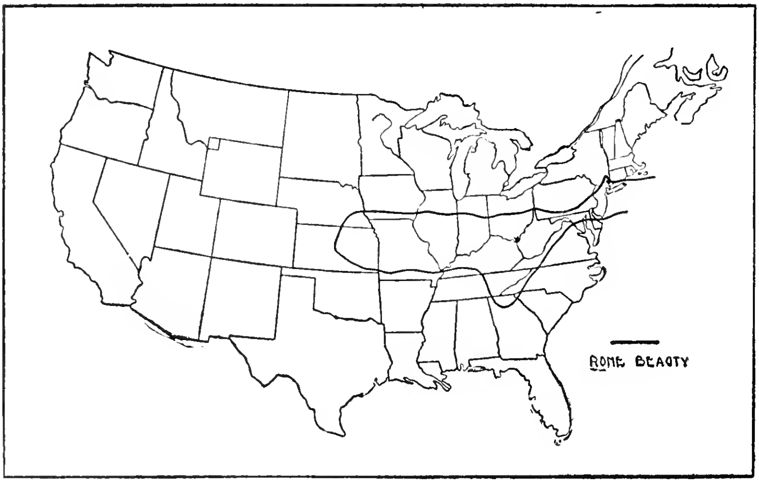

FIG. 12.

and Alabama were of medium size, though somewhat inferior in color and of only moderately good quality. Summarizing his observations regarding its behavior in Virginia and North Carolina Gould says: —

It is apparent that the conditions in the northern portion of the Piedmont region at 1,000 to 1,200 feet elevation do not produce the best results, and that in the more southern counties of Virginia which have been referred to the conditions produce very excellent fruit, but less satisfactory results are secured at points having elevations which much exceed that of the Piedmont region, while still farther south this variety can be grown at higher altitudes than is possible in the northern portion of the Piedmont. Its behavior thus indicates in an interesting way the corresponding relationship between altitude and latitude in their influence upon the behavior of this variety.[1]

Rome Beauty. — The Rome Beauty is an apple grown principally in southern Ohio, although it is found quite generally over the entire middle portion of the central belt. It is mentioned as a valuable commercial apple for Maryland, Delaware, southern Ohio, southern Indiana and southern Illinois. Specimens from Arkansas were of poor quality, but were of good size and color.

In Virginia, on Cecil sandy loam, at 900 feet, it is especially satisfactory, particularly in view of the fact that these conditions are unfavorable to most varieties. So grown, it is said to keep until the holidays. Cecil clay and Porters clay at elevations of 1,000 to 1,500 feet, in the northern Piedmont and Blue Ridge regions, usually combine conditions which are favorable to this variety. At 1,500 feet altitude on Porters clay it becomes an early winter variety of very fine appearance and good dessert quality. As a rule, it is considered especially well adapted to sandy soil. On Porters black loam, at 2,300 feet, it is considered of more than usual value. It is highly prized in western North Carolina, where it occurs at an altitude of 3,000 feet, on a deep porous mountain loam. It is, however, somewhat inclined to drop.[2]

York Imperial. — While the York Imperial is believed to have originated fully one hundred years ago, its period of commercial development extends over a much shorter time. It came from southeastern Pennsylvania, and there it has attained its greatest commercial value. It has spread, however, over nearly the whole of the south central belt. It is recommended as a valuable commercial variety in New Jersey, through southern Ohio to southern Iowa and Nebraska. To the south it is much valued as far as North Carolina on the higher elevations and west through Missouri and eastern Kansas. Its distribution is therefore very similar to the Ben Davis, although it has not spread into northern localities as has that variety, nor does it extend quite as far west. As to its behavior in the southern Appalachian Mountains Gould says: —

It appears to be less influenced by soil conditions than by elevation. In the Piedmont orchards having less than 1,000 to 1,200 feet elevation

[1] Bureau of Plant Industry, Bulletin 135, p. 46.

[2] Gould, Bureau of Plant Industry, Bulletin 135, p. 43.

serious rotting and premature dropping are apt to occur, and while frequent exceptions to this have been observed, it is sufficiently constant to suggest that extensive plantings of it in this region should be made cautiously, if at all, except in the northern portion, where it appears to be more nearly free from serious faults than almost any other commercial variety that is being grown, and is considered one of the most profitable sorts. This applies specially to locations in Rappahannock County, in close proximity to the mountains. In the Blue Ridge region above an elevation of 1,200 to 1,500 feet premature dropping is generally less severe than it is at lower points. Especially satisfactory results have usually been obtained on Porters clay at these middle elevations, where very heavy crops are expected, at least in alternate years. If heavy dropping occurs in such cases, a sufficient quantity of fruit

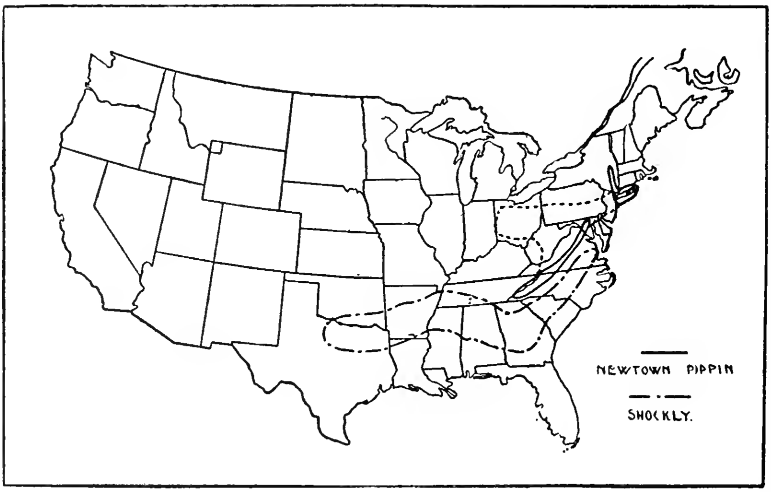

FIG. 13.

usually remains to result in a heavy crop. At the higher altitudes this is considered a valuable variety, especially in North Carolina, where it has grown at 2,500 to 3,500 feet altitude. . . . The contrast between this variety and Winesap in the manner in which they respond to the influence of elevation is of interest. The elevation at which Winesap begins to deteriorate and above which it becomes more inferior as the elevation increases appears to be about the point below which York Imperial is inclined to manifest certain faults which tend to disappear at higher altitudes.[1]

Yellow Newtown. — This variety is one of restricted cultivation. The only region in the east where it can be said to have

[1] Bureau of Plant Industry, Bulletin 135, p. 49.

commercial standing is in the Hudson Valley and Long Island, and in the Upper Piedmont and Blue Ridge sections of Virginia and North Carolina. It has also attained favor in certain sections of the Pacific northwest. It is therefore an apple of the central belt. The climatic conditions, particularly the mean summer temperature, of the several regions where this variety is cultivated are even more alike than is indicated by the temperature map. The tree makes a slow growth and is rather late in coming into bearing. The variety requires better care than do many of the leading commercial sorts. The tree is evidently unable to withstand the conditions of the western plains, and apparently does not succeed west of Indiana. We are confident, however, that if given good care it will do well in many places in Pennsylvania and central Ohio, provided, also, that the soil conditions are right. Gould devotes considerable space to a discussion of the behavior of this variety in the southern Appalachians, mostly with reference to its soil preferences. He concludes that it requires a soil or high fertility and of a loose, friable texture; and a subsoil comparatively open and porous. Bearing on climatic conditions he says: —

This apple is found principally in the mountains, at various altitudes and in coves where Porters black loam abounds, often at elevations not exceeding the general level of the Piedmont. Even these lower points, where the drainage is good, are favorable places for this variety, though the higher altitudes are to be preferred.[1]

In Nelson County, Va., the slopes of the mountains and hills at elevations of 1,000 to 1,500 feet are considered desirable locations. In northeastern Georgia premature dropping was observed. In Fig. 13 the solid line shows where the variety is generally recommended, and the dotted line includes additional territory where we believe it would do well in favorable locations and with good care.

Ben Davis. — This variety has been quite fully dealt with in a previous publication.[2] We have little to add to the statements made at that time. Many other samples of the variety have

[1] Bureau of Plant Industry, Bulletin 135, p. 48.
[2] Massachusetts Experiment Station Report, 1910, p. 197.

been studied and additional data as to variation in form and size have been secured, and these are set forth in an earlier portion of this paper. It cannot be grown to its full development north of southern Pennsylvania, central Ohio and Indiana, north central Illinois and central Iowa, although it is often a profitable commercial variety further north than this. It is, however, inferior in most respects to the variety grown south of that line. It is apt to be hard and astringent and poorly colored, and undersized unless grown under relatively high cultural conditions. The map given in Fig. 14 shows the

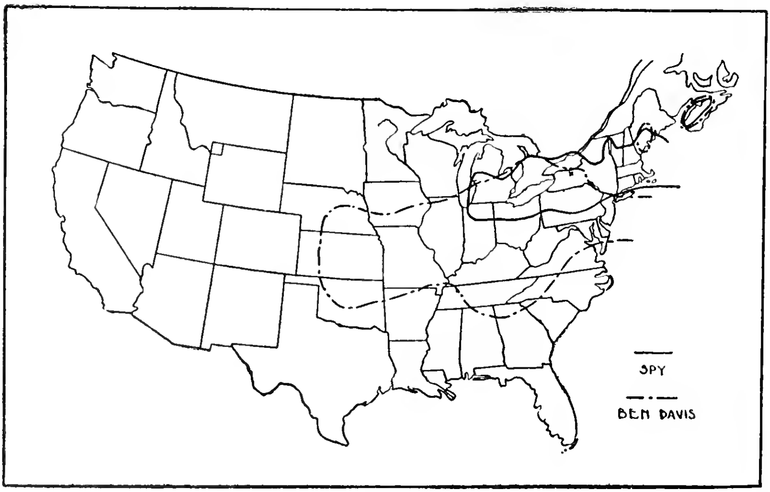

Fig. 14.

distribution of this variety. This shows it extending farther north than the map given in a previous report. It should be borne in mind that the previous map shows the area over which it is the leading commercial variety and the present map the area where it may be said to rank as a valuable commercial sort.

Shockley. — Shockley is a variety belonging almost exclusively to the southern belt. It flourishes in regions where the summer heat is greater than that favorable to most commercial varieties. It is recommended for cultivation in the hill and pine belt regions of South Carolina, and west through northern and central Alabama to northeastern Texas. Gould gives the following concerning its behavior in the southern Appalachian Mountains: —

At 1,500 feet altitude in Albemarle County, Va., on Porters clay, this variety is not considered of special value, but at the same elevation in Georgia on a soil containing rather more sand than Porters clay does, with good culture it comes to a high degree of perfection, and when held until midwinter it generally brings very satisfactory prices in local markets. In the southwestern part of North Carolina, at 1,700 feet elevation, on a friable, porous loam, with good culture it bears annual crops of highly colored fruits, which develop to a larger size than under most conditions. In North Carolina at 3,500 to 3,800 feet, while the Shockley bears heavily and colors well, it is usually too small to be of much value, especially as other more desirable sorts succeed at these elevations. The clay and clay loam soils of the Piedmont region, with the usual elevations of those soils, may be expected, as a rule, to produce this variety in a fair degree of perfection.[1]

The Relation of Temperature to Development.

The Mean Summer Temperature. — There is a close relation between the mean summer temperature and the development of the fruit. For every variety there can be determined a mean summer temperature at which it reaches its highest and most satisfactory development. Any departure from this mean results in greater or less inferiority of the fruit, the degree of inferiority depending on the amount of the departure, and the variety. For the successful growth of the tree the mean summer temperature is of little significance, but the major controlling factors are the minimum winter temperature and the mean of the hottest part of the summer. Other factors enter in, but we believe that these are the principal ones and must first be complied with if a variety is to succeed.

The Winter Minimum. — The temperature which a tree of a given variety can withstand cannot be stated with definiteness. It depends not only on the degree of cold, but also on the condition of the tree and the rapidity and amount of the fall and subsequent rise of the temperature. In the northwestern belt this is the great problem of apple culture, and much study has been given to it. The Minnesota Horticultural Society men-

[1] Bureau of Plant Industry, Bulletin 135, p. 43.

tions the following varieties as of sufficient hardiness to endure the severe winters of that State:[1] —

Of the first degree of hardiness, Oldenburg, Hibernal, Charlamoff, Patten, Okabena.

Of the second degree of hardiness, Wealthy, Tetofski, Malinda, Peerless, Northwestern Greening.

Many other sorts thrive in the more favorable parts of this belt, but the great bulk of the varieties grown in localities of similar summer temperatures in the east perish from winter-killing. The minimum winter temperatures in this territory, according to the records of the Weather Bureau,[2] are around —40° F., which may be considered a degree of cold which any tree of *Pyrus malus* can rarely endure without injury (see Fig. 15). It should be borne in mind that this temperature must be taken in accordance with the methods of the Weather Bureau and with correct instruments, else the figures obtained are likely not to be comparable.

The Heat of Summer.— A glance at the figures (Figs. 6–14) giving the distribution of varieties shows that some extend the entire length of its belt, while others succeed well only through the eastern portion. There are three differences between the eastern and western portions of these belts. In the west we find (1) lower humidity, (2) less precipitation, (3) more severe heat during the summer. Probably all these have their influence in limiting the western spread of certain varieties, for their effects on the plant are similar, in that they tend to dry it out. In relative importance the greater heat is probably of the greatest significance followed by rainfall and humidity.

The Effects of Low and High Mean Summer Temperatures. — The effects on the fruit of a low summer heat, as indicated by the mean summer temperature, are as follows: —

1. Greater Acidity. — It is shown that the acidity of the fruit steadily decreases all through the stages of growth, ripening and decay. It naturally follows that if the fruit does not have time to mature properly it will be acid, and this is clearly shown in the table of analyses.

[1] Report, 1907, p. 34.

[2] United States Weather Bureau, Bulletin Q.

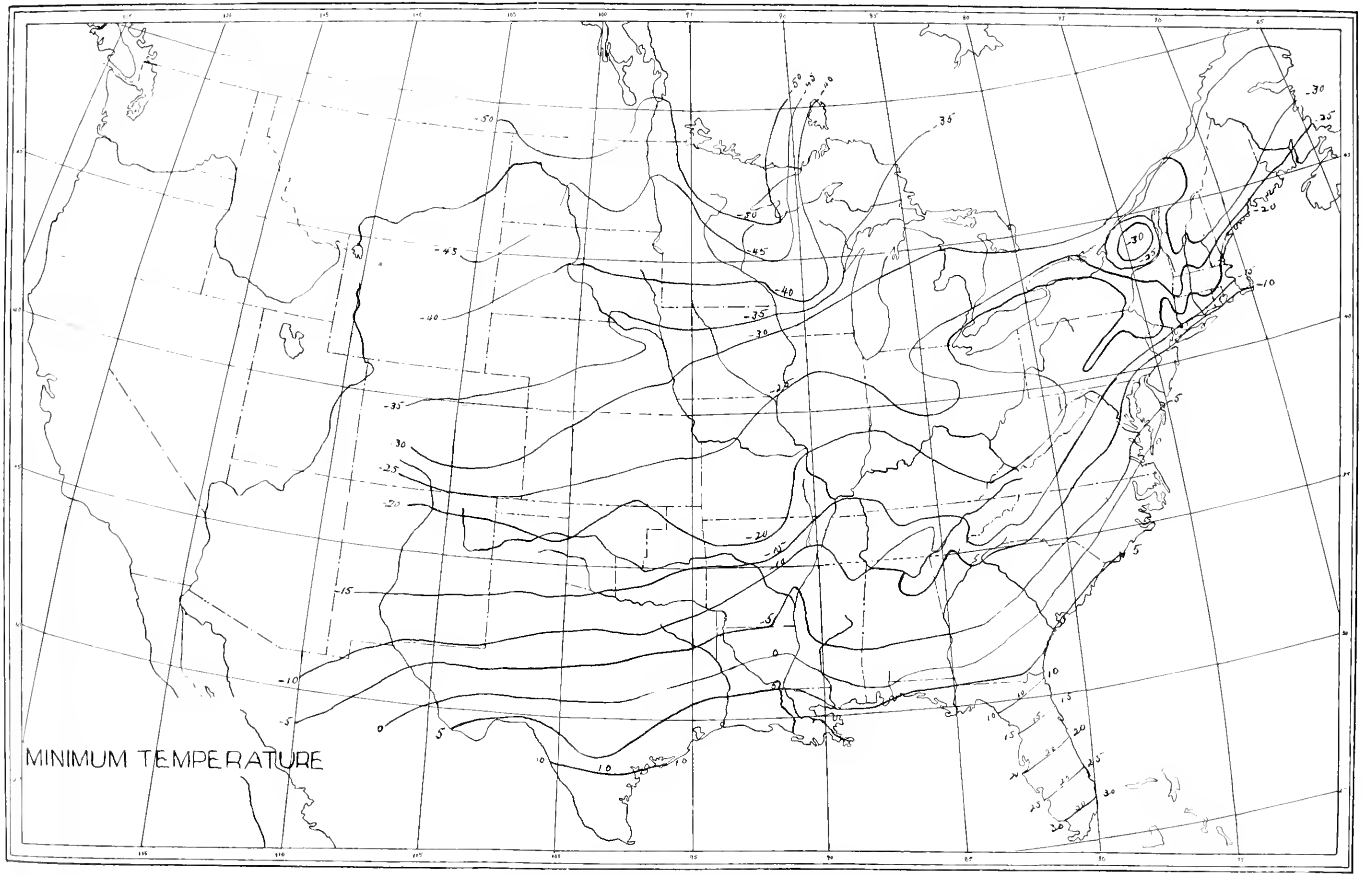

FIG. 15.—ISOTHERMS OF MINIMUM WINTER TEMPERATURE.

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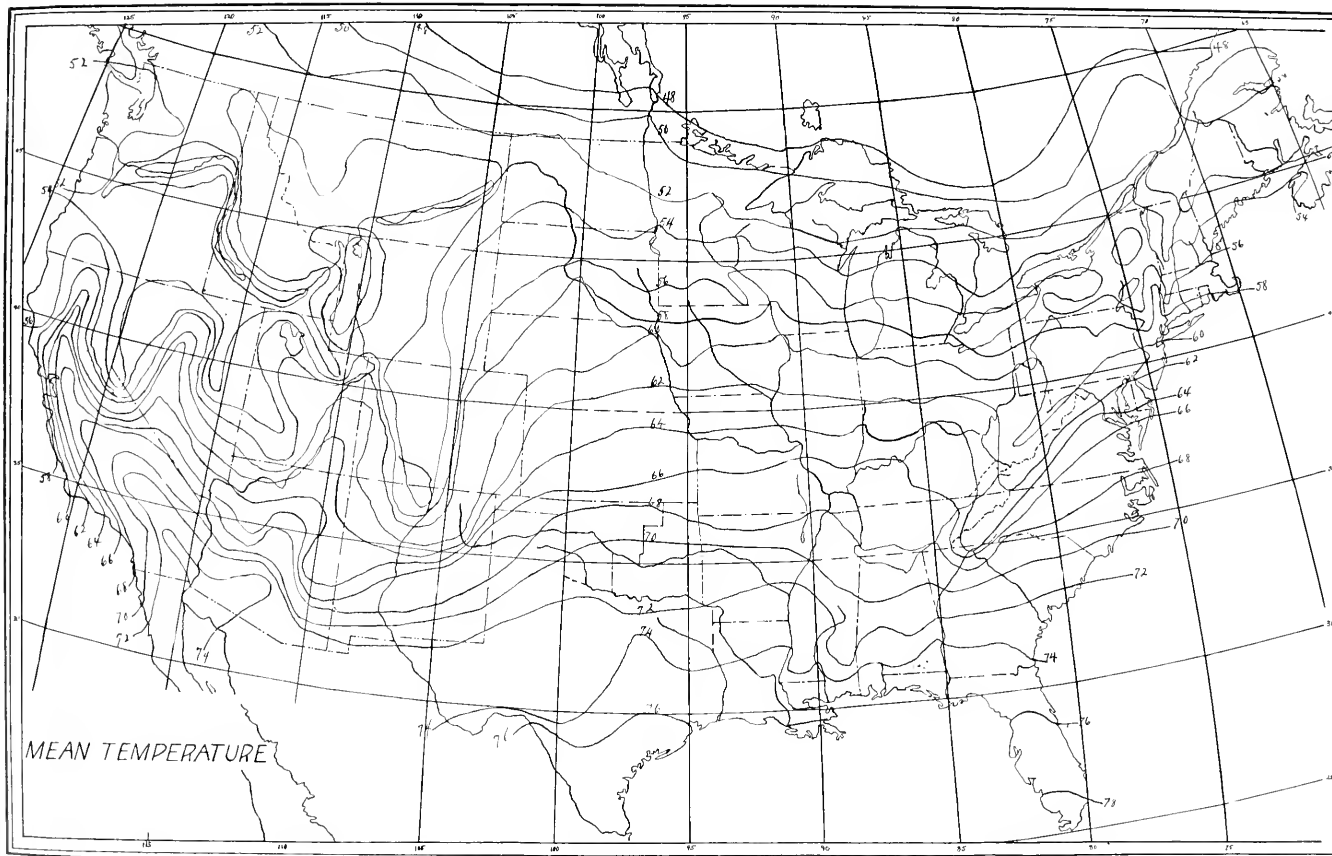

FIG. 16. — ISOTHERMS OF MEAN SUMMER TEMPERATURE.

2. A Higher Content of Insoluble Solids. — The analyses show that there is a decided tendency for the insoluble solids to decrease during the stage after ripening. The figures do not show just when the content of insoluble solids is highest, but it must be at or before the time of picking. The analyses also give clear indication of the immaturity of the fruit when grown too far north. This is especially marked in the case of the Ben Davis, doubtless owing to the fact that some lots of this variety came from the far north of the region in which it matures properly, and it falls far short of full maturity. It shows an average content of 2.97 per cent. for the Ben Davis belt and 3.60 per cent. for the specimens from north of this region. Other sorts show similar differences.

3. Greater Astringency. — All apples in an immature state doubtless contain small amounts of tannin. No determinations of tannin have been made in connection with this work, nor have we discovered any report that shows conclusively just what changes in tannin content go on in the growing and ripening fruit. Nevertheless, it is evident to the taste that green apples have greater astringency than do ripe specimens, and we have repeatedly observed a markedly greater astringency in northern-grown apples than in the same sort grown farther south.

4. Less Coloration. — It is well known that plants exhibit brighter, more intense coloration when grown in high latitudes and altitudes. This is true of the coloration of red apples. In the north we find bright intense reds, which become duller towards the south, with a tendency toward a pinkish red towards the southern limit. The proportion of the fruit covered, however, behaves in a different way. We find the greatest proportion of color near the middle of a distribution, with a decrease to both the north and south. We find then, near the center of a distribution of most varieties of red apples, fruit well covered with fairly bright color, which is brighter and more intense in northern varieties than in those of the south.

5. Decreased Size. — When the season is short or cool it is natural that a variety should not reach the maximum size. It is somewhat difficult to determine, in lots of varying size, how much of the difference is due to climatic causes and how much to cultural methods and conditions. However, in the case of the Ben Davis a study of the table on page 199 shows clearly not only the general influence of the different regions on size, but also that of different seasons, and almost invariably a lower summer mean is accompanied by decreased size.

6. *Scalding in Storage.* — It has been shown by Powell [1] and Beach [2] that immature apples are more likely to scald in storage than are those that have been well matured on the trees. In order to keep longest in storage an apple should have fully completed the stages of growth and ripening on the tree, and been picked and without delay placed and kept in a temperature barely above the freezing point of the fruit. In practice it is necessary to allow a margin for safety, owing to possible lack of uniformity of the temperature at different times and in different parts of the storage rooms, but the better the control of the temperature the closer may the ideal conditions be approached. It is probable that scalding may also appear on fruit that has been poorly grown, but still has reached full maturity. The chemical work here reported indicates that fruit matured on poor soil or under unfavorable cultural conditions may be in some respects similar to immature fruit. The poorly grown fruit is lower in most of the soluble solids.

When a variety is grown where the summer mean temperature is excessively high we note the following effects: —

1. *Uneven Ripening.* — Summer and fall varieties always show a tendency to ripen unevenly, making it desirable to make two or more pickings as the different specimens reach maturity. Late fall and winter sorts show less evidence of this, though a difference in the maturity of specimens in a lot of winter fruit may be detected without difficulty. Inasmuch as the result of growing a variety south of its natural range is to cause earlier maturity, and fall varieties tend to become summer varieties, it is to be expected that the uneven ripening characteristic of summer sorts should follow. This is not marked with winter varieties unless they are grown a considerable distance south of their most favorable localities.

[1] Bureau of Plant Industry, Bulletin 48.

[2] New York Experiment Station, Bulletin 248; Iowa Experiment Station, Bulletin 108.

2. *Premature Dropping.* — It is but natural that dropping of ripened fruit should follow uneven ripening, and this is commonly observed to be the case. We find, also, that apples may drop even at immature stages when the summer heat is too great for the liking of the variety, particularly when the heated period closely follows the period of blossoming.

3. *Rotting on the Tree.* — This is another sign of summer heat too great for the variety, which is right along the line of those already mentioned. It occurs with most varieties only when the heat is excessive. The Jonathan is especially subject to this trouble, because the margin between temperature that will give the maximum size, color and quality and one that will cause rotting seems to be narrow, and perhaps within the range of seasonal fluctuations. Therefore there is great danger that the apples will become overripe and decay before being picked.

4. *Poor Keeping Quality.* — This defect of southern-grown specimens is also along the same lines of those already dealt with. The apples mature to the end of the ripening or after-ripening stages, and being still subject to high temperature, continue rapidly on the road to decay. It is probable that in many cases this difficulty might be largely overcome by picking the apples at the proper stage and placing them at once in cold storage. I am informed by Mr. W. A. Taylor of the Department of Agriculture that Baldwins grown in West Virginia kept in a satisfactory manner when handled in this way. The chemical work here reported shows no material difference in the chemico-physiological processes of the growth and maturing of the fruit of a given variety, whether grown in the north or in the south, but only in the degree of completeness with which they are achieved.

The converse of this proposition is that northern-grown fruit, if well matured, will keep better than that variety grown farther south, and this indicates that any variety should be grown as far north as possible to fully mature it in the coolest seasons that are likely to occur. The progress of the stage of after ripening may be easily controlled if the proper facilities are at hand, but it is an advantage to have the air temperature low at this time unless it is desired to hasten instead of retard this stage.

5. Lack of Flavor. — The basis of flavor in apples has already been discussed. The leading element of flavor for discussion here is that of the flavoring oils. It appears that for high development of these a relatively cool atmosphere is desirable. Summer and early fall varieties do not, as a rule, possess high flavors, and any late fall or winter variety grown so far south that it ripens before the cool weather of autumn comes is likely to be inferior in the development of flavoring oils.

6. "Mealiness." — This is another sign of overripeness that is an indication that the variety is grown in too great summer heat. Mention has already been made of the softening of the middle lamellæ, which is the cause of this mealiness (see page 186). The result is that when eaten the cells separate from each other without breaking open and releasing the juices contained therein, and the apple is said to be "dry," whereas it probably contains a normal amount of water. Some varieties, the Jonathan, for example, do not show this characteristic in marked degree, but most varieties do if they can be kept long enough without parasitic decay, and the warmer they are the shorter the time necessary to bring about this result.

7. Less Intense Color. — A red variety grown to the south of its normal range is apt to show a less intense color, though it may be pretty well spread over the fruit. There is often a decided tendency toward a pinkish red, which may appear pale or faded in extreme cases.

Bright sunlight during the ripening period of the fruit has much to do with the attainment of high color, especially if at this time the nights are cool and frosty. But in order for these influences to have their full effect the apple must have been brought to the proper stage of development by a sufficient amount of heat during the period of growth. Underdeveloped apples do not take on a satisfactory color, no matter how favorable the conditions may be during the ripening period.

8. Smaller Size. — This effect does not manifest itself unless the variety is grown far to the south of its most favorable region. The signs of overripeness show themselves much sooner as one goes south over the distribution of a variety. Nevertheless, in some cases, at least, it is evident that a variety may fail to reach its normal size on account of too severe summer heat. It is probable that this occurs most noticeably in the extreme south of the apple region. We have seen evidences of it in the Ben Davis and Winesap that were grown about as far south as these varieties are much cultivated.

The Optimum Mean Summer Temperature. — It is evident from the foregoing discussion that the development of the highest perfection in any given variety is closely related to most favorable mean summer temperatures. In Table 5 is given a list of varieties, with an estimate of the optimum temperature for each sort, and in some cases of their possible range and hardiness with respect to the cold of winter. The list of varieties includes all those that are given the double star, indicating highly successful varieties, in the list of the American Pomological Society, with a number of additions of varieties that, for various reasons, seemed worthy of consideration. Inasmuch as we consider keeping quality of considerable account with most sorts, the policy has been to prescribe about as low a temperature as will suffice to thoroughly mature a variety, leaving a margin of about 2° for seasonal fluctuations; that is, we believe that any variety may be matured when the summer mean is 2° lower than the one given. This applies more particularly to the fall and winter varieties. We believe, on the other hand, that any increase in the summer mean for any variety, unless it be the earliest ones, will be a disadvantage, though a very slight one, if the rise is not more than 1° or 2°. Up to a certain degree the overmaturity of the fruit in a too warm climate may be overcome if the grower will pick at the time of full maturity and put the fruit at once in cold storage. If the heat is too great, however, even with this method the fruit will be inferior in flavor and color, and, in very extreme cases, in size. We believe that a departure of more than 2° in either direction from the temperatures given will be a noticeable disadvantage with any of the winter varieties. This remark will apply less to the fall sorts and still less to the summer varieties; or, to put it in other words, the earlier the variety the greater may be its range of temperature without marked deterioration of the fruit. There are doubtless errors in the case of some varieties, concerning which we have limited information. It is hoped that these may, in time, be corrected, as we are able to learn more concerning the behavior of these varieties under different conditions.

In Table 6 these same varieties are grouped under their optimum temperatures for convenience in reference.

In Table 5 there is also given for some varieties the range of temperature which they can stand without serious deterioration. This is, as already stated, closely connected with the season of the variety, being wide with early sorts and relatively narrow with most winter sorts. Just how much difference there is between the ranges of varieties of the same season is difficult to say. It is complicated with a variety of related questions.

In the case of a few of the varieties given in Table 5 an attempt is made to give their hardiness with respect to the winter cold. Inasmuch as the ability of the tree to withstand cold depends on a variety of factors other than the temperature, it is of no use to attempt to state this in degrees. The designation Ex. H. is used for the varieties equal in hardiness to those classified as of the first degree of hardiness; the designation V. H. for those of the second degree of hardiness (by the Minnesota Horticultural Society); and the designation H., M. and T. for various degrees of hardiness below these two classes. Many of the more southern sorts are not grown far enough north on account of a lack of summer heat to test their winter hardiness in a satisfactory manner. Therefore it is impossible to make any statements regarding them, nor would there be any practical value in such statements were they possible.

TABLE 5. — *Mean Summer Temperatures.*

	Optimum Temperature (Degrees).	Range.	Hardiness.
Akin,	52		
Alexander,	54		H.
Arctic,	53		H.
Arkansas,	65		
Arkansas Black,	63		
Babbit,	57		
Bailey Sweet,	58		
Baldwin,	56	N.	M.
Baxter,	53		H.
Beach,	65		
Ben Davis,	64	M.	H.
Benoni,	59		
Bethel,	53		H.
Bietigheimer,	53		
Bismark,	53		
Black Gilliflower,	55		
Blenheim,	55		
Blue Pearmain,	54		H.
Boiken,	57		
Bonum,	65		
Borovinka,	53		
Bough,	57		
Buckingham,	66		
Buncombe,	66		
Cabashea,	58		
Cannon Pearmain,	65		
Charlamoff,	53		Ex. H.
Chenango,	57		
Collins,	65		
Cooper Market,	60		
Cox Orange,	35		
Delicious,	59		
Dominie,	60		
Dudley,	53		
Early Harvest,	56	V. W.	
Early Joe,	56		
Early Pennock,	56		
Early Strawberry,	58		
English Russet,	56		
Esopus,	59	N.	
Ewalt,	58		
Fallawater,	60		
Fall Harvey,	57		
Fall Orange,	57		
Fall Pippin,	58		
Fameuse,	54	M.	H.
Fanny,	63		
Flushing Spitzenburg,	58		
Foundling,	54		H.
Gano,	64	M.	
Gideon,	54		H.
Golden Russet,	56		
Golden Sweet,	58		
Gravenstein,	55	M.	M.
Green Sweet,	58		
Grimes,	62	M.	H.
Haas,	59		H.
Hagloe,	60		
Hibernal,	52	N.	Ex. H.
Holland Pippin,	57		

	Optimum Temperature (Degrees).	Range.	Hardiness.
Holland Winter,	57		
Horse,	66		
Hubbardston,	57		
Huntsman,	62	N.	N.
Hyde King,	60		
Ingraham,	62		
Jefferis,	57		
Jewett,	54		
Jonathan,	59	N.	N.
July,	59		
Kent Beauty,	58		
Keswick,	58		
King David,	59		
Kinnaird,	59		
Lady,	58		
Lady Sweet,	57		
Lankford,	61		
Lawver,	64		
Limbertwig,	66		
Longfield,	57		
Lowell,	58		
Lowland Raspberry,	58		
Maiden Blush,	61	M.	V. H.
Malinda,	54	N.	H.
Mann,	55	M.	
McAffee,	60		H.
McIntosh,	56	W.	H.
McMahon,	55		
Melon,	57		
Milden,	58		H.
Milwaukee,	54		H.
Minkler,	60		
Missouri Pippin,	64		
Monmouth,	57		
Mother,	58		
Newell,	55		
Newtown Spitzenburg,	60		
Northern Spy,	56	M.	H.
Northwestern Greening,	55		V. H.
Okabena,	52		Ex. H.
Oldenburg,	52	V. W.	Ex. H.
Oliver,	64		
Ontario,	56		H.
Ortley,	61		
Paragon,	64		
Patten,	55		Ex. H.
Payne,	62		
Peck Pleasant,	58		
Peerless,	56		V. H.
Pewaukee,	53		V. H.
Plumb Cider,	57		
Pomme Gris,	55	N.	
Porter,	57	W.	
Primate,	57		
Pumpkin Sweet,	57		
Ralls,	62		
Rambo,	60		
Red Astrachan,	54	W.	H.

TABLE 5. — *Mean Summer Temperatures* — Concluded.

	Optimum Temperature (Degrees).	Range.	Hardiness.		Optimum Temperature (Degrees).	Range.	Hardiness.
Red Canada,	59	M.		Tolman,	56	M.	H.
Red June,	58	M.		Tompkins King,	56	M.	M.
Rhode Island Greening,	56	M.	H.	Twenty Ounce,	58		M.
Ribston,	55	N.		Twenty Ounce Pippin,	58		
Rolfe,	56		H.				
Roman Stem,	61			Wagener,	59		
Rome Beauty,	60			Walbridge,	54		H.
Roxbury Russet,	57	W.	H.	Washington Royal,	56		
				Wealthy,	56	W.	V. H.
Salome,	55		H.	Westfield,	56		
Scott Winter,	55		V. H.	White Astrachan,	54		
Shiawasse,	55		H.	White Pearmain,	62		
Shockley,	65	N.		White Pippin,	61		
Smith Cider,	61			Williams,	57	W.	
Smokehouse,	60			Willow,	64		
Stark,	62	M.	H.	Windsor,	55		H.
Stayman Winesap,	63			Winesap,	64	M.	
St. Lawrence,	54			Winter Banana,	58		
Sutton,	56			Wolf River,	54	M.	V. H.
Swarr,	58						
Swazie,	55	N.		Yates,	67		
Switzer,	58			Yellow Bellefiower,	61	W.	
				Yellow Newtown,	60	V. N.	
Terry,	67	N.		Yellow Transparent,	53	W.	V. H.
Tetofski,	53	V. W.	V. H.	York Imperial,	62	M.	
Titovka,	56		H.				

TABLE 6. — *Optimum Temperatures by Groups.*

52°.	53°.	54°.	55°.
Hibernal	Arctic	Alexander	Black Gilliflower
Okabena	Baxter	Blue Pearmain	Blenheim
Oldenburg	Bethel	Fameuse	Cox Orange
	Bietigheimer	Foundling	Gravenstein
	Bismark	Gideon	Mann
	Borovinka	Jewett	McMahon
	Charlamoff	Malinda	Newell
	Dudley	Milwaukee	Northwestern Greening
	Pewaukee	Red Astrachan	Patten
	Tetofski	St. Lawrence	Pomme Gris
	Yellow Transparent	Walbridge	Ribston
		White Astrachan	Salome
		Wolf River	Scott Winter
			Shiawasse
			Swazie
			Windsor

56°.	57°.	58°.	59°.
Baldwin	Babbit	Bailey Sweet	Benoni
Early Harvest	Boiken	Cabashea	Delicious
Early Pennock	Bough	Early Joe	Esopus
English Russet	Chenango	Early Strawberry	Haas
Golden Russet	Fall Harvey	Ewalt	Jonathan
Lowland Raspberry	Fall Orange	Fall Pippin	July
McIntosh	Holland Pippin	Flushing Spitzenburg	King David
Milden	Holland Winter	Golden Sweet	Kinnaird
Northern Spy	Hubbardston	Green Sweet	Red Canada
Ontario	Jefferis	Kent Beauty	Wagner
Peerless	Lady Sweet	Keswick	
Rhode Island Greening	Longfield	Lady	
Rolfe	Melon	Lowell	
Sutton	Monmouth	Mother	
Titovka	Plumb Cider	Peck Pleasant	
Tolman	Porter	Red June	
Tompkins King	Primate	Swarr	
Washington Royal	Roxbury Russet	Switzer	
Wealthy	Williams	Twenty Ounce	
Westfield		Twenty Ounce Pippin	
		Winter Banana	

60°.	61°.	62°.	63°.
Cooper Market	Lankford	Akin	Arkansas Black
Dominie	Maiden Blush	Grimes	Fanny
Fallawater	Ortley	Huntsman	Stayman Winesap
Hagloe	Roman Stem	Ingram	
Hyde King	Smith Cider	Payne	
McAffee	White Pippin	Ralls	
Minkler	Yellow Bellflower	Stark	
Newtown Spitzenburg		White Pearmain	
Rambo		York Imperial	
Rome Beauty			
Smokehouse			
Yellow Newtown			

64°.	65°.	66°.	67°.
Ben Davis	Arkansas	Buckingham	Terry
Gano	Beach	Buncombe	Yates
Lawver	Bonum	Horse	
Missouri Pippin	Cannon Pearmain	Limbertwig	
Oliver	Collins	Shockley	
Paragon			
Willowtwig			
Winesap			

Chemical Determinations.

The work here reported is based in considerable degree on chemical work done in the laboratory of the college. During the past two years over 150 samples of apples have been subjected to partial analysis, the results of which, so far as they are deemed worthy of publication, are presented in Table 7. The names and locations of the growers are as follows: —

Name.	Post-office Address.	Name.	Post-office Address.
F. Bovyer,	Charlottetown, P.E.I.	Slaymaker & Son,	Wyoming, Del.
C. E. Hardy,	Hollis, N. H.	Dr. S. S. Guerrant,	Callaway, Va.
Edw. Lefavour,	Marblehead, Mass.	G. C. Sheible,	Tiptop, Ky.
Massachusetts Agricultural College,	Amherst, Mass	G. H. & S. G. Ellis,	Dayton, Tenn.
J. M. Fisk,	Abbottsford, Que.	J. O. Kelley & Sons,	Jeff, Ala.
T. L. Kinney,	South Hero, Vt.	Joe H. Burton,	Mitchell, Ind.
G. H. Wright,	Middlebury, Vt.	J. C. B. Heaton,	New Burnside, Ill.
Wilfred Wheeler,	Concord, Mass.	Geo. T. Lincoln,	Bentonville, Ark.
F. S. Wallbridge,	Belleville, Ont.	Geo. L. Sipes,	West Fork, Ark.
Connecticut Agricultural College,	Storrs, Conn.	C. S. Bouton,	Springfield, Ark.
New York Experiment Station,	Geneva, N. Y.	G. S. Christy,	Lincoln, Neb.
Wm. Miller,	Gypsum, O.	Kansas State Agricultural College,	Manhattan, Kan.
U. T. Cox,	Proctorville, O.	Ira Townsend,	Iola, Kan.
Wm. Stewart,	Landisburg, Pa.	J. B. Fergus,	Kincaid, Kan.
F. H. Fasset,	Meshoppen, Pa.	G. B. Prince,	Santa Fé, N. M.
S. H. Derby,	Woodside, Del.	E. F. Cadwallader,	Mountain Park, N. M.
A. J. Norman,	Harris' Wharf, Md.	Stirling & Pitcairn,	Kelowna, B. C.

As a rule the samples represent about the best type of the various varieties grown in the different localities. The samples received varied from a half dozen to a barrel, and from these from six to twelve good specimens were selected for analysis. They were ground in a food chopper, and after weighing a sample for sugar determinations, were preserved in a glass jar with formaldehyde. The methods of analysis followed were those of Bulletins 66 and 107 of the Bureau of Chemistry.

The determination of total solids was made by drying 25 grams on pumice in a water oven at 95° to 98° for twenty to twenty-two hours. This probably gives results too low, but this method seemed the best with the facilities at hand. Insoluble solids were determined by washing 25 grams with 500 cubic centimeters hot water on muslin filters, and drying on pumice fourteen hours at 95° to 98°. The reducing sugars were determined by reducing Fehling's solution and weighing the precipitate as cuprous oxide; the sucrose, by means of the polariscope; and malic acid, by titrating with N/10 alkali with phenolphthalein as an indicator.

Most of the analyses were made during the winter of 1910-11. All samples, save those from Amherst, were shipped direct to cold storage in Holyoke, Mass., and transferred to Amherst a few samples at a time, as needed, where they were held as cool as possible. The Amherst samples, as well as all those of 1910, were kept in an excellent cellar storage at the college. The laboratory numbers were given in order of analysis, work being begun with No. 1 in November, 1910, and completed about March 1, 1911. The samples of 1910 were analyzed in March, and while no notes of their condition were taken, it can be said that they were in excellent condition, most of them eating ripe.

These analyses form the basis for the chemical side of the discussions of the different varieties in this paper. There are, however, certain questions not dealt with elsewhere which may receive consideration at this point.

Nearly all the differences in analyses between the different samples, aside from those fairly attributable to the unavoidable errors of sampling and analysis, can be traced to one of two causes: (1) varietal differences; these are brought out in Table 1; (2) those attributable to different stages of maturity of the fruit. The chemical changes occurring in the growth and ripening of the apple are clearly brought out in the work of the Bureau of Chemistry, reported in Bulletin 94 of the Bureau, and the reader is referred to that publication for a discussion of this question. During the past winter analyses were made of four samples in November and again in February. These were: —

	November.	February.		November.	February.
Greening, . .	No. 4	No. 93	Baldwin, . .	No. 2	No. 97
Baldwin, . .	No. 1	No. 98	McIntosh, . .	No. 27	No. 102

Reference to the analyses of these samples will show that they are in entire accordance with the results reported in the above-mentioned publication. A study of the figures given shows that, as a rule, varieties grown to the north of their natural range exhibit the characteristics of immature fruits. The analysis of the Ben Davis, sample 91, indicates an apple that failed to mature on the tree, and has gone down in storage after the manner of immature fruit. In general, the analysis of this variety shows that the more northern-grown specimens are low in solids and sugars and high in insoluble solids and acid, and the same is generally true of the other varieties.

TABLE 7. — *Chemical Determinations.*

VARIETY AND SOURCE.	Laboratory Number.	Total Solids (Per Cent.).	Insoluble Solids (Per Cent.).	Soluble Solids (Per Cent.).	Reducing Sugars (Per Cent.).	Sucrose (Per Cent.).	Total Sugars (Per Cent.).	Malic Acid (Per Cent.).	Size (Millimeters).	Color.	Quality.
Wealthy.											
Charlottetown, P. E. I.,	19	14.97	1.74	13.23	8.81	1.78	10.59	.60	75×60	40 to 60 per cent. striped and splashed; some blush on sunny side.	Rather poor; lacks Wealthy flavor; very slightly astringent.
Amherst, Mass.,	28	13.38	2.20	11.18	6.91	1.98	8.89	.44	Medium and below	Fair.	Ripe, or a little past; flavoring oils deficient; slightly mealy.
Storrs, Conn.,	6	12.97	2.29	10.68	6.47	1.36	7.83	.46	65×52	Fair; well covered, but not intense.	Rather flat; lacks flavor; may be overripe.
Wolf River.											
Charlottetown, P. E. I.,	16	14.81	3.05	11.76	5.84	6.61	12.45	.72	85×65	Poor to good.	Poor; lacks flavor; astringent; immature and overripe.
Kincaid, Kan.,	72	14.24	2.49	11.75	8.93	.85	9.78	.44	87×66	Pale; poorly covered; pale stripes.	Fair; slightly acid; somewhat mealy.
Mountain Park, N. M.,	14	12.59	2.49	10.10	6.22	3.82	10.04	.74	Medium	Good; nearly blushed; slightly pinkish.	Not equal to those of north; lacks flavoring oils; slight musty flavor.
Maiden Blush.											
Storrs, Conn.,	5	13.23	2.10	11.13	3.95	2.43	6.38	.50	70×53	Good; one-third blushed.	A little flat; perhaps a little overripe; slightly astringent; lacks flavor.
Callaway, Va.,	12	15.39	3.06	12.33	5.05	4.14	9.19	.72	Medium	Greenish; dull red.	Good; better than No. 10; not mealy.
Tip Top, Ky.,	10	15.15	2.83	12.32	5.39	2.85	8.24	.67	Medium	Good; one-third blushed.	Slightly overripe; better than No. 5.
Springdale, Ark.,	11	13.31	2.74	10.60	5.73	1.29	7.02	.35	Medium	Dull; poorer than No. 10.	Overripe; somewhat astringent; mealy; lacks acid.

TABLE 7. — *Chemical Determinations* — Continued.

VARIETY AND SOURCE.	Laboratory Number.	Total Solids (Per Cent.).	Insoluble Solids (Per Cent.).	Soluble Solids (Per Cent.).	Reducing Sugars (Per Cent.).	Sucrose (Per Cent.).	Total Sugars (Per Cent.).	Malic Acid (Per Cent.).	Size (Millimeters).	Color.	Quality.
Fameuse.											
Charlottetown, P. E. I.,	13	15.76	2.85	12.91	7.88	.99	8.87	.47	Small	Green; one third dull red.	Fair; rather acid and lacks oils; very thick skin.
Abbotsford, Que.,	44	14.36	2.50	11.86	7.81	1.72	9.53	.19	64×53	Fair to good.	Good.
Storrs, Conn.,	7	14.87	2.32	12.55	6.06	1.64	7.70	.41	68×58	Fair to good; deep dull red.	Fair; somewhat flat; not equal to more northern grown; a little past.
Landisburg, Pa.,	71	15.21	2.33	12.88	9.63	.49	10.12	.23	68×64	Fair; not intense.	Were fair; now overripe; not acid.
Gypsum, O.,	46	15.80	2.79	13.01	8.84	1.34	10.18	.45	Small	Fair.	Good, ripe, or a little past.
Santa Fé, N. M.,	18	14.65	2.75	11.90	8.00	.91	8.91	.43	68×53	Rather pale, blushed and striped.	Fair; lacks Fameuse flavor; not much acid.
McIntosh.											
Charlottetown, P. E. I.,	15	15.40	2.21	13.19	6.80	1.19	7.99	.43	Small; roundish	Green and dull red.	Poor; lacks oils; good texture; slightly astringent.
Abbotsford, Que.,	45	14.26	2.38	11.88	7.09	3.44	10.51	.45	68×60	Very good; deep, rich blush.	Good; ripe; possibly a trifle astringent.
Amherst, Mass.,	27	14.77	2.38	12.39	8.17	2.74	10.91	.38	Medium or above	Fair.	Very good; flavoring oils a little low.
Amherst, Mass.,	102	13.59	2.30	11.29	8.26	1.07	9.33	.31	76×57	Fair.	Much overripe; lacks flavor and body; still juicy.
Geneva, N. Y.,	9	15.05	2.21	12.84	9.90	2.68	12.58	.35	66×54	Striped and blushed; good.	More aromatic and tender than No. 8.
Storrs, Conn.,	8	14.10	2.42	11.68	5.50	2.14	7.64	.39	76×66	Fair to good.	Fair; perhaps a little overripe.
Bitter Root Valley, Mont.,	103	13.30	2.42	10.88	7.41	1.61	9.02	.29	Below medium	Very good.	Not equal to No. 27; seems astringent; perhaps picked immature.
Jonathan.											
Ghent, N. Y.,	105	15.60	2.68	12.92	9.39	.31	9.81	.40	67×56	Fair though not equal to best.	Good; lacks body; barely ripe.
Wyoming, Del.,	49	15.71	2.35	13.36	8.05	2.60	10.65	.42	72×62	Fair.	– –

Proctorville, O.,	24	14.42	2.21	12.21	8.43	1.52	9.95	.42	70×58	Fair; 40 per cent. over color.	Good, but not as rich as No. 23; less mature.
Moran, Kan.,	73	15.88	2.20	13.68	9.88	.00	9.88	.34	68×62	Very good.	Good; prime condition.
Kincaid, Kan.,	80	14.35	2.23	12.12	9.66	.61	10.27	.31	71×58	Fair, not very deep.	Good; fully ripe or a little past.
Tip Top, Ky.,	29	16.18	2.70	13.48	9.00	1.98	10.98	.60	Small	Deep, dull red.	Fair to good.
Mountain Park, N. M.,	23	15.68	2.30	13.38	8.35	3.42	11.77	.55	73×64	Very good; waxy yellow and deep red.	Good; slightly acid; eating ripe.
Hood River, Ore.,	106	13.83	2.23	11.60	8.16	1.34	9.50	.36	73×61	Good, about like No. 105.	Very good; more tender than No. 105; variable.
Ghent, N. Y.,	1910	13.97	2.35	11.62	5.36	2.40	7.76	.39	-	-	-
Kelowna, B. C.,	1910	16.24	2.58	13.66	6.48	2.40	8.88	.50	-	-	-
Esopus Spitzenburg.											
Cornwall, Conn.,	1910	16.51	2.54	13.97	6.81	3.10	9.91	.49	-	-	-
Hood River, Ore.,	1910	19.07	2.79	16.28	7.18	4.22	11.40	.62	-	-	-
Grimes.											
Storrs, Conn.,	109	14.97	2.55	12.42	6.71	2.98	9.69	.39	69×64	Good; considerable russet.	Good, but not equal to No. 108; ripe.
Gypsum, O.,	48	18.66	3.04	15.62	5.36	5.43	10.79	.47	67×56	Fair to good; some russet.	-
Proctorville, O.,	22	17.84	2.52	15.32	8.40	3.34	11.74	.34	71×58	Good; yellow; some russet.	Good, better than No. 21; very slightly acid.
Landisburg, Pa.,	70	14.33	2.24	12.09	7.08	3.50	10.58	.31	75×66	Fair to good; not clear and bright.	Good; more acid and not as rich as No. 68 and No. 69.
Wyoming, Del.,	50	17.58	2.81	14.77	5.81	4.71	10.52	.64	80×65	Good, slightly russeting.	Excellent; prime condition.
Mitchell, Ind.,	68	15.95	2.50	13.45	8.35	4.24	12.59	.24	76×67	Excellent; clear, rich yellow.	Excellent; fully ripe; sweetish.
Tip Top, Ky.,	21	19.87	3.07	16.70	8.35	5.54	13.89	.50	66×54	Good; very slightly russet.	Fair; lacks flavoring oils; slightly overripe.
Moran, Kan.,	69	16.62	2.48	14.14	8.39	3.46	11.85	.28	74×62	Very good.	Good; slightly wilted; a little overripe.
Kelowna, B. C.,	108	15.40	2.42	12.98	6.86	2.98	9.84	.34	71×65	Excellent; clear straw-yellow.	Excellent; crisp; mild subacid; just ripe.
Storrs, Conn.,	1910	16.00	2.84	13.16	6.53	2.97	9.50	.39	-	-	-
Kelowna, B. C.,	1910	16.68	2.65	14.03	7.82	3.38	11.20	.29	-	-	-

Table 7. — *Chemical Determinations* — Continued.

Variety and Source.	Laboratory Number.	Total Solids (Per Cent.).	Insoluble Solids (Per Cent.).	Soluble Solids (Per Cent.).	Reducing Sugars (Per Cent.).	Sucrose (Per Cent.).	Total Sugars (Per Cent.).	Malic Acid (Per Cent.).	Size (Millimeters).	Color.	Quality.
King.											
Amherst, Mass.,	26	15.20	2.53	12.67	8.61	2.06	10.67	.35	Medium	Rich, yellow, fair over-color.	Good; ripe, or a little past.
Gypsum, O.,	35	17.75	2.36	15.39	8.25	2.71	10.96	.41	82×72	Good, somewhat russeting.	Very good; clear, mild subacid; somewhat mealy; a little overripe.
Rhode Island Greening.											
Amherst, Mass.,	4	15.29	2.68	12.61	3.91	4.07	8.01	.62	Large	Good, yellow-green.	Good, though not very rich.
Amherst, Mass.,	93	14.23	2.91	11.32	6.04	1.42	7.46	.52	84×65	Good, yellow-green.	Very good; slightly past time.
Gypsum, O.,	53	16.25	3.12	13.13	6.45	3.88	10.33	.75	80×58	Good, greenish.	Very good; not very acid; eating, ripe.
Landisburg, Pa.,	75	17.51	2.86	14.65	7.98	3.71	11.69	.48	80×64	Good, deeper yellow than No. 74.	Good, better than No. 74; richer and sweeter.
Kincaid, Kan.,	74	15.05	2.68	12.37	7.48	1.77	9.25	.38	85×65	Good, clear yellowish-green.	Fair; not up to best; possibly a little overripe.
Northern Spy.											
Port Williams, N. S.,	1910	16.80	2.62	14.18	6.91	3.42	10.33	.43	-	- -	- -
Charlotteville, P. E. I.,	86	14.22	2.98	11.24	8.48	1.42	9.90	.59	72×62	Fair; 20 per cent. striped and splashed.	Poor; lacks Spy flavor; slightly astringent.
Middlebury, Vt.,	101	14.47	2.28	12.19	7.88	2.30	10.18	.44	86×74	Very good.	Good; more crisp than No. 100; a little better flavor.
Concord, Mass.,	87	14.51	2.14	12.37	9.14	1.53	10.67	.32	81×69	Good; 30 to 40 per cent. covered.	Very good; perhaps a trifle past prime.
Amherst, Mass.,	95	13.94	2.46	11.48	8.04	.00	8.04	.38	78×67	Rich yellow; over-color not best.	Fair to good; full ripe.
Meshoppen, Pa.,	54	15.80	2.21	13.59	7.84	2.86	10.70	.46	96×76	Good, but not brightest.	Good; lacks oils; not up to best.
Johnson, Neb.,	30	14.37	2.34	12.03	8.47	1.98	10.45	.44	Above medium	Good; yellow; over-color pale and scant.	Poor; lacks oils, sugars and acid; flat.

Kelowna, B. C.,	100	14.63	2.21	12.42	8.12	1.99	10.11	.44	83×72	Very good; well covered; bright.	Fair and crisp; lacks flavor, though good.
Grand Isle, Vt.,	1910	15.55	2.45	13.10	7.39	3.21	10.60	.48	-	- -	- -
Kelowna, B. C.,	1910	15.18	2.17	13.01	7.71	3.10	10.81	.41	-	- -	- -
Baldwin.											
Amherst, Mass.,	1	14.32	2.60	11.72	4.49	3.41	7.90	.86	Medium	Dull green and red.	Sour; not yet ripe.
Amherst, Mass.,	98	11.15	2.11	9.04	5.84	2.41	8.25	.73	71×56	Dull green and red.	Good; acid; probably lacks sugars.
Amherst, Mass.,	2	17.08	2.98	14.10	4.49	6.15	10.64	.63	Medium and above	Good; bright yellow and red.	Good; hardly ripe, but much riper than No. 1.
Amherst, Mass.,	97	15.77	2.74	13.03	6.19	2.75	8.94	.43	72×62	Very good; clear, rich, bright.	Very good; a bit overripe.
Amherst, Mass.,	3	16.10	2.76	13.34	3.74	5.53	9.27	.64	Medium and above	Clear, bright yellow; fairly well covered.	Fairly good; a little riper than No. 2; not as good.
Gypsum, O.,	51	17.01	2.83	14.18	6.25	4.75	11.00	.71	78×65	Fair, considerable russet.	Good; no signs of too much heat.
Meshoppen, Pa.,	52	16.59	2.86	14.73	6.23	3.66	9.89	.68	81×63	Good; more intense than No. 51.	Good; nearly ripe.
Kelowna, B. C.,	107	14.41	2.44	11.97	5.90	2.45	8.35	.41	84×68	Very good; bright.	Good; slight astringency; lacks flavor.
Kincaid, Kan.,	78	16.92	2.53	14.39	7.63	4.16	11.79	.43	77×64	Good, well covered; fairly bright.	Good, mild, subacid; almost sweetish; firm texture.
Hollis, N. H.,	1910	16.68	2.80	13.88	5.93	3.23	9.16	.53	-	- -	- -
Kelowna, B. C.,	1910	15.18	2.43	12.75	5.31	2.55	7.86	.52	-	- -	- -
Winesap.											
Amherst, Mass.,	94	14.88	3.18	11.70	7.46	1.31	8.80	.52	76×61	Dull, somewhat rusty.	Poor; acid; slightly astringent; not ripe.
Wyoming, Del.,	58	16.65	2.53	14.12	8.85	2.87	11.72	.35	78×64	Excellent; dark, rich red.	Very good; crisp and juicy; not very ripe.
Woodside, Del.,	60	14.55	2.63	11.92	8.97	.45	9.42	.49	63×56	Fairly deep, but dull.	Good; lacks richness; a bit acid.
New Burnside, Ill.,	34	18.89	2.83	16.06	10.88	2.24	13.12	.43	76×57	Good.	Rather poor; mealy; overripe.
Dayton, Tenn.,	32	17.07	2.74	14.33	11.02	.75	11.77	.38	62×49	Good.	Good, but not up to best; ripe, firm, crisp.
Johnson, Neb.,	33	19.05	2.70	16.35	10.35	2.84	13.19	.51	72×58	Good.	Fairly good; full ripe.
Kincaid, Kan.,	76	18.24	2.81	15.43	11.06	2.92	13.98	.48	66×56	Good, fairly rich red.	Fair; lacks richness.

TABLE 7. — *Chemical Determinations* — Continued.

VARIETY AND SOURCE.	Laboratory Number.	Total Solids (Per Cent.).	Insoluble Solids (Per Cent.).	Soluble Solids (Per Cent.).	Reducing Sugars (Per Cent.).	Sucrose (Per Cent.).	Total Sugars (Per Cent.).	Malic Acid (Per Cent.).	Size (Millimeters).	Color.	Quality.
Winesap — Con.											
Manhattan, Kan.,	31	17.51	2.85	14.66	9.02	3.35	12.37	.63	Small	Deep; not very bright.	Good; ripe.
Jeff, Ala.,	59	15.70	2.61	13.09	9.75	.08	9.83	.42	68×57	Fair, pale.	Poor; lacks flavor; much overripe.
Stayman Winesap.											
Wyoming, Del.,	62	16.14	2.39	13.75	7.11	4.52	11.63	.43	80×70	Well covered, but dull.	Extremely good; tender, juicy, subacid.
Woodside, Del.,	63	16.39	3.05	13.34	8.98	2.56	11.54	.70	68×58	Fair, not intense.	Fair to good; not so rich as No. 62; more acid.
Harris Wharf, Md.,	99	14.97	2.12	12.85	8.25	3.25	11.50	.42	79×69	Fair to good; some russet.	Very good; crisp, tender, juicy.
Rome Beauty.											
Gypsum, O.,	56	15.51	2.87	12.64	6.32	3.29	**9.61**	.43	80×69	Good; yellow, green and bright red (one-third to two-thirds).	Fair; seems undeveloped but ripe.
Iola, Kan.,	77	13.90	2.63	11.27	6.69	2.72	9.41	.30	85×66	Rich straw-yellow and pale red (30 to 40 per cent.).	Overripe; mealy; not good.
West Fork, Ark.,	90	17.75	3.18	14.57	7.30	3.48	10.78	.51	Medium	Good; well covered; fairly bright.	Not good; lacks flavor; mealy; probably overripe, though firm.
Smith Cider.											
Landisburg, Pa.,	89	17.96	3.56	14.40	7.02	2.37	9.39	.57	81×71	Good; 50 to 60 per cent. covered; fairly bright.	Pretty good: a little overripe.
Kincaid, Kan.,	88	16.78	3.05	13.73	8.05	2.37	10.42	.44	84×68	Fair, a little pale.	Extremely poor; far overripe; very dry and mealy.

Roxbury Russet.											
Amherst, Mass., . .	104	18.42	2.94	15.48	7.42	.84	8.28	.66	77×59	Good.	Very good; prime condition.
Proctorville, O., . .	43	19.55	2.72	16.83	9.65	4.19	13.84	.40	73×57	Good; well russeted.	Good, somewhat wilted; ripe, or a little past.
Wyoming, Del., . .	61	17.93	2.49	15.44	6.52	7.64	14.16	.70	77×58	Good, deep, even russet.	Fair to good.
Amherst, Mass., . .	1910	19.03	3.14	15.89	6.96	5.93	12.89	.60	-	- -	- -
York Imperial.											
Amherst, Mass., . .	96	14.38	2.89	11.49	7.67	.46	8.13	.41	78×62	Good, yellow, overcolor pale and scant.	Fair; just about ripe.
Landisburg, Pa., . .	81	15.13	2.62	12.51	8.57	1.65	10.22	.37	81×65	Excellent; rich; fairly deep red.	Good, firm and crisp; just ripe; sweetish.
Wyoming, Del., . .	25	15.60	2.84	12.76	7.78	2.66	10.44	.39	78×68	Good; straw-yellow; overcolor scanty.	Fair, firm and crisp; very nearly ripe.
Woodside, Del., . .	57	16.02	2.70	13.32	7.28	4.01	11.29	.28	88×78	Good; fairly bright; not intense.	Good; very juicy; sweetish; barely ripe; crisp.
Dayton, Tenn., . .	35	16.47	2.76	13.71	7.61	3.22	10.83	.42	79×58	Good.	Very good; just ripe.
Johnson, Neb., . .	36	17.62	2.85	14.77	7.45	3.78	11.23	.49	78×68	Good.	Very good; just ripe.
Manhattan, Kan., . .	37	16.20	2.45	13.75	8.68	3.40	12.08	.41	74×63	Good; a little rusty.	Very good; ripe; crisp.
Kincaid, Kan., . .	79	15.81	2.59	13.22	8.55	2.53	11.08	.38	80×66	Very good; nearly covered; rich red.	Good; prime condition; not as crisp as some.
Yellow Newtown.											
Milton-on-Hudson, N. Y.,	1910	17.25	2.66	14.59	7.38	3.13	10.51	.42	-	- -	- -
Hood River, Ore., . .	1910	15.70	2.83	12.87	7.79	3.00	10.79	.51	-	- -	- -
Ben Davis.											
Charlottetown, P. E. I., .	91	15.78	4.28	11.50	7.07	.46	7.53	.54	63×58	Poor; 25 to 40 per cent. covered.	Very poor; green; astringent; hard.
Abbotsford, Que., . .	67	14.38	3.34	11.04	6.28	2.26	8.69	.39	66×55	Poor; not well covered.	Not ripe; about like No. 66.
Marblehead, Mass., . .	66	14.21	3.61	10.60	7.24	2.41	9.50	.42	63×58	Poor; not well covered.	Not yet ripe; poor; slightly astringent; acid; tough.
Amherst, Mass., . .	92	15.08	4.02	11.06	5.64	1.87	7.51	.61	75×66	Good.	Fair to good; perhaps not quite ripe.
Belleville, Ont., . .	39	17.51	3.69	13.91	7.65	3.23	10.88	.42	70×58	Good.	Fair to good; not ripe; flesh greenish.

TABLE 7. — *Chemical Determinations* — Concluded.

Variety and Source.	Laboratory Number.	Total Solids (Per Cent.).	Insoluble Solids (Per Cent.).	Soluble Solids (Per Cent.).	Reducing Sugars (Per Cent.).	Sucrose (Per Cent.).	Total Sugars (Per Cent.).	Malic Acid (Per Cent.).	Size (Millimeters).	Color.	Quality.
Ben Davis — Con.											
South Haven, Mich.,	82	15.21	3.39	11.82	6.25	2.98	9.23	.44	70×65	Fair; 25 to 40 per cent. covered.	Fair; ripe.
Gypsum, O.,	65	16.53	3.28	13.25	7.46	3.32	10.78	.51	67×57	Fair; not well covered.	A little riper than No. 64; hardly as acid.
Mitchell, Ind.,	83	13.88	2.77	11.11	5.75	1.53	7.28	.45	80×68	Very good; all covered, striped.	Very good; prime condition.
Wyoming, Del.,	64	15.57	3.20	12.37	6.77	3.35	10.02	.52	78×62	Very good; not well covered.	Not quite ripe; promises good.
Johnson, Neb.,	38	15.31	2.68	12.63	6.53	3.46	9.99	.51	81×65	Excellent.	Excellent; just ripe; flesh white.
Manhattan, Kan.,	42	15.42	2.89	12.53	6.98	3.34	10.32	.39	74×61	Good.	Good; a little more acid than No. 41.
Kincaid, Kan.,	84	15.17	2.88	12.29	6.88	3.59	10.47	.41	81×70	Very good; like No. 83.	Very good; equal or better than No. 63.
Springdale, Ark.,	40	15.46	3.06	12.40	7.29	1.67	8.96	.43	77×66	Fair; slightly pinkish.	Good; ripe, lacks flavoring oils; flesh white.
Bentonville, Ark.,	41	15.64	2.86	12.78	7.44	2.35	9.79	.29	75×65	Good.	Very good; flesh white.
West Fork, Ark.,	85	16.53	3.13	13.40	6.95	3.71	10.66	.47	Above medium	Good; dark but dull.	Mealy and dry; overripe.

VII. SUMMARY.

Some of the more important results of this work may be summarized as follows: —

1. The many variations in apple varieties arise from many causes, which may be grouped as (1) cultural, using the word in a broad sense; (2) soil; and (3) climatic. Of climatic influences, temperature is the most potent.

2. The life history of the apple may for convenience in discussion be divided into four periods: (1) growth, extending from the blossom to the attainment of full size; (2) ripening, extending to the time of harvest; (3) after ripening, extending to complete edible maturity; and (4) decay, covering the period of physiological breaking down.

3. The apple of superior table quality is high in sugars, especially sucrose, and low in insoluble solids, indicating a tender flesh and fine texture. The acid is proportionate to sugars; the ratio may vary somewhat to accord with different tastes. Good kitchen apples are wider in ratio of sugars to acid, and the proportion of insoluble solids is of little significance. Good shipping apples are high in insoluble solids.

4. In any variety of apples, high development at full maturity is marked by the attainment of full normal size for the variety, high color, well spread over the apple, and a high development of sugars, especially sucrose.

5. Each variety has a characteristic chemical composition, fairly constant when perfect maturity is attained. Most of the differences found in different samples of a variety are due to a difference in the stage of development reached.

6. The fruit of individual trees shows slight differences in size, color, form and abundance that are characteristic and not due to environmental conditions. Some of this may be due to bud variation, but it is believed that most of it is due to the interrelation of stock and scion.

7. Variation in form in the Ben Davis, and probably in other sorts as well, is due principally to the temperature during a period of about two or three weeks following blossoming. The lower the temperature the more elongated the apple. This elon-

gation is seen in apples grown near large bodies of water, which lower the temperature at this season of the year, and in seasons when the temperature is low owing to seasonal fluctuations. This influence is also seen in the form of apples in different parts of the tree. Those in the lower north portion are more elongated than those from the warmer, upper south portion.

8. Seasonal temperature affects the size of apples, a cool season resulting in smaller fruit. This is marked only in full-season varieties, and is especially noticeable in the more northerly portions of their distribution. On the other hand, in the extreme south a variety is apt to be smaller than when grown in a somewhat cooler climate.

9. For convenience in discussion, North America may be divided into seven apple belts, each having a fairly characteristic list of varieties. These are named and illustrated in the text.

10. Some varieties are of wide distribution; others more or less limited. Varietal qualities favoring a wide distribution are (1) great hardiness of tree, (2) a short season of development, (3) great vigor and ability to thrive under generally unfavorable conditions, (4) productiveness and good market qualities.

11. The northern limit of apple growing is fixed by the minimum winter temperature, and the southern limit by the heat of the hottest part of the summer, occurring usually in July or August.

12. The attainment of the highest quality, appearance and keeping quality is very largely dependent on the warmth and length of the growing season. This may be measured with fair satisfaction for the apple-growing regions of North America by an average of the mean temperatures for the months of March to September inclusive. This is called the mean summer temperature, and give temperatures ranging from 52° to 72°.

13. Factors determining the mean summer temperature in a given orchard are (1) latitude, (2) elevation, (3) site and aspect, (4) soil, (5) culture, (6) prevailing winds, (7) sunshine.

14. The optimum mean summer temperature for different varieties may be determined with fair satisfaction, and some deter-

minations are shown in Table 5. A departure of over 2° from this mean will result in less desirable fruit, though this may not be marked in short-season varieties.

15. A summer mean too low for a variety results in (1) greater acidity, (2) increased insoluble solids, (3) greater astringency, (4) less coloration, (5) decreased size, (6) scalding in storage.

16. A summer mean too high for a variety results in (1) uneven ripening, (2) premature dropping, (3) rotting on the trees, (4) poor keeping quality, (5) lack of flavor, (6) "mealiness," (7) less intense color, (8) decreased size.

COMPILATIONS.

Introduction.

BY J. B. LINDSEY.

A compilation of the chemical composition of fodder articles, agricultural chemicals and manurial residues was first made by Prof. C. A. Goessmann and his assistants in 1887, and published in the fifth report of the Massachusetts State Agricultural Experiment Station, pages 181–227. This compilation included all analyses made by Goessmann and his co-workers since 1868. It was later enlarged to include compilations of the analyses made at this station of dairy products, fruits, garden crops and insecticides. The parties largely responsible for the details of the several compilations were W. H. Beal, C. S. Crocker, J. B. Lindsey, H. D. Haskins, E. B. Holland and P. H. Smith. In 1896 the classification of fodder articles was considerably modified and improved; the present compilation of agricultural chemicals and manurial residues has undergone a similar rearrangement, and the available analyses have been added to the compilation of fruits and garden crops. Naturally a few materials, being no longer of interest, have been omitted.

The tables of compilations are as follows: —

Compilation of Analyses of Fodder Articles and Dairy Products, made at Amherst, Mass., 1868-1910.[1]

P. H. SMITH AND J. B. LINDSEY.

Table I. — Composition and Digestibility of Fodder Articles.

- I. Green fodders.
  - (a) Meadow grasses and millets.
  - (b) Cereal fodders.
  - (c) Legumes.
  - (d) Mixed and miscellaneous.
- II. Silage.
- III. Hay and dry, coarse fodders.
  - (a) Meadow grasses and millets.
  - (b) Cereal fodders.
  - (c) Legumes.
  - (d) Straw.
  - (e) Mixed and miscellaneous.
- IV. Vegetables, fruits, etc.
- V. Concentrated feeds.
  - (a) Protein.
  - (b) Starchy.
  - (c) Poultry.

Table II. — Fertilizer Ingredients of Fodder Articles.
Table III. — Analyses of Dairy Products.

Explanation of Table I.

Under *composition* the figures mean that each 100 pounds of the fodder contains so many pounds of water, protein, fiber, etc.

Water. — The approximate average which is likely to occur in the material is stated.

Ash refers to the residue which is left behind when the material is burned, and consists of lime, potash, soda, magnesia, iron, phosphoric and sulfuric acids.

Protein is a collective name for all of the nitrogenous matter; it corresponds to the lean meat in the animal, and may be termed

[1] Part III. of the report of Department of Plant and Animal Chemistry.

"vegetable meat." It serves as the exclusive source of flesh, as well as a source of heat or energy, and fat.

Fiber is the coarse or woody part of the plant. It may be called the plant's framework. It is a source of heat or energy and fat.

Nitrogen-free extract represents the sugars, starches and gums. It is the principal source of heat or energy and fat.

Fat includes not only the various oils and fats in all grains and coarse fodders, but also waxes, resins and coloring matters. It is also termed ether extract because it is that portion of the plant soluble in ether. It serves as a source of heat or energy and body fat.

Under *digestibility* the figures mean that so many pounds of protein, fiber, nitrogen-free extract and fat in 100 pounds of the fodder are actually digested and made use of by the animal. No feed is entirely digestible; concentrates are more digestible than coarse fodders. The data under digestibility have been worked out by actual experiment. In cases where no figures appear, data as a result of experiments are lacking.

Net Energy Value. — The entire amount of heat or energy contained in a feeding stuff is termed its total heat or energy value. All of this heat or energy cannot be utilized by the animal for the purposes of maintaining its body in a state of equilibrium, or for aiding in the production of growth and milk. The several losses may be enumerated as follows: (*a*) the undigested material, *i.e.*, the fæces; (*b*) the incompletely used material of the urine; (*c*) the work required in the processes of digestion and assimilation in preparing the nutrients so that they can be used for maintenance and for the production of growth and milk. These several sources of loss expressed as energy, deducted from the total energy, leaves the real or *net energy value.*

The calorie is the unit of energy measurement.

The small calorie represents the amount of heat required to raise 1 gram of water 1° C.

The large calorie represents the amount of heat necessary to raise 1 kilogram (1,000 grams) of water 1° C.

The therm, a name proposed by Armsby, represents the amount of heat required to raise 1,000 kilograms of water 1° C. It is to be preferred to the small or large calorie as a unit of measurement because it can be expressed in fewer figures.

In the last column of the following table, headed net energy value, is given the number of therms contained in 100 pounds of the different feeding stuffs, based on the results of very carefully conducted experiments by Kellner, a German investigator.[1]

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[1] For a full explanation of the components of the animal body, the composition of feeds, the different ways in which the food is used in the animal body and the explanation for using the therm in the calculation of rations for farm animals, see Farmers' Bulletin 346, United States Department of Agriculture, prepared by H. P. Armsby.

Table I. — Composition and Digestibility of Fodder Articles.

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Composition.						Digestibility.				Net Energy Values (Therms).
		Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	
I. Green Fodders.												
(a) Meadow Grasses and Millets.												
Johnson grass (*Andropogon halepensis*),	1	75	1.4	1.2	8.9	13.2	0.3	–	–	–	–	–
Orchard grass (*Dactylis glomerata*),	7	70	2.1	2.9	10.4	13.7	0.9	–	–	–	–	–
Tall oat grass (*Arrhenatherum elatius*),	4	70	1.6	2.3	10.8	14.7	0.6	–	–	–	–	–
Fox-tail millets. Common millet (*Chætochloa Italica*),	16	80	1.0	1.5	6.5	10.5	0.5	0.9	4.6	7.0	0.3[1]	9.9
Fox-tail millets. Canary bird seed millet (*C. Italica*),	1	80	1.6	1.0	7.1	10.0	0.3	–	–	–	–	–
Fox-tail millets. Early harvest millet (*C. Italica*),	1	80	1.4	1.1	7.4	9.7	0.4	–	–	–	–	–
Fox-tail millets. Golden millet (*C. Italica*),	1	80	1.2	0.8	7.0	10.7	0.3	–	–	–	–	–
Fox-tail millets. Hungarian grass (*C. Italica*),	3	80	1.4	1.9	5.8	10.5	0.4	1.2	4.1	7.0	0.2	9.9
Fox-tail millets. Japanese millet (*C. Italica*),	12	80	1.2	1.7	6.2	10.5	0.4	0.9	3.8	7.0	0.3	9.4
Broom-corn millets. Millet (*Panicum miliaceum*),	1	80	1.1	1.1	5.3	11.7	0.8	–	–	–	–	–
Broom-corn millets. Broom-corn millet (*P. miliaceum*),	1	80	1.2	1.3	6.4	10.7	0.4	–	–	–	–	–
Broom-corn millets. Hog millet (*P. miliaceum*),	1	80	1.4	1.5	6.5	10.2	0.4	–	–	–	–	–
Broom-corn millets. Japanese broom-corn millet (*P. miliaceum*),	2	80	1.2	0.9	6.2	11.4	0.3	–	–	–	–	–
Barnyard millet (*Panicum crus-galli*),	8	80	1.7	1.9	6.6	9.4	0.4	1.2	4.8	6.7	0.2	9.9

[1] Same coefficients used as for Hungarian grass.

TABLE I. — COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Composition.						Digestibility.				Net Energy Values (Therms).
		Water.	Ash.	Protein.	Fiber.	Nitrogen free Extract.	Fat.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	
I. GREEN FODDERS — *Con.*												
(*a*) *Meadow Grasses and Millets* — Con.												
Pearl millet (*Pennisetum spicatum*),	1	80	1.4	1.4	6.9	10.1	0.2	–	–	–	–	–
Japanese millet (variety uncertain),	3	80	1.1	1.2	7.1	10.2	0.4	0.6	4.4	6 8	0.3	8.8
(*b*) *Cereal Fodders.*												
Barley,	1	75	2.1	3.2	9.4	9.6	0.7	2.3	5 7	6.8	0.4	10.7
Barley in milk,	1	75	1.2	2.6	7.3	13.2	0.7	1.8	4.1	9.8	0.3	12.9
Corn ears (as harvested),	4	70	0.7	2.9	4.0	21.5	0.9	–	–	–	–	–
Corn husks (as harvested),	6	80	0.7	1.2	6.0	11.8	0.3	–	–	–	–	–
Corn leaves (as harvested),	4	75	2.4	3.6	6.2	12.0	0.8	–	–	–	–	–
Corn stalks (as harvested),	4	80	1.0	0.8	6.5	11.5	0.2	–	–	–	–	–
Corn fodder, Brewers Dent,	2	80	1.0	2.0	5.0	11.7	0.3	1.4	3.4	9.0	0.2	12.0
Corn fodder Early Mastodon Dent,	3	80	0.9	1.7	4.6	12.4	0.4	1.0	2.8	9.8	0.3	12.3
Corn fodder, Klondike,	1	80	1.2	1.1	5.7	11.7	0.3	–	–	–	–	–
Corn fodder, Leaming,	5	80	1.0	1.6	4.9	12.1	0.4	1.0	3.0	9.3	0.3	11.8
Corn fodder, Longfellow,	1	80	1.1	1.8	4.0	12.8	0.3	–	–	–	–	–
Corn fodder, Pride of the North,	6	80	0.9	1.7	4.3	12.6	0.5	1.1	2.8	10.2	0.4	13.2

Corn fodder, Red Cob Silage,	1	80	0.9	1.2	5.4	12.2	0.3	–	–	–	–	–
Corn fodder, Sanford White,	1	80	0.8	1.4	4.0	13.3	0.5	0.7	3.0	9.4	0.3	12.1
Corn fodder, Twitchells,	1	80	0.9	2.0	3.4	13.1	0.6	–	–	–	–	–
Corn fodder, Wings Improved Whitecap,	2	80	1.0	1.8	4.6	12.3	0.3	1.1	3.0	9.3	0.2	14.8
Corn fodder, Whitecap Yellow Dent,	2	80	0.9	1.6	4.4	12.7	0.4	–	–	–	–	–
Corn fodder, average,	76	80	1.0	1.6	4.6	12.4	0.4	0.9	2.8	9.4	0.3	11.8
Sweet corn stover,	2	80	1.2	1.4	4.9	12.0	0.5	0.7	2.8	8.8	0.4[1]	10.9
Oats (stage uncertain),	6	75	2.0	3.5	7.5	11.2	0.8	2.6	4.1	6.9	0.6[2]	11.0
Oats in bloom,	1	75	1.7	1.6	9.0	12.0	0.7	1.1	5.0	7.4	0.5[2]	9.8
Oats in milk,	1	75	1.5	2.7	8.6	11.5	0.7	2.0	4.7	7.1	0.5[2]	10.4
Oats, ripe,	1	70	1.9	1.8	10.9	14.6	0.8	–	–	–	–	–
Rye,	2	75	1.4	1.9	8.0	13.2	0.5	1.5	6.4	9.4	0.4	14.3
Winter rye in bloom,	1	75	1.6	2.7	8.3	11.8	0.6	2.1	6.6	8.4	0.4	13.9
Sorghum, Early Amber (heading out),	2	80	1.2	1.3	6.2	10.9	0.4	0.7	4.7	8.5	0.3	11.7
Sorghum, Early Amber (full blossom),	1	80	1.0	1.0	5.9	11.6	0.5	0.5	4.4	9.0	0.4	12.1
Sorghum, Early Amber (beyond full blossom),	1	80	0.9	1.2	6.4	11.2	0.3	0.5	3.5	8.2	0.2	9.5
Sorghum, average,	4	80	1.0	1.2	6.2	11.2	0.4	0.6	3.8	8.4	0.3	10.4
(c) *Legumes.*												
Alfalfa (*Medicago sativa*),	6	80	1.6	2.7	6.2	9.1	0.4	2.0	2.7	6.6	0.2	8.5
Horse bean (*Faba vulgaris*),	1	85	0.9	2.5	4.3	6.9	0.4	–	–	–	–	–
Soy bean (*Glycine hispida*),	14	80	2.1	3.5	5.4	8.1	0.9	2.7	2.4	6.2	0.5[3]	9.6
Soy bean (early white),	4	80	2.6	3.4	4.5	9.0	0.5	2.7	2.0	6.9	0.3[3]	10.2

[1] Same coefficients used as for corn fodder.
[2] Same coefficients applied to oats in several stages of growth.
[3] Same coefficients applied to all soy beans except to medium green varieties in different stages of growth.

TABLE I. — COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

NAME.	Number of Analyses.	Composition.						Digestibility.				Net Energy Values (Therms).
		Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	
I. GREEN FODDERS — *Con.*												
(*c*) *Legumes* — Con.												
Soy bean (medium green),	18	80	2.3	4.1	5.2	7.8	0.6	3.2	2.4	6.0	0.3[1]	9.7
Soy bean (medium green), in bud,	1	80	2.5	4.2	5.5	7.3	0.5	3.3	2.8	5.3	0.3	9.2
Soy bean (medium green), in blossom,	5	80	2.3	4.0	5.5	7.7	0.5	3.1	2.6	5.5	0.3	9.0
Soy bean (medium green), in pod,	9	78	2.3	4.5	5.9	8.6	0.7	3.5	2.7	6.6	0.4	10.7
Soy bean (medium black),	2	80	2.5	3.8	4.7	8.0	1.0	3.0	2.1	6.2	0.6[1]	10.3
Soy bean (late),	4	80	2.6	4.6	4.2	8.0	0.6	3.6	1.9	6.2	0.3[1]	10.4
Clover, alsike (*Trifolium hybridum*),	8	80	2.3	3.3	5.4	8.5	0.5	–	–	–	–	–
Clover, crimson (*T. incarnatum*),	2	80	2.8	3.1	6.0	7.6	0.5	2.4	3.4	5.6	0.3	9.0
Clover, mammoth red (*T. medium*),	4	80	1.9	3.0	5.8	8.9	0.4	–	–	–	–	–
Clover, medium red (*T. pratense*),	13	80	1.8	3.1	5.7	8.8	0.6	2.0	3.0	6.3	0.4	9.3
Clover, medium red, in bud,	2	80	2.1	3.6	4.7	9.0	0.6	2.4	2.5	6.6	0.4[2]	10.1
Clover, medium red, in blossom,	3	79	1.9	3.5	6.0	9.0	0.6	2.3	3.2	6.5	0.4	9.9
Clover, medium red, seeding,	2	75	2.3	3.8	7.2	11.0	0.7	2.5	3.8	7.9	0.4	10.2
Sweet clover (*Melilotus alba*),	4	80	1.9	3.8	6.3	7.4	0.6	–	–	–	–	–
Cow pea (*Vigna catjang*),	12	85	2.0	2.8	3.5	6.3	0.4	2.1	2.1	5.1	0.2[3]	8.1

Cow pea, black,	6	85	2.2	2.8	3.6	6.1	0.3	2.1	2.2	4.9	0.2[3]	8.0
Cow pea, New Era,	1	85	1.9	2.6	3.6	6.4	0.5	2.0	2.2	5.2	0.3[3]	8.3
Cow pea, Whip-poor-will,	7	85	1.9	2.6	3.7	6.5	0.3	2.0	2.2	5.3	0.2[3]	8.9
Canada beauty pea (*Pisum arvense*),	1	85	1.2	2.4	4.4	6.6	0.4	–	–	–	–	–
Canada field pea (*P. arvense*),	8	85	1.3	3.2	4.3	5.8	0.4	2.6	2.1	4.4	0.2	8.0
Canada field pea (*P. arvense*), in bud,	2	85	1.1	3.2	4.1	6.1	0.5	2.6	2.5	4.3	0.3[4]	8.0
Canada field pea (*P. arvense*), in blossom,	3	87	1.2	2.8	3.8	4.8	0.4	2.3	1.7	3.6	0.2	6.1
Canada field pea (*P. arvense*), in pod,	2	84	1.2	2.3	4.8	6.3	0.4	1.9	2.2	4.8	0.2	6.9
English gray pea (*P. arvense*),	1	85	1.4	3.1	4.5	5.5	0.5	–	–	–	–	–
Prussian blue pea (*P. arvense*),	1	85	1.3	2.8	4.5	5.9	0.5	–	–	–	–	–
Flat pea (*Lathyrus sylvestris wagneri*),	2	85	1.3	4.4	3.7	5.0	0.6	–	–	–	–	–
Sainfoin (*Onobrychis sativa*),	1	75	2.1	4.4	6.0	11.6	0.9	–	–	–	–	–
Serradella (*Orinthopus sativus*),	3	85	1.6	2.2	4.4	6.5	0.3	–	–	–	–	–
Sulla (*Hedysarum coronarium*),	2	75	2.3	4.3	5.2	12.5	0.7	–	–	–	–	–
Spring vetch (*Vicia sativa*),	4	85	1.4	2.7	4.5	6.1	0.4	1.9	2.0	4.6	0.2	7.8
Winter or sand vetch (*Vicia villosa*),	7	85	2.1	3.4	4.4	4.7	0.4	2.8	2.8	3.6	0.3	7.5
Winter or sand vetch (*V. villosa*), in bud,	2	86	2.4	3.3	3.5	4.4	0.4	–	–	–	–	–
Winter or sand vetch (*V. villosa*), in blossom,	4	82	2.5	4.2	5.5	5.4	0.4	3.5	3.5	4.2	0.3	9.1
Kidney vetch (*Anthyllis vulneraria*),	1	85	2.0	2.8	2.3	7.4	0.5	–	–	–	–	–
(*d*) *Mixed and Miscellaneous.*												
Barley and peas,	1	80	1.6	2.8	6.8	8.2	0.6	2.1	3.5	5.6	0.4	8.5
Barley and vetch,	2	80	1.2	2.8	6.5	9.0	0.5	2.1	3.4	6.1	0.3[5]	8.9

[1] Same coefficients applied to all soy beans except to medium green varieties in different stages of growth.
[2] Coefficients taken from the German.
[3] Same coefficients applied to all cow peas.
[4] Same coefficients applied to Canada field peas in blossom and in pod.
[5] Same coefficients used as for barley and peas.

TABLE I. — COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Composition.						Digestibility.				Net Energy Values (Therms).
		Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	
I. GREEN FODDERS — *Con.*												
(*d*) *Mixed and Miscellaneous* — Con.												
Corn and soy bean,	3	80	1.5	2.6	5 0	10.4	0.5	–	–	–	–	–
Corn and cow peas,	1	80	1.8	2.1	5.3	10.4	0.4	–	–	–	–	–
Sweet corn and cow peas,	4	80	1.7	1.7	5.2	10.9	0.5	–	–	–	–	–
Millet and peas,	1	80	1.8	2.4	7.5	8 0	3.0	–	–	–	–	–
Tall oat grass and alsike clover,	2	80	1.5	2 7	5.8	9.5	0 5	–	–	–	–	–
Orchard grass and alsike clover,	1	80	1.5	2.4	6.5	9.0	0 7	–	–	–	–	–
Peas and oats,	4	80	1.7	2.9	6.0	8.8	0.6	2.1	3.8	6.3	0 4	10.0
Sorghum and cow peas,	1	80	1.6	1.6	6.5	9.9	0.4	–	–	–	–	–
Vetch and oats (1-1),	3	80	1.8	3.0	6.3	8.4	0.5	2.3	4.3	5.7	0 2	9.6
Vetch and oats (1-4),	1	80	1.8	2.7	6.0	8.8	0.7	–	–	–	–	–
Wheat and vetch,	4	80	1.6	3.4	6.4	8.1	0.5	2.6	4.4	5.9	0.3	10.4
Apple pomace,	6	83	0.6	1.0	2.9	11.6	0.9	–	1.9	9.9	0.4	11.7
Sugar beet pulp,	1	90	0.1	1.4	2.5	5.9	0.1	0.9	2.1	5.0	–	–
Cabbage waste,	1	82	4.9	3.6	2.6	6 6	0.3	–	–	–	–	–

Carrot tops,	1	80	2.8	4.2	2.7	9.9	0.4	-	-	-	-	-
Prickley comfrey (*Symphytum asperrimum*),	1	87	2.8	2.3	1.5	6.1	0.3	-	-	-	-	-
Purslane (*Portulaca oleracea*),	1	91	1.5	2.3	1.6	3.4	0.2	-	-	-	-	-
Dwarf Essex rape (*Brassica napus*),	1	85	2.4	1.9	2.9	7.2	0.6	1.7	2.5	6.6	0.3[1]	10.3
Summer rape (*B. napus*),	1	85	2.8	2.1	2.7	6.9	0.5	1.9	2.3	6.3	0.2	9.9
Winter rape (*B. napus*),	1	85	3.3	2.3	1.8	7.1	0.5	2.0	1.6	6.5	0.2	9.1
Sorghum (*Andropogon sorghum*),	7	80	1.3	1.7	5.5	11.1	0.4	0.8	3.4	8.3	0.3	10.6
Spurry (*Spergula arvensis*),	1	72	2.6	2.9	7.0	15.4	0.1	-	-	-	-	-
Teosinte (*Euchlæna Mexicana*),	2	70	2.3	2.3	9.4	15.6	0.4	-	-	-	-	-
II. Silage.												
Apple pomace,	1	85	0.6	1.2	3.3	8.8	1.1	-	2.2	7.5	0.5[2]	9.4
Corn,	49	80	1.1	1.7	5.4	11.1	0.7	0.9	3.5	7.7	0.5	10.6
Corn and soy bean,	6	76	2.3	2.7	7.3	10.9	0.8	1.7	4.5	8.5	0.7	12.6
Millet,	3	74	2.4	1.7	7.5	13.6	0.8	-	-	-	-	-
Millet and soy bean,	9	79	2.8	2.8	7.2	7.2	1.0	1.6	5.0	4.2	0.7	8.4
III. Hay and Dry Coarse Fodders.												
(a) Meadow Grasses and Millets.												
Canada blue grass (*Poa compressa*),	1	14	4.8	5.9	31.3	42.1	0.9	2.5	22.2	26.5	0.3	36.0
Kentucky blue grass (*Poa pratensis*),	3	14	6.4	7.7	30.5	39.7	1.7	4.4	20.1	24.2	0.9	35.0
Canada hay,	4	14	4.6	6.1	28.1	45.1	2.1	-	-	-	-	-
English hay (mixed grasses),	122	14	5.3	7.9	27.8	42.8	2.2	4.5	17.2	26.5	1.1	36.9
Fermented hay,	1	14	6.3	8.4	25.4	43.7	2.2	-	-	-	-	-

[1] Same coefficients applied to all varieties of rape.

[2] Same coefficients used as for fresh apple pomace.

Table I. — Composition and Digestibility of Fodder Articles — *Continued.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Composition. Water.	Composition. Ash.	Composition. Protein.	Composition. Fiber.	Composition. Nitrogen-free Extract.	Composition. Fat.	Digestibility. Protein.	Digestibility. Fiber.	Digestibility. Nitrogen-free Extract.	Digestibility. Fat.	Net Energy Values. Therms
III. Hay and Dry Coarse Fodders — *Con.*												
(*a*) *Meadow Grasses and Millets* — Con.												
Meadow fescue (*Festuca elatior pratensis*),	7	14	7.1	5.8	32.2	39.3	1.6	3.0	21.6	23.2	0.9	30.3
Millets. Barnyard grass (*Panicum crus-galli*),	1	14	8.6	13.1	29.0	33.6	1.7	–	–			
Millets. Barnyard millet (*P. crus-galli*),	8	14	7.3	8.2	28.4	40.4	1.7	5.2	17.6	21.0	0.8	30.7
Millets. Hungarian grass (*Chaetochloa Italica*),	3	14	6.3	8.4	24.6	45.0	1.7	5.0	16.7	30.2	1.1	42.4
Orchard grass (*Dactylis glomerata*,)	7	14	5.9	8.3	29.9	39.3	2.6	5.0	18.2	21.6	1.4	32.1
Tall oat grass (*Arrhenatherum elatius*),	4	14	4.6	6.4	30.9	42.1	1.9	3.3	17.0	24.4	1.1	30.8
Red top (*Agrostis alba vulgaris*),	6	14	4.6	6.5	28.5	44.9	1.5	4.0	17.4	27.8	0.8	36.6
Red top (*A. alba vulgaris*) early cut,	1	14	4.3	5.8	30.9	43.3	1.7	–	–	–	–	
Red top (*A. alba vulgaris*), late cut,	1	14	4.1	6.0	31.0	43.2	1.7		–	–	–	
Rowen,	32	14	6.5	11.4	24.1	41.0	3.0	7.9	15.9	26.2	1.4	41.1
Italian rye grass (*Lolium Italicum*),	4	14	6.4	7.1	28.6	42.2	1.6	–	–	–	–	
Perennial rye grass (*Lolium perenne*),	4	14	7.9	10.1	25.4	40.5	2.1	–	–	–	–	–
Salt hays. Black grass (*Juncus Gerardi*),	3	16	7.4	7.0	24.3	43.1	2.2	4.1	14.3	22.4	1.0	28.7
Salt hays. Branch grass (*Distichlis spicata*),	2	16	7.6	6.8	22.4	45.1	2.1	3.8	12.1	22.1	0.7	28.1
Salt hays. Flat sage (*Spartina stricta maritima* var.),	1	16	8.2	6.6	25.0	41.8	2.4	3.4	15.0	23.0	0.9	30.6

Salt hays.	Fox grass (*Spartina patens*),	2	16	5.8	6.7	22.5	46.9	2.1	4.0	11.9	24.9	0.8	31.3
	High-grown salt hay (largely *Spartina patens*),	1	16	7.0	6.3	22.2	46.4	2.1	3.8	11.8	24.6	0.8	30.8
	Cove mixture (black grass and red top),	1	16	6.0	7.4	23.2	45.6	1.8	3.6	13.9	24.2	0.7	31.6
	Mixed salt hay (largely fox grass and branch grass),	1	16	8.4	5.5	22.5	45.5	2.1	2.3	13.1	23.7	0.6	29.1
	Salt hay (variety uncertain),	2	16	4.3	3.4	24.0	49.8	2.5	–		–	–	
Swamp or swale hay,		2	14	5.8	7.1	26.7	44.5	1.9	2.4	8.8	20.5	0.8	19.6
Timothy (*Phleum pratense*),		9	13	4.1	8.0	28.3	43.7	1.9	3.8	14.2	27.1	1.0	30.8
Timothy (*P. pratense*), early cut,		1	14	4.0	5.7	31.0	43.5	1.8	3.2	17.7	27.4	0.9	34.3
Timothy (*P. pratense*), late cut,		1	14	3.9	5.2	29.7	45.2	2.0	2.2	13.7	26.7	1.0	29.2
White top (*Agrostis vulgaris* var.),		1	14	6.0	11.2	24.4	41.5	2.9	–	–	–		
(b) Cereal Fodders.													
Corn stover, from field,		46	40	3.9	4.6	20.6	30.1	0.8	1.7	13.2	17.8	0.6	23.4
Corn stover, very dry,		46	20	5.2	6.1	27.5	40.2	1.0	2.3	17.6	23.7	0.7	31.0
Oats,		6	15	6.9	11.7	25.5	38.3	2.6	6.2	13.0	21.1	1.6	30.4
(c) Legumes.													
Alfalfa, first cutting,		3	15	6.6	14.3	27.2	35.3	1.5	10.3	13.6	21.4	0.5	35.4
Alfalfa, second cutting,		1	15	5.7	13.0	32.3	32.9	1.1	10.0	11.9	24.3	0.5	33.3
Alsike clover,		8	15	9.7	14.0	23.1	36.1	2.1	9.2	11.6	23.8	0.8	34.6
Mammoth red clover,		4	15	8.2	13.1	24.4	37.6	1.7	–	–	–	–	–
Medium red clover, bud to early blossom,		1	15	9.5	15.1	24.1	34.6	1.7	9.7	14.2	23.5	0.9	37.2
Medium red clover, full blossom,		1	15	7.6	13.0	25.4	37.1	1.6	7.8	11.7	25.8	0.9	34.2
Medium red clover,		15	15	7.7	13.3	24.3	37.2	2.5	7.7	13.1	21.2	1.4	35.6

TABLE I. — COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

NAME.	Number of Analyses.	Composition. Water.	Composition. Ash.	Composition. Protein.	Composition. Fiber.	Composition. Nitrogen-free Extract.	Composition. Fat.	Digestibility. Protein.	Digestibility. Fiber.	Digestibility. Nitrogen-free Extract.	Digestibility. Fat.	Net Energy Values (Therms).
III. HAY AND DRY COARSE FODDERS — *Con.*												
(*d*) *Straw.*												
Barley,	2	15	4.8	6.5	32.2	39.0	2.5	1.3	18.0	21.1	1.1[1]	25.5
Horse bean,	1	15	8.1	8.3	35.2	32.1	1.3	–	–	–	–	–
Soy bean,	3	15	6.1	4.7	36.1	36.3	1.8	2.4	13.7	24.0	1.1[1]	31.2
Millet (*Chætochloa Italica*),	1	15	5.3	3.6	35.2	39.5	1.4	–	–	–	–	–
Millet (*Panicum crus-galli*),	1	15	4.6	5.2	30.4	42.7	2.1	–	–	–	–	–
Millet (*P. miliaceum*),	1	15	5.2	3.3	35.9	38.1	2.5	–	–	–	–	–
Millet (variety uncertain),	1	15	5.8	4.2	35.5	38.3	1.2	–	–	–	–	–
Wheat,	1	15	4.1	6.2	30.5	42.8	1.4	0.7	15.9	16.3	0.4[1]	17.2
(*e*) *Mixed and Miscellaneous.*												
Hairy lotus,	2	15	7.0	12.6	16.8	46.1	2.5	–	–	–	–	–
Oat grass and alsike clover,	2	15	6.5	11.6	24.5	40.1	2.3	–	–	–	–	–
Orchard grass and alsike clover,	1	15	6.6	10.1	27.6	38.3	2.4	–	–	–	–	–
Peas and oats,	4	15	7.2	12.2	25.5	37.5	2.6	8.9	14.8	22.9	1.5	36.7
Vetch and oats (1-1),	3	15	7.4	12.8	26.7	35.8	2.3	8.3	13.1	21.1	1.4	31.4
Wheat and vetch,	4	15	6.8	14.5	27.2	34.4	2.1	10.7	17.7	23.4	1.3	40.7
White daisy,	1	15	6.0	6.6	30.7	39.7	2.0	–	–	–	–	–

IV. Vegetables, Fruits, etc.												
Apples,	2	78	0.7	1.0	1.5	18.3	0.5	–	–	–	–	–
Artichokes,	1	78	1.1	2.9	0.9	16.9	0.2	–	–	–	–	–
Beets, red,	7	88	1.1	1.5	0.7	8.6	0.1	–	–	–	–	–
Sugar beets,	13	86	0.9	1.6	0.9	10.5	0.1	1.5	0.9	10.5	0.1	10.5
Yellow fodder beets,	4	89	1.0	1.3	1.0	7.5	0.2	1.0	–	4.2	–	3.3
Cabbages,	1	90	0.8	2.6	0.9	5.5	0.2	–	–	–	–	–
Carrots,	5	89	0.9	1.0	1.1	7.8	0.2	–	–	–	–	–
Cranberries,	1	89	0.2	0.5	1.2	8.5	0.6	–	–	–	–	–
Mangolds,	5	88	1.2	1.4	0.8	8.5	0.1	1.0	0.3	7.7	–	6.9
Parsnips,	1	80	1.5	1.3	1.5	15.0	0.7	–	–	–	–	–
Potatoes,	54	80	0.8	2.1	0.5	16.5	0.1	1.0	–	14.8	–	16.9
Potatoes,	125	80	–	–	–	14.3[2]	–	–	–	–	–	–
Ruta-bagas,	3	89	1.1	1.2	1.3	7.2	0.2	1.0	1.0	6.8	0.2	7.6
Japanese radish,	1	93	0.7	0.5	0.7	5.0	0.1	–	–	–	–	–
Turnips,	5	90	0.9	1.5	1.2	6.6	0.2	1.4	1.2	6.3	0.2	7.7
V. Concentrated Feeds.												
(a) Protein.												
Alfalfa meal,	1	9	8.0	13.2	32.7	35.8	1.3	9.8	15.0	25.8	0.5[3]	31.2
Horse beans,	1	14	3.8	25.8	7.0	48.6	0.8	–	–	–	–	–
Red adzinki beans,	2	14	3.6	21.0	4.0	56.7	0.7	–	–	–	–	–
Saddle beans,	1	14	5.3	13.0	4.1	49.4	14.2	–	–	–	–	–
Soy bean,	5	14	5.0	31.2	4.7	28.4	16.7	28.4	–	23.0	15.5	91.7

[1] Digestion coefficients taken from the German. [2] Starch. [3] Same coefficients used as for alfalfa hay.

TABLE I. — COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Composition.						Digestibility.				Net Energy Values (Therms).
		Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	
V. CONCENTRATED FEEDS — *Con.*												
(*a*) *Protein* — Con.												
Soy bean (medium green),	3	14	4.6	35.3	4.0	24.3	17.8	32.1	–	19.7	16.6	94.7
Soy bean cake,	1	8	5.4	41.6	4.8	31.6	8.6	–	–	–	–	–
Blood meal, Armour's edible,	3	11	3.1	84.3	–	1.2	0.4	70.8	–	–	–	–
Brewers' dried grains,	19	10	3.6	24.0	13.4	42.8	6.2	19.4	6.6	24.4	5.5	56.4
Brewers' wet grains,	1	77	0.7	6.7	3.8	9.8	2.0	5.3	2.0	5.7	1.8	15.2
Buckwheat feed,	2	10	3.2	15.9	22.0	44.8	4.1	–	–	–	–	–
Buckwheat middlings,	3	10	4.7	26.7	6.8	44.6	7.2	22.7	1.1	37.0	6.4	76.8
Calf meal (Schumachers),	2	9	2.2	18.7	2.0	60.2	7.9	–	–	–	–	–
Cocoanut meal,	3	9	4.7	20.4	11.0	40.6	4.3	–	–	–	–	–
Cottonseed meal,	404	7	6.7	44.6	6.5	25.2	10.0	37.5	2.3	19.7	9.4	80.8
Cottonseed meal (low grade),	33	8	4.6	24.9	18.0	37.0	7.5	18.9	7.0	27.0	7.1	62.2
Dairy feed, Union Grains,	1	7	6.2	25.2	9.9	44.1	7.6	19.2	9.2	37.9	7.4	–
Dairy feed Buffalo Creamery,	1	9	4.3	19.9	12.4	50.2	4.2	16.1	6.8	35.6	3.7	–
Dairy feed, Unicorn,	1	8	3.3	27.3	9.0	46.1	6.3	21.3	6.5	41.0	6.0	–
Distillers' dried grains, largely from corn,	81	8	1.7	31.7	12.3	34.1	12.2	23.1	11.7	27.6	11.6	80.2

Gluten feed,	278	8.5	1.9	25.9	7.2	53.3	3.2	22.0	6.3	48.0	2.6	77.8
Gluten flour, wheat,	1	5.5	0.4	84.8	0.2	8.1	1.0	-	-	-	-	-
Gluten meal, wheat,	2	8.0	0.9	39.8	0.8	48.9	1.6	-	-	-	-	-
Gluten meal,	139	9.5	1.0	36.0	2.1	49.1	2.3	31.7	-	43.2	2.1	74.9
Germ oil meal,	13	9.0	2.7	22.7	9.3	45.9	10.4	15.7	-	37.2	10.1	79.4
Flax screenings,	2	8.0	6.0	16.8	13.7	40.9	14.6	-	-	-	-	-
Flaxseed meal,	2	7.0	3.5	23.5	5.5	23.3	37.2	-	-	-	-	-
Linseed meal (new process),	58	9.0	5.6	37.4	8.9	36.4	2.7	31.5	6.6	29.1	2.4	72.7
Linseed meal (old process),	138	8.5	5.2	34.3	8.5	36.4	7.1	30.5	4.8	28.4	6.3	80.3
Malt sprouts,	32	11.0	5.9	26.4	12.3	43.1	1.3	20.1	12.2	36.6	1.1	56.4
Bibby's dairy cake,	4	10.0	7.7	19.7	8.6	44.9	9.1	13.0	4.0	36.4	8.4	-
Holstein sugar feed,	1	8.0	6.7	12.6	10.0	60.0	2.7	8.3	4.4	48.6	2.4	-
Sucrene dairy feed,	9	9.0	6.4	16.9	11.4	52.0	3.3	10.3	8.2	38.0	3.1	-
Oat middlings, fine,	4	9.0	2.3	15.8	2.4	64.3	6.2	12.8	1.2	61.7	5.8	92.2
Pea meal,	1	10.0	2.6	18.9	17.5	49.4	1.6	15.7	4.6	46.4	0.9	70.4
Peanut bran,	2	5.0	4.8	19.2	9.1	33.6	28.3	-	-	-	-	-
Peanut germ,	2	3.0	3.4	28.5	3.3	18.4	43.4	-	-	-	-	-
Peanut meal,	1	8.0	4.0	49.0	3.5	24.7	10.8	44.6	0.8	22.7	9.6	94.1
Rye feed,	20	11.0	3.3	14.8	3.8	64.4	2.7	11.8	-	56.7	2.4	78.2
Sun flower seed cake,	1	10.0	4.2	34.8	10.9	21.8	18.3	-	-	-	-	-
Wheat middlings (flour),	140	10.0	3.2	18.8	3.3	59.9	4.8	16.5	1.2	52.7	4.1	83.8
Wheat middlings (standard),	371	10.0	4.3	17.8	7.0	55.9	5.0	13.8	2.1	43.5	4.4	57.6
Wheat mixed feed, bran and middlings,	859	10.0	5.3	16.9	8.1	55.2	4.5	13.2	5.0	42.5	3.9	-

TABLE I. — COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Composition.						Digestibility.				Net Energy Values (Therms).
		Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	
V. CONCENTRATED FEEDS — *Con.*												
(a) *Protein* — Con.												
Wheat mixed feed, adulterated,	7	10.0	4.3	12.3	15.5	54.6	3.3	7.7	4.3	38.8	3.0	-
Wheat bran,	452	10.0	6.2	16.1	10.0	53.3	4.4	12.4	3.9	37.8	2.8	49.0
Wheat bran (spring),	4	10.0	5.8	16.1	10.5	52.6	5.0	12.2	4.6	38.9	3.2	-
Wheat bran (winter),	3	10.0	6.2	15.3	8.6	57.0	2.9	11.8	2.3	37.1	1.9	-
Wheat screenings,	1	8.0	4.9	15.6	9.1	54.7	7.7	11.7	5.9	46.5	7.2	-
(b) *Starchy.*												
Bakery refuse,	1	13.0	10.1	8.0	0.3	63.0	5.6	-	-	-	-	-
Barley,	7	12.0	2.5	11.4	5.7	66.6	1.8	10.0	4.0	61.9	1.5	82.3
Dried beet pulp,	2	10.0	3.3	9.1	18.6	58.3	0.7	-	-	-	-	-
Dried molasses beet pulp,	4	8.0	5.8	9.9	14.1	61.7	0.5	6.3	11.8	56.1	-	72.1
Broom corn seed,	3	12.0	2.7	10.4	7.4	64.2	3.3	-	-	-	-	-
Buckwheat,	1	12.0	1.9	9.9	10.3	63.5	2.4	-	-	-	-	-
Cassava starch refuse,	1	12.0	1.6	0.8	6.1	78.8	0.7	-	-	-	-	-
Cocoa dust,	1	7.0	6.3	14.4	5.5	42.7	24.1	-	-	-	-	-
Cocoa shells,	1	5.0	8.4	18.0	15.9	50.9	1.8	-	-	-	-	-

Cocoanut meat,	1	1.0	0.8	9.9	7.5	15.3	65.5	-	-	-	-	-
Corn bran,	2	11.0	2.0	10.8	12.4	59.8	4.0	5.8	7.3	46.0	3.1	66.5
Corn cobs,	15	8.0	1.4	2.2	32.2	55.8	0.4	0.4	20.9	33.5	0.2	28.9
Corn and cob meal,	38	11.0	1.4	8.9	6.7	68.4	3.6	4.6	3.0	60.2	3.0	-
Corn kernels,	119	11.0	1.3	9.8	2.0	72.0	3.9	-	-	-	-	-
Corn kernels,	16	14.0	-	-	-	60.3[1]	-	-	-	-	-	-
Corn meal,	119	11.0	1.3	9.8	2.0	71.9	3.9	6.6	-	66.1	3.5	85.5
Sweet corn kernels,	3	11.0	1.9	12.5	2.4	64.9	7.3	-	-	-	-	-
Corn and oat feed,	48	10.0	3.0	9.1	9.9	64.8	3.2	-	-	-	-	-
Corn and oat feed (Victor),	39	10.0	3.5	8.6	11.3	62.9	3.7	6.1	5.4	52.2	3.2	-
Corn, oat and barley feed,	8	10.0	3.1	11.4	8.3	62.4	4.8	-	-	-	-	-
Corn, oat and barley feed (Schumachers),	15	8.0	4.0	11.3	11.8	60.4	4.5	7.9	6.1	47.7	4.0	-
Corn screenings,	1	11.0	2.1	7.4	2.9	72.6	4.0	-	-	-	-	-
Cotton hulls,	5	11.0	2.6	5.3	39.7	39.0	2.4	-	15.9	16.0	2.1	-
Cotton-hull bran,	1	11.0	1.9	2.3	35.0	48.7	1.1	-	-	-	-	-
Cottonseed feed,	4	11.0	3.1	10.5	36.0	35.9	3.5	5.4	16.6	19.8	3.0	43.1
Flax bran (stalks and pods),	1	7.0	12.1	6.2	45.1	27.4	2.2	-	-	-	-	-
Hominy meal,	239	11.0	2.5	10.4	4.2	63.9	8.0	6.8	2.8	57.0	7.2	89.6
Mellen's food refuse,	1	7.0	3.9	11.4	7.1	67.2	3.4	-	-	-	-	-
Millet seed,	4	12.0	2.6	11.1	7.7	62.9	3.7	-	-	-	-	-
Barnyard millet seed,	1	11.0	3.3	12.2	7.6	60.3	5.6	-	-	-	-	-
Molasses, Porto Rico (low grade),	15	26.0	6.2	3.2	-	64.6	-	-	-	-	-	-

[1] Starch.

TABLE I. — COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Concluded.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Composition.						Digestibility.				Net Energy Values (Therms).
		Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Protein.	Fiber.	Nitrogen free Extract.	Fat.	
CONCENTRATED FEEDS—*Con.*												
(*b*) *Starchy* — Con.												
Oat kernels,	10	11.0	3.0	12.5	8.5	60.4	4.6	10.7	2.6	47 7	3.8[1]	69.7
Oats, ground,	10	12.0	3.0	12.3	8.4	59.7	4.6	10 1	1.2	51.3	3.7[1]	71.2
Oat feed,	122	7.0	5.5	7.9	21.8	55.0	2.8	5.1	7.0	23.1	2.5	40.9
Oat feed (low grade),	17	7.0	5.5	5.1	26.4	54.4	1.6	3.2	8.4	18.0	1.5	33.2
Oat feed, Canada,	2	7.0	5.4	13.2	24 8	44 7	4.9	9.1	8.2	22.8	4.3	49.5
Pea bran,	2	11.0	2.7	10.0	39.7	35.6	1.0	-	-	-	-	-
Peanut shells, ground,[2]	5	9.4	2.4	7.4	60.6	16.9	3.3	-	-	-	-	-
Rice, cleaned,	1	11.0	0.3	8.5	0.1	79.8	0.3	-	-	-	-	-
Rice, bran,	2	11.0	12.7	6.8	20.6	42.8	6.1	4.3	6.0	33.4	5.4	-
Rice meal,	2	11.0	8.2	11.8	5.3	50.8	12.9	7.3	-	46.7	11.7	87.7
Rye middlings,	1	11.0	3.6	11.7	3.3	65.4	5 0	-	-	-	-	-
Speltz,	1	8.0	3.9	11.5	11 1	62.9	2.2	9.2	6.7	56.0	1.9	-
Starch refuse,	2	12.0	1.8	4.8	3.8	76.3	1.3	-	-	-	-	-
Red wheat kernels,	1	12 0	1.7	8.8	2.6	72.4	2 5	5.9	1.0	66.6	2.0	78.9
White winter wheat kernels,	1	12.0	1.7	11.5	2.1	70.8	1.9	9.4	1.6	65.8	1.2	80.3

Wheat kernels,	13	12.0	1.8	12.0	2.6	69.7	1.9	9.0	1.5	64.8	1.4	78.9
Wheat flour,	2	12.0	0.4	9.9	0.1	76.8	0.8	-	-	-	-	-
(c) Poultry.												
Green cut bone,	2	27.0	19.2	18.6	-	5.8	29.4	-	-	-	-	-
Raw ground bone,	1	8.0	64.4	23.9	-	3.4	0.3	-	-	-	-	-
Cut clover,	2	10.0	6.8	17.9	20.5	41.8	3.0	-	-	-	-	-
Meat and bone meal,	38	6.0	37.3	39.6	-	6.3	10.8	-	-	-	-	-
Meat scrap,	12	9.0	18.4	50.6	-	4.2	17.8	-	-	-	-	-
Rava meat meal,	1	10.0	1.7	83.2	-	-	5.1	-	-	-	-	-
Mutton scrap,	1	7.0	33.1	39.9	-	5.3	14.7	-	-	-		-
Fish glue waste,	1	14.0	34.9	39.1	-	4.1	7.9	-	-	-	-	-
Milk albumen,	1	11.0	31.4	42.4	-	14.4	0.8	-	-	-	-	-
Granulated milk,	1	10.0	26.5	35.9	-	18.1	9.6	-	-	-	-	-

[1] Coefficients obtained from digestion experiments with horses.
[2] Valueless for feeding.

Table II. — Fertilizer Ingredients of Fodder Articles.[1]

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
1. Green Fodders.					
(a) Meadow Grasses and Millets.					
Orchard grass,	4	70	0.43	0.56	0.13
Millet,	1	80	0.29	0.43	0.11
Barnyard millet,	3	80	0.30	0.67	0.10
Hungarian grass,	1	80	0.30	0.42	0.12
Japanese millet,	3	80	0.33	0.22	0.10
(b) Cereal Fodders.					
Corn fodder,	22	80	0.39	0.30	0.13
Oats,	3	75	0.72	0.56	0.19
Rye,	2	75	0.27	0.57	0.11
(c) Legumes.					
Alfalfa,	4	80	0.44	0.31	0.11
Horse bean,	1	85	0.41	0.21	0.05
Soy bean (early white),	1	80	0.57	0.55	0.13
Soy bean (medium green), average,	14	80	0.64	0.53	0.14
Soy bean (medium green), in bud,	1	80	0.66	0.58	0.15
Soy bean (medium green), in blossom,	5	80	0.64	0.60	0.13
Soy bean (medium green) in pod,	7	78	0.72	0.52	0.17
Soy beau (medium black),	1	80	0.70	0.50	0.16
Soy bean (late),	1	80	0.60	0.68	0.14
Alsike clover,	6	80	0.53	0 50	0.15
Mammoth red clover,	3	80	0.50	0.27[2]	0.12
Medium red clover, average,	10	80	0.52	0.57	0.11
Medium red clover, in bud,	2	80	0.58	0.71	0.13
Medium red clover, in blossom,	3	79	0.51	0.58	0.12
Medium red clover, seeding,	2	75	0.61	0.65	0.13
Sweet clover,	1	80	0.43	0.40	0.12
White lupine,	1	85	0.45	0.26	0.05
Yellow lupine,	1	85	0.40	0.44	0.09
Canada field peas, average,	6	85	0.50	3.08	0.12

[1] Many of these analyses were made in earlier years by the Massachusetts State Experiment Station. The percentages of the several ingredients will vary considerably depending upon the fertility of the soil, and especially upon the stage of growth of the plant. In the majority of cases the number of samples analyzed is too few to give a fair average. The figures, therefore, must be regarded as close approximations rather than as representing absolutely the exact fertilizing ingredients of the different materials. (J. B. L.)

[2] Evidently below normal.

TABLE II. — FERTILIZER INGREDIENTS OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

NAME.	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
I. GREEN FODDERS — *Con.*					
(c) *Legumes* — Con.					
Canada field peas, in bud,	2	85	0.50	0.44	0.11
Canada field peas, in blossom,	2	87	0.45	0.32	0.11
Canada field peas, in pod,	2	84	0.52	0.37	0.13
Cow pea, average,	9	85	0.45	0.47	0.12
Black cow peas,	4	85	0.40	0.47	0.12
Whip-poor-will cow peas,	5	85	0.49	0.47	0.12
Flat pea,	1	85	0.75	0.32	0.10
Small pea,	1	85	0.40	0.31	0.09
Sainfoin,	1	75	0.68	0.57	0.20
Serradella,	2	85	0.36	0.37	0.12
Sulla,	2	75	0.68	0.58	0.12
Spring vetch,	1	85	0.36	0.45	0.10
Hairy or sand vetch, average,	5	85	0.55	0.51	0.13
Hairy or sand vetch, in bud,	2	86	0.52	0.54	0.12
Hairy or sand vetch, in blossom,	3	82	0.65	0.57	0.16
Kidney vetch,	1	85	0.44	0.28	0.08
Average for legumes,	–	–	0.53	0.44	0.12
(d) *Mixed and Miscellaneous.*					
Vetch and oats,	4	80	0.30[1]	0.30	0.14
Apple pomace,	2	83	0.21	0.12	0.02
Carrot tops,	1	80	0.69	1.08	0.13
Prickley comfrey,	1	87	0.37	0.76	0.12
Common buckwheat,	1	85	0.44	0.54	0.09
Japanese buckwheat,	1	85	0.26	0.53	0.14
Silver-hull buckwheat,	1	85	0.29	0.39	0.14
Summer rape,	1	85	0.34	0.78	0.10
Sorghum,	8	80	0.26	0.29	0.11
Teosinte,	1	70	0.47	1.18	0.90
II. SILAGE.					
Corn,	7	80	0.42	0.39	0.13
Corn and soy bean,	1	76	0.65	0.36	0.35[2]
Millet,	3	74	0.26	0.62	0.14
Millet and soy bean,	5	79	0.42	0.44	0.11

[1] Too low; 0.43 nearer correct. [2] Evidently too high.

Table II. — Fertilizer Ingredients of Fodder Articles — *Continued.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
III. Hay and Dry Coarse Fodders.					
(a) Meadow Grasses and Millets.					
Barnyard millet,	3	14	1.29	2.88	0.43
Hungarian grass,	1	14	1.29	1.79	0.52
Italian rye grass,	4	14	1.12	1.19	0.53
Kentucky blue grass,	2	14	1.20	1.54	0.39
Meadow fescue,	6	14	0.93	1.98	0.37
Orchard grass,	4	14	1 23	1.60	0.38
Perennial rye grass,	2	14	1.16	1.47	0.53
Red-top,	4	14	1.07	0.95	0.33
Timothy,	3	14	1.20	1.42	0.33
English hay (mixed grasses),	13	14	1.34	1.61	0.32
Rowen,	13	14	1.72	1.58	0.48
Branch grass,	1	16	1.06	0.87	0.19
Fox grass,	1	16	1.18	0.95	0.18
Salt hay (variety uncertain),	1	16	1.05	0.64	0.23
(b) Cereal Fodders.					
Corn stover, from field,	17	40	0.69	0.92	0.20
Corn stover, very dry,	17	20	0.92	1.22	0.26
Oats,	3	15	2.45[1]	1.90	0.65
(c) Legumes.					
Alsike clover,	6	15	2.26	2.10	0.63
Mammoth red clover,	3	15	2.14	1.16[2]	0.52
Medium red clover,	10	15	2.21	2.42	0.47
(d) Straw.					
Barley,	2	15	0.95	2.03	0.19
Soy bean,	1	15	0.69	1.04	0.25
Millet,	1	15	0.68	1.73	0.18
(e) Mixed and Miscellaneous.					
Vetch and oats,	4	15	1.29[3]	1.27	0.60
Broom corn waste (stalks),	1	10	0.87	1.87	0.47
Palmetto root,	1	12	0.54	1.37	0.16
Spanish moss,	1	15	0.61	0.56	0.07
White daisy,	1	15	0 26	1.18	0.41

[1] Too high; 1.90 nearer correct. [2] Evidently below normal.
[3] Too low; 1.80 nearer correct.

TABLE II. — FERTILIZER INGREDIENTS OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
IV. VEGETABLES, FRUITS, ETC.					
Apples,	2	78	0.12	0.17	0.01
Artichokes,	1	78	0.46	0.48	0.17
Beets, red,	8	88	0.24	0.44	0.09
Sugar beets,	4	86	0.24	0.52	0.11
Yellow fodder beets,	1	89	0.23	0.56	0.11
Mangolds,	3	88	0.15	0.34	0.14
Carrots,	3	89	0.16	0.46	0.09
Cranberries,	1	89	0.08	0.10	0.03
Parsnips,	1	80	0.22	0.62	0.19
Potatoes,	5	80	0.29	0.51	0.08
Japanese radish,	1	93	0.08	0.40	0.05
Turnips,	4	90	0.17	0.38	0.12
Ruta-bagas,	3	89	0.19	0.49	0.12
V. CONCENTRATED FEEDS. (*a*) *Protein.*					
Red adzinki bean,	1	14	3.27	1.55	0.95
White adzinki bean,	1	14	3.45	1.53	1.00
Saddle bean,	1	14	2.08	2.09	1.49
Soy bean,	3	14	5.61	2.12	1.82
Blood meal (Armour's),	1	11	13.55	0.18	0.26
Brewers' dried grains,	2	8	3.68	0.86	1.06
Cottonseed meal,	167	7	7.08	2.05	2.90
Distillers' dried grains,	20	8	4.50	0.31	0.61
Gluten feed,	106	8.5	4.13	0.40	0.77
Gluten meal,	46	9.5	5.87	0.21	0.55
Linseed meal (new process),	21	9	5.97	1.42	1.79
Linseed meal (old process),	56	8.5	5.35	1.30	1.66
Malt sprouts,	12	11	4.32	2.00	1.56
Bibby's dairy cake,	1	10	2.94	1.67	2.07
Sucrene feed,	1	10	2.62	2.08	0.55
Pea meal,	1	10	3.04	0.98	1.81
Peanut meal,	1	8	7.84	1.54	1.27
Proteina,	1	8	3.01	0.58	1.02

TABLE II. — FERTILIZER INGREDIENTS OF FODDER ARTICLES — *Continued.*

[Figures equal percentages or pounds in 100.]

NAME.	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
V. CONCENTRATED FEEDS — *Con.*					
(*a*) *Protein* — Con.					
Rye feed,	11	11	2.36	1.08	1.60
Wheat middlings (flour),	44	10	3.06	1.01	1.65
Wheat middlings (standard),	103	10	2.88	1.28	2.06
Wheat mixed feed,	282	10	2.72	1.44	2.57
Wheat bran,	116	10	2.59	1.45	2.79
(*b*) *Starchy.*					
Ground barley,	1	13	1.56	0.34	0.66
Buckwheat hulls,	1	12	0.49	0.52	0.07
Cocoa dust,	1	7	2.30	0.63	1.34
Corn cobs,	8	8	0.52	0.63	0.06
Corn and cob meal,	29	11	1.38	0.46	0.56
Corn kernels,	13	11	1.82	0.40	0.70
Corn meal,	3	14	1.92	0.34	0.71
Corn and oat feed (Victor),	2	10	1.38	0.61	0.59
Corn, oat and barley feed (Schumachers),	1	8	1.80	0.63	0.83
Cotton hulls,	3	11	0.75	1.08	0.18
Hominy meal,	125	11	1.65	0.76	1.27
Common millet seed,	2	12	2.00	0.45	0.95
Japanese millet seed,	1	12	1.58	0.35	0.63
Molasses (Porto Rico),	1	24	0.51	3.68	0.12
Dried molasses beet pulp,	1	8	1.60	1.47	0.16
Oat kernels,	1	11	2.05	-	-
Oat feed,	14	7	1.26	0.75	0.48
Oat feed (low grade),	15	7	0.88	0.70	0.35
Peanut feed,	2	10	1.46	0.79	0.23
Peanut husks,	1	13	0.80	0.48	0.13
Louisiana rice bran,	1	11	1.42	0.83	1.70
Rye middlings,	1	11	1.87	0.82	1.28
Damaged wheat,	1	13	2.26	0.51	0.83
Wheat flour,	2	12	2.02	0.36	0.35
(*c*) *Poultry.*					
American poultry food,	1	8	2.22	0.52	0.98
Meat and bone meal,	10	6	5.92	-	14.68
Meat scraps,	4	9	7.63	-	8.11

TABLE II. — FERTILIZER INGREDIENTS OF FODDER ARTICLES — *Concluded.*

[Figures equal percentages or pounds in 100.]

Name.	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
VI. DAIRY PRODUCTS.					
Whole milk,	297	86.4	0.57	0.19[1]	0.16
Human milk,	3	88.1	0.24	–	–
Skim milk,	22	90.3	0.59	0.18[2]	0.20
Butter milk,	1	91.1	0.51	0.05	0.04
Whey,	1	93.7	0.10	0.07	0.17
Butter,	117	12.5	0.19	–	–

[1] From Farrington and Woll. [2] From Woll's Handbook.

TABLE III. — ANALYSES OF DAIRY PRODUCTS.

[Per Cent.]

Name.	Number of Analyses.	Solids.			Fat.			Proteids (N. × 6.25).	Salt.	Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.			
Whole milk,	6,399[1]	19.55	10.02	13.55	10.70	1.50	4.49	3.52[2]	–	0.73[3]
Human milk,	3	13.59	10.50	11.87	3.77	1.66	2.52	1.48	–	0.24
Colostrum,	2	24.75	21.25	23.00	3.00	3.00	3.00	2.84[4]	–	1.00
Skim milk (largely from Cooley process),	359	10.48	7.68	9.20	1.80	0.05	0.32	–	–	–
Buttermilk,	31	9.86	6.83	8.33	0.38	0.11	0.27	–	–	–
Cream (from Cooley process),	203	32.78	18.12	26.10	25.00	10.53	17.60	–	–	–
Butter (salted),	189	94.84	82.55	86.95	89.33	75.94	82.65	1.11[5]	3.21	–
Butter (fresh),	14	85.36	72.49	82.24	85.05	72.21	81.48	0.76	–	–

[1] Largely station herd, Jersey blood predominating. [2] Average of 961 samples. [3] Average of 388 samples. [4] Nitrogen. [5] Curd and natural ash.

Table IV. — Coefficients of Digestibility of American Fodder Articles. Experiments made in the United States.[1]

J. B. LINDSEY AND P. H. SMITH.

Experiments with Ruminants.
Experiments with Swine.
Experiments with Horses.
Experiments with Poultry.
Experiments with Calves.

Complete through Aug. 1, 1910.

Explanation of Table IV.

The first compilation of all digestion coefficients resulting from experiments made in the United States was made and published by J. B. Lindsey in 1896.[2] Jordon and Hall also published very complete data in 1900.[3] Since then the writer and his co-workers have revised and published similar tables in 1902[4] and 1906.[5] The present publication is intended to be complete to December, 1910.

By *coefficient of digestibility* is meant the percentage of the ingredients which the animal can actually digest. Thus, of the 6.3 pounds of total protein in 100 pounds of Timothy hay, experiments have shown that 48 per cent., or 3 pounds, are digestible. The figure 48 is the digestion coefficient. The average coefficients determined have been applied to the average fodder analyses in Table I., and have enabled us to calculate the average amount of each fodder constituent digestible.

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[1] Being a portion of the report of the Department of Plant and Animal Chemistry.
[2] Ninth report of the Hatch Experiment Station, pp. 157–170.
[3] Bulletin 77, United States Department of Agriculture, Office of Experiment Stations.
[4] Fourteenth report of the Hatch Experiment Station, pp. 195–216.
[5] Eighteenth report of the Hatch Experiment Station, pp. 224–248.

EXPERIMENTS WITH RUMINANTS.

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
I. Green Fodders.									
(a) Meadow Grasses and Millets.									
Grass, native blue, Nevada (*Poa Sandbergii*),	1	2	52—53 53	– –	20—25 23	64—64 64	44—45 45	60—61 60	48—51 50
Grass, meadow, young,	1	1	69	–	–	65	74	72	55
Grass, meadow, young, dried,	1	1	71	–	–	71	77	73	60
Grass, timothy,	1	3	63—65 64	– –	31—33 32	48—48 48	54—58 56	65—67 66	52—54 52
Grass, timothy, rowen,	1	2	– –	65—67 66	– –	72—72 72	60—68 64	67—68 68	51—55 52
Grass, Western brome (*Bromus marginatus*),	1	2	60—60 60	– –	42—42 42	68—68 68	53—53 53	67—67 67	15—16 16
Barnyard millet in blossom (Massachusetts) (*Panicum crus-galli*).	3	6	67—76 70	– –	45—67 56	58—70 65	71—77 73	65—77 71	54—67 58
Japanese millet, bloom to early seed (Storrs),	2	3	– –	62—66 64	52—58 55	45—57 50	59—63 62	64—68 67	60—72 68
Hungarian grass, early to late bloom,	3	8	61—71 66	61—74 68	– –	59—72 63	65—76 70	64—71 67	48—85 62
(b) Cereal Fodders.									
Barley fodder, bloom,	2	4	– –	62—71 67	– –	69—73 72	49—66 61	69—76 71	56—63 60
Barley fodder, seeds forming,	2	2	– –	66—71 68	40—44 42	67—71 69	47—65 56	– 74	48—50 49
Corn fodder, dent, immature,	5	14	64—74 68	– –	42—43 42	56—80 66	56—76 65	64—79 71	37—83 86

Corn fodder, dent, milk, average,	7	17	70	-	39[1]	62	64	77	76
Corn fodder, dent, mature, average,	12	23	69	72[2]	34	54	59	75	75
Corn fodder, dent, mature, B. & W., coarse,	1	2	51—54 52	- -	- -	20—28 24	46—47 46	57—61 59	74—82 78
Corn fodder, dent, brewers, milk,	1	2	71—73 72	- -	44—49 46	68—69 69	67—71 69	76—77 77	67—70 68
Corn fodder, dent, early Mastodon, milk,	1	2	72—72 72	- -	33—38 36	56—58 57	60—60 60	79—79 79	80—81 81
Corn fodder, Eureka silage, ears just forming,	1	3	64—69 67	- -	42—43 42	67—68 67	56—61 60	70—74 72	65—67 66
Corn fodder, dent, Leaming, milk,	1	2	69—71 70	- -	34—40 36	60—60 60	60—63 61	76—77 77	75—77 76
Corn fodder, dent, Pride of the North, mature,	2	4	69—81 74	- -	29—40 35	59—68 63	58—74 66	76—86 81	74—78 80
Corn fodder, dent, Rustler's white, mature,	1	2	69—70 70	- -	25—30 28	40—45 43	57—61 59	77—79 78	75—78 76
Corn fodder, dent, Wing's improved white cap, milk,	1	2	70—71 70	- -	38—40 39	62—64 63	62—68 65	76—76 76	69—71 70
Corn fodder, flint, Sanford, mature,	2	4	63—73 69	67—75 71	14—50 34	46—57 52	67—80 75	67—75 71	53—74 66
Corn fodder, sweet, milk stage,	1	2	77—78 77	- -	- -	77—78 77	74—76 75	80—81 81	73—74 74
Corn fodder, sweet, roasting stage,	9	12	- -	67—79 72	22—61 48	52—69 62	54—72 60	73—82 77	62—82 74
Oat fodder, bloom to early seeding,	3	5	- -	56—65 62	49—68 60	68—76 73	43—63 55	60—67 62	67—72 69
Rye fodder, heading,	1	2	73—74 74	- -	- -	79—80 79	80—80 80	70—71 71	74—74 74
Sorghum fodder, blossom,	1	2	73—73 73	- -	- -	51—56 53	74—75 75	78—78 78	81—82 81

[1] Average eight trials.

[2] Average seventeen trials.

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
I. GREEN FODDERS — *Con.*									
(*b*) *Cereal Fodders* — Con.									
Sorghum fodder, Early Amber, past blossom,	2	4	61—69 65	- -	40—43 42	38—51 44	42—72 55	70—74 73	60—67 64
Sorghum fodder, average,	3	6	68	-	42	47	62	75	70
(*c*) *Legumes.*									
Alfalfa, fodder,	1	2	61—61 61	- -	40—40 40	73—75 74	42—43 43	71—72 72	38—39 39
Soy beans, variety uncertain, before bloom,	1	2	- -	64—67 66	- -	77—80 79	45—55 50	71—73 72	50—58 54
Soy beans, variety uncertain, seeding,	1	2	- -	61—63 62	- -	68—71 69	38—43 41	72—75 73	49—59 54
Soy beans, medium green, full blossom,	1	2	- -	62—63 63	22—28 25	76—78 77	45—49 47	69—73 71	46—54 50
Soy beans, medium green, seeding,	4	12	62—69 65	65—69 67	16—45 28	74—84 78	31—53 45	71—81 77	31—69 55
Clover, crimson, late blossom,	1	3	- -	68—70 69	- -	77—77 77	54—58 56	74—75 74	63—69 66
Clover, red, late blossom,	1	2	65—67 66	- -	- -	66—68 67	52—53 53	76—79 78	63—66 65
Clover, rowen, late blossom,	1	2	- -	60—62 61	- -	61—62 62	51—54 52	64—68 65	60—61 61
Clover, average two samples,	2	4	65—67 66	60—62 61	- -	61—68 65	51—54 53	64—79 72	60—66 63
Cow peas, ready for soiling,	2	4	66—77 68	72—76 74	19—28 23	73—77 76	57—62 60	76—84 81	56—62 59

Little Lupine (*Lupinus Sp.*),	1	2	62—74 68	- -	65—69 67	73—77 75	46—65 56	67—84 76	42—72 57
Canada field peas, before bloom,	1	2	68 -	71—72 71	- -	81—83 82	62—62 62	71—71 71	50—55 52
Canada field peas, bloom to seeding,	2	6	60—67 64	- -	26—45 37	79—83 81	40—52 45	72—80 76	45—64 55
Spring vetch (*Vicia sativa*),	1	2	62—62 62	- -	- 17	71—72 72	42—46 44	75—77 76	57—60 59
Winter or hairy vetch (*Vicia villosa*), bloom,	4	14	66—78 71	- -	29—55 42	79—88 83	52—73 63	68—84 77	63—82 71
(*d*) *Mixed and Miscellaneous.*									
Apple pomace,	2	6	66—80 72	- -	24—63 49	- -	36—85 65	80—90 85	39—52 46
Balsam root or big sunflower (*Balsamorhiza sagittata*),	1	2	66—66 66	- -	34—42 38	76—79 78	57—61 59	74—76 75	74—75 74
Barley and peas, bloom,	3	4	- -	55—71 65	52—55 54	73—81 75	38—61 52	56—76 68	54—65 59
Bitter brush (*Kunzia tridentata*),	1	2	75—79 77	- -	48—69 59	79—85 82	56—83 70	86—87 87	70—73 71
Wild carrot (*Septotaenia multifida*),	1	2	68—69 69	- -	52—54 53	70—72 71	43—52 47	82—84 83	81—82 82
Wild dandelion (*Crepis intermedia*),	1	2	62—63 63	- -	58—60 59	61—65 63	34—37 36	77—78 78	31—35 33
Thousand headed kale (*Brassica oleracca*),	2	4	66—71 68	- -	37—45 39	78—83 81	55—64 59	74—77 76	61—72 66
Oats and spring vetch, bloom,	1	3	65—69 67	- -	49—55 53	73—76 75	65—72 68	66—70 68	42—52 47
Oats and peas, bloom,	2	5	69—72 70	67—69 68	45—52 49	68—82 74	54—70 64	66—77 72	51—74 64
Oats and peas, partly seeded,	3	5	- -	58—70 62	36—63 47	68—83 74	48—67 55	56—67 63	55—74 64

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
I. GREEN FODDERS — *Con.*									
(*d*) *Mixed and Miscellaneous* — Con.									
Prickly pear (*Opuntia lindheimeri*),	1	2	65—67 66	71—77 74	34—37 36	57—59 58	41—41 41	82—83 83	67—68 68
Prickly pear (*Opuntia lævis?*),	1	2	62—65 64	70—73 71	33—38 36	39—42 41	51—56 54	78—80 79	69—69 69
Prickly pear (*Opuntia engelmannii cycloides*),	2	4	57—70 65	63—75 71	39—44 42	– –	30—45 39	77—83 81	74—88 83
Mountain Indian Pink or Painted Cup (*Castilleia miniata* var.).	1	2	66—68 67	– –	46—47 47	63—66 65	48—50 49	79—81 80	75—78 77
Indian potato (*Atænia Gairdneii*),	1	2	66—67 67	– –	50—50 50	54—59 57	73—75 74	64—66 65	76—78 77
Dwarf Essex rape, first growth,	1	2	88—88 88	– –	76—77 76	90—91 90	90—90 90	94—94 94	54—55 54
Dwarf Essex rape, second growth,	1	2	81 –	– –	47—51 49	86—89 87	84—84 84	90—91 90	42—44 43
Dwarf Essex rape, average,	2	4	85	–	63	89	87	92	48
Common sunflower, Nevada (*Wyethia mollis*),	1	2	60—62 61	– –	53—53 53	69—70 69	54—55 54	59—63 61	62—64 63
Winter wheat and hairy vetch,	2	5	68—71 69	– –	40—46 44	69—78 75	66—71 68	71—76 73	54—61 57
II. SILAGE.									
Soy bean silage, goats,	1	2	52—66 59	– –	– –	71—80 76	47—62 55	46—58 52	66—77 72
Soy bean silage, steers,	1	2	50—50 50	– –	– –	54—56 55	42—44 43	61—61 61	47—52 49

Soy bean silage, mammoth yellow, bloom,	1	3	52—65 58	63—73 67	- -	57—69 61	51—67 59	74—80 76	48—60 52
Soy bean silage, average,	3	7	56	67	-	66	53	65	57
Soy bean and barnyard millet silage,	1	4	54—65 59	- -	- -	55—62 57	61—73 69	54—63 59	69—75 72
Soy bean and corn silage (9 pints beans, 14 pints corn),	4	8	62—73 69	71—75 72	39—48 42	54—68 63	51—73 63	73—81 78	67—91 83
Clover silage,	2	5	32—52 44	36—54 45	26—51 36	22—40 35	41—55 48	31—56 45	36—60 45
Corn silage, dent, immature, average all trials,	7	17	59—68 64	60—68 64	31—35 33	42—65 53	54—78 68	60—70 66	61—85 71
Corn silage, dent, mature, average all trials,	10	27	57—76 66	60—77 70[1]	24—54 38	21—69 51	45—80 65	63—83 71	65—90 82
Corn silage, dent, Leaming, immature,	2	4	59—66 62	60—68 64	31—35 33	46—51 49	54—71 63	62—66 65	61—77 72
Corn silage, dent, Leaming, mature,	1	2	68—72 70	- -	46—54 50	59—69 64	68—74 71	71—74 73	83—86 85
Corn silage, dent, Pride of the North, mature,	1	2	72—76 74	- -	24—28 26	- 45	72—73 73	81—83 82	72—82 77
Corn silage, dent, Virginia, mature,	1	4	57—74 64	60—75 66	- -	21—55 39	51—69 58	66—79 72	65—84 77
Corn silage, Sanford, ears glazing,	1	2	74—76 75	76—77 77	47—48 48	54—54 54	77—78 78	78—80 79	76—78 77
Corn silage, dent, average all trials,	17	48	64	70[1]	38	50	65	69	77
Corn silage, flint, mature, small varieties,	4	11	68—78 75	66—80 77	- -	48—73 65	75—79 77	71—83 79	- 82
Corn silage, flint, large white. partly eared,	1	2	69—70 70	72—73 72	31—37 34	56—56 56	72—72 72	75—76 76	72—74 73
Corn silage, fine crushed, steers,	1	2	60—68 64	- -	- -	32—44 38	72—78 75	60—70 65	75—77 76

[1] Average twenty-five trials.

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
II. SILAGE — *Con.*									
Corn silage, fine crushed, sheep,	1	2	51—56 54	- -	- -	21—22 21	59—68 64	53—57 55	67—69 68
Corn silage, mature, fed raw,	1	1	-	-	-	45	59	71	86
Corn silage, mature, cooked,	1	1	-	-	-	39	70	75	87
Corn silage, steamed,	1	2	73—74 73	75—76 76	46—50 48	53—57 55	75—76 76	75—77 76	90—90 90
Corn silage, variety unknown,	1	2	- -	- -	- -	55—58 57	68—68 68	78—78 78	66—67 66
Corn silage, variety unknown, raw,	1	2	71—73 72	- -	40—45 43	54—63 59	72—75 74	74—76 75	90—90 90
Corn silage, variety unknown, steamed,	1	2	60—62 61	- -	5—13 9	5—6 5	62—64 63	70—72 71	79—80 79
Corn silage, sweet, mature,	1	2	67—70 68	68—72 70	- -	53—55 54	68—74 71	71—73 72	82—85 83
Kaffir corn silage, well matured,	1	3	54—56 55	56—59 57	- -	22—23 28	57—59 57	59—62 62	47—54 50
Oat and pea silage,	1	2	63—68 65	63—70 67	52—53 52	74—75 75	58—65 61	64—70 67	73—77 75
Cow pea silage,	1	4	59—60 60	- -	- -	57—58 57	50—54 52	72—73 72	62—64 63
Sorghum silage, well matured,	1	3	51—60 57	53—62 59	- -	6—13 9	51—63 58	59—67 64	53—60 56
Silage, mixture of corn, sunflower heads and horse beans,[1]	1	2	64—68 66	66—70 68	40—41 41	60—65 63	56—64 60	71—74 72	75—78 77

Silage, mixture of corn, sunflowers (whole plant) and horse beans.[1]	1	2	64—67 (65)	68—71 (69)	20—31 (26)	57—59 (58)	63—68 (65)	72—75 (74)	72—76 (74)
Vetch silage, raw,	1	2	62—64 (63)	– –	46—48 (47)	56—57 (56)	61—64 (63)	66—68 (67)	76—79 (77)
Vetch silage, steamed,	1	2	50—53 (51)	– –	35—40 (38)	13—16 (15)	50—53 (51)	61—64 (63)	63—63 (63)
III. Hay and Dry Coarse Fodders.									
(a) Meadow Grasses and Millets.									
Kentucky blue grass (*Poa pratensis*),	2	7	56[2] –	– –	9—42 (23)	47—63 (57)	63—74 (66)	53—69 (61)	43—62 (52)
Canada blue grass (*Poa compressa*), bloom,	1	2	62—63 (62)	– –	42—42 (42)	43—44 (43)	70—71 (71)	63—63 (63)	36—39 (37)
Blue-joint, bloom,	1	2	67—70 (69)	68—71 (70)	– –	68—72 (70)	71—73 (72)	66—71 (69)	51—53 (52)
Blue-joint, past bloom,	1	1	40	42	–	57	37	43	37
Bromus inermis hay,	2	4	– –	– –	– –	45—52 (50)	55—61 (59)	66—70 (68)	17—31 (24)
Buffalo grass (*Bulbilis Dactyloides*),	1	1	55	–	6	54	65	62	62
Chess or cheat (*Bromus secalinus*),	1	1	45	–	23	42	46	49	32
Colorado upland hay (largely *Agropyrum tenerum*),	2	6	47—63 (56)	45—59 (52)	40—48 (43)	58—67 (62)	54—63 (59)	49—66 (57)	16—53 (34)
Cord grass (*Spartina Cynosuroides* L.),	1	6	– –	– –	16—38 (23)	34—42 (39)	54—58 (56)	46—52 (49)	47—55 (50)
Crab grass (*Eragrostis Neo Mexicana*), ripe,	3	8	47—57 (53)	– –	29—52 (43)	30—56 (58)	50—66 (60)	50—59 (53)	30—52 (43)
Dakota lowland prairie hay,	1	2	– –	– –	– –	41—44 (43)	59—61 (60)	56—57 (57)	40—40 (40)
Dakota upland prairie hay,	1	6	– –	– –	5—17 (11)	28—40 (32)	45—61 (53)	44—55 (51)	25—84 (32)

[1] Proportion of one acre corn, one-fourth acre sunflower heads and one-half acre horse beans.

[2] One trial.

EXPERIMENTS WITH RUMINANTS — *Continued.*

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. HAY AND DRY COARSE FODDERS — *Con.*									
(*a*) *Meadow Grasses and Millets* — Con.									
Meadow fescue (*Festuca elatior pratensis*), bloom,	1	2	60—61 61	- -	- 46	51—53 52	- 67	58—60 59	53—54 54
Johnson grass (*Andropogon halepensis*),	2	3	57	-	-	40	68	57	38
Millets. Barnyard millet, well headed,	1	3	57—58 57	- -	63—64 63	63—64 64	60—64 62	50—52 52	44—50 46
Millets. Barnyard millet, just heading out,	1	2	59—62 61	- -	51—52 52	56—59 58	66—71 69	55—59 57	47—49 48
Millets. Cat-tail millet (*Pennisetum spicatum*),	1	2	61—64 62	- -	- -	61—65 63	65—68 67	58—60 59	45—48 46
Millets. Golden millet,	1	1	54	-	31	23	56	58	49
Millets. Hungarian,	1	2	64—66 65	66—67 66	- -	- 60	67—68 68	67—67 67	- 64
Millets. Millet (*Chætochloa Italica*),	1	2	52—58 56	- -	16—32 24	30—32 31	60—66 63	52—59 56	48—52 50
Mixed grasses, rich in protein (8 to 10 per cent.),	21	73	54—69 61	60—66 62[1]	37—53 47	34—65 57	49—78 62	56—68 62	26—58 50
Mixed grasses, timothy predominating,	5	10	49—59 55	51—61 58	16—36 30	37—54 47	46—50 65	56—66 59	39—57 45
Meadow, swale or swamp hay,	1	2	38—40 39	- -	- -	31—37 34	30—36 33	- 46	- 44
Nevada native hay, second growth, mixed grasses,	1	2	75—77 76	- -	62—63 63	71—72 71	77—79 78	76—79 77	78—80 79

Nevada native hay, half clover,	1	2	65—67 66	– –	44—44 44	51—53 52	66—67 66	70—72 71	61—62 62
Nevada native hay, largely Buckley's blue grass,	1	2	64—65 65	– –	44—45 45	46—47 47	—66 66	68—69 69	68—71 70
Nevada native hay, largely timothy and tickle grass,	1	2	73—75 74	– –	57—61 59	64—64 64	71—77 74	78—79 79	70—74 72
Nevada native hay, largely wire grass and brown top sedge,	1	2	64—67 66	– –	50—52 51	48—49 49	75—77 76	58—64 61	70—71 71
Tall oat grass (*Arrhenatherum elatius*), late bloom,	1	2	54—57 55	– –	39—43 41	– 51	53—57 55	56—59 58	54—58 56
Wild oat grass (*Danthonia spicata*),	2	3	60—68 64	61—69 65	– –	49—68 58	65—71 68	62—69 65	36—63 50
Orchard grass, ten days after bloom,	1	1	54	56	–	59	58	54	54
Orchard grass, stage not given,	1	2	57—60 59	– –	– –	60—60 60	60—67 64	55—57 56	55—57 56
Orchard grass, average both samples,	2	3	56	56	–	60	61	55	55
Pasture grass,	1	3	73	73	52	73	76	74	67
Prairie grass (*Sporobolus Asper*),	1	1	56	–	25	18	61	61	57
Red top,	2	3	58—62 60	59—64 61	– –	60—62 61	61—62 61	59—65 62	44—59 51
Rowen, mixed grasses,	3	12	– –	63—68 65	– –	– 70	62—72 66	60—69 65	44—51 47
Rowen, chiefly timothy,	1	4	– –	62—67 64	– –	66—69 68	62—73 66	60—65 63	48—51 49
Rowen, average all trials,	4	16	-	65	–	69	66	64	47

[1] Average sixty trials.

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. HAY AND DRY COARSE FODDERS — *Con.*									
(*a*) *Meadow Grasses and Millets* — Con.									
Salt hays: Black grass (*Juncus Geradi*),	2	5	50—62 56	– –	67—71 69	53—63 58	50—66 59	46—59 52	37—51 44
Salt hays: Branch grass (*Distichlis spicata*),	2	5	49—57 52	– –	– 58	– 56	48—57 54	45—55 49	27—42 35
Salt hays: Flat sage (*Spartina stricta maritima* var.),	1	3	55—58 57	– –	61—62 62	50—55 52	60—61 60	54—57 55	33—40 36
Salt hays: Fox grass (*Spartina patens*),	3	7	51—56 54	– –	57—59 58	56—63 60	46—60 53	51—55 53	17—51 36
Salt hays: Salt hay mixture, fox and branch grasses, etc.,	1	2	52—56 54	– –	68—70 69	41—43 42	54—61 58	51—54 52	26—30 28
Slough grass hay, Dakota,	1	6	– –	– –	20—31 24	36—46 42	54—68 59	49—65 55	44—68 54
Timothy, in bloom,	4	8	54—66 59	51—67 58	33—34 34	50—60 57	50—62 57	57—72 63	26—62 48
Timothy, past bloom,	8	17	47—61 52	43—62 52	30—68 59	32—50 43	32—57 46	53—70 59	23—70 51
Timothy, stage unknown,	1	4	57—62 59	57—62 59	47—54 50	38—41 40	– –	– –	– –
Timothy, average all trials,	24	58	55	56	39	48	50	62	50
Timothy fed with cottonseed meal (16 hay, 1 meal),	1	2	52—56 54	– –	17—28 22	24—32 28	46—52 49	61—63 62	36—37 36
Timothy fed with cottonseed meal (12 hay, 1 meal),	1	2	49—55 52	– –	9—30 20	27—38 32	43—51 47	58—62 60	52—54 53

Timothy fed with cottonseed meal (8 hay, 1 meal),	1	2	44—48 46	– –	3—10 6	18—23 21	40—44 42	53—56 54	42—45 44
Timothy fed with cottonseed meal (4 hay, 1 meal),	1	2	45—46 46	– –	– –	4—4 4	42—43 43	56—75 67	44—66 55
Timothy fed with cottonseed meal (2 hay, 1 meal),	1	2	48—56 52	– –	– 13	– 13	34—44 39	65—71 68	72—74 73
Timothy fed with cottonseed meal (1 hay, 1 meal),	1	2	47—52 49	– –	19—23 21	– –	24—26 25	68—78 73	79—87 83
Timothy fed with cottonseed meal, average all trials,	6	12	50	–	16	20	41	62	57
Timothy and clover, poorly cured,	1	2	54—55 55	– –	– –	37—38 38	52—54 53	– 60	– 58
Timothy and red top, late bloom,	1	7	48—60 54	– –	11—24 19	35—43 39	49—63 55	55—66 60	28—51 42
Western wheat grass (*agropyrum glaucum occidentale*),	1	6	– –	– –	2—30 14	42—61 51	62—74 68	55—69 61	31—49 39
Wyoming native hay, wire grass,	2	5	51—64 57	– –	31—55 42	33—60 47	56—66 61	53—65 56	53—63 58
Wyoming native hay, wheat grass,	4	9	61—67 64	– –	28—54 40	53—62 57	63—74 68	63—70 66	38—54 47
Witch grass (Triticum repens),	2	4	60—63 61	61—64 62	– –	49—64 58	56—68 62	62—70 66	54—60 57
(*b*) *Cereal Fodders.*									
Barley hay,	1	4	59	62	–	65	62	63	41
Corn fodder, dent, immature, average all trials,	6	15	51—70 62	51—71 63	39—47 43	20—67 50	45—77 67	55—70 62	44—84 65
Corn fodder, dent, immature, B. & W.,	1	4	51—64 57	– –	– –	20—36 27	45—74 59	57—66 61	66—84 76
Corn fodder, dent, in milk,	5	11	59—66 63	– –	– –	44—51 50	50—71 64	61—69 66	67—79 75
Corn fodder, dent, mature,	10	30	57—70 66	– –	16—30 23	30—61 45	43—73 63	61—81 73	56—82 70

EXPERIMENTS WITH RUMINANTS — *Continued.*

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. HAY DRY AND COARSE FODDERS — *Con.*									
(*b*) *Cereal Fodders* — Con.									
Corn fodder, flint, ears forming,	1	3	69—72 70	71—73 71	- -	69—73 70	72—73 72	71—73 71	63—71 67
Corn fodder, flint, mature,	5	11	63—73 70	- -	- -	56—79 64	69—80 76	63—78 71	59—79 71
Corn fodder, sweet, mature,	3	6	60—71 67	62—74 70	- -	54—73 64	70—77 74	57—73 68	63—71 74
Corn stover, dent, Pride of the North,	1	2	53—55 54	- -	29—33 31	45—45 45	58—63 61	53—55 54	63—66 65
Corn stover, Eureka silage, ears just forming,	2	4	54—64 59	- -	40—46 43	57—58 53	56—72 65	53—64 59	62—67 65
Corn stover, average all trials,	12	33	53—61 57	49—58 55	29—46 41	11—58 37	52—74 64	53—64 59	36—77 69
Corn stover, below ear,	1	2	64—69 67	- -	- -	15—27 21	71—75 74	65—73 69	79—80 80
Corn stover, above ear,	1	2	52—58 55	- -	- -	17—27 22	69—72 71	50—57 54	62—65 64
Corn stover, minus pith (by hand),	1	3	54—57 55	55—59 57	- -	16—28 20	60—65 63	55—58 57	70—75 72
Corn stover, minus pith, ground (Marsden's process),	1	3	63—64 63	- -	46—55 49	57—62 60	60—61 61	65—66 66	82—83 83
Corn stover minus pith, ground (Marsden's process), steamed,	1	3	51—59 59	- -	47—55 50	59—60 60	37—54 48	57—62 59	70—85 80
Corn stover, minus pith, average,	3	9	51—64 58	55—59 57	46—55 50	16—62 47	37—65 57	55—66 61	70—85 78

Corn stover, blades and husks,	1	4	60—68 65	– –	15—35 23	41—55 48	67—76 73	64—71 66	53—64 58
Corn stover, tops and blades,	1	2	59—60 60	– –	– –	54—57 55	71—72 71	62—63 62	71—72 71
Corn stover, leaves,	1	2	55—56 56	– –	– –	43—69 56	54—67 61	57—61 59	61—65 63
Corn stover, leaves,	1	2	62—67 65	– –	– –	28—41 35	75—80 78	66—70 68	52—59 56
Corn stover, leaves, average both trials,	2	4	55—67 61	– –	– –	28—69 46	54—80 70	57—70 64	52—65 60
Corn stover, husks,	1	2	71—73 72	– –	– –	24—35 30	78—81 80	– 75	23—42 33
Kaffir corn fodder,	1	4	59—62 61	– –	5—11 8	34—42 38	56—63 60	64—68 66	57—67 61
Kaffir corn stover, shredded,	1	4	54—58 56	– –	13—26 19	29—34 30	65—69 67	56—60 58	77—81 79
Kaffir corn stover,	1	1	63	–	43	50	67	67	60
Kaffir corn stover, average both trials,	2	5	57	–	24	31	67	60	75
Oat hay, bloom to milk,	2	6	51—59 55	50—61 55	35—54 45	47—66 57	54—71 58	47—58 53	44—65 53
Oat hay, milk to dough,	4	14	48—60 54	48—61 54	20—54 37	34—60 52	39—62 48	49—62 56	52—72 64
Oat hay, average all trials,	6	20	54	54	39	53	51	55	60
Oat straw,	4	12	42—61 54	51—53 52	21—62 38	3—36 21	34—76 61	43—64 55	24—58 42
Sorghum fodder, Minnesota Early Amber,	1	3	58—60 58	54—55 54	41—49 44	40—47 43	42—56 49	57—67 61	62—67 65
Sorghum fodder, variety unknown,	1	6	– –	– –	9—55 23	30—74 53	57—84 71	49—82 64	66—87 77

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. HAY AND DRY COARSE FODDERS — *Con.*									
(*b*) *Cereal Fodders* — Con.									
Sorghum fodder, leaves,	1	2	60—66 63	- -	- -	59—62 61	65—76 70	62—67 65	46—47 47
Sorghum fodder, bagasse,	1	1	61	-	-	14	64	65	46
(*c*) *Legumes.*									
Alfalfa, first crop,	19	33	55—72 63	- -	34—67 54	61—85 75	19—65 47	61—79 72	23—65 43
Alfalfa, second crop,	13	27	54—67 63	- -	35—59 52	64—81 77	40—53 46	65—80 74	14—51 42
Alfalfa, third crop,	1	2	56—60 58	- -	40—49 44	68—70 69	28—40 34	71—71 71	38—45 42
Alfalfa, poor quality,	1	2	56—56 56	58—58 58	35—44 39	66—66 66	38—43 40	68—72 70	31—45 38
Alfalfa, stage of cutting unknown,	1	2	54—55 55	- -	24—25 25	67—70 69	40—42 41	68—70 69	13—19 16
Alfalfa, stage of cutting unknown,	1	6	- -	- -	31—40 35	74—80 78	40—50 44	65—77 72	33—42 37
Alfalfa, average all trials,	42	80	62	-	50	74	46	72	40
Soy bean,	1	2	62—63 62	- -	- -	70—72 71	59—62 61	66—71 69	19—40 29
Clover, alsike, full to late bloom,	4	9	55—64 59	56—65 60	- 42	64—71 66	40—59 50	59—74 66	21—69 38
Clover, crimson,	3	9	57—65 62	52—58 56	- -	64—73 69	32—58 45	52—74 62	29—54 44

Clover, red, bud to early blossom,	1	2	63—64 64	– –	59—61 60	64—64 64	57—62 59	67—68 68	52—52 52
Clover, red, full blossom,	1	2	58—61 60	– –	54—58 56	59—61 60	43—49 46	68—71 69	55—56 55
Clover, red, stage of cutting not given,	10	21	49—67 58	51—66 55	0—44 32	47—69 57	42—70 54	56—72 65	40—70 56
Clover, red, average all trials,	12	25	58	55	36	58	54	65	56
Clover, white,	1	1	66	67	–	73	61	70	51
Clover, rowen,	2	4	– –	58—60 59	42—50 46	60—69 65	45—51 47	62—64 63	58—60 60
Sweet clover,	1	3	58—62 61	– –	65—67 66	75—76 75	27—37 34	71—73 72	28—33 31
Pea straw,	1	3	65—69 67	– –	27—37 33	76—80 78	48—54 51	78—80 79	47—51 50
Cow pea,	1	2	– 59	– –	– –	64—65 65	41—45 43	– 71	46—54 50
Peanut vine,	1	2	59—60 60	– –	– –	63—64 63	51—53 52	69—70 70	62—70 66
French pea (*Lathyrus* ——),	1	2	67—68 68	– –	65—69 67	81—82 82	49—50 49	75—76 75	58—60 59
Spring vetch (*Vicia sativa*),	2	4	64—67 66	66—68 67	52—60 56	61—71 66	54—61 58	70—72 72	68—72 70
Winter or hairy vetch (*Vicia villosa*),	2	8	59—71 67	– –	34—67 47	68—83 82	51—63 58	62—75 67	53—74 67
(*d*) *Mixed and Miscellaneous.*									
Buttercups (*Ranunculus acris*),	1	2	56	57	–	56	41	67	70
Cottonseed feed (4-1),[1] sheep,	2	6	54—60 56	– –	23—25 28	36—45 41	51—60 56	57—60 59	86—94 91
Cottonseed feed (4-1), steers,	1	2	54	–	46	54	45	58	85

[1] Four hulls to one meal.

EXPERIMENTS WITH RUMINANTS — *Continued.*

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. HAY AND DRY COARSE FODDERS — *Con.*									
(*d*) *Mixed and Miscellaneous* — Con.									
Cottonseed feed, average both (4-1) trials,	3	8	56	-	33	44	53	59	90
Cottonseed feed (5—1) steers,	2	5	42—60 49	- -	20—46 31	32—54 42	28—54 50	50—67 60	83—94 88
Cottonseed feed (7—1) and (6—1), steers,	1	3	45—46 46	- -	- 28	44—46 45	34—40 37	50—51 50	81—82 82
Cottonseed feed (3-1) to (2-1), steers,	2	9	54	-	32	64	47	54	85
Cottonseed feed, average all trials,	8	25	53	-	31	51	47	56	87
Cottonseed hulls,	4	13	35—47 41	- -	- -	0—25 6	.5—58 47	13—46 34	58—89 79
Oats and peas,	2	7	56—67 61	56—67 60	54—65 58	69—78 73	50—64 58	54—66 61	51—69 59
Oats and sand vetch,	1	2	55—55 55	56—56 56	43—46 44	64—66 65	48—50 49	58—59 59	58—67 63
Oats and spring vetch,	2	5	57—63 59	- 60	- 60	60—71 65	47—67 57	34—65 59	17—76 52
Oats and vetch, average,	3	7	58	58	56	65	55	59	55
Salt bush (*Atriplex Argentea*),	1	3	46—47 46	31—32 31	71—72 72	65—68 66	3—15 8	46—51 49	50—55 52
Wheat and sand vetch, blossom,	2	6	64—69 66	- -	33—60 47	70—77 74	63—66 65	67—71 68	62—67 64
White weed (*Leucanthemum vulgare*),	1	2	58	58	-	58	46	67	62
Willows (*Salix exigna*),	1	2	50—58 54	- -	24—40 32	20—38 29	40—44 42	63—70 67	73—67 70

IV. Roots and Tubers.									
Sugar beets,	1	2	94—95 95	98—100 99	- -	90—93 91	88—113 100	100—100 100	40—53 50
Mangolds,	1	2	77—80 79	83—87 85	- -	70—80 75	27—59 43	91—92 91	- -
Potatoes,	1	3	73—80 77	75—81 78	- -	43—45 44	- -	87—93 91	- 13
Ruta-bagas,	1	2	84—90 87	89—93 91	- -	75—86 80	61—87 74	94—95 95	77—92 84
English flat turnips,	1	2	91—95 93	93—99 96	- -	84—95 90	89—117 100	96—97 97	82—92 88
V. Concentrated Feedstuffs.									
(a) Protein.									
Soy bean meal, variety unknown,	2	3	75—79 78	- -	- -	89—91 90	0—73 33	68—73 71	81—98 89
Soy bean meal, medium green, coarse ground,	2	4	81—98 90	- -	42—77 57	88—95 91	- -	61—100 81	89—97 93
Bibby's dairy cake,	2	6	61—81 70	- -	18—44 33	58—76 66	1—68 46	71—88 81	84—99 92
Bile's Union Grains,	2	3	72—94 81	- -	22—70 39	69—86 76	78—118 93	75—98 86	95—102 98
Blood meal, Armour's,	1	2	- -	- -	- -	80—88 84	- -	- -	- -
Brewers' dried grains,	2	5	56—62 62	- -	- -	78—84 81	28—62 49	51—60 57	87—93 89
Buckwheat middlings,	1	3	71—79 75	- -	26—41 36	83—86 85	8—26 17	79—87 83	87—92 89
Buffalo Creamery Feed,	1	2	68—71 69	- -	20—25 23	80—82 81	52—57 55	70—72 71	83—91 87
Chapins Alfalfa Meal, a dairy feed,	1	2	52—67 59	- -	13—40 26	67—75 71	31—58 45	56—70 63	76—92 84

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
V. CONCENTRATED FEEDSTUFFS — *Con.*									
(*a*) *Proteins* — Con.									
Cottonseed, raw,	1	2	63—69 66	– –	– –	66—70 68	65—86 76	49—50 50	– 87
Cottonseed, roasted,	1	2	53—58 56	– –	– –	44—50 47	62—69 66	50—53 51	68—75 72
Cottonseed meal,	4	12	67—90 79	81—95 88	– 84[1]	76—96 84	26—55 35	66—96 78	87—100 94
Cottonseed meal, high grade (Maine),	1	2	90	95	–	83	–	96	100
Cottonseed meal, medium grade (Maine),	1	2	67—79 73	73—83 78	– –	81—86 84	40—47 44	73—91 82	95—95 95
Cottonseed meal, low grade (Maine),	1	2	60—63 62	62—67 65	– –	72—73 73	30—45 38	66—70 68	87—93 90
Cottonseed meal, low grade (Massachusetts),	1	2	60—76 68	– –	80—89 85	77—80 78	– 40	73—83 78	100—100 100
Cottonseed meal, high grade, dark colored, slightly fermented (Maine).	1	2	81—91 86	85—95 90	– –	82—83 83	– –	90—100 95	95—100 98
Dairy feed, H-O,	2	4	65—65 65	– –	– –	68—80 76	14—43 35	67—75 72	83—88 84
Distillers' dried grains, largely from rye,	1	2	56—59 58	– –	– –	56—63 59	– –	61—73 67	80—88 84
Distillers' dried grains, largely from corn,	8	17	70—89 79	– –	– –	66—80 73	59—100+ 95	69—97 81	88—98 95
Germ oil meal,	2	5	72—83 76	– 75	– –	65—77 73	– –	68—82 76	95—98 96

Gluten feed,	10	18	85—98 88	92—93 93[2]	78—99 88[3]	69—93 85	64—100+ 87	83—97 90	60—83 81
Gluten meal,	4	8	75—95 87	– –	– –	86—93 88	– –	78—94 88	91—99 93
Linseed meal, old process,	1	3	75—82 79	– –	– –	86—93 89	38—71 57	76—79 78	85—92 89
Linseed meal, new process,	1	3	73—83 78	– –	– –	82—88 85	49—100 74	82—87 84	90—98 93
Linseed meal, new process, Cleveland flax,	3	9	76—88 83	– 79	– –	– 83	– –	– 79	– 87
Linseed meal, new process, average,	4	12	82	79	–	84	74	80	89
Malt sprouts,	1	1	67	68	–	80	34	69	100
Malt sprouts (Massachusetts),	1	3	75—89 82	– –	3—33 19	74—77 76	98—100 99	76—91 85	74—100 87
Maize feed (Chicago),	1	2	83—85 84	– –	– –	83—84 84	68—76 72	84—87 85	90—90 90
Oat middlings, fine,	1	2	88—91 90	– –	31—40 36	80—81 81	21—77 49	94—97 96	93—94 94
Pea meal,	1	2	85—88 87	86—89 88	– –	80—86 83	25—26 26	93—94 94	52—57 55
Protena Dairy Feed,	1	2	63—66 65	– –	33—37 35	70—73 72	33—45 39	72—76 74	97—99 98
Cow pea meal,	1	2	85—88 87	– –	22—45 33	80—85 82	62—66 64	92—94 93	74—74 74
Rye feed, bran and middlings,	1	3	77—83 82	– –	25—48 35	78—82 80	– –	86—89 88	79—99 90
Unicorn Dairy Ration,	2	3	81—87 83	– –	6—40 25	73—77 76	62—84 72	86—94 89	95—96 96

[1] One trial. [2] Average thirteen trials. [3] Average two trials.

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
V. CONCENTRATED FEEDSTUFFS — *Con.*									
(*a*) *Protein* — Con.									
Wheat bran, spring,	3	7	62—70 67	69—74 71	20—32 25	74—82 76	22—76 44	70—80 74	38—83 63
Wheat bran, winter,	1	3	57—66 62	– –	– –	75—79 77	– 27	62—76 65	51—80 64
Wheat bran, average all trials,	4	10	66	–	–	77	39	71	63
Wheat feed flour,	1	2	67—67 67	70—70 70	– –	78—80 79	– –	73—78 76	– –
Wheat middlings, flour,	2	4	78—86 82	81—84 83	– –	82—91 88	33—40 36	84—91 88	82—88 86
Wheat middlings, standard,	2	6	–	73	25	77	30	78	88
Wheat mixed feed, bran and middlings,	2	4	71—78 73	73—81 76	34—43 37	77—79 78	47—79 62	74—79 77	81—92 87
Wheat mixed feed, adulterated with corn cobs,	1	3	59—65 62	61—67 64	28—34 31	62—63 63	17—36 28	68—74 71	91—93 92
Wheat screenings,	1	2	70—87 79	– –	– –	68—81 75	45—85 65	81—89 85	92—95 94
(*b*) *Starchy.*									
Feed barley meal,	1	2	87—91 89	– –	28—47 38	86—90 88	45—96 70	92—94 93	86—87 86
Hanna barley,	3	13	– –	– –	– –	68—90 77	15—98 56	87—96 92	55—99 78
Manchuria barley,	1	2	– –	– –	– –	84—84 84	– 54	89—93 91	78—82 80

Cerealine feed,	1	3	89—92 90	– –	– –	79—81 80	72—92 82	93—97 95	78—83 81
Chop feed, corn bran and germs,	2	6	71—92 80	– –	– –	56—77 67	54—70 62	64—92 84	61—86 82
Corn bran,	2	4	70—71 70	– –	– –	53—55 54	50—65 59	74—80 77	69—85 77
Corn cobs,	1	2	59—60 59	– –	– –	13—22 17	65—66 65	60—60 60	44—56 50
Corn meal, coarse,	2	4	74—93 84	75—94 86	– –	45—54 48	– –	79—91 86	– –
Corn meal, fine,	5	8	84—90 87	89—90 90[1]	– –	48—81 65	– –	87—98 93	75—95 85[2]
Corn meal, average all trials,	12	26	74—98 88	75—94 90	– –	40—87 67	– –	79—100 92	71—99 90
Corn and cob meal,	1	3	74—83 79	– –	– –	43—65 52	2—86 45	86—91 88	82—85 84
Corn and oat feed, Victor,	1	3	74—76 75	– –	– –	66—75 71	36—58 48	81—85 83	84—88 87
Kaffir corn kernels,	2	6	29—58 43	– –	– –	28—54 41	– –	34—62 45	– –
Kaffir corn meal,	3	7	54—81 70	– –	38—99 69	36—65 56	61[3] –	67—88 79	25—81 55
White Kaffir corn heads,	1	4	14—35 24	– –	24—83 54	7—23 12	0—46 27	14—40 31	5—65 31
Dairy feed, Quaker,	3	8	58—64 62	– 52	– –	62—72 70	54—56 55	55—71 59	72—80 74
Hominy meal,	3	8	71—91 82	– –	11—60 37	54—71 65	2—100+ 67	82—94 89	88—95 92
Horse feed, H-O,	3	5	70—77 74	– 78	– –	62—81 70	52—59 56	79—85 83	74—87 80

[1] Average three trials. [2] Average five trials. [3] One trial.

EXPERIMENTS WITH RUMINANTS — *Concluded.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
V. CONCENTRATED FEEDSTUFFS — *Con.*									
(*b*) *Starchy* — Con.									
Milo maize meal,	1	2	77—91 84	- -	84—100 92?	61—71 66	- 100	83—86 85	87—94 90
Molasses feeds. Alma dried molasses beet pulp,	1	2	82—87 85	- -	55—69 62	59—69 64	83—84 84	89—93 91	- -
Molasses feeds. Blomo feed,	1	2	64—69 67	- -	31—32 32	61—64 63	51—72 61	73—79 76	14—17 16
Molasses feeds. Green Diamond sugar feed,	1	2	61—70 66	- -	36—39 38	68—72 70	36—52 44	70—78 74	75—92 84
Molasses feeds. Holstein sugar feed,	1	3	70—74 71	- -	24—43 33	61—71 66	26—62 44	79—82 81	86—89 88
Molasses feeds. Macon sugar feed,	1	2	69—72 71	- -	20—21 20	57—61 59	36—51 44	81—83 82	74—91 82
Molasses feeds. Sucrene dairy feed,	1	2	67—72 69	- -	28—47 38	57—64 61	70—73 72	71—75 73	93—96 95
Molasses feeds. Molasses feeds, average last four,	4	9	69	-	32	64	50	79	87
Red Orenburg millet,	2	4	- -	- -	- -	39—64 55	24 -	84—95 88	86—91 88
Black Voronezh millet,	4	8	- -	- -	- -	54—93 70	14—65 30	76—95 88	68—91 81
Sixty day oats,	1	1	-	-	-	86	50	86	79
Swedish seleet oats,	4	11	- -	- -	- -	67—85 77	16—55 36	76—87 81	82—97 89
Oats, unground,	2	6	66—74 70	68—74 71	2—61 25	72—81 77	15—40 31	74—79 77	87—92 89

Oat feed, Royal, many hulls,	1	3	42—51 47	42—53 48	33—40 37	64—72 69	20—43 33	50—54 51	86—92 88
Oat feed, excessive hulls,	1	3	29—38 34	- -	8—21 13	51—69 62	25—37 32	29—36 33	89—97 92
Oat feed, average last two,	2	6	40	-	25	65	32	42	90
Parson's "Six-dollar" feed, mill sweepings,	1	2	55—56 56	- -	10—14 12	56—62 59	45—50 47	63—65 64	80—81 81
Peanut feed, largely husks,	1	2	32—32 32	- -	- -	70—71 71	10—13 12	41—58 49	90—90 90
Rice meal,	1	2	71—76 74	- -	- -	- 62	- ?	89—95 92	91—92 91
Rice bran,	1	2	56—66 62	- -	1—34 18	58—68 64	13—42 21	76—81 78	52—92 72
Rye meal,	1	2	85—90 87	- -	- -	83—85 84	- -	89—94 92	63—65 64
Rice polish,	1	2	82—83 83	- -	27—36 31	65—66 66	22—23 22	92—93 93	66—81 74
Speltz or emmer, unground (Minnesota),	1	2	93—94 94	- -	51—56 53	85—88 87	82—85 84	96—97 97	90—91 92
Speltz or emmer (South Dakota),	3	9	- -	- -	- -	68—85 78	42—60 50	81—95 87	74—99 87
Speltz or emmer, average,	4	11	-	-	-	80	60	89	88
Schumacher's stock feed (corn, oat and barley),	1	2	70—72 71	- -	- -	68—72 70	46—59 52	79—79 79	87—89 88
Durum wheat,	1	2	- -	- -	- -	76—80 78	40 -	92—92 92	61—69 65
Red wheat meal,	1	2	83—88 86	- -	26—29 28	66—68 67	40 -	91—94 92	79—81 80
White Winter wheat meal,	1	2	86—91 88	- -	10—49 30	81—83 82	77 -	92—95 93	62—66 64

EXPERIMENTS WITH SWINE.

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
Barley meal,	1	1	80	80	–	81	49	87	57
Linseed meal, old process,	1	4	76—79 77	– –	8—12 10	83—90 86	10—14 12	82—87 85	78—82 80
Maize kernels,	1	1	83	83	–	69	38	89	46
Maize meal,	2	2	89—90 90	91—92 92	– –	86—90 88	29—49 39	94—94 94	78—82 80
Maize meal with cobs,	1	1	76	77	–	76	29	84	82
Hog millet seed (*Panicum milia ceum*),	1	1	73	–	19	68	33	92	59
Pea meal,	1	1	90	92	–	89	78	95	50
Potatoes,	1	4	97	–	–	84	–	98	–
Wheat, whole,	1	?	72	–	–	70	30	74	60
Wheat, cracked,	1	?	82	–	–	80	60	83	70
Wheat shorts (middlings),	1	2	74—79 77	– –	– –	71—75 73	25—48 37	85—88 87	– –
Wheat bran,	1	2	54—78 66	– –	– –	74—76 75	30—39 39	56—75 66	65—78 72

Experiments with Horses.

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
Corn kernels,	1	2	71—78 74	– –	20—32 26	40—76 58	– –	85—92 88	43—52 48
Corn meal, same as above,	1	2	84—93 88	– –	– –	74—77 76	– –	93—99 96	70—76 73
Corn stover minus pith, ground (Marsden's process),	1	2	40—59 50	– –	6—37 22	65—70 68	38—71 55	39—54 47	48—72 60
Oat kernels,	1	2	67—77 72	– –	31—36 33	84—87 86	13—49 31	75—83 79	80—85 82
Oats, ground, same as above,	1	2	73—78 76	– –	9—49 29	81—83 82	.6—28 14	85—87 86	79—81 80
Oats, average,	2	4	74	–	31	84	22	82	81
Timothy hay,	1	2	39—48 44	– –	29—39 34	18—24 21	37—48 43	44—50 47	44—51 47

Experiments with Poultry.

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fiber (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
Clover, second crop, just beginning to blossom,	1	3	-	28	-	71	10	14	36
Corn kernels,	1	3	- -	- 86	- -	44—58 50	- -	90—96 92	88—95 92
Corn kernels,	2	6	- -	86—87 87	- -	68—87 81	1—25 15	88—92 90	81—87 85
Corn, cracked,	1	2	- -	83—84 83	- -	72—73 72	- -	87—89 88	87—88 87
Corn meal,	1	3	- -	- 85	- -	41—55 48	- -	91—92 91	92—94 93
Corn meal,	1	2	- -	82—84 83	- -	72—77 75	- -	84—88 86	87—88 88
Kaffir corn kernels,	1	3	- -	- 88	- -	50—55 53	17—22 20	94—98 96	71—73 74
Kaffir corn meal,	1	3	- -	- 87	- -	42—44 43	30—42 35	95—97 96	82—84 83
Meat,	1	2	- -	87—87 87	- -	90—91 91	- -	- -	86—87 87
Beef scrap,	1	2	-	80	-	93	-	-	96
Oats, whole,	2	12	- -	59—68 63	- -	68—84 75	4—11 8[1]	62—75 69	77—89 83
Oats, rolled,	1	2	- -	79—84 82	- -	78—81 80	- -	85—87 86	86—102 94
Cow peas,	1	3	- -	- 71	- -	32—48 40	2—43 18	86—88 87	87—90 89

Cow pea meal,	1	3	– –	– 72	– –	40—49 44	8—11 10	84—91 88	75—98 89
Wheat,	1	1	–	84	–	77	–	89	59
Wheat, hard,	1	1	–	82	–	71	–	81	57
Wheat, soft,	1	5	– –	81—85 82	– –	57—79 74	– 17	87—90 89	45—69 54
Wheat bran, coarse,	1	3	– –	46—47 47	– –	69—74 72	13—14 14	46—46 46	35—38 37
India wheat,	1	3	– –	67—76 73	– –	71—80 75	5—29 21	79—86 83	79—87 84

EXPERIMENTS WITH CALVES.

Whole milk,	2	8	– –	– –	– –	90—98 95	– –	– –	93—99 97
Pasteurized whole milk,	2	9	– –	– –	– –	88—95 93	– –	– –	91—99 95
Cooked whole milk,	1	3	– –	– –	– –	80—94 87	– –	– –	92—99 95
Raw skim milk,	1	3	– –	– –	– –	94—95 95	– –	– –	– –
Skim milk, with sheep,	1	3	96—102 97	– 100	46—74 62	93—96 94	– –	– 100	– 100

[1] Eight trials.

Average Digestion Coefficients obtained with Poultry.[1]

[German and American Experiments.]

Kind of Fodder.	Number of Experiments.	Organic Matter.	Crude Protein.	Nitrogen-free Extract.	Fat.
Bran, wheat,	3	46.70	71.70	46.00	37.00
Beef scrap,	2	80.20	92.60	–	95.00
Beef (lean meat),	2	87.65	90.20	–	86.30
Barley,	3	77.17	77.32	85.09	67.86
Buckwheat,	2	69.38	59.40	86.99	89.22
Corn, whole,	16	86.87	81.58	91.32	88.11
Corn, cracked,	2	83.30	72.20	88.10	87.60
Corn meal,	2	83.10	74.60	86.00	87.60
Clover,	3	27.70	70.60	14.30	35.50
India wheat,	3	72.70	75.00	83.40	83.80
Millet,	2	–	62.40	98.39	85.71
Oats,	13	62.69	71.31	90.10	87.89
Peas,	3	77.07	87.00	84.80	80.01
Wheat,	10	82.26	75.05	87.04	53.00
Rye,	2	79.20	66.90	86.70	22.60
Potatoes,	6	78.33	46.94	84.46	–

[1] Compiled by J. M. Bartlett, Bulletin 184, Maine Agricultural Experiment Station.

Literature.

The following publications have been consulted in compiling the foregoing tables of digestibility: —

Colorado Experiment Station, Bulletins 8, 93.

Connecticut (Storrs) Experiment Station, reports for 1894–96, 1898; Bulletin 43.

Illinois Experiment Station, Bulletins 43, 58.

Kansas Experiment Station, Bulletin 103.

Louisiana Experiment Station, Bulletin 77, second series.

Maine Experiment Station, reports for 1886–91, 1893, 1894, 1897, 1898, 1900; Bulletins 110, 184.

Maryland Experiment Station, Bulletins 20, 41, 43, 51, 77, 86.

Massachusetts Agricultural Experiment Station, reports for 1895–99, 1901–05, 1907; and Digestion Experiments, Series XII., XIII., XIV., XV., unpublished.

Massachusetts, State Experiment Station, reports for 1893, 1894.

Minnesota Experiment Station, reports for 1894–96; Bulletins 26, 36, 42, 47, 80, 99.

Mississippi Experiment Station, report for 1895.

Nevada Experiment Station, Bulletins 64, 66, 71.

New York Experiment Station, reports for 1884, 1888, 1889; Bulletin 141.

North Carolina Experiment Station, Bulletins 80*c*, 81, 87*d*, 97, 118, 148, 160, 172.

Oklahoma Experiment Station, Bulletins 37, 46.

Oregon Experiment Station, Bulletins 6, 47, 85, 102.

Pennsylvania Experiment Station, reports for 1887–94, 1897, 1898, 1900–01, 1903–04, 1906–07.

South Dakota Experiment Station, Bulletin 114.

Tennessee Experiment Station, unpublished data.

Texas Experiment Station, Bulletins 13, 15, 19, 104.

Utah Experiment Station, Bulletins 16, 54, 58.

United States Department of Agriculture, Bureau of Animal Industry, Bulletins 56, 106.

Wisconsin Experiment Station, report for 1889; Bulletin 3.

Wyoming Experiment Station, Bulletins 69, 78.

Table V. — Compilation of Analyses of Agricultural Chemicals, Refuse Salts, Phosphates, Guanos, Ashes, Lime Compounds, Marls, By-products, Refuse Substances and Animal Excrements.

H. D. HASKINS AND L. S. WALKER.

A. Chemicals and Refuse Salts.
- (*a*) Nitrogen chemicals.
- (*b*) Potash chemicals.
- (*c*) Refuse salts.

B. Phosphates and Guanos.
- (*a*) Natural phosphates.
- (*b*) Dissolved phosphates.
- (*c*) Guanos.

C. Ashes, Lime Compounds and Marls.
- (*a*) Ashes.
- (*b*) Lime compounds.
- (*c*) Marls.

D. By-products and Refuse Substances.
- (*a*) Abattoir products.
- (*b*) Fish products.
- (*c*) Seaweeds.
- (*d*) Vegetable products.
- (*e*) Wool products.
- (*f*) Miscellaneous substances unclassified.

E. Animal Excrements.

F. Insecticides.

As a rule, the analyses reported in the following compilation were made at this laboratory.[1] Some of them were made many years ago. Refuse products from various manufacturing industries are likely to vary more or less in composition, due to frequent changes in the parent industry. The revision of the

[1] In the compilation of analyses of seaweeds, five of said analyses were taken from Bulletin No. 21 of the Rhode Island Agricultural Experiment Station.

compilation every five years, however, insures quite reliable figures in most instances. In case of the agricultural chemicals and by-products which are commonly known to the fertilizer trade, the present compilation includes the samples collected by our inspectors during the last five years, as well as those samples sent by farmers and farmer organizations. In all cases where samples are forwarded for analysis, they are taken according to printed directions furnished from this office, which is a reasonable assurance that the analyses are representative of the materials sampled. In many instances extremely wide variations occur in different analyses of the same product. This emphasizes the importance of careful sampling as well as the purchase of such materials on a specific guarantee of plant food which they furnish.

In the majority of instances only the highest, lowest and average percentage of nitrogen, potash and phosphoric acid are given in the tables, but it should be remembered that blanks do not imply the absence of the other ingredients.

A. Chemicals and Refuse Salts.

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
(a) Nitrogen Chemicals.																							
Calcium cyanide,	3	.71	–	–	–	19.06	–	–	–	–	–	–	–	–	–	–	63.19	–	2.10	–	–	–	1.00
Carbonate of ammonia,	1	–	–	–	–	22.23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nitrate of potash,	10	1.58	–	14.58	11.42	12.57	45.62	43.48	44.20	–	–	–	–	–	–	–	–	–	–	–	–	9.74	–
Nitrate of soda,	186	1.76	–	16.57	14.14	15.38	–	–	–	–	–	–	–	–	–	35.50	–	–	–	–	–	.50	.50
Nitrate of lime,	1	5.88	–	–	–	12.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nitrogenous chalk,	4	.78	–	9.88	8.42	9.11	–	–	–	–	–	–	–	–	–	–	29.30	–	–	–	–	–	2.28
Phosphate of ammonia,	1	6.05	–	–	–	10.87	–	–	–	–	–	43.86	–	43.86	–	–	–	–	–	12.46	–	–	.82
Sulfate of ammonia,	35	1.01	–	22.72	19.44	20.91	–	–	–	–	–	–	–	–	–	–	–	–	–	60.00	–	–	–
(b) Potash Chemicals.																							
Carbonate of potash, high grade,	26	2.25	–	–	–	–	67.20	55.68	63.02	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Carbonate of potash and magnesia,	2	18.22	–	–	–	–	20.00	18.48	19.24	–	–	–	–	–	–	–	–	19.52	–	–	–	–	.39
Carnallite,	1	–	–	–	–	–	–	–	13.68	–	–	–	–	–	–	7.66	–	13.19	–	.56	–	41.56	–
Hard salts,	1	.45	–	–	–	–	–	–	17.30	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kainit,	24	3.04	–	–	–	–	16.50	10.90	13.07	–	–	–	–	–	–	18.97	2.37	6.37	–	20.25	–	20.64	2.13
Krugite,	1	4.82	–	–	–	–	–	–	8.42	–	–	–	–	–	–	5.27	12.45	8.79	–	31.94	–	6.63	14.96

Muriate of potash,	134	1.50	-	-	-	-	58.08	43.08	49.82	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Phosphate of potash,	1	3.76	-	-	-	-	-	-	32.55	-	-	37.50	-	37.50	-	-	-	-	-	13.43	-	-	.92
Sulfate of potash, high grade,	113	.90	-	-	-	-	53.60	45.40	49.69	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulfate of potash and magnesia,	52	4.65	-	-	-	-	31.68	19.55	26.37	-	-	-	-	-	-	6.25	2.57	13.65	-	44.62	-	1.92	2.26
Silicate of potash,	5	8.26	-	-	-	-	27.62	18.62	20.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vegetable potash,	11	3.40	-	-	-	-	27.84	23.96	25.59	-	-	2.55	-	-	-	-	20.65	-	-	-	-	-	9.70
(*c*) *Refuse Salts.*																							
Cyanide of potash refuse,	1	39.23	-	-	-	.96	-	-	7.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Niter salt cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Sulfate of magnesia,	12	24.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.18	-	36.10	-	-	5.73
Sulfate of soda,	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	45.50	-	-	-	59.43	-	-	-
Saltpeter waste,	27	3.63	-	10.12	.52	3.41	50.94	1.55	24.82	-	-	-	-	-	-	37.04	.79	.19	-	1.85	-	44.37	-

B. Phosphates and Guanos.

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
(a) Natural Phosphate.																							
Apatite,	2	.07	-	-	-	-	-	-	-	37.74	32.62	35.18	-	2.09	33.09	-	-	-	-	-	-	-	-
Arkansas rock phosphate,	1	.91	-	-	-	-	-	-	-	-	-	25.10	-	-	-	-	-	-	-	-	-	-	-
Belgian phosphate,	1	.21	-	-	-	-	-	-	-	-	-	9.54	-	-	-	-	41.27	-	-	-	-	-	-
Bone ash,	13	3.09	-	-	-	-	-	-	-	39.14	28.38	35.96	-	4.07	31.89	-	52.12	-	-	-	-	-	.96
Bone black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3 64
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Florida rock phosphate,	2	.53	-	-	-	-	-	-	-	40.34	33.10	36.72	-	.10	36.62	-	-	-	-	-	-	-	-
Florida soft phosphate,	2	5.22	-	-	-	-	-	-	-	-	-	23.24	-	.85	22.40	-	-	-	-	-	-	-	-
Novassa phosphate,	1	5.77	-	-	-	-	-	-	-	-	-	24.56	-	1.66	22.90	-	-	-	-	-	-	-	-
South American bone ash,	1	7.00	-	-	-	-	-	-	-	-	-	35 89	-	-	-	-	44.89	-	-	-	-	-	4.50
South Carolina rock phosphate,	12	1.36	-	-	-	-	-	-	-	31.87	20.60	26.62	-	3.40	24.60	-	-	-	-	-	-	-	-
Tennessee phosphate,	1	1.09	-	-	-	-	-	-	.44	-	-	27.97	-	-	-	-	-	-	-	-	-	-	-
(b) Dissolved Phosphates.																							
Acid phosphate,	97	10.49	-	-	-	-	-	-	-	19.44	11.60	16.07	9.53	4.62	1.92	-	-	-	-	-	-	-	-
Basic slag phosphate,	42	.68	-	-	-	-	.52	.04	.38	-	-	18.08	-	14.17	2.79	-	44.33	-	16.18	-	2.51	-	9.14

Dissolved bone,	27	8.09	-	-	-	2.57	-	-	-	24.12	14.58	16.84	3.49	9.37	3.98	-	-	-	-	-	-	-	-
Dissolved bone black,	67	11.09	-	-	-	-	-	-	-	21.14	14.69	17.40	12.24	4.04	1.12	-	-	-	-	-	-	-	-
Double super phosphate,	2	6.27	-	-	-	-	-	-	-	50.14	45.42	47.78	18.36	20.97	8.45	-	-	-	-	-	-	-	-
Precipitated phosphate,	1	9.40	-	-	-	-	-	-	-	-	-	25.45	.72	24.17	.56	-	32.22	-	-	-	-	-	-
Upton phosphate,	1	9.07	-	-	-	-	-	-	-	-	-	40.15	-	37.84	2.31	-	-	-	-	-	-	-	-
(c) Guanos.																							
Guano, bat (Texas),	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.76	-	-	-	-	-	-	-	-	-	-	2.00
Guano, bat (Florida),	2	15.66	-	-	-	9.74	-	-	1.77	3.44	3.26	3.35	-	-	-	-	-	-	-	-	-	-	19.33
Guano, bat (Havana, Cuba),	2	5.83	-	6.96	1.70	4.33	1.20	.53	.86	14.00	5.04	9.52	-	-	-	6.17	11.04	-	5.76	-	-	-	9.47
Guano (Cuban),	5	21.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Guano, Caribbean (Orchilla),	12	7.31	-	-	-	-	-	-	-	35.43	18.14	26.77	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27
Guano (Damaraland),	1	17.70	-	-	-	5.79	-	-	3.53	-	-	14.78	4.90	5.79	4.09	7.03	14.21	2.05	-	5.94	-	5.76	9.26
Guano, Mona Island,	1	13.32	-	-	-	.76	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45
Guano, Peruvian,	30	13.58	37.61	13.50	4.44	6.36	4.08	1.14	2.62	20.60	5.96	14.85	3.72	5.49	5.64	-	12.85	-	-	-	-	-	6.60
Guano, rat (Florida),	1	10.32	-	-	-	3.32	-	-	6.85	-	-	2.30	-	-	-	-	-	-	-	-	-	-	1.15

C. Ashes, Lime Compounds and Marls.

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
(a) Ashes.																							
Ashes, bamboo,	1	31.84	–	–	–	–	–	–	1.92	–	–	1.80	–	–	–	–	1.56	–	–	–	–	–	–
Ashes, bituminous coal,	2	3.66	–	–	–	–	–	–	.38	–	–	.44	–	–	–	–	1.88	–	–	–	–	–	74.17
Ashes, brick-yard,	2	.58	–	–	–	–	3.59	3.32	3.45	1.61	1.33	1.47	–	–	–	–	24.33	–	–	–	–	–	47.63
Ashes, blue works,	1	12.14	63.78	–	–	–	–	–	9.02	–	–	–	–	–	–	–	–	–	–	–	–	–	12.30
Ashes, corn-cob,	2	5.47	–	–	–	1.18	42.38	7.08	24.73	7.08	2.37	4.72	–	–	–	–	7.00	–	–	–	–	–	38.12
Ashes, cottonseed hull,	39	7.66	–	–	–	–	32.80	13.44	21.86	15.53	6.26	8.60	–	6.88	1.28	–	7.22	12.47	–	7.31	–	–	10.01
Ashes, cremation swill,	15	4.86	–	–	–	–	8.83	1.25	3.97	32.36	7.47	14.16	–	–	–	–	33.58	1.87	4.65	–	–	–	21.57
Ashes, garbage,	3	3.01	–	–	–	–	6.01	3.72	5.13	10.21	7.16	8.77	–	–	–	15.65	20.22	1.16	9.22	4.57	10.85	4.75	28.42
Ashes, hard pine,	1	.75	–	–	–	–	–	–	10.16	–	–	2.24	–	–	–	–	24.95	–	–	–	–	–	29.90
Ashes, hay and straw,	1	.40	–	–	–	–	–	–	1.55	–	–	1.02	–	–	–	–	5.22	–	–	–	–	–	66.35
Ashes, hemp,	1	none	–	–	–	–	–	–	2.48	–	–	1.74	–	–	–	–	60.47	–	–	–	–	–	3.14
Ashes, jute waste,	1	.19	–	–	–	–	–	–	.51	–	–	.54	–	–	–	3.84	6.04	.39	7.60	–	–	.57	81.02
Ashes, leather scrap,	3	5.94	–	–	–	.15	3.36	1.00	2.23	3.96	1.80	2.89	–	–	–	–	7.80	–	–	–	–	–	46.08
Ashes, lime,	42	9.10	–	–	–	–	4.93	.16	1.77	1.68	.03	.70	–	–	–	–	44.58	1.30	–	–	–	–	7.27
Ashes, log wood,	1	1.50	–	–	–	–	–	–	.08	–	–	2.30	–	–	–	–	3.90	–	–	–	–	–	9.70

Ashes, magnolia,	1	1.58	-	-	-	-	-	-	2.56	-	-	45	-	-	-	-	-	-	-	-	-	-	6.12
Ashes, peach-tree trimmings,	1	.54	-	-	-	-	-	-	4.92	-	-	2.44	-	-	-	7.53	18.74	-	10.50	2.20	-	-	13.54
Ashes, peat,	3	6.50	-	-	-	-	.46	.07	.33	1.62	.11	.72	-	-	-	-	7.23	1.63	6.13	-	-	-	45.17
Ashes, picker waste,	1	.28	-	-	-	-	-	-	6.56	-	-	1.18	-	-	-	-	-	-	-	-	-	-	63.43
Ashes, pine wood,	1	2.76	-	-	-	-	-	-	4.37	-	-	3.07	-	-	-	-	23.61	-	-	-	-	-	37.46
Ashes, pulp,	1	none	-	-	-	-	-	-	.46	-	-	.12	-	-	-	-	67.72	-	-	-	-	-	7.00
Ashes, railroad ties,	1	4.70	-	-	-	-	-	-	92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Ashes, refuse from sawdust,	1	13.92	-	-	-	-	-	-	3.58	-	-	7.92	-	-	-	-	34.76	-	-	-	-	-	25.27
Ashes, roofing paper,	1	.06	-	-	-	-	-	-	.08	-	-	.63	-	-	-	-	5.65	12.90	11.17	-	-	-	63.02
Ashes, seaweed,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	68.65
Ashes, soft coal and sawdust,	1	3.36	-	-	-	-	-	-	.73	-	-	.74	-	-	-	-	2.80	-	-	-	-	-	69.53
Ashes, soft and buckwheat coal,	1	.85	-	-	-	-	-	-	.45	-	-	.37	-	-	-	-	1.70	-	-	-	-	-	-
Ashes, spent tan bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Ashes, tan bark,	1	1.50	-	-	-	-	-	-	.52	-	-	.77	-	-	-	-	24.29	-	-	-	-	-	13.54
Ashes, walnut wood,	1	3.79	-	-	-	-	-	-	5.06	-	-	2.07	-	-	-	-	10.73	-	-	-	-	-	2.29
Ashes, wood and coal,	1	1.32	-	-	-	-	-	-	.44	-	-	1.15	-	-	-	-	2.39	-	-	-	-	-	40.94
Ashes, wood,	735	12.67	-	-	-	-	13.58	1.12	5.13	6.07	.06	1.51	-	-	-	-	32.44	3.31	7.43	-	-	-	16.52
Ashes, wool waste,	1	8.40	-	-	-	-	-	-	27.24	-	-	.26	-	-	-	-	2.88	-	-	-	-	-	27.82
Acetylene gas tank refuse,	2	30.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42.65	-	-	-	8.17	-	2.48
Wood charcoal,	2	2.65	-	-	-	-	-	-	.40	-	-	.16	-	-	-	-	-	-	-	-	-	-	1.58
(b) Lime Compounds.																							
Agricultural lime,	38	2.79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61.26	3.08	2.93	-	13.55	-	4.68
Bleachery refuse,	2	4.19	-	-	-	-	1.24	.35	79	-	-	-	-	-	-	11.69	35.79	-	-	-	-	-	23.09

C. Ashes, Lime Compounds and Marls — *Concluded.*

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
(*b*) *Lime Compounds* — Con.																							
Boiler cleanings,	1	3.44	–	–	–	.28	–	–	4.15	–	–	1.14	–	–	–	–	21.92	–	–	–	–	–	24.32
Burned lump lime,	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	93.63	–	–	–	–	–	1.33
Carbonate of lime,	4	.56	–	–	–	–	–	–	–	–	–	–	–	–	–	–	52.33	–	–	–	40.75	–	.42
Carbonate of lime (coral),	2	19.76	–	–	–	.28	.14	.11	.13	.21	.16	.18	–	–	–	.32	38.18	.93	.62	–	43.39	–	9.49
Gas-house lime,	5	11.16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	48.19	8.30	–	19.66	–	–	8.99
Ground lime stone (unburned),	1	.28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	42.56	–	–	–	30.56	-	19.66
Gypsum,	3	8.01	–	–	–	–	–	–	–	–	–	–	–	–	–	–	36.00	–	–	51 43	–	–	–
Lime waste from tannery,	2	.88	–	–	–	.65	–	–	–	–	–	–	–	–	–	–	54.78	–	–	–	–	–	2.83
Lime waste from sugar factory,	1	36.30	–	–	–	–	–	–	.22	–	–	2.25	–	–	–	–	27.51	–	–	–	–	–	.26
Lime waste from soda factory,	1	24.07	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14 86	1.36	–	23.14	–	–	1.33
Lime sludge from glue factory,	1	37.20	–	–	–	.63	–	–	–	–	–	.15	–	–	–	–	19.62	–	–	–	14.51	–	–
Magnesia lime,	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	47.55	32.75	–	–	1.35	–	–
Nova Scotia plaster (gypsum),	17	6.45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33.74	.75	–	44.87	–	–	5.79
Onondaga plaster, New York, gypsum,	4	13.27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30.00	4.66	–	32.50	8.20	–	9.83
Oyster shell lime, partially burned,	7	5.13	–	–	–	.17	–	–	–	–	–	.36	–	–	–	–	45.87	–	–	–	20.73	–	10.08

Plastering,	1	7.20	-	-	-	-	-	-	-	-	-	.22	-	-	-	-	11.50	-	-	-	-	-	66.50
Soot,	5	7.92	-	.68	.18	.60	1.57	.17	.58	1.02	.23	.76	-	-	-	-	3.49	1.19	6.38	-	-	-	77.33
Soot, from soft coal,	1	32.61	-	-	-	.97	-	-	.04	-	-	trace	-	-	-	-	4.80	-	-	-	-	-	16.55
(c) Marls.																							
Ammoniated marl,	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl, Caledonia (New York),	1	.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.52	-	-	-	42.08	-	-
Marl, green sand (Virginia),	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Marl, Massachusetts,	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	10.50	.64	.69	-	28.57	-	3.44
Marl, North Carolina,	1	.70	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
Marl, Virginia,	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Olive earth (Virginia),	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55

D. By-Products and Refuse Substances.

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
(a) Abbattoir Products.																							
Ammoniate,	1	5.88	–	–	–	11.33	–	–	–	–	–	3.43	–	–	–	–	–	–	–	–	–	–	1.38
Blood and bone,	5	5.97	–	7.19	5.70	6.23	–	–	–	12.86	11.38	12.14	–	4 41	7.73	–	–	–	–	–	–	–	–
Bone dust,	1	5 06	–	–	–	3.06	–	–	–	–	–	17.80	–	7.24	10.56	–	–	–	–	–	–	–	–
Bone fiber,	1	5.38	–	–	–	4.61	–	–	–	–	–	12.44	–	6.76	5.68	–	–	–	–	–	–	–	–
Beef scrap,	1	7.12	–	–	–	7.46	–	–	–	–	–	9.42	–	3.10	6.32	–	–	–	–	–	–	–	–
Bone soup,	2	87.01	–	1.42	1.14	1.28	–	–	.01	1.26	.04	.65	–	–	–	–	–	–	–	–	–	–	–
Bone scrapings,	1	–	–	–	–	4.04	–	–	–	–	–	27.22	–	–	–	–	–	–	–	–	–	–	–
Concentrated tankage,	1	7.99	–	–	–	11.16	–	–	–	–	–	1.72	–	–	–	–	–	–	–	–	–	–	–
Condensed bone steam,	1	81.75	–	–	–	1.94	–	–	–	–	–	.07	–	–	–	–	–	–	–	–	–	–	–
Dried blood,	61	10.48	6.37	13.78	7.99	10.26	–	–	–	8.83	.03	2.69	–	–	–	–	–	–	–	–	–	–	–
Dried soup from meat and bone,	1	14.80	8.40	–	–	9.97	–	–	–	–	–	.53	–	–	–	–	–	–	–	–	–	–	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	–	–	14.47	–	–	–	–	–	.46	–	–	–	–	–	–	–	–	–	–	.26
Fresh-cut bone,	1	24.98	–	–	–	3.00	–	–	–	–	–	16.85	–	5.26	11.59	–	–	–	–	–	–	–	–
Ground bone (raw),	17	6.12	–	6.32	2.19	3.82	–	–	–	27.40	13.94	22.75	–	7.43	15.32	–	–	–	–	–	–	–	–
Ground bone (steamed),	160	6.92	–	3.63	.97	2.99	–	–	–	31.37	23.22	24.93	–	9.25	15.68	–	–	–	–	–	–	–	–

Ground bone damaged by salt water,	1	32.81	-	-	-	1.78	-	-	-	-	-	17.21	-	5.26	11.95	-	-	-	-	-	-	-	-
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-
Horn waste,	5	8.59	-	13.96	5.18	10.59	-	-	-	16.78	.04	4.22	-	-	-	-	-	-	-	-	-	-	-
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	-
Hoof meal,	5	8.63	-	15.19	13.08	13.85	-	-	-	.77	trace	.47	-	-	-	-	2.06	-	-	-	-	-	-
Hair waste,	1	6.52	22.77	-	-	9.22	-	-	.14	-	-	.51	-	-	-	4.10	-	-	-	-	-	-	-
Meat meal,	2	5.51	8.55	9.97	9.23	9.60	-	-	-	3.65	3.08	3.37	-	-	-	-	-	-	-	-	-	-	-
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	58
Meat scrap,	2	24.79	-	-	-	6.33	-	-	-	-	-	5.79	-	-	-	-	-	-	-	-	-	-	-
Meat and bone,	12	8.64	-	-	-	5.29	-	-	-	-	-	16.81	-	7.06	9.74	-	-	-	-	-	-	-	-
Rawhide waste,	3	32.95	8.03	13.91	3.29	10.07	-	-	-	1.06	.24	.65	-	-	-	-	4.44	-	-	-	-	-	-
Soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Tankage,	147	7.96	-	11.27	3.14	5.95	-	-	-	21.62	.76	13.89	-	6.49	7.40	-	16.84	-	-	-	-	-	-
Undried tankage,	1	29.00	-	-	-	1.06	-	-	-	-	-	3.51	-	2.94	.51	-	-	-	-	-	-	-	-
(b) Fish Products.																							
Bone from fish,	1	8.78	-	-	-	4.82	-	-	-	-	-	23.54	-	8.04	15.50	-	-	-	-	-	-	-	-
Dry ground fish,	145	9.89	-	10.91	6.06	8.35	-	-	-	18.32	5.50	8.58	-	5.15	3.43	-	-	-	-	-	-	-	-
Fish with 20 per cent. to 40 per cent. water,	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.66	-	-	-	-	-	-	-	1.68
Fish with more than 40 per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
(c) Sea Weeds.																							
Broad leaf kelp (*Laminaria Digitala*),	3	87.50	-	.29	.16	.23	.50	.12	.31	.08	.04	.06	-	-	-	-	.41	.22	-	-	-	-	.05
Eel grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Eel grass wrack (*Lostera Marina*),	3	81.19	-	.52	.20	.35	.43	.13	.32	.09	.63	.07	-	-	-	-	.51	.32	-	-	-	-	.12

D. By-Products and Refuse Substances — *Continued.*

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analysis.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
(*c*) *Sea Weeds* — Con.																							
Irish or Carogeen moss (*Chondrus Crispus*),	3	76.13	-	.81	.34	.57	1.46	.66	1.02	.20	.10	.13	-	-	-	-	.49	.33	-	-	-	-	.09
Kelp or ribbon weed (*Laminaria Saccharina*).	3	87.99	-	.22	.12	.17	.17	.14	.16	.06	.03	.05	-	-	-	-	.38	.17	-	-	-	-	.04
Rockweed (green),	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed (dry),	2	13.73	35.75	1.45	1.07	1.26	4.89	1.56	3.22	2.75	.14	1.44	-	-	-	5.97	4.88	.96	1.22	-	-	.16	-
Round stalked rockweed (*Ascophyleum nodaseum*).	3	77.26	-	.32	.18	.24	.75	.55	.64	.08	.08	.08	-	-	-	-	.48	.35	-	-	-	-	.03
Sea weed (decomposed),	1	78.93	-	-	-	.55	-	-	.15	-	-	.04	-	-	-	-	.24	-	-	-	-	-	13.97
(*d*) *Vegetable Products.*																							
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lungbia Majasculas*),	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Brewers' grains (rotten),	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59
Brewery, kiln dust from,	1	9.72	-	-	-	4.32	-	-	2.16	-	-	.96	-	-	-	-	.78	-	-	-	-	-	7.11
Broom corn seed,	1	7.40	-	-	-	1.51	-	-	.50	-	-	.57	-	-	-	-	-	-	-	-	-	-	-
Calico works, refuse from,	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Castor bean pomace,	24	8.20	5.70	6.17	4.65	5.22	3.40	.64	1.21	2.26	1.57	2.07	-	-	-	-	.92	.29	.82	-	-	-	1.75
Cassava waste,	1	9.03	-	-	-	.33	-	-	.28	-	-	.06	-	-	-	-	.61	-	-	-	-	-	-

Cork dust,	1	.74	-	-	-	.59	-	-	.33	-	-	.10	-	-	-	-	.74	.08	-	-	-	-	.24
Cocoa nut fibre pit,	1	6.20	3.78	-	-	.34	-	-	.84	-	-	.03	-	-	-	-	.57	-	-	-	-	-	1.01
Cocoa shells,	2	4.56	15.42	2.57	2.33	2.45	3.39	2.48	2.92	1.02	.36	.69	-	-	-	-	.95	-	2.79	-	-	-	2.85
Cocoa, damaged,	1	6.60	7.14	-	-	3.10	-	-	2.49	-	-	1.66	-	-	-	-	trace	-	-	-	-	-	-
Cottonseed compost,	3	45.35	-	.93	.52	.75	.76	.32	.55	.62	.39	.48	-	-	-	-	1.82	-	-	-	-	-	13.94
Cottonseed droppings,	1	4.08	-	-	-	.96	-	-	1.85	-	-	.20	-	-	-	-	.66	-	-	-	-	-	-
Cottonseed dust,	1	4.38	-	-	-	1.22	-	-	1.48	-	-	.54	-	-	-	-	1.48	-	-	-	-	-	-
Cotton waste (wet),	4	24.02	34.42	1.34	.84	1.21	.76	.43	.64	.74	.56	.65	-	-	-	-	2.73	-	-	-	-	-	38.16
Cotton waste (dry),	19	6.92	13.05	1.60	.55	1.19	1.62	.48	1.47	.66	.08	.37	-	-	-	-	2.79	-	-	-	-	-	13.27
Cottonseed meal,	346	7.25	14.70	7.99	3.24	6.59	2.10	1.41	1.65	3.39	1.71	2.57	-	-	-	-	.26	-	.38	-	-	-	30
Damaged grain,	3	42.15	-	1.97	.84	1.44	.43	.16	.28	.83	.35	.55	-	-	-	-	-	-	-	-	-	-	-
Fiber waste,	1	61.53	-	-	-	.22	-	-	.49	-	-	.10	-	-	-	-	.36	-	-	-	-	-	53
German peat moss,	1	9.50	1.14	-	-	.72	-	-	.06	-	-	.05	-	-	-	-	.21	-	-	-	-	-	36
Glucose factory refuse,	1	.13	-	-	-	-	-	-	-	-	-	42.76	-	2.88	39.88	-	38.78	-	2.92	3.00	-	-	-
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Gluten from starch manuf. (wet),	1	56.10	.08	-	-	5.00	-	-	none	-	-	.03	-	-	-	-	-	-	-	-	-	-	-
Gluten from starch manuf. (dry ground),	1	5.40	1.52	-	-	12.29	-	-	.10	-	-	.41	-	-	-	-	-	-	-	-	-	-	-
Hop refuse,	3	85.35	1.71	.69	.49	.59	.06	.05	.05	.17	.10	.12	-	-	-	-	.27	-	-	-	-	-	.78
Jadoo fiber,	2	10.20	11.60	.97	.77	.87	.48	.38	.43	1.24	.26	.75	-	-	-	-	3.50	-	-	-	-	-	4.05
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Linseed meal,	24	8.93	7.68	6.42	5.23	5.76	1.62	1.32	1.51	2.15	1.36	1.58	-	-	-	-	.47	-	.51	-	-	-	.95
Linen waste,	1	-	-	-	-	.99	-	-	23	-	-	.53	-	-	-	-	-	-	-	-	-	-	38.94
Madder,	2	11.93	-	-	-	.91	-	-	2.40	-	-	.35	-	-	-	-	3.93	.51	-	-	-	-	4.67

D. By-Products and Refuse Substances — *Continued.*

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
(*d*) *Vegetable Products* — Con.																							
Morocco factory waste,	1	22.72	–	–	–	1.16	–	–	.36	–	–	2.56	–	–	–	–	19.60	–	–	1.24	–	–	21.17
Muck (dry),	12	6.24	64.23	2.10	.26	.95	–	–	–	–	–	.31	–	–	–	–	.77	–	–	–	–	–	–
Muck (wet),	50	65.60	11.32	1.35	.12	.50	.16	.02	.05	.19	.01	.06	–	–	–	–	.40	–	–	–	–	–	6.73
Mud,	6	46.19	53.37	.65	.19	.34	.15	.11	.14	.06	.02	.04	–	–	–	–	.15	–	–	–	–	–	27.93
Mussel mud (dry),	1	2.24	72.02	–	–	.72	–	–	–	–	–	.35	–	–	–	–	23.39	–	8.26	–	–	–	37.60
Peat, dry ground,	6	6.83	32.67	2.74	1.02	2.09	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Peat, partially dried,	5	45.30	20.47	1.88	.34	.92	–	–	.64	.11	trace	.08	–	–	–	–	.88	–	–	–	–	–	16.23
Pine needles,	1	9.48	3.42	–	–	.46	–	–	.03	–	–	.12	–	–	–	–	–	–	–	–	–	–	1.22
Pine barren grass,	1	8.48	2.40	–	–	.16	–	–	.07	–	–	.18	–	–	–	–	–	–	–	–	–	–	1.67
Salt marsh mud,	6	60.72	30.99	.31	.18	.25	–	–	.14	–	–	.08	–	–	–	–	.11	–	–	–	–	2.06	37.88
Sediment from water filter,	1	94.22	–	–	–	.12	–	–	–	–	–	.05	–	–	–	–	–	–	–	–	–	–	–
Sediment from bottom of pond,	4	41.91	87.57	.40	.13	.26	–	–	.44	–	–	.06	–	–	–	–	.64	–	–	–	–	–	72.96
Spent brewers' grain,	1	73.10	–	–	–	1.23	–	–	.07	–	–	.33	–	–	–	–	–	–	–	–	–	–	–
Silt deposit,	1	7.15	–	–	–	1.14	–	–	.39	–	–	.25	–	–	–	–	.70	–	–	–	–	–	–
Starch waste from rubber factory,	1	10.01	.23	–	–	.02	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Sugar beet refuse,	1	7.70	-	-	-	6.39	-	-	9.72	-	-	trace	-	-	-	7.00	trace	-	-	2.82	trace	1.87	-
Sugar house refuse,	1	42.70	63.19	-	-	1.08	-	-	.10	-	-	7.42	-	6.91	.51	-	-	-	-	-	-	-	-
Sugar waste,	1	64.13	-	-	-	2.18	-	-	.19	-	-	.72	-	-	-	-	3.50	-	-	-	-	-	-
Sumac waste from tannery,	2	48.27	-	1.19	1.18	1.18	3.25	.21	1.73	.09	.09	.09	-	-	-	-	2.57	-	-	-	-	-	2.01
Tartar pomace,	2	8.85	-	-	-	4.22	-	-	2.25	-	-	3.93	-	-	-	-	6.83	-	4.00	-	-	-	12.76
Teopik fibre,	1	56.54	-	-	-	.53	-	-	1.26	-	-	.55	-	-	-	-	5.15	-	-	-	-	-	.75
Tobacco dust,	5	5.04	58.68	2.25	1.54	1.80	6.81	1.53	2.93	1.28	.36	.61	-	-	-	-	3.09	-	-	-	-	-	31.18
Tobacco leaves,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stalks weathered during winter and spring,	2	7.62	-	1.40	1.18	1.29	4.01	.52	2.26	.92	.38	.65	-	-	-	-	-	-	-	-	-	-	1.86
Tobacco stems,	10	9.10	20.91	2.72	1.99	2.03	8.68	3.88	6.36	1.15	.32	.63	-	-	-	-	6.49	-	-	-	-	-	1.58
Turf,	2	19.29	6.36	1.97	1.91	1.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vegetable mold,	1	26.07	-	-	-	.62	-	-	.66	-	-	.45	-	-	-	-	-	-	-	-	-	-	-
Water abstract of dry forest leaves,	1	99.46	.16	-	-	.004	-	-	.03	-	-	.022	-	-	-	-	.025	-	-	-	-	-	-
Wood and leaf mold,	1	68.94	4.90	-	-	.35	-	-	.05	-	-	.05	-	-	-	-	.19	-	-	-	-	-	-
(e) Wool Products.																							
Felt refuse,	1	29.34	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mill gloss,	2	9.43	-	13.16	12.22	12.69	-	-	.50	-	-	.20	-	-	-	-	-	-	-	-	-	-	6.50
Wool waste,	19	9.38	-	8.30	.39	3.60	5.92	.18	1.55	1.02	trace	.48	-	-	-	-	2.39	-	-	-	-	-	31.58
Wool washing, water from,	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool waste and sheep manure,	1	7.13	-	-	-	2.63	-	-	2.20	-	-	.64	-	-	-	-	-	-	-	-	-	-	-
Wool dustings,	1	14.10	16.01	-	-	3.65	-	-	.29	-	-	.32	-	-	-	-	1.02	-	-	-	-	-	9.25
Wool washings acid,	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings alkaline,	5	90.67	3.28	.21	.03	.09	1.09	.13	.45	.12	.001	.04	-	-	-	.92	.48	.04	-	-	-	-	-

D. By-Products and Refuse Substances — *Concluded.*

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
(*e*) *Wool Products* — Con.																							
Wool washings and concentrated paste,	2	41.37	-	1.09	.93	1.01	13.38	10.15	11.76	.32	.10	.21	-	-	-	-	-	-	-	-	-	-	-
Wool washing, refuse from,	5	39.80	51.18	.44	.31	.38	.89	.41	.63	.18	.09	.12	-	-	-	-	1.29	-	1.66	-	-	-	47.02
Wool, raw,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3 63
Wool scouring, dried refuse from,	4	3.51	-	8.20	1.52	3.60	3.52	.82	2.27	.52	trace	.20	-	-	-	-	-	-	-	-	-	-	30.40
(*f*) *Miscellaneous Substances.*																							
Dredging from Cape Cod,	1	18.99	-	-	-	.99	-	-	.13	-	-	.67	-	-	-	-	-	-	2.06	-	-	.54	-
Egg shells, ground,	1	1.15	73.30	-	-	1.19	-	-	.14	-	-	.38	-	-	-	-	47.47	-	-	-	-	-	.10
Feldspar,	2	.11	-	-	-	-	11.56	7.32	9.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fleshings from tannery,	2	33.20	-	7.55	.85	4.20	-	-	-	.31	.12	.22	-	-	-	-	-	-	-	-	-	-	8.48
Garbage tankage,	1	2.12	-	-	-	5.95	-	-	-	-	-	6.66	-	4.40	1.66	-	-	-	-	-	-	-	-
Glass factory, refuse from,	1	16.48	-	-	-	-	-	-	19.50	-	-	-	-	-	-	6.12	-	-	-	-	-	-	-
Glue refuse,	1	28.03	11.67	-	-	1.90	-	-	-	-	-	.37	-	-	-	-	-	-	-	-	-	-	-
Granite,	3	.30	-	-	-	-	3.50	1.33	2.11	-	-	trace	-	-	-	-	trace	.11	19.53	-	-	-	70.25
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Lactate factory, waste from,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92

Leather, dissolved,	1	6.85	13.01	-	-	7.93	-	-	-	-	-	.18	-	-	-	-	-	-	-	-	-	-	-
Leather meal (raw),	2	8.75	2.08	7.72	5.76	6.74	-	-	-	-	-	.03	-	-	-	-	-	-	-	-	-	-	.17
Leather waste,	1	56.85	14.89	-	-	4.89	-	-	.20	-	-	.18	-	-	-	-	1.33	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Milk casein,	1	7.15	-	-	-	7.30	-	-	.76	-	-	8.06	-	-	-	-	11.78	-	1.40	-	-	-	.10
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Paper mill dustings,	3	3.88	-	2.04	.35	1.23	.60	.44	.50	.17	trace	.10	-	-	-	-	1.15	-	4.40	-	-	-	11.70
Paper mill washings,	2	94.18	1.36	.18	.15	.16	.15	.14	.15	-	-	trace	-	-	-	-	.52	-	-	-	-	-	-
Paper mill, sludge from,	2	81.35	7.24	.33	.20	.27	.10	.06	.08	.56	.03	.29	-	-	-	-	2.91	-	-	-	-	-	1.84
Pillow manufacture, refuse from,	1	15.06	-	-	-	7.04	-	-	.41	-	-	3.17	-	-	-	-	-	-	-	-	-	-	-
Sea deposits,	1	13.82	-	-	-	1.06	-	-	.37	-	-	.19	-	-	-	-	-	-	-	-	-	-	-
Sewage,	4	54.11	72.89	1.04	.30	.55	.44	.09	.27	-	-	.63	-	-	-	-	2.79	-	-	-	-	.03	35.87
Sizing paste,	3	49.93	.49	2.13	1.13	1.49	-	-	-	.34	.02	.18	-	-	-	-	-	-	-	-	-	-	-
Sludge from filter beds,	4	48.35	17.70	1.07	.34	.66	.68	.05	.29	.33	.07	.24	-	-	-	-	5.48	-	-	-	-	-	19.84
Sludge from sewage tanks,	4	37.74	-	1.31	.46	.91	.66	.07	.25	.86	.39	.61	-	-	-	-	3.10	2.19	8.55	.41	4.86	-	28.70
Soap grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05
Tannery refuse from filter bed,	3	46.03	-	1.57	.18	.91	-	-	.10	1.58	.15	.86	-	-	-	-	20.58	.98	3.89	-	8.07	-	13.40
Tannery refuse from vats,	1	44.36	-	-	-	.64	-	-	.33	-	-	.11	-	-	-	-	1.67	-	-	-	-	-	36.07
Whale bone scrapings,	1	6.90	-	-	-	13.01	-	-	-	-	-	.26	-	-	-	-	-	-	-	-	-	-	-
Whale meat, raw,	1	44.50	1.94	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

E. Animal Excrements.

[Figures equal percentages or pounds in 100.]

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
Barnyard manure,	47	72.71	8.29	1.19	.18	.46	.92	.25	.55	.74	.10	.35	-	-	-	-	4.51	-	-	-	-	-	5.74
Compost,	1	1.70	-	-	-	.79	-	-	.97	-	-	.56	-	-	-	-	-	-	-	-	-	-	-
Dog manure,	1	6.50	-	-	-	1.91	-	-	.30	-	-	9.95	-	-	-	-	-	-	-	-	-	-	-
Drainage from manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Duck manure (fresh),	1	61.62	-	-	-	1.12	-	-	.49	-	-	1.44	-	-	-	-	1.12	-	-	-	-	-	13.37
Goose manure (fresh),	2	57.99	-	1.12	.21	.67	.81	.51	.66	.95	.53	.74	-	-	-	-	.26	-	-	-	-	-	11.10
Guinea pig manure,	1	8.35	-	-	-	1.74	-	-	1.66	-	-	.55	-	-	-	-	.39	-	-	-	-	-	3.87
Hen manure (fresh),	8	65.14	-	2.30	1.07	1.56	.63	.42	.44	2.07	.50	1.09	-	-	-	-	1.62	-	-	-	-	-	10.20
Hen manure (dry),	1	5.66	-	-	-	2.08	-	-	1.01	-	-	1.68	-	-	-	-	2.72	-	-	-	-	-	-
Hen house refuse,	2	7.37	-	-	-	.71	-	-	1.03	-	-	1.02	-	-	-	-	-	-	-	-	-	-	71.07
Horse manure,	2	44.44	-	.74	.33	.54	2.82	.69	1.75	1.46	.21	84	-	-	-	-	-	-	-	-	-	-	-
Liquid manure,	1	96.56	-	-	-	.56	-	-	.02	-	-	.01	-	-	-	-	-	-	-	-	-	-	-
Pigeon manure (fresh),	2	22.24	16.00	-	-	4.19	-	-	1.41	-	-	2.24	-	-	-	-	1.49	-	-	-	-	-	13.76
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Sheep manure, dry,	15	7.77	-	-	-	2.13	-	-	2.08	-	-	1.38	-	-	-	-	2.91	-	-	-	-	-	22.90

F. Analyses of Insecticides.

[Figures equal percentages or pounds in 100.]

	Analyses.	Moisture.	Arsenious Oxide As_2O_3.	Copper Oxide.	Arsenious Oxide As_2O_5.	Water Soluble Arsenic.	Lead Oxide.	Zinc Oxide.	Barium Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulfur.	Sulfuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxide.	Insoluble Matter in Hydrochloric Acid.
Barium arsenate (white arsenoid),	1	2.35	31.90	-	-	-	.96	-	48.31	-	-	-	-	-	3.19	-	-	-	-
Copper arsenite, ...	2	5.21	51.52	36.82	-	8.08	-	-	-	-	-	-	-	-	-	-	-	-	.09
Lead arsenate (dry neutral), . .	3	2.49	-	-	25.92	.25	68.19	-	-	-	-	-	-	-	-	-	-	-	.22
Lead arsenate (dry acid), . .	2	.50	-	-	30.21	.09	64.50	-	-	-	-	-	-	-	-	-	-	-	.04
Lead arsenate (waste from), . .	8	44.58	-	-	15.58	-	36 21	-	-	6.76	-	-	-	-	-	-	-	-	.06
Laurel green, ...	1	7.64	7.34	13.50	-	-	-	-	-	-	-	-	-	-	-	26.31	-	-	-
Lime arsenite, ...	1	.80	76.31	-	-	40.88	-	-	-	-	-	-	-	-	-	21.63	-	-	.02
Nicotina, ...	1	10.00	-	-	-	-	-	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Paris green, ...	27	.85	58 44	30.96	-	4.41	-	-	-	-	-	-	-	-	-	-	-	-	.21
Paris green (aceto copper arsenite, .	2	1.12	56.65	31.34	-	1.46	-	-	-	11.95	-	-	-	-	-	-	-	-	.03
Paris green (collected during 1901),	14	.81	57.73	29.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrox, ...	1	58.09	-	4.21	6 79	-	16.35	-	-	-	-	-	-	-	-	5 27	-	-	-
Tobacco liquor, ...	1	37.71	-	-	-	-	-	-	-	-	2.12	-	-	-	-	3.07	6.55	.23	-
Tobacco liquor, ...	1	40 89	-	-	-	-	-	-	-	-	.53	-	-	-	-	1 47	16.34	.01	-

Table VI. — Compilation of Analyses of Fruits and Garden Crops.

H. D. HASKINS.

A. Analyses of fruits.
B. Analyses of garden crops.
C. Relative proportions of phosphoric acid, potassium oxide and nitrogen found in fruits and garden crops.

The figures in A and B are in parts per 1,000. To convert into percentages or pounds in 100, move the decimal point one place to the left.

Some of the following analyses were taken from the compilation of E. Wolff. Those marked with an asterisk (*) were made at the laboratory of the Massachusetts Agricultural Experiment Station.

The tables will be found suggestive when one is preparing fertilizer formulas for various fruit and garden crops. One has also to consider, however, in making such fertilizer mixtures, the influence of cultivation and crop rotation as well as the plant food in the soil.

Members of the clover family are not dependent wholly upon supplied nitrogen, they having the power, after a vigorous start, to acquire atmospheric nitrogen when plenty of potash phosphoric acid and lime are supplied. An excess of phosphoric acid may be used in formulas without danger of loss from leaching. The same is true, to a certain extent, in case of potash, although this element is more often found in a water-soluble form in soils than is phosphoric acid. The well-known system of crop fertilization advocated originally by Wagner is based upon the necessity of an abundant supply of potash and phosphoric acid in the soil, while the nitrogen is added in such limited amounts and at such times as will provide for the maximum growth of the crop and the minimum loss through leaching.

A. Analyses of Fruits.

Fertilizer Constituents of Fruits.

[Parts per 1,000.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulfuric Acid.	Chlorine.
Ericaceæ: —										
*Cranberries, ...	996	–	1.8	.9	.1	.3	.1	.3	–	–
*Cranberries, ...	894	.8	–	1.0	–	.2	.1	.3	–	–
Rosaceæ: —										
Apples, ...	831	.6	2.2	.8	.6	.1	.2	.3	.1	–
*Apples, ...	799	1.3	4.1	1.9	.3	.3	.3	.1	–	–
Cherries, ...	825	–	3.9	2.0	.1	.3	.2	.6	.2	.1
*Peaches, ...	884	–	3.4	2.5	–	.1	.2	.5	–	–
Pears, ...	831	.6	3.3	1.8	.3	.3	.2	.5	.2	–

Fertilizer Constituents of Fruits — Concluded.

[Parts per 1,000.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulfuric Acid.	Chlorine.
Rosaceæ — *Con.*										
Plums,	838	–	2.9	1.7	–	.3	.2	.4	.1	–
Strawberries,	902	–	3.3	.7	.9	.5	–	.5	.1	.1
*Strawberries,	–	–	5.2	2.6	.2	.7	.4	1.0	–	–
*Strawberry vines,	–	–	33.4	3.5	4.5	12.2	1.3	4.8	–	–
Saxifragaceæ: —										
*Currants, red,	871	–	4.1	1.9	.2	.8	.3	.9	–	–
*Currants, white,	–	–	5.9	3.1	.2	1.0	.3	1.1	–	–
Gooseberries,	903	–	3.3	1.3	.3	.4	.2	.7	.2	–
Viticeæ: —										
Grapes,	830	1.7	8.8	5.0	.1	.7	.4	1.4	.5	.1
Grape seed,	110	19.0	22.7	6.9	.5	5.6	1.4	7.0	.8	.1

B. Analyses of Garden Crops.

Fertilizer Constituents of Garden Crops.

[Parts per 1,000.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulfuric Acid.	Chlorine.
Chenopodiaceæ: —										
*Beets, red,	877	2.4	11.3	4.4	.9	.5	.3	.9	–	–
Beets, sugar,	750	1.4	6.0	2.3	1.4	.6	.5	.8	.2	.2
*Beets, sugar,	869	2.2	10.4	4.8	.8	.6	.4	1.0	.1	–
Beets, sugar, leaves,	800	3.0	15.0	3.0	3.0	1.5	1.1	.7	.5	1.0
Beets, sugar, seed,	146	–	45.3	11.1	4.2	10.2	7.3	7.5	2.0	1.9
Beets, sugar, tops,	840	2.0	9.6	2.8	2.3	.9	1.1	1.2	.2	.3
Mangolds,	900	1.2	6.5	2.8	1.5	.3	.4	.6	.3	.9
*Mangolds,	873	1.9	12.2	3.8	1.3	.6	.4	.9	–	–

Fertilizer Constituents of Garden Crops — Continued.

[Parts per 1,000.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ — *Con.*										
Mangold leaves,	905	3.0	14.6	5.0	2.8	1.6	1.4	.8	.8	2.3
Spinach,	903	4.9	16.0	2.7	5.7	1.9	1.0	1.6	1.1	1.0
*Spinach,	922	3.4	9.6	9.6	2.1	.6	.5	.5	–	–
Compositæ: —										
Artichoke,	811	–	10.1	2.4	.7	1.0	.4	3.9	.5	.2
*Artichoke, Jerusalem,	775	4.6	–	4.8	–	–	–	1.7	–	–
Lettuce, common,	940	–	8.1	3.7	.8	.5	.2	.7	.3	.4
Lettuce, head,	943	2.2	10.3	3.9	.8	1.5	.6	1.0	1.1	.8
*Lettuce, head,	970	1.2	–	2.3	.2	.3	.1	.3	–	–
Lettuce, Roman,	925	2.0	9.8	2.5	3.5	1.2	.4	1.1	.4	.4

Convolvulaceæ: —										
Sweet potato,	758	2.4	7.4	3.7	.5	.7	.3	.8	.4	.9
Cruciferæ: —										
Cabbage, Savoy,	871	5.3	14.0	3.9	1.4	3.0	.5	2.1	1.2	1.1
Cabbage leaves,	890	2.4	15.6	5.8	1.5	2.8	.6	1.4	2.4	1.3
Cabbage, white,	900	3.0	9.6	4.3	.8	1.2	.4	1.1	1.3	.5
*Cabbage, white,	984	2.3	–	3.4	.3	.2	.1	.2	–	–
Cauliflower,	904	4.0	8.0	3.6	.5	.5	.3	1.6	1.0	.3
Horse-radish,	767	4.3	19.7	7.7	.4	2.0	.4	2.0	4.9	.3
Kohlrabi,	850	4.8	12.3	4.3	.8	1.4	.8	2.7	1.1	.6
Radishes,	933	1.9	4.9	1.6	1.0	.7	.2	.5	.3	.5
*Ruta-bagas,	891	1.9	10.6	4.9	.7	.9	.3	1.2	–	–
Turnips, white,	920	1.8	6.4	2.9	.6	.7	.2	.8	.7	.3
*Turnips, white,	895	1.8	10.1	3.9	.8	.9	.3	1.0	1.0	–
Turnips, white, leaves,	898	3.0	11.9	2.8	1.1	3.9	.5	.9	1.1	1.2

Fertilizer Constituents of Garden Crops — Continued.

[Parts per 1,000.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulfuric Acid.	Chlorine.
Cucurbitaceæ: —										
Cucumbers,	956	1.6	5.8	2.4	.6	.4	.2	1.2	.4	.4
Pumpkins,	900	1.1	4.4	.9	.9	.3	.2	1.6	.1	–
Gramineæ: —										
Barley, grains,	108	19.2	–	4.8	–	–	–	7.9	–	–
Buckwheat, grain,	134	17.3	–	3.0	–	–	–	6.9	–	–
Corn, kernels,	144	16.0	12.8	3.7	.1	.3	1.9	5.7	.1	.2
*Corn, kernels,	100	18.2	–	4.0	.3	.3	2.1	7.0	–	–
*Corn, whole ears,	90	14.1	–	4.7	.6	.2	1.8	5.7	–	–
*Corn, stover,	282	11.2	37.4	13.2	7.9	5.2	2.6	3.0	–	–
Corn, whole plant, green,	829	1.9	10.4	3.7	.5	1.4	1.1	1.0	.3	.5

*Corn, whole plant, green,	786	4.1	–	3.8	.5	1.5	.9	1.5	–	–
Hay, English,	140	12.6	–	16.1	–	–	–	3.2	–	–
Millet seed,	140	18.5	29.5	3.3	.4	.2	2.8	6.5	.1	.1
Oats, grain,	143	17.6	27.4	4.8	.4	1.0	1.9	7.4	.5	.3
Rye, grain,	87	18.1	–	5.8	–	–	–	8.6	–	–
Wheat, grain,	144	20.0	–	5.2	–	–	–	8.0	–	–
Leguminosæ: —										
Alfalfa hay,	68	24.7	–	17.9	–	–	–	6.1	–	–
Bean straw,	160	–	40.2	12.8	3.2	11.1	2.5	3.9	1.7	3.1
Clover, hay,	153	19.7	–	18.7	–	–	–	5.5	–	–
*Cow pea, green,	788	2.9	–	3.1	.6	3.0	1.0	1.0	–	–
Garden beans, seed,	150	39.8	27.4	12.1	.4	1.5	2.1	9.7	1.1	.3
Hay of peas cut green,	167	22.9	62.4	23.2	2.3	15.6	6.3	6.8	5.1	2.0
*Leaves and stems of velvet beans,	58.8	28.6	–	–	–	–	–	–	–	–
Peas, straw,	160	10.4	43.1	9.9	1.8	15.9	3.5	3.5	2.7	2.3
Peas, seed,	143	36.5	27.5	12.5	.2	1.1	1.9	10.0	.8	.4

Fertilizer Constituents of Garden Crops — Concluded.

[Parts per 1,000.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulfuric Acid.	Chlorine.
Leguminosæ: —										
*Small pea, dry (*Lathyrus Sylvestris*),	90	38.5	–	25.7	4.7	17.9	5.0	9.0	–	–
Soy bean, seed,	100	53.4	28.3	12.6	.3	1.7	2.5	10.4	.8	.1
*Velvet beans, kernel,	111.6	31.1	–	13.2	–	–	–	7.7	–	–
*Velvet beans, with pod,	115.2	19.6	–	13.1	–	–	–	8.4	–	–
Liliaceæ: —										
*Asparagus,	942	3.3	–	3.29	–	–	–	1.08	–	–
Asparagus,	933	3.2	5.0	1.2	.9	.6	.2	.9	.3	.3
*Asparagus roots,[1]	81.7	16.2	58.8	21.6	1.8	2.8	1.4	4.7	4.0	–
Onions,	860	2.7	7.4	2.5	.2	1.6	.3	1.3	.4	.2
*Onions,	892	–	4.9	1.8	.1	.4	.2	.7	–	–
Solanaceæ: —										
Potatoes,	750	3.4	9.5	4.0	.3	.3	.5	1.6	.6	.3
*Potatoes,	798	2.1	9.9	2.9	.1	.1	.2	.7	–	–

Potato tops, nearly ripe,	770	4.9	19.7	4.3	.4	6.4	3.3	1.6	1.3	1.1
Potato tops, unripe,	825	6.3	16.5	4.4	.3	5.1	2.4	1.2	.8	.9
Tobacco leaves,	180	24.5	150.7	50.9	4.5	50.7	10.4	6.6	8.5	9.4
*Tomatoes,	940	1.7	–	3.6	–	.3	.2	.4	–	–
*Tobacco, whole leaf,	103.1	24.3	–	57.9	24.7	45.8	13.8	4.3	16.3	1.59
Tobacco stalks,	180	16.4	74.7	38.2	6.6	12.4	.5	9.2	2.2	2.4
*Tobacco stems,	106	22.9	140.7	64.6	3.4	38.9	12.3	6.0	–	–
Umbelliferæ: —										
Carrots,	850	2.2	8.2	3.0	1.7	.9	.4	1.1	.2	.4
*Carrots,	898	1.5	9.2	5.1	.6	.7	.2	.9	–	–
Carrot tops,	822	5.1	23.9	2.9	4.7	7.9	.8	1.0	1.8	2.4
Carrot tops, dry,	98	31.3	125.2	48.8	40.3	20.9	6.7	6.1	–	–
Celery,	841	2.4	17.6	7.6	–	2.3	1.0	2.2	1.0	2.8
Parsnips,	793	5.4	10.0	5.4	.2	1.1	.6	1.9	.5	.4
*Parsnips,	803	2.2	–	6.2	.1	.9	.5	1.9	–	–

[1] Twenty-four analyses.

C. Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits and Garden Crops.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Fruits.			
Ericaceæ: —			
*Cranberries,	1	3.0	–
*Cranberries,	1	3.33	2.66
Rosaceæ: —			
Apples,	1	2.7	2.0
*Apples,	1	1.9	1.3
Cherries,	1	3.3	–
*Peaches,	1	1.3	–
Pears,	1	3.6	1.2
Plums,	1	4.3	–
Strawberries,	1	1.4	–
*Strawberries,	1	2.6	–
*Strawberry vines,	1	.7	–
Saxifragaceæ: —			
*Currants, red,	1	2.1	–
*Currants, white,	1	2.8	–
Gooseberries,	1	1.9	–
Viticeæ: —			
Grapes,	1	3.6	1.2
Grape seed,	1	1.0	2.7
Garden Crops.			
Chenopodiaceæ: —			
*Beets, red,	1	4.1	3.3
Beets, sugar,	1	2.88	1.75

C. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Continued.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Chenopodiaceæ — *Con.*			
*Beets, sugar,	1	4.8	2.2
Beets, sugar, leaves,	1	4.28	4.28
Beets, sugar, tops,	1	2.3	1.7
Beets, sugar, seed,	1	1.5	-
Mangolds,	1	4.66	2.0
*Mangolds,	1	4.2	2.1
Mangold leaves,	1	6.25	3.75
Spinach,	1	1.7	3.06
*Spinach,	1	19.2	6.8
Compositæ: —			
Artichoke,	1	.63	-
*Artichoke, Jerusalem,	1	2.8	2.7
Lettuce, common,	1	5.3	-
Lettuce, head,	1	3.9	2.2
*Lettuce, head,	1	7.7	4.0
Lettuce, Roman,	1	2.3	1.8
Convolulaceæ: —			
Potato, sweet,	1	4.6	3.0
Cruciferæ: —			
Cauliflower,	1	2.3	2.5
Cabbage, leaves,	1	4.1	1.7
Cabbage, Savoy,	1	1.9	2.5
Cabbage, white,	1	4.1	1.7
*Cabbage, white,	1	11.0	7.6

C. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Continued.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Cruciferæ — *Con.*			
Kohlrabi, ...	1	1.6	1.8
Radishes, ...	1	3.2	3.8
Radish, horse, ...	1	3.9	2.2
*Ruta-bagas, ...	1	4.1	1.6
Turnips, white, ...	1	3.6	2.3
*Turnips, white, ...	1	3.9	1.8
Turnips, white, leaves,. . .	1	3.1	3.3
Cucurbitaceæ: —			
Cucumbers, ...	1	2.0	1.3
Pumpkins, ...	1	.56	.69
Gramineæ: —			
Barley, grain, ...	1	.61	2.43
Buckwheat, grain, ...	1	.43	2.51
Corn, whole plant, green, . .	1	3.7	1.9
*Corn, whole plant, green, . .	1	2.2	2.8
Corn, kernels, ...	1	.6	2.8
*Corn, kernels, ...	1	.6	2.6
*Corn, stover, ...	1	4.4	3.7
*Corn, whole ears, ...	1	.8	2.5
Hay, English, ...	1	5.03	3.93
Millet, seed, ...	1	.51	2.84
Oats, grain, ...	1	.65	2.38
Rye, grain, ...	1	.67	2.10
Wheat, grain, ...	1	.65	2.50

C. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Continued.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Leguminosæ: —			
Alfalfa, hay,	1	2.93	4.05
Bean straw,	1	3.3	–
Clover, hay,	1	3.4	3.58
*Cow pea, green (*Dolichos*),	1	3.1	2.9
Garden beans, seed,	1	1.2	1.0
Hay of peas, cut green,	1	3.4	3.4
Peas, seed,	1	1.2	3.65
Pea straw,	1	2.8	4.0
Soy bean seed,	1	1.21	5.12
*Small pea, dry (*Lathyrus sylvestris*),	1	3.4	4.2
*Velvet beans, kernel,	1	1.7	4.0
*Velvet beans, with pod,	1	1.56	2.3
Liliaceæ: —			
*Asparagus,	1	3.05	3.06
Asparagus,	1	1.3	3.6
*Asparagus roots,[1]	1	4.60	3.45
Onions,	1	1.9	2.1
*Onions,	1	2.6	–
Solanaceæ: —			
Potatoes,	1	2.5	2.1
*Potatoes,	1	4.1	3.0
Potato tops, nearly ripe,	1	2.7	3.1
Potato tops, unripe,	1	3.7	5.3

[1] Twenty-four analyses.

C. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Concluded.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Solanaceæ — *Con.*			
Tobacco leaves,	1	7.71	3.71
*Tobacco, whole leaf,	1	13.46	5.65
Tobacco stalks,	1	4.15	1.78
*Tobacco stems,	1	10.7	3.8
*Tomatoes,	1	8.7	4.5
Umbelliferæ: —			
Carrots,	1	2.7	2.0
*Carrots,	1	5.7	1.7
Carrot tops,	1	2.9	5.1
Carrot tops, dry,	1	8.0	5.1
Celery,	1	3.5	1.1
Parsnips,	1	2.8	2.8
*Parsnips,	1	3.3	1.2

COMPOSITION OF SOME MASSACHUSETTS SOILS.

BY J. B. LINDSEY.

In the year 1892 samples of typical soils were taken from different parts of the State under the general supervision of Prof. William P. Brooks. Prof. Benjamin K. Emerson, the geologist of Amherst College, advised as to the most suitable location to secure some of the soils, in order that they might be representative. The soils were carefully analyzed under the direct supervision of the late Prof. C. A. Goessmann, and the completed results of each soil are here presented for the first time.

Description of Types.

Soil No. 1. — Ten inches surface soil taken on the grounds of the Massachusetts agricultural experiment station, north of Hatch barn.

Soil No. 2. — Ten inches surface soil taken on Agawam Plains, not cultivated for ten years.

Soil No. 3. — Twelve inches surface soil taken from hill pasture in Agawam. The soil known as Agawam red sandstone.

Soil No. 4. — Granite till from Dedham, locality of Fox Hill; 12 inches surface soil.

Soil No. 5. — Cranberry bog from Colony Stock Farm; 6 inches surface soil.

Soil No. 6. — Diked Salt Marsh, Marshfield; tide shut off twenty years ago; soil cultivated.

Soil No. 7. — Soil of alluvial formation from Hadley meadows; overflowed in 1862 and 1872, and a deposit of sand was left which injured it materially.

Soil No. 8. — Virgin soil, taken from South River salt marsh, Marshfield, Mass.

Soil No. 9. — Natural fresh-water meadow from Sudbury, Mass.; very wet.

Soil No. 10. — Gneiss till from Shutesbury, Mass.; very barren.

Soil No. 11. — Mica schist from Deerfield, Mass.; taken from base of hill. Virgin soil, good pasture land, never cultivated.

Soil No. 12. — Limestone till from Pittsfield, Mass.

Soil No. 13. — Copperas rock from Hubbardston. Virgin soil, very strong.

Analysis of Types of Massachusetts Soils.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.	No. 13.
Coarse materials (.5 mm.),	1.42	14.48	45.81	23.63	–	6.13	.05	–	–	26.26	14.92	18.03	44.36
Fine earth,	98.58	85.52	54.19	76.37	100.00	93.87	99.95	100.00	100.00	73.74	85.08	81.97	55.64
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
ANALYSIS OF FINE EARTH.													
Insoluble matter,	80.38	86.68	73.89	76.48	9.25	72.45	82.42	78.31	9.49	82.68	77.83	81.05	70.39
Soluble silica,	2.41	1.73	7.57	3.88	–	1.15	1.78	2.11	.26	1.20	1.82	.78	.92
Potash (K_2O),	.38	.18	.30	.19	.16	.24	.22	.33	.53	.13	.40	.25	.46
Soda (Na_2O),	.29	.38	.46	.42	.34	.19	.21	1.63	1.78	.38	1.56	.96	.95
Lime (CaO) .	.70	.68	.47	.41	.01	.68	.99	.36	1.71	.92	1.15	1.58	.50
Magnesia (MgO),	.26	.81	.90	.49	–	.72	.93	.19	.66	.19	.79	.34	.22
Manganese oxide (Mn_3O_4),	.06	.17	.13	.09	–	.05	.07	.06	.09	.06	.07	.07	.04
Ferric oxide (Fe_2O_3),	3.76	3.49	4.59	3.86	39	4.47	5.09	3.54	1.71	3.79	5.93	5.39	12.26
Alumina (Al_2O_3),	6.22	4.27	6.64	4.69		5.37	3.15	2.57	2.09	3.01	5.86	4.32	4.98
Phosphoric acid (P_2O_5),	.31	.10	.22	.06	.04	.24	.32	.13	.20	.20	.29	.29	.36
Sulfur trioxide (SO_3),	.15	.12	.12	.21	.38	.64	.27	.33	.71	.03	.05	.08	.05
Volatile matter,	4.88	2.08	4.37	9.81	89.76	14.42	3.83	9.89	80.13	6.89	4.45	4.92	8.72
Total,	99.80	100.69	99.66	100.59	100.33	100.62	99.28	99.45	99.36	99.48	100.20	100.03	99.85
Humus,	1.72	.46	.54	1.89	41.23	6.56	1.97	1.30	26.86	1.80	1.05	.87	1.46
Ash,	.406	.026	.199	.249	1.90	.443	.64	.22	.56	.275	.28	.23	.34
Phosphoric acid,	.079	.012	.032	.036	.027	.093	.145	.026	.11	.036	.053	.029	.026
Silica,	.107	.006	.084	.12	–	.228	.320	.144	.28	.124	.11	.12	.17
Nitrogen,	.20	.07	.09	.30	.27	.50	.11	.28	.43	.18	.12	.18	.155
Hygroscopic moisture,	5.38	3.69	10.69	7.40	26.29	14.85	3.81	20.66	36.78	5.200	4.25	8.88	14.54

According to Hilgard[1] "Virgin soils with high plant food percentages are always productive, provided, only, that extreme physical characters do not interfere with normal plant growth." By high plant food percentages is meant 1 per cent. of acid soluble potash, 1 of lime, the same or less of magnesia and .15 per cent. of phosphoric acid. In case there is a low percentage of one of the above elements, it is an indication that this will be the first to fail, and will have to be supplied in the form of farm-yard manures or chemical fertilizers. The total percentage of nitrogen in the soil is of less importance than the nitrogen percentage in the humus, of which there should be at least 4 per cent. to insure satisfactory production.

It will be seen that none of the above soils could be classed as highly productive, yet by comparing the analyses with the standards for average soils as given further on, it will be seen that, in so far as their chemical analysis is concerned, most of them would be capable of producing satisfactory crops.

Miscellaneous Soil Analyses.

From time to time during the last ten or fifteen years the station has had occasion to examine soils sent from different sections of the State. The following tabulation shows the percentages of the more important fertilizer constituents which they contained. The data concerning the history of each soil are not at present available. From our present knowledge of the value of chemical analysis in determining soil fertility it is doubtful if such data would have proved particularly helpful, so much depending upon the physical character of the soil and subsoil, drainage and the character of the crops to be grown. This matter is briefly referred to further on. In general it may be said that the soils were taken from the cultivated fields of Massachusetts farms.

[1] Soils, by E. W. Hilgard, p. 343.

Table of Miscellaneous Soil Analyses (Per Cent.).[1]

Source.	Organic Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Calcium Oxide.
Abington (garden?),	-	.85	.78	.44	-
Amesbury (reclaimed marsh),	6.21	1.41	.24	.36	-
Amherst (Massachusetts Agricultural College, productive),	-	.23	.26	.112	.06
Amherst (Massachusetts Agricultural College, unproductive).	-	.23	.16	.114	.07
Amherst (Massachusetts Agricultural College, experiment station).	-	.20	.16	.253	1.64
Amherst (Massachusetts Agricultural College, south acre),	-	.16	.13	.271	1.33
Amherst,	-	.48	.11	.36	.54
Amherst,	-	.18	.24	.17	.34
Amherst,	-	.08	.15	.07	.24
Amherst,	-	.11	.20	.15	.24
Amherst,	7.28	.21	.10	.21	.17
Amherst,	-	.16	.11	.28	1.04
Amherst,	-	.22	.07	.29	.73
Amherst,	-	.24	.11	.23	.67
Arlington (average of 3 samples),	-	.14	.15	.23	.80
Athol,	8.79	.27	.13	.11	.23
Barre (average of 3 samples),	-	.20	.25	.29	.65
Belmont,	8.57	.27	.21	.15	.12
Berlin,	-	.26	.14	.30	.46
Bernardston,	-	.12	.25	.20	.95
Bernardston,	-	.08	.15	.11	.15
Beverly,	-	.37	.30	.56	.56
Beverly,	-	.02	.22	.56	.50
Bisbees,	-	.21	.13	.25	.32
Boston,	6.02	.16	.205	.401	trace
Boston,	-	.35	.387	.26	1.17
Boston,	-	.13	.04	.09	.11
Boston,	-	.25	.26	.19	.13
Boston,	-	.11	.04	.11	.16
Boston,	4 25	.11	.04	.07	.55
Boston,	6 69	.20	.06	.01	.33
Boston,	6 04	.14	.06	.07	.21
Boston (near seacoast),	8 53	.47	.17	1.02	1.08

[1] Analyses made by H. D. Haskins and assistants.

Table of Miscellaneous Soil Analyses (Per Cent.) — Continued.

Source.	Organic Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Calcium Oxide.
Brockton (greenhouse?),	-	.42	.19	.11	.69
Brookfield,	-	.47	.36	.29	.20
Brookline (greenhouse?),	-	.93	.23	.21	1.42
Brookline (greenhouse?),	-	.51	.07	.25	1.48
Cambridge,	-	.18	.29	.18	.77
Canton,	-	.30	.19	.23	.78
Clinton,	-	.22	.13	.15	1.52
Clinton,	-	.22	.24	.81	.65
Concord,	9.88	.48	.21	-	trace
Concord (asparagus),	4.30	.13	.21	.09	.22
Conway,	-	.24	.07	.17	-
Conway,	-	.41	.09	.21	-
East Holliston,	-	.19	.14	.14	1.00
East Whately,	-	.14	.25	.21	.16
East Whately,	-	.11	.34	.18	.19
East Whately,	-	.19	.09	.18	.10
East Whately,	-	.12	.32	.49	.69
East Whately,	-	.08	.18	.53	.85
Florence (tobacco),	2.24	.81	.98	-	1.79
Florence (tobacco),	-	.96	.37	-	1.12
Foxborough,	9.47	.28	.08	.10	.63
Foxborough (average of 7 samples),	-	.21	.25	.16	1.19
Framingham,	-	.17	.34	.23	.56
Framingham,	-	.13	.13	.13	.21
Gloucester (low and swampy; reclaimed),	-	.86	.60	.71	1.00
Greenfield,	-	2.42	.30	.30	3.57
Hadley,	-	.15	.49	.24	.49
Hadley (mill pond basin),	-	.17	.08	.56	.82
Halifax (average of 6 samples),	12.18	.28	.03	.09	.26
Halifax (average of 2 samples),	-	.66	.31	.22	2.88
Halifax,	-	.10	.09	.26	.75
Hampden,	-	.20	.23	.13	.39
Hampden,	-	.41	.30	.08	.46
Harding,	-	.14	trace	.12	.30

Table of Miscellaneous Soil Analyses (Per Cent.) — Continued.

Source.	Organic Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Calcium Oxide.
Harding,	–	.12	trace	.11	.41
Harding,	–	.17	.04	.13	.24
Harding,	–	.14	trace	.17	.33
Haverhill,	–	.17	.45	.20	1.30
Haverhill (meadow, 3½ feet),	72.60	1.61	.09	.12	1.01
Haverhill (bank of river),	–	.51	.21	.13	.32
Holliston,	–	.20	.22	.25	1 00
Hubbardston,	–	.26	.12	.39	1.88
Lenox,	–	.07	.39	.28	1.41
Lenox,	9.18	.29	.23	.32	.10
Lenox,	–	.28	.34	.33	.85
Lenox,	–	.30	.17	.26	1.20
Lynn,	–	.39	.40	.32	1.51
Longmeadow,	–	34	.20	.21	.54
Malden (garden soil),	12 57	.64	–	.49	.79
Mansfield (average of 3 samples),	–	.16	.15	.13	1.28
Mattapoisett,	–	.19	.20	.11	.73
Merrick,	–	.13	.35	.29	.79
Monson,	8.46	.24	.03	.21	.10
Montague (corn experiment plat),	–	.16	.13	.37	1.41
Newbury,	–	.26	trace	.16	.15
Newbury,	–	.28	.13	.15	.29
Newbury,	–	.28	.16	.23	.17
Newbury,	–	.28	.29	.15	.11
Newbury,	–	.29	.17	.15	.15
Newton,	–	.18	.01	.23	.59
Newton,	–	.18	.01	.23	.59
Newton,	–	.23	.07	.13	.76
Newton,	–	.22	.01	.14	.42
Newton,	–	.26	.08	.14	.82
Newton,	–	.22	.01	.14	.42
Newton,	–	.38	.23	.22	.85
Newton,	–	.10	.15	.22	1.19
Newton Highlands,	7.42	.31	.18	.16	–

Table of Miscellaneous Soil Analyses (Per Cent.) — Continued.

Source.	Organic Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Calcium Oxide.
Newton Highlands,	-	.34	.07	.50	.65
New Bedford (average of 6 samples),	-	.24	.14	.25	.53
Northampton (average of 3 samples),	-	.11	.19	.39	1.00
North Adams,	-	.60	.36	.89	2.41
North Adams,	-	.23	.14	.62	.40
North Adams,	-	.25	.10	.55	.30
North Eastham (asparagus farm),	-	.22	05	.07	.58
North Easton,	-	.12	.09	.21	-
North Easton,	-	.19	.24	.20	-
North Weymouth,	-	.35	.10	.31	.67
North Weymouth,	-	.32	.32	.25	.71
Norton,	-	.18	.05	.09	.75
Norton (average of 3 samples),	-	.14	.15	.09	.84
Orange,	-	.20	.11	.28	.38
Orange,	-	.44	.20	.20	.49
Plymouth,	-	.15	.10	.18	.50
Rutland (sanatorium),	-	.20	.16	.25	.09
Scituate,	-	.33	.13	.10	.16
South Carver,	-	.06	.08	.19	23
South Carver,	-	.10	.29	.59	.48
South Carver,	-	.11	.31	.39	.27
South Framingham (average of 6 samples),	6 89	.22	.14	.19	.47
Springfield,	-	.16	.18	.22	.57
Springfield,	-	.15	.16	.16	.55
Springfield,	-	.39	.14	.48	1 32
Sunderland,	11 09	.64	.70	.49	.54
Swift River,	-	.23	.09	.23	.17
Taunton,	-	.34	.23	.22	trace
Tewksbury (average of 2 samples),	6.93	.36	-	.29	.64
Truro,	-	.19	.24	.27	.81
Upton (carnation soil),	-	.41	.44	.20	.64
Upton (carnation soil),	-	.23	.69	.23	.83
Upton (carnation soil),	-	.50	.81	.46	.60
Waltham (greenhouse?),	-	.76	.40	.47	.83

Table of Miscellaneous Soil Analyses (Per Cent.) — Concluded.

Source.	Organic Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Calcium Oxide.
Webster,	1.25	-	.03	-	-
Wellesley,	-	.28	.66	.28	1.77
Westfield,	-	.29	.25	.31	.95
Westminster,	-	.32	.13	.30	.28
West Newton,	-	.14	.25	.16	1.14
West Springfield (average 14 samples),	-	.25	.51	.36	.97
Weymouth,	5.69	.24	.11	.24	.34
Whately,	-	.12	.02	.58	1.07
Whately,	-	.13	.20	.36	.94
Williamstown,	-	.27	.21	.37	.18
Winter Hill,	6.39	.27	.18	.23	.92
Worcester,	-	.29	.07	.45	1.23
Worcester,	-	.14	.05	.20	1.57

European Standards for Comparison (Hilgard).[1]

Practical Rating of Soils by Plant Food Percentages.[2]

Grade of Soil.	Potash.	Phosphoric Acid.	Lime.		Total Nitrogen.
			Clay Soil.	Sandy Soil.	
Poor,	Below 0.05	Below 0.05	Below 0.10	Below 0.05	Below 0.05
Medium,	0.05–0.15	0.05–0.10	0.10–0.25	0.10–0.15	0.05–0.10
Normal,	0.15–0.25	0.10–0.15	0.25–0.50	0.15–0.20	0.10–0.15
Good,	0.25–0.40	0.15–0.25	0.50–1.00	0.20–0.30	0.15–0.25
Rich,	Above 0.40	Above 0.25	Above 1.00	Above 0.30	Above 0.25

In case of the above analyses of Massachusetts soils, the potash percentage varies from .01 to 1.02, with an average of .26; the phosphoric acid from .01 to .98, with an average of .21; the lime from .06 to 3.57, with an average of .71, and the nitrogen from .02 to 2.42, averaging .30.

[1] Soils, p. 343.

[2] According to the late Prof. Max. Maercker of the Halle Station, Germany.

Judging from such results most of the soils can at least be classed as normal from a chemical standpoint, some of them good and a few rich. Practically all of them are quite suitable for crop production if properly handled. One, however, would not care to say, from a chemical analysis alone, whether any one of them was suited to a particular crop, so many other conditions entering into the problem. Brooks, in Circular No. 29 of this station, has made this matter clear, as follows: —

1. *The Crop Adaptation.* — While the chemical condition of a soil is not altogether without influence in determining the crops to which it is suited, this, as a rule, at least within such range of soil variation as exists in this State, plays a much less important part than mechanical and physical peculiarities. The crops to which a soil is suited are determined chiefly by its drainage, its capacity to hold and to conduct water, its temperature and its aëration, and these in turn are determined by the mechanical structure of the soil and sub-soil. Variations in the proportions of gravel, sand, silt and clay, and not in chemical composition, cause the usual differences in these respects. The varying proportions of these, therefore, usually determine the crops to which a soil is suited.

2. *Fertilizer Requirements.* — The results of a chemical analysis of a soil do not, as a rule, afford a satisfactory basis for determining manurial requirements. The chemist, it is true, can determine what the soil contains, but no ordinary analysis determines with exactness what proportion of the several elements present is in available form for the crop. Indeed, there is no such thing as a constant ratio of availability. While one crop finds in a given soil all the plant food it requires, another may find a shortage of one or more elements. Further, on the very same field one crop may find an insufficient amount of potash; another may find enough potash for normal growth, but insufficient phosphoric acid; while a third may suffer only from an insufficient supply of nitrogen.

Most of our soils are of mixed rock origin, and, as a rule, possess similar general chemical characteristics, providing they have been farmed under usual conditions. The manurial and fertilizer requirements are determined more largely in most soils by the crop than by peculiarities in the chemical condition of the soil.

3. *Crop Diseases.* — The chemical composition of the soil may in some instances exercise a controlling influence in determining a condition of health or disease, and is never unimportant from the standpoint of vigorous, normal and healthy growth; but in the case of most diseases, the immediately active cause is the presence of a parasitic fungus, and this fungus is usually capable of fixing itself upon the

plant, whatever may be the composition of the soil. A knowledge of the chemical composition of soils, therefore, will not make it possible to advise such manurial or fertilizer treatment as will insure immunity from disease.

Conditions under which Analyses will be made.

For the reasons which have been briefly outlined, the chemical analysis of soils does not, as a rule, afford results which have a value commensurate with the cost; and this station, therefore, will not make such analysis unless the soil differs widely from the normal in natural characteristics, or has been subjected to unusual treatment of such a nature as to probably greatly influence its chemical condition. In order that we may decide whether analysis seems called for, correspondents are urged to write before taking samples, and when doing so to state all the conditions as fully as possible. This statement should include a full description of the soil and as full a report as possible as to the manures and fertilizers applied and crops raised for a number of years previous to the date of writing. In all cases in which, on the basis of the information given, it appears that a chemical analysis promises results of value, such an analysis will be made, and for the present free of charge; but, as explained in the preceding paragraphs, such analyses appear to be only rarely worth while. It will usually be possible to give helpful advice in relation to the use of manures and fertilizers on receipt of a full statement as to the character and history of the soil and the crop which is to be raised, and such advice will always be gladly given.

In case analysis is regarded as desirable, full directions for taking and forwarding samples will be sent.

INDEX.

INDEX.