Compliments of

Z. A. Gilbert,

Secretary.

AGRICULTURE OF MAINE.

TWENTY-FOURTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

MAINE BOARD OF AGRICULTURE,

FOR THE YEAR

1880.

PRINTED BY ORDER OF THE LEGISLATURE.

AUGUSTA:
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1880.

To the Honorable the Governor
and Council of Maine:

In accordance with the act of the Legislature remodeling the Maine Board of Agriculture, I have the honor to present the Report for 1880.

Z. A. GILBERT,
Secretary.

EAST TURNER, January 19, 1881.

MAINE BOARD OF AGRICULTURE—1880.

OFFICERS.

G. M. GOWELL, President.
D. A. WADLIN, Vice President.
Z. A. GILBERT, Secretary.

Members chosen by County Societies.

			Term expires Dec. 31.	
Androscoggin county,		D. J. Briggs,	South Turner,	1880
Kennebec	"	Sullivan Kilbreth,	Manchester.	1880
Lincoln	"	Samuel Kennedy,	Whitefield,	1880
Waldo,	"	D. A. Wadlin.	Belfast,	1880
Washington,	"	A. R. Lincoln,	Dennysville,	1880
Cumberland,	"	J. Marshall Brown.	Portland.	1881
Oxford,	"	S. S. Smith,	Norway,	1881
Sagadahoc,	"	G. M. Gowell,	Bowdoin.	1881
Somerset,	"	L. L. Lucas,	St. Albans,	1881
York,	"	Nathan Dane, Jr.,	Kennebunk.	1881
Aroostook.	"	J. D. Gove,	Linneus.	1882
Franklin,	"	T. B. Hunter.	Phillips,	1882
Penobscot.	"	A. O. Ingersoll,	Lincoln,	1882
Piscataquis,	"	O. T. Goodridge,	Milo,	1882
Knox,	"	Erastus Lermond,	Thomaston.	1882
Hancock,	"	Vacancy.		

Members from State College.

President, M. C. Fernald, Orono.
Professor of Agriculture, W. H. Jordan, Orono.

Elected by the Board.

Z. A. Gilbert, East Turner, Secretary.

An Act to Remodel the Board of Agriculture.

SECT. 1. The president and the professor of agriculture of the state college of agriculture and mechanic arts, together with one person from each county in the state as now provided for, whose terms of office and the election of their successors shall also be as now provided for, shall constitute the Maine board of agriculture for the improvement of agriculture and the advancement of the general interests of husbandry.

SECT. 2. The board shall hold a business session of not exceeding two days, at the capital, on the first Wednesday of April next, and thereafter annually on the third Wednesday of January in each year, for the election of officers and perfecting plans for the execution of the work for the year.

SECT. 3. The board, by its secretary and one of its members, shall hold annually one farmers' institute in each county, and as many more as it shall deem expedient or find practicable with the means at its disposal, for the public discussion of topics relating to husbandry, either independently or in connection with any organization devoted to the same general object, and it may, in its discretion, issue bulletins, employ experts, lecturers, a reporter or other aids to enhance the usefulness of said institutes to the public; and shall, as far as practicable, aid and encourage agricultural societies and associations in their efforts. The members of the board shall receive no compensation for time and services rendered, but shall be reimbursed for expenses incurred in the discharge of their duties, two dollars per day for subsistence and six cents per mile for travel. The whole expenses under this section not to exceed fourteen hundred dollars annually.

SECT. 4. The board shall appoint a secretary as its chief executive officer for a term of three years and until his successor shall be appointed, and may prescribe his duties, a part of which shall be, to acquaint himself, by personal observation, investigation, and correspondence with the methods and wants of practical husbandry, the means of fertilization, the adaptation of various products to the soils and climate of Maine; also with the progress of scientific and practical agriculture elsewhere, with a view to the more complete development of the natural resources of the state. He shall, annually, on or before the third Wednesday in January, present to the governor and council a report of the doings of the board and the results of his own labors and investigations, together with such communications, suggestions and recommendations as may be useful. Ten thousand copies of said report, in size not exceeding two hundred pages, shall be printed; nine thousand bound in paper covers, one thousand in cloth, one-half of those in paper covers for the use of the legislature, and the remainder, after reserving a suitable number for foreign exchanges, for distribution under the direction of the board, among the agricultural associations and the people of the state.

SECT. 5. The compensation of the secretary shall be six hundred dollars per annum and reimbursement for necessary expenses incurred in the discharge of his duties, an account thereof to be first audited by the governor and council. The secretary shall be an ex-officio member of the board of trustees of the state college of agriculture and the mechanic arts, also of the board of commissioners provided for in section fifty of chapter fourteen of the revised statutes relative to contagious disease in cattle.

SECT. 6. Such portions of sections one to six inclusive of chapty fifty-eight of the revised statutes, and all other acts and parts of acts inconsistent with this act are hereby repealed.

SECT. 7. This act shall take effect when approved.

[Approved March 18, 1880.]

REPORT.

In accordance with an act of the Legislature of 1880, entitled "an act to remodel the Board of Agriculture," (herein presented) the Board met at the Capitol, April 7th, 1880, and elected the following officers: President—G. M. Gowell of Bowdoin; Vice President—D. A. Wadlin of Belfast; Secretary—Z. A. Gilbert of East Turner. The necessary committees were appointed, and such plans perfected as were deemed necessary for the execution of the work for the year. A feeling of hearty co-operation in the work in hand was manifested among the members, and a determination expressed to enter earnestly into whatever duties devolved upon them in the execution of that work.

The time embraced in this report represents only nine months of the calendar year—three months having passed before its organization. Among the prescribed duties of the Board, as laid down in the law, is the requirement that it shall, as far as practicable, aid and encourage agricultural societies and associations in their efforts. In conformity therewith the Secretary has represented the Board, as far as time and his other duties would allow, at the Agricultural Fairs, Grange Meetings, Farmers' Clubs and other public farmers' gatherings; and the members have done much work in the same direction. Aside from the assistance rendered these organizations, it has been the means of learning much of the methods and wants of the agriculture in the localities visited.

In further compliance with the law, the Board, by its Secretary and one or more of its members, together with such other assistance as was deemed necessary, has held two public Farmers' Institutes in each of the larger counties of the State, and one in each of the others. At those Institutes have been given nearly a hundred lectures, which have been attentively listened to by full houses of interested farmers. These lectures treated topics especially appropriate to the locality in which they were delivered; and while it has been the aim to present them in terms which would be attractive to the hearers, at the same time care was taken that they be elevating in their character and lead to a higher study of, and further progress in, the subjects treated. Our agriculture being to a large degree stock husbandry in some one or other of its branches, many of the Institutes have been devoted largely to the discussion of principles and practices relating to and bearing upon the feeding and care of domestic animals. Other subjects have been introduced for variety, and to conform to special wants in certain localities. To the extent of the space allowed these lectures are presented herewith.

It is further specified that the Secretary shall acquaint himself by personal observation, investigation and correspondence with the methods and wants of practical husbandry, the means of fertilization, the adaptation of various products to the soils and climate of Maine; also with the progress of scientific and practical agriculture elsewhere. In complying with these requirements, such time as has remained from other duties has been devoted to the study, by observation and investigation, of our own agriculture—its methods and practices, conditions and wants; and this has been the basis in a measure from which the work of the Board has been shaped.

Science, in its application to practical agriculture, is continually modifying methods and practices, and pressing these modifications upon the attention of farmers. Investigation into their practicability and into their adaptation to the conditions and to the wants of our own husbandry, is made a duty of the Secretary, and has been, to a limited extent, pursued; and is still being continued. Some of the results of this work herein are presented.

The year just passed has been marked by the occurrence of one the severest droughts on record, extending all over our broad State, and also outside our own borders. It did not, however, affect all quarters of the State alike; and, fortunately, its greatest severity in any section was not reached till the cultivated crops of the farm had arrived to a degree of maturity which placed them in a measure beyond its influence. In Oxford county, the northern part of Androscoggin and Kennebec, and in Somerset county, it reached a degree of severity never before experienced, and subjected the inhabitants to serious inconvenience on account of the scarcity of water. Wells and streams were lower than ever was known before, and in some cases farmers were obliged to drive their cattle several miles for water. The shore counties, and the extreme eastern counties of Washington and Aroostook were in a measure exempt from its severity.

The stand of grass was unusually good in early spring, and so vigorously and early did it start into growth that notwithstanding the month of June was dry, yet an abundant crop of hay was harvested—the only exception being in Franklin county, where an unusually heavy crop having been harvested the year before, it was not above an average. Pasturage was sweet and abundant the early part of the season, but fell off seriously the latter part, and stock came early to the barn, and in severe cases not in so good condition as usual.

Grain crops were light all over the State, and especially so in the central, western and northern portions. Wheat, which has again become an important crop among us, was so seriously cut off as to be denominated a failure, except in the eastern part of the State and in Aroostook county, where it made three-fourths of a crop. In Washington county, as well as in Aroostook, wheat growing has recently been rapidly on the increase, and promises to assume an importance which will soon give a surplus above their own needs. In Washington county, in 1879, the average was thirty bushels to the acre, and the present year, notwithstanding the drought, was above twenty.

Potatoes are an important crop to the State. They were in reduced yield in all parts, except in Aroostook county, where was harvested the most bountiful crop ever realized in that section.

The long, hot and dry season was favorable to the perfection of the corn crop, save in exceptional cases, on extremely dry soils, where it failed from drought. This crop is largely on the increase, and is being considered by our progressive farmers all through the State, from York to Piscataquis, as one of the surest and at the same time, one of the most profitable crops produced. A better knowledge of the needs of the crop, together with improved methods and improved implements is revolutionizing corn growing among us.

The apple crop was a bountiful one. For three years in succession we have now been favored with an abundant yield of this fruit. So abundant also has been the crop in adjoining States that prices have ruled low, and in autumn fruits the markets have been so crowded that paying prices were difficult to obtain. Late keeping varieties are being held for improved prices later in the season.

The fruit crop is rapidly increasing in importance among us. Many orchards have recently been set, which are just coming into bearing and the increase is beginning to tell on the crop. Planting is still going on, and this, together with more attention to the needs of the trees, which is everywhere manifest, will soon give additional importance to the crop. The business of shipping apples to England has recently assumed an importance not before reached, and the superior keeping and handling qualities of Maine fruit render it especially valuable for that trade. The chief part of our crop for the past three years, which has gone on the market, has been taken for shipping purposes. As long, therefore, as we can produce late keeping fruit, and the shipping trade holds out, so long shall we find a ready demand for all we may produce.

The business of evaporating fruits by improved and rapid processes, which was introduced into the State in 1879, and has been largely extended the past year, promises to be an important industry, and will relieve fruit-growers of perishable fruit which shippers will not take. For this purpose also it is found that our fruits furnish a superior article which the market is ready to take at a premium.

Dairy products have been cut short in quantity, on account of short supply of pasture grasses occasioned by drought. Butter and cheese are gradually being improved in quality, yet they are not increasing in quantity. It is a fact well worthy of careful consideration, that while it is conceded by all that our State is especially adapted to the prosecution of this branch of farming, we are not making as much butter as our population consumes, and of cheese not more than half our consumption is supplied with our own make. Associated dairying promised at one time to increase the interest in this industry, and through that increase the products of the dairy. In 1874 and in 1875, the State Dairymen's Association obtained returns from forty-three factories which were in operation those two years. There are now no means of knowing the number still operating, yet, careful inquiry will not warrant placing the number above twenty-five. The patrons of those factories which have been operated the past season, are generally well satisfied with the business of dairying and with the associated system of cheese-making. In those localities where the farmers have taken hold of the business in earnest, and are making a specialty of it, the returns are satisfactory, and indicate the possibilities of our State in this direction.

Sheep husbandry and wool production, to which broad sections of our State seem well adapted, are receiving increased attention. This branch of stock husbandry is gradually establishing itself as a specialty in those localities specially suited to it, and much attention is being given to the improvement of the flocks by increased care and attention, and by the introduction of improved blood.

Agricultural societies have met with a gratifying degree of success in their efforts the past year for the encouragement of practical agriculture. Generally, the exhibitions have been of a complimentary quality and the receipts satisfactory. The only exceptions to this are where their number in a county has been unwisely multiplied till some or all are so weakened in their patronage and support that their influence is as limited as their receipts. The question may well be considered, whether certain county societies would not be greatly benefited—and the cause for which they were organized meet with no check—if their efforts were consolidated.

The State Agricultural Society is now located for a term of years at Lewiston. While the exhibits there shown were complimentary to the various branches of our agriculture there represented, the receipts were sufficient to meet all the liabilities of the society, and it now stands on a safe basis and has the confidence of the people. Statistics of the operations of these societies for the past year will be found appended to this Report.

The State Pomological Society and the State Dairymen's Association cancelled their winter meetings last year. Representing, as these societies do, two of the most important branches of our agriculture, they should receive that encouragement and that support which will enable them to go on in the important work so well inaugurated by them in past years. The feature of their work embraced in public meetings is too important to be passed by, as through it their influence is chiefly felt.

SILOS AND ENSILAGE.

The foundation of Maine agriculture is stock forage. With a large majority of our farmers, their success in the business in which they are engaged is measured, to a greater degree than with any other class of products, by the amount of stock forage of different kinds which they are able to grow upon their farms; and their profits and their losses are usually measured by the abundance or the failure of this class of products. With abundant crops of hay and other forage, large herds and flocks may be kept and liberally fed, which insures, in turn, by proper attention, abundant supplies of manure. These manures are the means at hand for increased fertility and still more abundant crops. This being the case, the economical production of stock forage becomes a matter of paramount importance to all farmers. If it be so to the interior farmers on their cheap lands and broad acres, it is even more so to those farming high-priced lands. These premises being, as we claim, correct, then certainly the preservation and disposition of these same products are matters of equal importance, and may well command our most thoughtful consideration. Abundant crops of stock feed, however valuable they may be when grown, may, by imperfect preservation, lose much of that value, and thus net the owner but little. So, also, fodder well preserved, may, by careless inattention to the disposition of it, bring small returns from its use.

For generations we have been producing for stock fodder a stereotyped list of products, and have all this time practiced a uniform method of preserving it for future use, namely, by drying and storing in barns. Unanimously we seem to have adopted a settled policy in these matters, broken in upon only by limited experiments in the production of some fodder products which formerly did not enter the lists. It is a pretty safe conclusion, usually, that the settled practice of a community of intelligent, thoughtful farmers, is based on correct principles, and one may adopt the methods and practices found among them with the assurance that under like conditions he will not be far out of the way. Still, these uniform practices, many times, finally give way to others which prove to be steps of progress. We have seen this in the providing of warm quarters for stock in winter; in the adoption of better methods for saving and preserving manures; and, to a more uniform extent, in the practice of the earlier cutting of the hay crop. These are all innovations on the settled practices of former times—and many others might be named—yet they are now admitted without question to be improvements on the past. Should we not, then, in view of the great importance of fodder crops in the economy of the farm, and in view of the cost of present methods of preserving them, consider carefully the question whether changes may not be introduced which will reduce the cost of stock food and thereby increase the profits. The margin of profit, at the present time, in all products obtained through the feeding of stock, is so small that any successful experiments for the widening of this margin can but be hailed with pleasure.

The attention of farmers has of late been called to the subject of Silos and Ensilage. This is a method of preserving fodder in a green state—without drying—in pits or cisterns. The pit is termed a Silo, and the material preserved in the silo is termed Ensilage. This method of preserving fodder has been introduced to public notice through the experiments of a farmer by the name of M. Auguste Goffart. This gentleman has been experimenting on the method for thirty years, and at last has perfected arrangements by which fodder may be preserved in a perfectly green state for an indefinite length of time. The results of his experiments were given to the public through the publication of a book at Paris, in 1877, under the title of "Ensilage of Maize." This book was translated by J. B. Brown, and published in English at New York in 1879. Previous to the publication, however, of M. Goffart's book in this country, this method of preserving fodder had been tried with incomplete success by Mr. Francis Morris, of Oakland Manor, Howard county, Maryland; and also in a small way by other parties. The appearance of the book gave greater publicity to the matter here, and soon attracted the attention of farmers. To Dr. John M. Bailey, of Billerica, Mass., we are indebted for the first complete successful attempt to put in practice in this country this method of preserving fodder. In the summer of 1879 Dr. Bailey constructed, in the most thorough manner, two large silos, and in the autumn of the same year put down one hundred and twenty-five tons of green corn fodder. The silo was opened December third, and from it stock was fed through the winter and till late in spring. The matter was deemed of sufficient importance to claim the attention of the Board of Agriculture, and accordingly the Secretary visited the farm of Dr. Bailey, inspected his silos, examined the preserved corn fodder, saw the stock which had been fed on it, and saw it fed to the stock. He has also availed himself of the opportunity to carefully examine all that has been published in relation to this system of preserving fodder, and here presents the method of constructing a silo and filling it, and also conclusions in regard to the value and importance of this method of storing and preserving stock forage. I might here add, that during the past summer several silos have been constructed in our own State, which, last autumn, were filled with green corn fodder.

A silo should be located near the barn in which the stock to be fed from it is kept, and should be excavated in a side hill, after the manner of a barn cellar, that it may be filled from the top of the embankment and emptied from the opposite end. In shape it should be a rectangle, with its length about three times the width, and twelve to sixteen feet in depth. A considerable depth is indispensable, on account of the fact that the contents can thus be more easily and securely compacted. If large quantities of fodder are to be preserved, it is better to construct two silos side by side, rather than have all the space in one. The walls may be laid in stone, brick or concrete; but must be perpendicular, and must be plastered smooth with cement, in order to avoid all possible resistance to the packing down of the ensilage, and also to keep out all water. An opening should be left in the end, of dimensions sufficient for the removal of the contents as wanted for use. The size should depend on the amount of fodder to be preserved. The preservation of ensilage in small silos is always less perfect than in large ones, yet they should not be so large that they cannot be economically filled, packed and emptied. Dr. Bailey has two, side by side, each forty feet long, twelve feet wide and sixteen feet deep, and estimated to hold about 800,000 pounds. A cubic foot of ensilage, after being compacted, will weigh from forty to fifty pounds. The silo must be covered by a roof, and must, of course, be protected from frost in the winter, and from the ingress of water at all times.

The green corn or other fodder, with which it is to be filled, must be cut very fine—less than half an inch in length—since the success of this method of preserving fodder depends on excluding the air by close packing, and the finer it be cut the more perfectly these conditions will be secured. After the silo is filled and trodden down as solid as possible, a layer of six inches of dry straw is placed over it, when it is covered closely with plank and weighted heavily with stone. All understand that when air is admitted into any moist substance, laying in a mass, that heat is generated, fermentation sets in and decay follows. Hence the necessity for the extremest care in this part of the process. The air, remaining in the interstices as the mass settles, escapes, or is forced out through cracks in the plank covering, and the heavy weight exerting a continual pressure reduces the mass almost to a solid. Sheep manure and horse manure, when solidly packed by the continual treading of the animals upon it, will remain for a long time with scarcely any evidence of change. With the ensilage, if the work be properly done, only a slight change can take place. The aim is to prevent fermentation as far as possible, and thus secure perfect preservation. The process admits of no errors without liability to loss.

The cost of silos will depend much on locality. Where suitable stone are plenty and within easy reach, the walls can be built of that material without heavy cost; or, if brick are near at hand or cobble stone plenty, and the cement can be delivered at small cost for cartage, then those materials will not be found expensive. Dr. Bailey's two, of the dimensions before given, built of concrete, cost $500, or about one dollar and a quarter per ton's capacity. In this State, in the country towns, the cost would not exceed one dollar; and in favorable localities would fall below it. It will be seen, therefore, that the cost for storage-room for ensilaged fodder would be less in the first cost than it is for the present method of dry storage; while the pits, if properly constructed, will last indefinitely without repairs.

Now, then, several important questions present themselves here for consideration:

1. Can this method of preserving fodder be recommended to the farmers of Maine for their adoption?

If we accept the testimony of M. Goffart and Dr. Bailey, without examination, there would be no hesitation on that point. The advantages they *claim* would, if substantiated by facts, place the matter above queston. In fact, they have succeeded in exciting a very lively interest in the subject among farmers, and have made some converts here in our own State. There seems to be an ensilage "boom" abroad, and judging from the way it is booming, the conclusion is a safe one that all the bearings of the matter are not taken into consideration. Dr. Bailey has published a book under the title of "The Book of Ensilage," which he is selling at an extravagant price, and in which, together with advertising himself, his farm and his stock—with what he has done and much more that he is going to do—he gives an intelligent account of the construction of his silos and his success with ensilage. In this book, and in M. Goffart's also, most extravagant claims are made as to the advantages of the system. Whether designed or not, these claims are calculated to mislead the careless readers of the books, and raise expectations to a pitch that it is believed is not warranted by facts. The translator of M. Goffart, with prophetic vision catches a glimpse of a pastoral paradise where real estate is to advance in value to the extent that all the mortgages may be cancelled, and still land enough be left for the happy proprietor, since not so much will be needed, as "cattle on a thousand hills can be supported in a few valleys." This increase of wealth will bring new-found leisure which we may confidently claim will be devoted to picking open the eyes of the community to the wily snares of the trading politician, and thus "the whole nation may look forward to lighter taxes and an easier life as the grand result of"—packing your fodder in silos. "Cattle can be raised in New York—(and in New England as well.) cheaper than they can be driven in Texas to the shipping points." "A growth of farming villages, with all the social privileges, rather than this stupid life in scattered farm houses, may be anticipated as one of the happy results of"—ensilage. And, in closing, he says with apparent soberness and honesty, that "it certainly seems to promise to contribute more to the happiness of the human race than any other physical discovery that has ever been made."

Dr. Bailey, in summing up the advantages of the system, says its introduction "will re-people and restore the deserted farms of New England. In short, it will bring about an agricultural millennium—almost."

These extracts are only a sample of what is being published and laid before the enquiring farmer. I might fill pages with similar extracts, but the above is enough space to devote to that kind of material. Unless one's head is level, it is not strange that extravagant ideas are raised, and that grave mistakes are followed by disappointment.

From a standpoint unaffected by self-interest on the one hand, or by a stolid conservatism on the other, the effort is here made to examine the matter by the aid of such light as can be thrown around it, and search out such merits as the practice may justly claim.

Green fodder of all kinds—grass, rye, oats, corn fodder, and fodder corn—can be preseved in silos in excellent condition for stock food. It has been done and can again be done at the pleasure of any who wish to try it. It is no longer an experiment but has become an established fact. The first point to be considered then, is:

What are its advantages? The fodder stored in its green state must either be of greater value when kept in that condition, or the cost of storage must be essentially less than by the present method in order to commend the practice. So far as the grass crop is concerned—and the same will hold true of rye, oats or any other small strawed forage product—the expense of harvesting, drying, storing, and feeding out will not be lessened by the method of ensilage. There need be no minute calculation entered into here to prove this. If any one doubts the ground taken, he has only to go over the items of cost entering into the work and he will obtain a correct solution. Coarse fodder plants like corn, which are difficult to dry, the cost will be in favor of the silos. In fact, this product is so difficult to dry that it is impracticable to store it under cover in large quantities; and if left exposed to the weather the deterioration in quality is great. Hence a distinction must be made between the grasses and corn fodder.

If then the ensilaging of grass has any advantage over the present method of drying it, the superiority must come from its being preserved and fed in a green instead of a dry condition. Goffart says, in the first paragraph of his book: "If there is one fact recognized by all agriculturists, it is that a certain quantity of grass which consumed in a green state represents an ascertained nutritive value, loses a considerable portion of that value in passing into the state of hay intended for winter fodder." With due respect for the opinions of all candid men, exception is here taken to Goffart's statement. It is not admitted as a "fact" that grass loses a considerable portion of its nutritive value by being dried into the form of hay. Dr. Bailey, too, says in his work: "It does not seem to have struck the scientific agriculturists that during the process of curing by drying, a very large proportion of the most valuable elements of nutrition are returned to the atmosphere from whence they

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came." Nor has it yet "struck" the practical farmer that this is the case. There is too much intelligence abroad among practical farmers at the present time, to have such fallacies pass current for established facts. It might be well to suggest to amateur farmers, that if they would be the teachers, and win the confidence of those who are leading this "stupid life in scattered farm houses," it will be well to keep within the limits of reason and truth.

Hay is grass dried—nothing more, nothing less. In drying the grass has simply parted with a part of its water. Grass, minus its water, becomes hay. All know that water has no nutritive value; hence grass in drying—in changing into the form of hay, cannot, by this process of drying, have "lost a considerable portion of its nutritive value." If during the process of making into hay the partially dried grass gets washed by rains, or if allowed to ferment in the mow, then another factor enters into the problem; and of course a part of its nutritive value is thus lost. If then the chemist finds no loss of nutrition through the process of making hay from grass, we have only to resort to practice for further testimony.

Fresh grass is made up of from seventy to eighty-five per cent. of its own weight of water, varying in different varieties and at different stages of its growth. Prof. Jordan found in Timothy, just before blossoming, seventy-eight per cent. of water. (See report of experiments at State College.) Young clover has much more. In feeding grass in this green state, it is found that this large percentage of water is more than the animal requires; hence, the almost universal practice, when feeding grass in the soiling system, or second crop in autumn, is to partially dry it before feeding. Better results are secured than when it is fed fresh. The latest researches have quite conclusively proved that the solids of green grass are no more digestible in the animal system than they are when the same is dried into hay; or, to put it in another form—as large a percentage of the solids of hay are digestible as of the grass from which it is made. *Drying grass does not decrease its digestibility.*

Grass dried—made into hay—returns to the feeder just as good results as it would have produced if it had been fed, in the same stage of its growth, in a green state. Hence we have this much for evidence that this class of fodder is not improved by being preserved by the new process. There is an impression prevailing among feeders, that when green grass is consumed by stock, that the physical modifications, which it must pass through before it is assimilated, are more easily secured than if the same were fed in a dry state. It is believed that this impression is gained from a comparison of green grass with hay made from grass in a more mature, and perhaps ripe, condition. If reliable conclusions are to be reached, the comparison should be made in like stages of growth. It may be that further experiments will establish new facts, but just now there is a lack of proof that grass will net the farmer greater profits preserved in silos or fed in a green state than if dried and stored in the form of hay.

The strong point which the advocates of silos and ensilage make, however, is that this process makes it practicable to grow and utilize fodder-corn to any extent desired for stock forage. (The term "fodder-corn" is used in the sense usually understood when used to designate corn grown without ears of grain expressly for stock fodder.) The great obstacle heretofore to its extensive production has been the difficulty of preserving it in its full value. The process of ensilage overcomes that difficulty, and its enthusiastic advocates claim, will, when adopted, entirely revolutionize our agriculture. Goffart says: "If I speak more particularly of maize, it is because I have found in that wonderful plant all the elements of a new and boundless agricultural wealth, from the day when I arrived at the assurance of its indefinite preservation by ensilage for the nourishment of cattle throughout the whole year." Dr. Bailey claims, with apparent honesty, that by this system a half dozen cows may be fed a full year from a single acre of land; and that butter may be made at a handsome profit for ten cents a pound, milk at one cent a quart, and mutton for nothing. E. W. Stewart, of Erie county, N. Y., a gentleman of large experience in feeding stock, a careful writer, and reliable authority in agricultural matters, says: "I have great confidence in the silos for the preservation of green food for stock, and believe that it is likely to revolutionize our present system; but let us keep the imagination within the bounds of probability."

Rather than depend on the imagination for guidance in this matter, it will be well to enquire into the value of fodder-corn as stock food. It has been grown by the farmers of Maine to a greater or less extent as a supplement to the short pasturage of autumn, and the universal testimony is that it is not a rich fodder. Many closely observing farmers have stoutly maintained that they could get no benefit from feeding it. At the present time, probably there is no farmer among us who makes it a chief reliance, and only uses it as an accompaniment to other and better feed.

Examined by the chemist the same conclusion is reached. Dr. Atwater, of the Connecticut Experiment Station, examined samples grown on the college farm at Orono, and reported the thin sown as containing 88.1 per cent. water; the thick, 93.6 per cent. A crop of twenty tons—a good yield for one acre—would, using the lowest per centage, contain 4.760 lbs. dry matter, and 35.240 lbs. of water. Using the larger per centage would give 2.560 lbs. dry matter, and 37.440 lbs. of water. A silo containing 500 tons corn ensilage, giving it the benefit of the smaller water content, would contain 440.5 tons of water.

When examined for nutritive elements the estimate put upon it by the feeder is corroborated. Aside from the fact that it contains an excessive amount of water, the nutritive elements are not properly balanced. The full explanation of the office of the different elements of nutrition in stock food will not be attempted, and only such allusion made to it as seems necessary. It is an important matter, and worthy of the closest study, and will be treated at some length in another part of this report.

The value of any cattle food is based upon the percentages it contains of *albuminoids*, *carbohydrates* and *fats*. Each of these classes have certain functions to perform by which the animal economy is carried on. One class may be able to do what another cannot. In a perfect food they should maintain a ratio corresponding with the demands of the animal. The *albuminoids* occupy by far the most important place; and no cattle food will produce satisfactory results when this class of nutritive elements do not come up to the proper ratio with the others. Fodder corn is found to be largely deficient in albuminoids; which fact, taken in connection with the excess of water, accounts for the unsatisfactory results following all attempts to use it as an exclusive ration. The operation of ensilaging cannot add anything to its nutritive contents, nor can it correct the proportions of its nutritive ingredients. Therefore the ensilage, as well as the fodder before this process, needs to have grain, cotton-seed-meal or some other highly nitrogenous food combined with it in order to secure satisfactory results in feeding it. The enthusiastic advocates of the system admit this. M. Goffart says: "Sheep and cattle fatten with wonderful rapidity upon maize ensilage, with the addition of eight to ten per cent. in weight of oil-cake-meal"—a statement which no one will question. The point, however, to be noted is that the oil-cake is required in order to secure such results. Bailey says: "To receive the fullest benefit there should be some nitrogenous food fed with the corn ensilage." And again says: "The ensilage is by no means a perfect food; it is deficient in albuminoids." So important does this fact appear to him, that he has secured letters patent for mixing concentrated feed with the corn in the silo. If any one, then, who has built a silo wishes to make his ensilage corn suitable for stock food by mixing bran, or cotton-seed-meal with it at time of packing, he can do so by paying a royalty to that great discoverer and public benefactor. So we learn by this that all the experience we have to refer to in this matter, points to the fact that corn ensilage is the same imperfect food that the corn has been heretofore found to be by those who have extensively used it. Goffart still further admits this in a back-handed way by saying: "My fodder of all kinds, fed exclusively to my animals, produces exactly the same effects, the same abundance of milk and butter, the same flavor and the same color to the butter." Those of us who have tried to make choice butter, and much of it, from fodder corn alone, can appreciate the value of this statement. It is not a rich food.

There now remains one point more to be considered:—Is the nutritive value of fodder increased by the process of ensilage? I have here again to quote from the authorities so many times referred to before. Goffart says, notwithstanding he has before said that he obtained *exactly* the same results with the preserved as with the green fodder—that "the nutritive power increases when it has been softened by lying several weeks in a silo." Dr. Bailey says: "From my experience in feeding, so far, I consider ensilage to be worth one-half as much as the best timothy hay;" a statement so wild that it would not be quoted here were it not for the purpose of showing how unreliable statements may be when made by interested parties. With his estimate of eighty tons of green corn to the acre, holding good in fact, we should then have the equivalent of forty tons of the best of timothy hay to the acre. Compared with this modern Don Quixote, his distinguished predecessor pales into insignificance. Wouldn't this "revolutionize agriculture!" He further says: "my experiments thus far, satisfy me that the value of corn-fodder is doubled by the softening and fermentive process which it undergoes in the silo."

The value of ensilage, as compared with the same fodder in a green state, for stock food can only be fully determined by experiment. An analysis alone is only an indicator of value, and to a certain extent is valuable aid in determining the feeding value of a product; but its true value can only be ascertained by putting it to the test of the organs of digestion and assimilation found in the animal to which it is fed. Still, before accepting the testimony here given, it may be well, although entirely without that safe and reliable guide, experience, to apply to this question—as we should to all others of whatever nature—such reason and common sense as may be at command. Experince—admitted the best of all teachers in these matters—proves what we learn through analysis—that fodder-corn is a weak food, and altogether unfit, alone, for stock food; that it becomes necessary to combine with it concentrated and richer food of some kind in order to secure satisfactory results from its use. Analysis proves the same—that is, that the ingredients of a rich and valuable stock food are not contained in its contents. Analysis may and does show the ingredients contained in a food product, and what are not there. If the chemist cannot find certain ingredients from the fact that they do not exist there, then when it is fed to the animal the organs of digestion cannot find them.

So, when this corn goes into the silo, it carries nothing with it that it did not before contain; and in this "softening down" nothing is created. Therefore the conclusion is sound that the ensilage contains nothing that the corn did not contain before it went in there. Then, if there can be any increased feeding value to this material, in this form, over the form it was in before the process of ensilaging, it must come from material being made more digestible by the change through which it passes. The low estimate placed upon it, when fed in a green state, comes from there being an excess of water, a low percentage of nutritive ingredients, and a deficiency of albuminoid compounds. These defects cannot be corrected by the process of ensilaging, and therefore must exist in the ensilage. Determined, then, by whatever test it may be submitted to, there can be no improvement in food value of the material after it goes into the silo. I cannot do better at this point than to quote from that eminent authority, Samuel W. Johnson:

"That the silo cannot create any fodder, or that we cannot take out of the silo any food element that we do not put in, is evident."

"It is, I scarcely doubt, equally true that ensilage is no more palatable, no more digestible, and no more nutritious than the fresh corn from which it is produced. The rumor that ensilage is worth more, nay, much more than the fresh corn fodder, has nothing solid to rest upon."

In the further elucidation of the question, as to the comparative values of the fodder before and after its preservation, the results are given of careful experiments, which have recently been made by Moser at the Vienna Experiment Station, and which show the changes taking place in the green fodder. This seems to be the only reliable data we have at the present time upon this vital point. Table I. needs no explanation. The experiments were made by dertermining by analysis the composition of the green corn. Bundles of the same, weighing 13.2 lbs.,were placed at different depths in the silos and surrounded by the cut corn where all was covered in the usual manner. At the end of several months it was taken out, the ingredients determined by analysis, and the table shows the result.

TABLE I.—*Composition of Water-free Substance.*

DESCRIPTION OF SAMPLE.	Albuminoids, per cent.	Fat, per cent.	Nitrogen, free extract, per cent.	Crude fibre, per cent.	Ash, per cent.
Fresh maize	4.36	3.68	52.40	32.30	7.26
Sour maize, 17 inches from top of pit	4.40	4.44	39.21	43.30	8.65
do 34 " "	4.78	4.87	33 75	46.84	9.76
Br'n maize 34 " "	5.39	5.71	47.49	34.84	6.57
do 68 " "	4.44	4.85	49.74	32.60	8.37
Fresh maize (another sample)	4.21	3.95	52.58	36.08	3.18
Sour maize, 38 inches from top	4.13	5.73	35.00	43.37	11.77
Fresh maize (Grandeau's analyses)	6.52	1.30	58.71	26.59	6.88
Sour maize " "	6.62	1.92	53.21	26.23	12.02

The following table shows the weight of the bundles when taken from the silo, as compared with the original weight:

TABLE II.

DESCRIPTION OF SAMPLES.	Fresh, pounds.	Water-free, pounds.
Fresh maize	13.20	2.73
Sour maize, 17 inches from top	4.64	1.97
do 34 "	8.04	1.78
Brown maize, 34 inches from top	9.35	2.05
do 68 "	12.66	2.49
Fresh maize, (another sample)	13.20	3.07
Sour maize, 38 inches from top	10.60	2.05

From these figures it will be seen that the fodder lost in the process of ensilage from 8.9 to 34.8 per cent. of its solids.

The following table shows the loss in each ingredient:

TABLE III.

INGREDIENTS.	Water, lbs.	Albuminoids, lbs.	Fat, lbs.	Nit., free ex't, lbs.	Crude fibre, lbs.	Ash, lbs.
Fresh maize	14.47	0·12	0.10	1.43	0.88	0.20
Sour maize, 17 inches from top	2.67	0.09	0.09	0.77	0.85	0.17
Loss	7.80	0.03	0.01	0.66	0.03	0.03
Sour maize, 34 inches from top	6.26	0.08	0.09	0 60	0.83	0.18
Loss	4.21	0.04	0.01	0.83	0.05	0.02
Brown maize, 34 inches from top	7.30	0.11	0.12	0.97	0.71	0.14
Loss	3.17	0.01	0.02	0.46	0.17	0.06
Brown maize, 68 inches from top	10.17	0.11	0.12	1.25	0.81	0.20
Loss	0.30	0.01	0.02	0.18	0.07	0.00
Fresh maize	10.13	0.13	0.12	1.61	1.02	0.19
Sour maize, 38 inches from top	8.55	0.08	0.12	0.72	0.89	0.24
Loss	1.58	0.05	0.00	0.89	0.13	0.05

From this table it is learned that the albuminoid compounds have been reduced from 8 to 38 per cent , and the carbohydrates from 13 to 58 per cent. These amounts have disappeared—been destroyed—through the changes which the fodder has gone through in the silo. These results do not seem to confirm the claim previously referred to, that the fodder is "doubled in value by the softening and fermentive process which it undergoes in the silo."

From the examination here given to the subject the conclusion is obvious, that the advantage of the silo is simply to store green fodder; and with this it wholly ends.

If, then, a farmer proposes to change his forage crops by substituting fodder corn for his former product of hay, he will find himself called upon to decide the question, whether upon the point of economy, it will be better to prepare silos, and store it in a green state, or provide barns and store it dry. Chiefly on account of the difficulty of drying it, so that it may be stored in large quantities in a body, the preference undoubtedly will be in favor of the silo. But that farmers have that high appreciation of fodder corn that they will deem it advisable or to their advantage to adopt the growing of it as their chief forage crop to take the place of the grasses and clover, cannot now be conceded, nor can such a course be recommended. On strong soils—natural grass lands—*grass will not be* *superseded by corn*, but will remain as now, the king of crops. The owner of light and sandy lands, where corn ordinarily delights to grow and grass produces but scanty yields, may well consider whether a revolution in the system may not be desirable. By combining concentrated foods with the large production of green corn, a large amount of stock food may be secured to a given area, but that it will be at a greatly reduced cost from present management is not quite conceded.

From whatever standpoint, then, this question of silos and ensilage is viewed, the extravagant claims and wild estimates of the interested enthusiasts, which have been of late thrown upon the attention of the farmer, are not sustained. Facts should always have their due weight, and farmers should always be progressive, —willing to give all methods and practices an impartial and candid hearing, but at the same time be so cautious and considerate, as to ever be guarded against any great and sudden innovations on what are now conceded to be the best practices. Our agriculture is not so thoroughly and radically wrong as to need to be completely revolutionized at one swoop of the reformer's wand.

What has been intended here, is to present the subject in all its bearings, calling attention to its advantages, and presenting its objections, that any farmer considering the practicability of this method of preserving stock food, may not be deceived by highly colored representations, but may be aided in reaching just those conclusions which experience with its use, would in time bring. While, without question, silos will come into use with those feeders wishing to preserve sugar beet leaves and beet pulp, and where fodder corn is to be substituted in place of pasturage and hay mows, yet it is not admitted that all our rich pasturage is to be given up and our fields of waving timothy and rank clover exchanged for green corn. And this position is taken on the ground that a further trial and greater experience will not prove the change a desirable one only in isolated cases. So, too, it may again be repeated, it will not be found economy to ensilage grasses or other forage crops, which can be easily prepared for preservation by drying.

Cattle Foods and Methods of Producing Them;

BY A. W. CHEEVER,

Agricultural Editor "New England Farmer."

Mr. Chairman, and Ladies and Gentlemen:

I am very glad that the subject for our consideration this afternoon is so closely related to the one treated by the lecturer of the forenoon. Had the Secretary of your Board of Agriculture, when selecting topics for discussion here to-day, given you a lecture in the morning on cattle breeding, in the afternoon on horticulture, and in the evening on the education of farmers' sons, you might have found it a little difficult to "switch off" from one train of thought to another more or less remote. In conventions like these you are holding I like to see the subjects investigated as far as may be,—clear to the bottom, and all difficulties arising, met and overcome, or the methods of meeting them clearly pointed out.

In the lecture of the morning, Mr. Barnes endeavored to show you why your cheese factory enterprise has not had a greater success, and chief among the reasons given is the fact that you sent too little milk to the factory. You built a fine, large structure, and fitted it up with all the appliances for making a large amount of cheese, but failed to furnish the one essentail factor—milk. He tells you, that you not only send too little milk while the season lasts, but you make the season too short at both ends. Carrying on a business of this kind in a small, half hesitating way, the profits are necessarily small, and this leads to the temptation of hiring cheap help, which is often the dearest in the end. Having compared the profits of your factory with the one at Houlton, he has shown you, not only that one is earning for its patrons nearly twice as much as the other, but that the product of one factory is establishing a reputation in the market, which will allow of a great increase in the amount of goods manufactured, with no danger of over-stocking the market.

He has told you that if you would make your cheese factory here pay you a larger profit. you must, first of all, contrive in some way to furnish the cheese factory plenty of milk with which to work; that you must begin sending earlier in the spring, and continue the supply as late in the fall as possible; in short, you must work the factory to its full capacity, in order to obtain full rates of interest on the capital invested. With a larger supply of milk you can afford to employ more competent cheese-makers, and with more milk and a higher grade of help, the product will be increased, both in quantity and quality, while its character and reputation will go far toward increasing the final net profits to be divided among the patrons.

I have fancied, as I sat listening to the speaker this morning, that some of you may have thought to yourselves, that it is not half so easy to double the quantity of milk sent to the factory, as to figure out the increased profits on paper. Indeed, I have already heard the remark since I entered the town, that the factory here can never yield so good returns as do factories in some of the surrounding towns, because the pastures here are too cold and wet in the spring, and pinched by drought in autumn, or they have been depleted by a long continued course of cropping without receiving any return for the plant-food they have yielded up. I have fancied too, when noting the preponderance of gray heads in this audience, that possibly many of the young men of this region had lost confidence in the ability of New England soil to support a family in accordance with modern ideas, and that many of the boys, who were bred on these once beautiful hills, and along the banks of these musical streams, have already been captured by some western railroad director or land speculator, and are now engaged in sapping the fertility of the prairies, just as a former generation sapped the once fertile lands of New England.

But I see some young men here, and some young women, too, who, judging by the close attention they have given to the words of the speaker, are deeply interested in the subject which has been presented and so ably discussed during the earlier session of the day.

It will be my aim this afternoon, to endeavor to point out and illustrate one of the methods by which a greater amount of milk can be furnished to the factory. I might urge the selection or breeding of better cows, or cows better adapted to the cheese dairy, but this, it seems to me, is a secondary matter. It is of little use to purchase superior cows, if they are to be turned into a barren pasture to find their support. It is true that the cow manufactures the milk, but equally true that not an ounce is drawn from the udder that has not first entered the mouth in the shape of food. I claim that no man is justified in purchasing an animal or in allowing his animals to propagate the species on his hands, without first making himself reasonably sure that he can furnish those animals with a full supply of wholesome, nourishing food, suited to their wants.

So, in the time allotted me in this discussion, I will speak of methods of increasing the food supply on dairy farms.

I might urge the importance of improving pasture lands, and would advise this course, wherever practicable, but I see many obstacles in the way for any marked or rapid improvement in this direction. Your pastures are large and the fences poor; their surface is covered, in many cases, by stumps and trees, which must be removed before the land can be greatly improved by cultivation, and a large portion can never be profitably worked, till it is brought under a thorough system of drainage. These obstacles, if removed, will incur an expense that would rarely be met by any return that lands can possibly yield under a system of pasturage. At the best, the pasturing season is short, requiring the feeding of mowing lands in the fall, much to their damage, while in the flush of feed in midsummer, there is great waste from the tramping and defilement caused by the animals pastured.

I would not, however, ignore all the advantages and conveniences of a good pasture, but would endeavor by all economic means to keep the pastures worthy the name.

Whoever looks abroad over the farms of New England, cannot but see that her agriculture is more or less in a transitory state. The old agriculture was a system of cropping, the new agriculture will be a system of cultivation. The era of virgin soil and spontaneous productions has already passed away in my state, and is rapidly passing away in yours, except perhaps, in those valleys on your northern border, which the western emigrant has unwisely passed by. The old fields require cultivation and the application of plant food to replace in part, that which successive cropping has removed.

Were I to purchase a farm in Maine, I am sure that I should transplant certain methods which I now follow on my dairy farm at

Sheldonville. If I found a pasture, which by a little repairing of the out-side fence, would hold cattle so long as the feed was good and abundant, I should certainly repair the fence and turn my stock in after the ground was settled in the spring and the feed well started; but, so soon as the feed became short and scanty, I should take out all my best milkers, and let the young stock and dry cows remain to use up what feed grew; or I should feed the entire herd, at the barn, night and morning, allowing the animals to drink, perhaps, and take a little exercise in the pasture during a short period each day. I should begin on the best plow-land near the buildings to prepare for growing the food required for these morning and night feedings. I might not remove every obstruction to the plow at once, but as the best land near the buildings is to be constantly devoted to crops which require smooth lands, I should aim to put it in first-class condition as early as practicable.

If the season is autumn, I should select the most suitable spot I could find, and put in a crop of winter rye to be cut the following spring, to feed green. Winter rye may be grown where potatoes or the corn crop has been removed; or it may be sown on an inverted grass sod. Rye does best on a warm, sandy loam, where water will never stand in winter, and where the frost cannot destroy it by heaving. Four bushels of seed per acre will, on suitable land, produce a fine, heavy growth, and cutting may commence just as soon as it will turn out a fair, paying crop, which will be as soon as the first indication of heading is noticeable. It will nearly double in weight during the next week or ten days, and if not all fed green, should be cut and made into hay before the blossoms fall.

The land may then be ploughed and planted to potatoes, corn, beans or many varieties of garden vegetables, or it may be sown with other forage crop like millet or Hungarian grass. The weight of the crop will depend very much upon the amount of manure applied to the land at the time of sowing the seed, but one need charge nothing to the crop for interest on capital, nor for the use of the land, as the rye will grow at both ends of the year, when the land would otherwise lie idle.

If the rye is followed by field corn, it may, in the northern portions of New England, be necessary to select an early maturing variety. The season of green cutting may be somewhat extended by having two or more sowings from September first to October first, or even later, though the difference in the time of blooming will be less than the difference in the time of sowing the seed.

Winter wheat is an equally good crop for feeding green and comes in just after the rye season is past. My own farm of twenty-six acres has now growing upon it about nine acres of winter rye and wheat which will be cut for green feed or hay next May; from one and one-half to two tons per acre being a moderate yield of well cured dry fodder. These crops, whether dry or green, are a great help to a farmer, who in the spring of the year finds his hay mow insufficient for carrying his stock through to the time for turning to pasture. They add to the length of the green food season, and cows will always increase in their yield of good milk or butter, when changed from dry hay to green rye or wheat.

Owing to a short hay crop last year, my own cattle were kept on rye hay for nearly a month previous to turning to pasture, and the past spring yielded nearly their usual flow of milk. In California hay from grain is more common and better known in the markets than hay made from grasses.

Rye will, on many farms, fill the gap between hay and grass, but when the area of pasture is limited, I would sow early in spring, as soon as the soil is in suitable condition, a field of spring rye at the rate of four bushels per acre. This crop will come immediately following the winter rye or wheat. Oats may be sown at the same season, but they will be longer in coming to the scythe. Oats will need five bushels of seed, if it is desired to have the straw fine and soft. A little later barley may be sown, for the same purpose, using four bushels of seed.

After the danger from spring frosts is passed, Western or Southern dent corn, may be sown broadcast at the rate of eight to ten bushels of seed per acre, well worked in with a disk harrow or cultivator. This is rather expensive seeding, and no larger plot should be devoted to this crop than will be required for green feeding, and the cutting should all be finished by the time the growth has reached four feet in height. It will then be full of green, healthy leaves and but a small proportion of stalk. If allowed to stand late the lower leaves fade and die, and the stalks which are densely shaded, are very inferior, especially if they fall down and lie for weeks on the ground. Corn sown thickly, later in the season, after the weather becomes warm and favorable to rapid growth, would be almost sure to lodge and rot on the ground. The later plantings I prefer to make in drills, using from fifteen to twenty quarts of seed per acre. I have grown the sweet varieties quite largely, but a large variety of common field corn will bring a very satisfactory crop, planted thin enough in drill to yield fair sized ears in case the crop exceeds the demands of the stock kept. A stalk of sweet corn will usually be preferred by cattle to a stalk of field corn of the same size, age and weight, but the seed is slower to germinate, and it is more expensive than seed of field corn. Corn may be planted at intervals of a week or ten days, from the first warm weather, till early in July. If put in later, its growth is slow, and early frosts will be likely to injure it very seriously.

I suppose corn has been grown for green fodder, to a considerable extent in Maine, for many years, but I believe its culture may be considerably increased in all the dairy sections, and with satisfactory results. It is grown, I suppose, for bridging over the usual season of drought in early autumn, and is given morning and night to cows that run in pastures all day. If one desires to increase his business it may constitute with a ration of grain the entire forage of the animals. The same may be said of the other crops, I have named—rye, oats, wheat, barley and millet.

The last named may be sown at any time when the season is suited to corn planting. I think this plant, in some of its varieties, should be better known in Maine, than it seems to be, judging by the numerous enquiries on the subject, addressed to the *New England Farmer*. Millet, whether the common variety, with a green head, turning to amber as it ripens; Hungarian grass, with its smaller purple spike, or the later and larger variety recently introduced from the West, is *not* a perennial, producing crops year after year, like timothy grass and red top, but it is an annual plant, and is valued chiefly, because of its luxuriant and rapid growth, allowing a crop to be grown in a comparatively short time after the seed is sown. It grows best in hot weather, and like corn, likes a light, warm soil, though it will do well on clay land, that is sufficiently dry and mellow. It will make a crop of hay in fewer days, from the seed, than any agricultural plant known to New England farmers. It is so vigorous a grower, that it will for once, make a large growth on soils not over rich, but successive crops on the same land will require manure. One bushel of seed (48 pounds) is the quantity usually sown per acre, and a smaller quantity would be too little.

Where there is a mowing field that shows signs of decline, and needs plowing and re-seeding, the grass may be cut early, say, by the middle or last of June, and the sod turned over for growing a crop of millet. If the work is pushed along, and the cultivation well done, and a fair dressing of some kind of fertilizer applied, there should be no difficulty in obtaining two tons of good hay from each acre sown, provided the season is at all favorable. A full crop may be obtained from seed sown at any time between June first and the middle of July. The later variety, previously alluded to, often called golden millet, requires a longer season, and if a full crop is expected, must not be sown later than the first of July. I grew a a crop the past summer after early cut hay, which in September, yielded at the rate of over eighteen tons of green fodder per acre, and a measured area cut, and dried near a kitchen stove for two months, or till quite brittle, weighed at the rate of over four and three-fourths tons per acre. The fodder is coarse, and seldom lodges while growing, but cattle are very fond of it when cured for hay.

When the season becomes too far advanced, for sowing millet or planting corn, I use all otherwise idle land for growing fall crops of spring grain. I have grown oats, wheat and barley with excellent success, but barley gives the best satisfaction, as it is less subject to rust than oats, and the seed is usually cheaper than wheat. None of these crops are materially injured by autumnal frosts. I have cut heavy crops of barley, that have stood under several inches of snow, and have cut it after the germ was considerably frozen. Less seed is required for fall sowing, as the growth is rapid during July and August, and there is danger of waste from lodging, if it stands too thickly. Three bushels of good seed barley is enough for fall seeding. It may be sown from the middle of July to the middle of August. Have had a good crop from seed sown the 23d of August, but the crop is usually lighter when put in very late.

These late grown summer and fall crops may be cured for hay just so long as good hay weather lasts. I made hay this year of barley, grown after a crop of winter wheat had been cut for seed, the wheat being out of the way the 10th of July. Hay often cures very slowly, late in the season, but as the cold increases, there is less necessity for getting it very dry, as it will heat in the mow much less readily in October than in July. In naming forage plants, I must not forget our leading staple grass. Nothing is better than grass, and nothing is grown more cheaply on land that just suits it. The crops I have previously named, except oats, all do best on rather warm land, such as is not the very best for growing successive crops of hay without frequent re-dressing.

Nor are all grasses alike in their habits of growth or actual value for hay. Orchard grass, (*Dactylis glomerata*) is a grass that should, I think, be better known by New England Farmers. It is one of the earliest to ripen, coming into flower with the June or Kentucky blue grass, (*Poa pratensis*) sometimes called spear grass, and like that is remarkable for its habit of producing heavy second, and even third crops the same season; and mainly composed of long, soft leaves, which make the very best quality of rowen hay. My rule for seeding an early mowing is two bushels orchard grass (28 lbs.), one bushel June grass (14 lbs.), and eight to twelve pounds common red clover. Have sown fields early in the spring, which have yielded three heavy cuttings the same year; and have sown in August and had a crop to cut in October.

I prefer to sow, usually, the last of July or first of August, as orchard grass is too tender to bear very late fall seeding. After the first year it is as hardy as other grasses.

Orchard grass should be put on the best grass land, such as may be expected under high manuring to produce heavy rowen crops every season. Dry lands, like sandy plains, or gravelly knolls, are unsuited to it, so are level meadows that are over-flowed in winter and liable to be covered by a coating of ice. It is very desirable not to have the haying season come all at once. Early and late varieties, if kept separate, enable one to push his haying leisurely, making it possible to cut each variety at the very best time, which is not the case when Timothy, red-top and clover only are grown, and these mixed in the same field.

The very latest crop for feeding green, except cabbages, that I have yet grown, is winter rye and barley, sown together at the rate of from one to one and one-half bushels of seed per acre of each variety. Winter rye sown very early in autumn on rich land, will sometimes make so heavy a growth, as to endanger the crop wintering safely, and yet it may not pay very well for mowing; but if barley is sown with it the two together will turn out a large, heavy swath. The barley running up with a strong stem helps somewhat to support the rye and prevent it from lodging or pressing too closely on the ground. I have had but one season's experience with these grains mixed, but am so well pleased with the results thus far, that I shall continue the experiment further. Mr. A. W. Putnam of Danvers, Mass., and others in the vicinity, have had a larger experience, and write me highly favorable reports of their success. The sowing of the two together, may continue at intervals of a week or ten days, from early in July to the middle or last of September, and the crop will afford cuttings till after the ground freezes. My last cutting this year was made the first week in November, the late frost having injured it very slightly. One advantage of growing these grains together is that a full crop of rye may be expected the following spring and without the expense of the second plowing and seeding. It is like sowing grass seed with a grain crop, the grain to be cut this year, and the grass next.

The question may be asked, which of these several forage crops named is, on the whole, the best? I should answer, that each is best in its appropriate place and season. I grow them all, and can at present dispense with none. When the growing of grain crops specially for fodder was first introduced, some farmers felt that it was wicked, claiming that it was interfering with nature, to cut down a field of rye or oats just as it was coming into bloom. Well, it may require a little courage to strike a scythe into the first rye field in the spring before it is more than half grown.

Some of us possibly, may estimate how many gallons of good whiskey the crop would have made, if allowed to stand for seed. But seriously, why is it less *natural* to grow these grains and cut them for fodder, when they are in the very best condition for that use, than to cut our common English grasses when in bloom, instead of letting them stand to ripen their seed?

This talk about certain methods and customs being contrary to nature, is often very weak talk. Almost everything we eat, drink or wear, is in some sense, the result of methods that are more or less contrary to nature. Our butter and cheese, the flesh of domesticated animals, eggs, veal and all cultivated fruits, are more or less artificial products. I contend that a man or a nation of men are living up to the highest ideal of conformity to nature when all the good things found on this beautiful earth of ours are made to serve man's highest and purest desires. The time may come when population will be so dense in this country, that it will be unprofitable to keep cattle at all, and man will use food direct from nature at first hands; when it will not, as now, be considered good economy to feed ten pounds of good corn meal that would sustain a man a week to a hog, and take in return one pound of bone, muscle and fat which will not support him well a single day. But that day has not arrived. We are now wishing to know how we can remain in New England on the farms where we were born, and among associations that are dear to us, and obtain a good comfortable living and maintain a respectable position in society. To do this we must have money, and the main question is how to get it. Here in Milo you have put capital into a cheese factory. Facts have been produced here to-day showing that there is some money in cheese making by such systems as you have followed. The lecturer from Aroostook county has given you figures proving it a better business, as carried on there. Now which will you do, move to Aroostook, or stay where you are?

A part of the business there is clearing and fencing new land. Yours is already cleared and fenced. A part of the work of the new settler is to build a house, a barn, and dig a well. You have them all. A part of the income from farms in a new country goes for building churches, school houses, roads and bridges. These you have in abundance, all built and paid for. With all these advantages in your favor, can you not make as large a profit from your lands here, as you could from the new lands of Aroostook county, or the prairies of the West? I believe you can, but you must work them more; must make a more full use of the capital you have invested. By adopting so much of the system I have described as may seem adapted to your wants or locality, you will be able to keep your land in almost constant use. The successful merchant or manufacturer aims to turn his capital often, and by so doing, to work on small margins. A profit of two per cent. a month, is more than four times better than a profit of six per cent. a year. Very few of the crops, I have named, require much over two months for their growth. Our single crop of hay, which is grown on so many thousands of acres here in New England, grows in less than three months, and a rowen crop, when we get one, seldom requires more than sixty days for its maturity. But there are twelve months in the year, and if we have interest to pay on a mortgage, it is reckoned for the whole 365 days. So our taxes and insurance are paid for the whole year. Can we afford to do business in that way? If so, can we not *better* afford to use our capital more of the time? I believe we can. I believe after a crop of potatoes has ripened, it is better to dig them, and then grow on the same land a crop of barley for fodder, at the rate of one and a-half or two tons per acre, than to leave the field to grow up to weeds, that may have to be mowed and burned, before the potatoes can be reached.

If you find late in June, you have a piece of grass land so badly run-out that it will need plowing before another year comes round, I believe you will do better to cut what grass there is, turn over the sod, apply a suitable quantity of fertilizer, and sow to millet, getting two tons of good fodder per acre, for filling you empty hay mows, than to let it lie idle all summer.

I believe that cultivated lands on side hills, are safer from blowing and washing away through the late fall, winter and early spring, when they are covered by a coat of winter rye or wheat, than if left bare and exposed to the full action of the elements.

I believe that two or three annual forage crops grown in one year, add much to the fertility and improve the texture of soils by the large amount of roots and stubble that is left to be turned under. The clay soils of this State, it seems to me, would be greatly improved in texture by such a course. The stubble from a heavy crop of winter rye cut green, almost equals an average grass sod, in its amount of vegetable matter. Of course, it is understood that manure or fertilizer, in sufficient amount, must be applied to make a crop grow.

The best rotation to follow in growing successive crops the same season, is a question for each to decide, according to his own peculiar circumstances. Winter rye or wheat will follow almost all our summer crops, except late cabbages and roots. An early variety of field corn will have ample time to ripen fit to cut and stack, planted after winter rye cut for fodder. Millet and fodder corn may be grown after spring grains have been harvested, and all the spring grains may be grown after a crop of the same has ripened seed. A heavy crop of fodder corn may be grown, by sowing the seed with a drill, or planting by hand between rows of early potatoes, ten days or two week before digging. The digging will equal one good hoeing. A little fertilizer sprinkled on the rows at planting, will of course, be required.

In an orchard of bearing apple trees, chiefly winter varieties, I cut in the summer of 1878, a crop of winter rye in May; a full crop of oats in July, which was followed by a heavy crop of barley, fit for cutting, in September, or before it was time to gather the fruit on the trees. Each of the forage crops was headed out, and all had attained their full height. Such a system of culture, allows one to work near his home, most of the time, and within hearing of his dinner bell. It saves a vast amount of extra expense in traveling and teaming, if the work can be kept near the buildings. It makes a man with a twenty-five-acre farm, feel that he has a fifty-acre farm, except when he pays taxes or interest, and it does enable one to easily keep double the stock, and make double the milk, butter or cheese, that can be made by the old one-crop-a-year system. The farmer who adopts this system to any considerable extent, will find that his farm will be far less infested by grasshoppers and crickets, than when the soil is left undisturbed year after year. These insects hatch from eggs laid in the ground, usually mowing fields, where the young will find suitable food at once, and in abundance, but if the soil is worked often, their family affairs are so interfered with, that they have poor chance for existence. My own farm of twenty-six acres, has at times, been badly over-run with these voracious insects, but the past year, with twenty acres under the plow, a grasshopper has been rarely seen.

But the one great advantage to be gained by a system of crop cultivation, in place of exclusive pasturing for dairy stock, is from the saving in fences. A fence around a permanent pasture is a thing of necessity, for the present at least, here in New England. In countries where the land is cultivated better than with us, cattle are sometimes tethered out, or are watched by an attendant; but here where pasture fences are required, as they are on most of our New England farms, I care not how substantial they are built. Good fences make good neighbors, but I find by referring to statistics that our self-imposed fence taxes are by far the heaviest taxes we pay, unless the tax for tobacco and spirits be excepted. According to the returns of the United States census bureau, the live stock in the whole country in the year 1870, including horses, cattle, mules, sheep and swine, amounted to the sum of $1,695,211,935. The estimated value of the fences required for restraining these animals, was $1,748,529,185, while the value of all the crops grown that year, and which had been saved from destruction by those animals, amounted in round numbers to $2,450,000,000. These are large amounts, almost beyond human comprehension, for to count a single million of dollars, counting at the rate of one dollar a second, and ten hours per day, would require a full month, Sundays included, and to count a billion, would at the same rate, take one the nice little period of eighty-three years; and to count the proceeds of our country's agricultural productions for a single year, would require the services of three eighty-year old men, their entire lives from the cradle to the grave.

It is little use to attempt to realize the extent of such values, but by casting away the seven right hand figures in these amounts, we can comprehend the relative proportion one set bears to another set. Looking at it in this way, we find that the relative value of our live stock, fences and crops is 165 : 174 : 245; or in other words it takes one dollar and seventy-four cents worth of fence to keep one dollar and sixty-five cents worth of animals from eating up and destroying two dollars and forty-five cents worth of products. Is this, I ask, a specimen of good economy, either individual or political? It occurs to me not.

You may say that these fences are largely, permanent structures, and that the picture makes the case look worse than it really is.

Well, let us look at it in another light. It is estimated upon equally good authority that the cost of fences at the present time in the United States, (1880) has reached $2,000,000,000. Now the *annual* cost of keeping these in repair, of building when needed, together with the interest and taxes on the same, is, according to careful estimates made by Orange Judd and published in the American Agriculturist, sufficient to pay all the cost of our United States army, navy, general government expenses, including pensions, and leave enough balance to pay every cent of the interest on the public debt. This, remember, is our *annual* fencing tax.

I am very glad to learn through recent volumes of your reports of the State Board of Agriculture, that the farmers of Maine are looking into this matter.

I am glad also, to see so many farms with the roadside fences removed, in your own and adjoining counties. The old saying that good line fences make good neighbors, is no more true than that *no* fences on the roadside make good neighbors. The law in nearly all the states now makes it obligatory upon the owner of cattle to keep those cattle upon his own premises, so that he who owns no animals is not compelled to fence against those who do.

Roadside fences are a temptation to some persons to pasture the highway, and they are always inclined to cultivate habits of laziness or carelessness in boys, who are sent to drive or watch cattle on the road. A case of my own may illustrate the point. A neighbor, some years ago, was in the habit of turning his animals into the street to eat the grass growing on his own side, but the cattle finding that insufficient, or liking that by my fields better, were repeatedly straying, and frequently came inside through any open gate or other entrance into my garden and fields. Finding that driving the cattle home did little good, I unhung my roadside gates, pulled up all the bar posts, loaded the bars upon a wagon and carried all to the wood pile, selecting the best of course, for use in the pasture fences. No words were spoken, no notices posted up, nor any threats made, but not a hoof from that neighbor's stock has troubled me since; and now other neighbors are dispensing with their roadside fences, though not to the commendable extent I find here in some of your towns.

In this connection let us imagine what is the moral effect upon those who build them, especially of fences around our village lots, where there is nothing to fence out. Do we mean to give our neighbors to understand that our yards are our castles, and that whoever sets foot therein without permission may be kicked out? Do we need expensive picket fences all around our half acre or quarter lots, to mark their boundary lines? How much neater does a village look, where there are no fences between lots of the different proprietors; how much more like an extensive lawn or park, all dotted over by tasty homes! The corner of a fence affords a great temptation to use it as a depository for rubbish of all kinds, old boots, broken crockery, disabled furniture, etc., and on farms, as a receptacle for worn out implements, old wheels and the like.

I have seen both methods tried in villages, and I find that where fences are dispensed with, both boundary and roadside, that the surroundings are almost invariably kept neat and tidy. A habit of neatness comes naturally, and it is contagious too.

Now, by depending less upon pastures for our stock, and more upon crops grown specially for feeding at the barn, (and all such crops should be fed at the barn) we will gradually learn to dispense with a very large proportion of the fences we now deem necessary, and thus greatly lighten the burthen of taxation. The saving of manure is also an item of no small account, when considering this matter of doubling our stock and increasing our profits.

Manure, either solid or liquid, dropped by cattle in wooded pastures, mirey swamps or barren hillsides, is of little value to the farmer, compared to that which lies in his barn cellar mixed with enough dry earth of some kind, or straw, or other material to retain the liquids, and which can be drawn out at will and cultivated into the soil for a farm crop.

In doubling up a stock of cows for cheese making, one will of course use his own judgment as to the better course to pursue. He can buy cows at once, and purchase feed sufficient to keep them the first year, after which, if he has plenty of good land he may be able to grow most of the food, by using the accumulated manure; or he may purchase manure or fertilizers, and raise his cattle foods in advance. In either case capital will be required. I should advise no one to make very sudden changes in his plans or methods, but to mature his plans fully, and then adopt changes gradually. I doubled the stock on my own farm, and also doubled its capacity for production in four or five years. The farm formerly kept about a dozen head, but now keeps more than twice that number. I wanted to produce more milk, and saw no better way, as I thought and still think, than to give more food. I find it better economy to buy fertilizers and grow fodder than to buy fodder. I aim to keep what capital I have in land constantly employed, and to grow as large crops as seems practicable. What the possibilities of a twenty-five acre farm may be, I am hardly prepared, as yet, to venture a guess; but after five years' trial of the system I have attempted to describe, and keeping at least six times as much stock as my pasture could carry, I am fully convinced that any land of fair quality may be depended upon to keep a stock of dairy cows through the year at the rate of one cow for each and every acre cultivated, giving them all the forage they can possibly consume. Whether the grain ration, which every cow in milk should have, could also be grown on the same land, is with me an open question. It is claimed that it has been done, and I am inclined to believe that it can be, on very good land.

Buying wheat bran and cotton seed meal for feeding milch cows, in connection with fodder grown on the farm, is one method of buying fertilizers for the soil. When large quantities of either of these grains are purchased, fed judiciously, and the manure saved, a farm should not grow poorer, even though the milk is sold for cheese-making.

In closing I would again advise entering upon a new system with caution. Do not adopt any new practice on a large scale till you have looked the ground well over, and decided wherein you can improve by a change. Adopt just so much of a new system as seems adapted to your own peculiar needs. Don't give away your pastures, nor spend a small fortune in removing fences at once. But you may put in an acre of winter rye in its season, to be cut green for your cows early in spring. You may also put in a field of oats, barley or other spring grain for forage only. And you can safely try some idle acre with a crop of millet, sown in midsummer. You can endeavor to use your land more near the buildings instead of running in debt for the adjoining farm. Learn to concentrate forces. In short, do a good deal of *thinking*, and I doubt not you will come to think wisely.

PRINCIPLES OF MANURING.

A Paper on the value, production and use of Manures, by W. H. Jordan, B. S., Instructor in Agriculture at the Maine State College.

General Considerations.

I do not want my farmer friends to pass by this article and not read it, because they more than half suspect that it is so very theoretical and scientific that they can't understand it, or gain any practical knowledge from it. I wish every word read, even if you do not find a single fact new to you, or do not believe half I state. I shall try to write, so that the ideas I advance can be understood and applied to your farm practice. I also propose to state nothing but facts, and these largely in the form of well established principles that lie at the foundation of the farmer's prosperity. The life of the farmer is too real; his margin of profits too narrow for him to spend very much time and money in proving any theory or notion to be unsound.

I write this paper, not that I feel especially competent to teach others about the great facts of agricultural science, nor because it is in my power to solve all the knotty problems that farmers meet, but because I wish to suggest some of the truths that have already been of help to thousands of farmers; old truths they may be, but which are still largely ignored.

Farmers live by doing two things, growing crops and growing animals, and the millennium will come to agriculture when its devotees possess all knowledge in regard to these two operations. From the soil and air come crops; from the crops animals. We make use of manures as an aid to crop production, and therefore as an aid to the growing of animals; in fact we can say that for Maine farming, manures serve as a basis for production of both kinds.

Two important facts stare farmers in the face, viz: 1. That by certain methods of farming the soil can be brought into such a condition that it will refuse to grow paying crops. 2. That manures will not only remedy but prevent such a state of affairs.

The method of farming that is surest to incapacitate most soils for plant production, is that of continuous cropping without the use of manures. By such practices the fertile plains of the West have in some states been brought to a condition that requires for their cultivation, methods similar to those for a long time used of necessity in Maine. A system of farming that leads to such a result should be designated as careless, and ignorant, especially in older states. Judged by its results, what proportion of Maine agriculture could escape the above designation?

Cause of Infertility.

What change does the soil undergo that diminishes its power for plant production? We must arrive at an answer to this question somewhat indirectly. A discussion of the changed composition of the soil, as shown by analysis, would not tell us all we desire to know.

If a plant is burned some of it passes off and disappears in the air, and a portion remains behind as the ash. When wood is burned we speak of the residue as "ashes." Were I to burn a stalk of wheat or corn with the ripened grain attached, and carefully save and analyze the ash, I should find it to contain several compounds, made up principally of the following substances, viz: phosphorous, sulphur, silicon, chlorine, potassium, sodium, calcium, magnesium and iron. A similar examination of that portion of the plant which passed off in the air would reveal the presence of oxygen, hydrogen, nitrogen and carbon. The plant in growing had gathered these materials from the soil and air. From them the plant had been builded by the forces of nature. Now if these materials are available in sufficient quantities, there seems to be no reason why a plant may not reach its fullest size and development. In fact, there seldom is any reason why luxuriant crops do not grow, save a simple lack of materials to grow from. Is this lack one that extends to all, or only part of the ingredients that plants are found to contain? In replying to this question, it should first be stated that not all the substances found in plants are absolutely essential to their growth. It seems that vegetable life makes use of some substances simply because they are at hand, and not because they are needed.

Our German friends have proved for us what are the essential constituents of the structure of our common agricultural plants, and they have conclusively shown that any of our ordinary crops could not be grown on land entirely destitute of the compounds of any one of the substances, nitrogen, phosphoric acid, sulphuric acid, potash, lime, magnesia or iron.* Oxygen and hydrogen can be furnished from water, and carbon may come entirely from the air. Nature must have every one of the above ingredients in order to construct plants. But if the demand is absolute, what about the supply. To state our former question a little more differently,—what one or ones of these *essential* ingredients do plants fail to obtain from "run out" soils?

So long as it is a fact that poor crops are almost always the result of a deficiency of the materials of growth, it is very necessary for us to know just what is deficient, in order that we may supply a larger quantity of the material lacking. I have growing this year, on the college farm, a piece of experimental corn. Some of the plots received no manure this year, while others were manured with a mixture containing bones that had been treated with oil of vitriol, potash salts and dried blood. The corn receiving no fertilizer is small and poorly eared, or with no ears at all, while that to which was applied the above mixture is quite tall, and very fairly eared. Had it not been for the drought, the latter would have been nice corn. Evidently the mixture of substances applied furnished an additional supply of those ingredients that were not present in the soil in an available form sufficiently large to meet the demands of a good crop of corn. The mixture contained phosphoric acid (in the bone), potash (in the potash salts), and nitrogen (in the dried blood), as the essential ingredients. Sulphuric acid, lime and magnesia were also present in the fertilizer. Besides the ingredients mentioned as present in the mixture, the plant took up oxygen, hydrogen, carbon, silica, chlorine, sodium, iron, and possibly small quantities of one or two other substances. Experience has demonstrated, however, that when a fertilizer supplies phosphoric acid, potash and nitrogen compounds, nature can do the rest. To epitomize the whole matter I will make the following statements:

1. To grow fifty bushels of corn a certain quantity of a certain number of ingredients are absolutely necessary.

2. The soil and air can always furnish a sufficient quantity of a part of these ingredients, while the supply of others in an available form may become exhausted.

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* Chlorine and silica may be necessary in very minute quantities.

3. The essential materials for vegetable growth that the soil and air can always furnish in abundance are oxygen, hydrogen, carbon and iron, sulphuric acid, lime and magnesia being very seldom wanting. So long as only minute quantities of silica and chlorine are needed we have no occasion to fear but that any soil will meet all the possible demands that can be made for those substances. Inexhaustible stores of carbon exist in the air and in decaying vegetable and animal matter, oxygen and hydrogen are as free as water, while it would be utter nonsense to purposely put iron in a fertilizer.

4. The substances that plants most often have need to hunger after are nitrogen, phosphoric acid, and potash. A "run out" soil may lack one, two or all of these in an available condition, but a soil is seldom found that fails in any other materials.

5. The main reason why substances called manure cause an increase of crops is that they contain all or part of these valuable ingredients, nitrogen, phosporic acid and potash. This is true of both commercial and farm manures.

6. The chief value of any manure depends upon what it contains of these last mentioned substances. It is not a question of bulk, color, odor, or any other condition save the one mentioned that chiefly determines the value of manures. Remove these three ingredients wholly from any manure and it would be of very little value.

7. One farmer manufactures better manure than another simply because his cattle are so fed that larger quantities of nitrogen, phosphoric acid and potash are found in it. A manufactures better phosphates than B because he causes them to contain more phosphoric acid in an available form.

Means by Which a Soil Becomes Barren or Run Out.

Soils become run out by continuous cropping without the subsequent return to them of the materials that the plants have removed, especially nitrogen, phosporic acid and potash. The same weight of different crops does not remove the same number of pounds of these valuable ingredients. The removal of a ton of wheat impoverishes the land much more than the removal of a ton of sugar beets. The following table shows quite nearly the quantities of nitrogen, phosphoric acid and potash contained in a ton of the various productions, that a farmer in Maine would be likely to sell from his farm. The figures are taken from a German book, "Praktische Düngerlehre," written by Dr. Emil Wolff.

Kind of Product.	Quantities of valuable ingredients removed by one ton of product.			Quantities of ingredients less valuable removed by one ton of product.		
	Nitrogen.	Phosphoric acid.	Potash.	Sulphuric acid.	Lime.	Magnesia.
English hay	31 lbs.*	8.2 lbs	26.4 lbs.	4.8 lbs.	17.2 lbs.	6.6 lbs.
Clover hay	39.4	11.2	36.6	3.4	40.	12.2
Green fodder corn	3.8	2.6	8.6	0.8	3.2	2.8
Wheat straw	11.2	4.	22.	2.4	5.2	1.8
Barley straw	12 8	3.8	18.8	3	6.4	2.2
Oat straw	11.2	3.8	17.8	2.6	7.2	3.2
Rye straw	11.2	6.	22.4	2.4	8.4	3.6
Potatoes	6.8	3.2	11.4	1.2	0.4	0.8
Fodder beets	3.6	1.2	8.2	0.4	0.6	0.6
Sugar beets	3.2	1.6	7.8	0.6	0.8	1.
Turnips	3.6	1.8	6.6	1.6	1.6	0.6
Wheat	41.	17.8	11.	0.6	1.	4.4
Rye	35.2	16.8	11.2	0.4	1.	4.2
Barley	32.	15.4	9.	0.8	1.2	3.8
Oats	38.4	12.4	8.8	0.8	2.	3.8
Corn	32.	11.8	7.4	0.4	0.6	4.0
Peas	71.6	17.2	19.6	1.6	2.4	3.8
Beans	81.6	23.8	26.2	1.6	3.	4.4
Milk	10.2	3.4	3.0	–	2.6	4.
Cheese	90.6	22.5	5.	–	13.8	0.4
Live oxen	53.2	37.2	3.4	–	41.6	1.2
Live sheep	44.8	24.6	3.	–	26.4	0.8
Live swine	40.	17.6	3.6	–	18.4	0.8
Washed wool	188.8	0.6	3.6	–	4.8	1.2

* German pounds, which equal 1.1 English pounds. In English pounds English hay would stand, nitrogen 34.1 lbs., phosphoric acid 9 lbs., and potash 29 lbs. The relation is as easily seen, however, by using German pounds.

The above table shows what one ton of the different products will carry away from the farm when sold. The next table shows what quantities of the valuable ingredients would be lost by selling the produce from one acre of land, estimated for such quantities of crops as a good farmer would be likely to raise.

Kind of Product.	Quantities of valuable ingredients removed by produce of one acre.		
	Nitrogen. lbs. *	Phosphoric acid. lbs.*	Potash. lbs.*
English hay (2 tons)	68.2	18.	58.
Clover hay (2 tons)	86.6	24.6	80.
Wheat (30 bushels, with straw)	59.1	24.2	47.2
Corn (75 bushels, without stover)	74.	27.3	17.
Oats (50 bushels, with straw)	51.3	16.5	36.6
Potatoes (200 bushels)†	45.	21.	75.
Sugar beets (20 tons)†	70.	36.	172.

* English pounds. † Without tops.

These figures are given only as approximations, but they serve to show in a general way the amounts of the valuable ingredients that an acre of different kinds of farm produce would make use of; also the relative quantities that different crops extract from the soil. While studying these tables it should be remembered that the composition of our farm crops varies according to the climate, season and manner of manuring the soil. Well fertilized soil produces crops richer in these essential ingredients, than will that which is poor and unmanured. It must also be borne in mind that the amount of any substance that a plant takes up is not a measure of the difficulty with which it obtains the material. For instance, an acre of land would need to contain more available nitrogen in order for thirty bushels of wheat to be grown, using about fifty-nine pounds of nitrogen, than would be necessary for the growth of two tons of clover hay, using nearly ninety pounds of nitrogen. In other words, clover can gather nitrogen more easily than wheat. The table shows very plainly that different crops would exhaust the land very differently. Twenty tons of beets contain over four times as much potash as seventy-five bushels of corn, but not very much more phosphoric acid. Like beets, potatoes and clover hay use a large relative amount of potash. But we shall have occasion to note the special needs of different crops later.

A study of the first table reveals one fact of great moment to the farmer. It is plainly shown that it makes a great difference as to the form in which a farmer sells his surplus productions, if he would harvest the resources of his land. In selling an ox weighing one ton, only as much nitrogen is sent from the farm as would be lost by selling about one and one-half tons of English hay. Of phosphoric acid, such an animal represents an amount found in less than five tons of hay, while an eighth of a ton of hay would furnish the ox with all the potash he has in his body. If the farmer were to sell the hay and grain necessary to use in the production of two thousand pounds of live animal weight, he would send from his farm vastly more of those substances that have a manurial value than if the animals had been grown and the manure returned to the land from which the hay or grain was taken. It will be seen later, that when food passes through an animal, only a small portion of its nitrogen, phosphoric acid and potash is retained, while a larger part of these substances passes into the manure. Unless a farmer buys manure, the method of farming surest to retain or increase the fertility of his fields, consists in the production of meat or butter.

Selling milk or cheese would economise the resources of the farm to a less extent, while the most wasteful course of all to pursue, is the selling of crops as such. Any man's method of farming must depend very largely upon his locality and other circumstances. Any method that results in the impoverishing of the soil is unwise and often ruinous, even as a temporary expedient. Every pound of the more valuable ingredients of plants that a farmer sends out of his reach, results in the loss of so much capital. What man, who has had the experience, does not know the cost of making a fertile out of a run out field?

We have considered the means by which our fields may be made barren. Let us now turn our attention to the methods to be used in retaining or increasing fertility.

We increase the crop producing power of our fields in two general ways:

1. By cultivation.
2. By use of manures.

The Theory and Practice of Cultivation.

Some one who has read the foregoing very likely may say,—"Why, I don't see how that can all be true! I have raised a good crop from a worn out field without adding a thing to the land. How can it be that the soil was deficient in certain ingredients that you say are absolutely essential to the growth of plants?" My friend, you did something to your land? Yes, I summer fallowed it, but that did not add anything to the soil did it? Certainly not. I will explain. Now I have not made the statement that when land is "run out" there is no nitrogen, phosphoric acid or potash in it. I have simply stated that in nearly all cases the reason why crops do not flourish, is that they cannot get from the soil on which they are growing enough of some one or more of those three ingredients. The ingredients may be there but not available to plants. Such indeed seems to be the fact. The following table shows the amounts of the so-called valuable ingredients found in three samples of soil taken from the College Farm:*

* From report by Professor W. O. Atwater for 1877-8.

In one acre to depth of one foot.	Nitrogen.	In Acid Extract.	
		Phosphoric acid.	Potash.
Wheat soil........................	5,772 lbs.	3,319 lbs.	3,896 lbs.
Timothy soil........................	4,537	972	4,861
Clover soil........................	4,735	2,029	5,074

No one of the above soils could grow a large crop of corn without the help of manure, and yet the corn would require for its use but a small fraction of the above quantities of nitrogen, phosphoric acid and potash. Suppose the Farm Superintendent were to summer fallow an acre of soil of like character and composition with the ones analyzed. The crops that it would then be able to produce for one year would be largely in excess of a crop grown on the land without fallowing. Evidently cultivation works a change in the soil.

Harris in his books on manures says that "Tillage is manure." He is right. Soils contain inert plant food. Tillage renders it active. It does this by causing more rapid disintegration. When soil is turned over and over and thoroughly pulverized the oxygen of the air can more readily act upon its organic, as well as mineral, constituents. This increased yet slow combustion of vegetable matter, aided by the solvent and decomposing action of its products, renders useful material that before had been securely locked up. We must remember that in most soils the upper layers are still a storehouse of plant food, while the under strata are no less so, and that cultivation is one of the efficient means of bringing such latent material into useful activity. The farmer who makes good use of his plows, cultivators and harrows, not only renders his land easy to work, and keeps down the weeds, but he helps feed his growing crops. And here let me make a statement that farmers will do well to heed. The use of a large quantity of yard or stable manure should always be accompanied by thorough tillage. To the extent that farmers fail in this respect, especially on heavy soils, to that extent do they stand in danger of having quite a portion of the manure lie inert in the soil for a long time. The completeness with which the manurial value of any organic fertilizer is utilized must depend very largely upon the thoroughness of cultivation following

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its application. Don't turn a heavy coat of manure ten inches under the surface and let it lie there. Or if turned under do not let it lie there but bring it back and mix it with the soil. But more concerning farm manures later.

No farmer can pulverize land as it should be when it is too dry or too wet. Land constantly wet must be drained before it can be properly tilled or before it will properly respond to tillage. Any soil that is full of water is pretty well preserved against the action of the various agencies of decomposition. Farmers, drain your wet fields, use a plow that pulverizes, also some effective cultivator, and when the land is lumpy roll it and plow or cultivate again. Do not be afraid of an extra plowing. Till thoroughly, for "tillage is manure."

Commercial Manures.

We have in our markets a class of subtances known as commercial fertilizers. Whenever they are of value, they contain one or more of the ingredients of plant food that have been pointed out, as especially liable to be lacking in the soil, in a form available to plants. In all first-class commercial manures these ingredients exist in quite large percentages; they are concentrated as compared with farm manures. While there would be 320 lbs. of phosphoric acid in a ton of first-class dissolved bone, (superphosphate) in a ton of farm manure from good hay, there would be only four or five pounds. Dried fish scraps would contain per ton, 150 to 160 lbs. of nitrogen, if of good quality, but not over a dozen pounds of that ingredient could be found in a ton of stable manure from the best of hay. Condense animal excrement by ridding it sufficiently of its large quantities of carbonaceous material and water, and it would then approach in character the fertilizers of our markets. Commercial manures are concentrated plant food, or ought to be.

Classes of Fertilizers.

The fertilizers called "commercial," are made up of various classes, according to their principal ingredient. They are nitrogenous, phosphatic, or potash manures, according as they contain principally nitrogen, phosphoric acid or potash. Some fertilizers cannot be distinguished by either of the above names, because they are made up of a mixture of two, or all of the three valuable ingredients.

Below are given the names of most of the principal manures sold in our markets, arranged in classes as indicated above.

Nitrogenous Manures.	Phosphate Manures.	Potash Manures.
Nitrate of Soda (Chili saltpetre)	Superphosphates.	Sulphate of Potash.*
Sulphate of Ammonia.	Phosphatic Guanos.	Muriate of Potash.*
Fish Scrap (fish guano).	Bone Meal.	Unleached wood ashes.
Dried Blood.	Bone Ash.	
Meat Scrap.	Bone Black.	
Horn Dust.	Phosphatic Rock.	* Potash salts.

Sources and Character of the Various Fertilizers.

Perhaps a brief description of the source and character of the commercial fertilizers in most common use may not be out of place.

Nitrate of soda, or Chili saltpetre, is obtained from the immense beds of that substance found in South America. The nitrogen exists in it as nitric acid (the *aqua fortis* of commerce,) and is united to soda. In the saltpetre used medicinally, the nitric acid is united to potash instead. Nitrate of soda should contain 15 to 16 per cent. of nitrogen, unless largely diluted with some other substance. It is very easy to do this with common salt, and the fraud escape detection by any ordinary method of examination. As common salt is much the cheaper material there is a strong temptation to such dishonesty. The nitrogen purchased in nitrates costs more per pound than when bought in any other form. In such combinations it is in a condition to be immediately used by plants. It should be remembered, however, that the soil has but little power of retaining nitric acid, and therefore when nitrogen is used in this form it should not be applied to the land very long before it will be needed by the growing crop, else it may be leached out and carried off in the drainage water.

Sulphate of ammonia is obtained from the waste products of gas manufacture. The nitrogen in the form of ammonia is combined with sulphuric acid (oil of vitriol), and costs less than when bought in Chili; saltpetre being valued by the Connecticut Experiment Station at 3½ cts. less per pound. A good sample of sulphate of ammonia should contain 20 per cent. of nitrogen, but like nitrate of soda. can be easily diluted with several cheaper substances. Ammonia is not leached from the soil like nitric acid, only to the extent that it is oxidized and converted into the latter; therefore its application some time previous to the time of planting or sowing is not so dangerous as it would be to use nitrates in such a way. It is probably advisable, however, to apply both forms of nitrogen in the spring.

Dried blood, dried fish, meat scraps, and all animal substances contain nitrogen in the organic forms in which it was built up in the animal body. When in such combinations it cannot serve as plant food until a certain amount of oxidation or decomposition has taken place. The various organic substances in the market differ very much in the ease and rapidity with which they decompose and render available their nitrogen in the form of ammonia or nitric acid. This transformation takes place rapidly with dried blood, fish and meat, but slowly with hair, horn and leather waste. This important difference has an effect upon the price and upon the methods of using such nitrogenous fertilizers. Such materials as horn dust, leather waste, &c., would be of value to a crop if applied to the soil long enough before the crop is grown, so that considerable decomposition could be effected; so that while it may not be an incorrect practice to manure a piece of land with dried blood just before it is sown to wheat, any substance resembling horn should have been applied some months previous. A very good method of effecting the decomposition of animal substances that do not readily pass through such a process is to compost them. By this means their manurial value is more quickly and profitably utilized. More or less phosphoric acid is contained in the above mentioned organic manures in the insoluble form, which becomes slowly available. In acidulated fish the phosphoric acid is to an extent soluble as in a superphosphate. Nitrogen in the organic form varies in price according to the substance containing it, costing in fish scraps and horn only three-fourths what it does in dried blood and meat. In any case a finely powdered fertilizer of this class would in justice bear a higher price than one very coarse. Certainly the agricultural value is increased by fineness of division.

Superphosphates contain phosphoric acid as their principal ingredient. They are manufactured by treating some form of bone or phosphatic rock with oil of vitriol. Part of the phosphoric acid is thus rendered soluble in water, the amount of this depending upon the amount of oil of vitriol used. A portion of the bone or rock are not acted upon, but this amount need be very small. The larger part should have its phosphoric acid rendered soluble. Besides the "soluble" and "unsoluble" forms of ingredients, we have in nearly all superphosphates a form called "reverted." This name applies to the phosphoric acid that was at first rendered soluble in water, but by chemical change has become insoluble in that liquid. Its chemical and molecular conditions give it a value greater than though it never had been soluble. Its value as compared with that which remains soluble is not determined; some experiments seeming to show that it is of equal value. In the market, however, it takes a lower valuation. Superphosphates made from ground phosphatic rock (usually phosphorite), are more likely to contain reverted phosphoric acid than those made from bone, owing to the influence of the iron and alumina compounds in the rock. Moisture also has a tendency to cause reversion.

The commercial values of the different forms of phosporic acid, soluble, reverted and insoluble, diminish in the order mentioned. The insoluble form is valued in price according to the form and condition of the substance containing it. When in bone, its value varies with the fineness of the bone. It is worth the least in ground rock. It is well known that superphosphate has a much more immediate effect on crops than bone or phosphorite that have not been treated with oil of vitriol. This results from the solubility of the phosphoric acid in the superphosphate,—at least, that is the explanation offered. But how is it that solubility is able to effect the value of this ingredient? Is it simply because that when soluble, it remains in the soil and can thus be readily taken up by plants? Not at all. Phosphoric acid when applied to the land as a superphosphate, remains soluble but a very short time. The lime, ron and alumina compounds in the soil soon precipitate it over the particles of earth, but in a very finely divided condition, so that the soil, water and roots are enabled to make a solution sufficient for the use of growing plants. The state of solubility seems desirable, chiefly, as a means of obtaining an extensive, even and intimate mixture of the phosphate with the soil.

From the facts just stated, it would seem that the finer bone is ground, the more nearly will its effect compare with that of superphosphate, so far as the phosphoric acid is concerned. The difference in the value of bone, according to its degree of fineness, is recognized by the Connecticut Experiment Station.

Nevertheless, bone meal is not a manure that generally causes a large increase of growth the first year of its application. At the same time its phosphoric acid is the most valuable of any that can be obtained in the insoluble condition. It is not advisable to apply bone meal to land, when the full benefits of it are desired at once. It is most rationally used where a gradual, lasting effect would be profitable. An admirable way to utilize bone meal or even ground phosphatic rock, when a farmer has land that responds to phosphoric acid, is to mix it with a fermenting manure or compost heap. The carbonic acid generated in a pile of moist decaying organic matter, is able to bring into an available condition a portion of the phosphates, which action in the case of the bone meal is aided by the fermentation communicated to it.

No farmer should ever buy bone black to apply to the land as such, for it is very slow in giving up its phosphoric acid, owing to the presence of carbon, which protects the particles of phosphate from decomposing influences. Phosphatic rock is still slower in allowing its phosphoric acid to become available. The application of any phosphate that has not been treated with sulphuric acid, cannot be depended upon to cause a large increase of crop the first year. The matter of home-made superphosphate is one of some importance. It is manufactured on a small scale by some farmers. Bones can be purchased before they are ground, for a cent a pound; bone meal costs nearly two cents per pound. If one lives near a bone mill, and can get the bones, it is a much cheaper way to purchase them and have them ground, than to pay thirty-five dollars per ton for no better bone meal. When a small quantity of superphosphate only is desired, it is doubtful if it is wise to take the trouble of manufacturing it; if one had a demand for several tons it would be another matter. It is wise, however, to save all the bones that collect about the house; purchase all that can be conveniently obtained from the neighbors, and then after they are crushed, put them in the compost heap or in moistened ashes. Do not burn the bones, as they contain considerable nitrogeneous material that is valuable. Bones decompose more quickly if the fat is extracted by steaming.

The idea of obtaining phosphoric acid cheaply by purchasing its insoluble forms and submitting to the action of a compost heap, is undoubtedly a practical one for a farmer, who finds that his soil needs that ingredient. A pound of insoluble phosphoric acid can be purchased from three and one-half to five cents, costing twelve and one-half cents when bought of the manufacturers in a soluble condition. If the consumer can get the same effect without paying the extra cost, it is exceedingly wise to do so. At least, do not allow any waste of bones.

Potash manures come largely from Germany in the shape of potash salts. We have also potash that is extracted from ashes, but is not used in this form as a fertilizer. The German potash salts are mined, and exist at first associated with other minerals. They are purified and sent to this country in quite large quantities. The substances found associated with them are common salt, and the sulphate and chloride of magnesia. These compounds are not always sufficiently removed from the imported potash manures, and while the common salt and sulphate of magnesia do no harm, chloride of magnesia in any considerable quantity is actually poisonous to plants.

For this reason it is well to apply potash salts, especially the chloride, to the land, some little time before the seed is put into the soil, so that the poisonous compounds, if present, can become sufficiently diffused to prevent harmful results. The sulphate of potash is the safer manure to use, but is more costly than the chloride, (muriate).

Unleached ashes contain quite a percentage of potash, which varies much according to the wood from which the ashes come, and the manner of burning. The potash in wood ashes is in a valuable form, (the carbonate) and ordinarily can be bought as cheaply as when purchased in any other form, if we take into account the phosphoric acid and lime which the ashes contain besides.

Good hard wood ashes from wood burned in fire-places or cooking stoves, are well worth twenty-five cents a bushel to any farmer, if he finds that his farm needs potash. The question is often asked, what is the difference between leached and unleached ashes, and which is the cheaper at ordinary prices? The chief difference is that the former contains much more potash than the latter. The process of leaching takes out very little but potash.

Now as to which kind a farmer had better buy, depends upon what he wants of the ashes. If his land needs potash manures, then he had better buy the unleached; but if he wishes to use the ashes simply as a means of liming his land, then the leached will serve his purpose just as well and be much cheaper. The manner in which a farmer is to learn whether he needs potash, lime, or any other ingredient applied to his fields, we will consider later.

The Commercial Value of Fertilizers.

At a Farmers' Institute held in Hampden, I made the following remarks:

"At present there is in the State of Maine an admirable chance for farmers to get cheated when buying commercial manures.

No one can tell the value of superphosphate by its color or odor. Not even by applying it to the soil can its *commercial* value be told, only its value to the man who uses it. It may do no good in one case and much good in another, but neither test can determine what it is worth in the markets. That is determined by the demand and supply. The value of any particular fertilizer depends upon its composition, and that the chemist must discover. We need in Maine a station where the fertilizers offered in our markets can be analyzed. Such a plan would save thousands of dollars to the farmers of the State. In Connecticut, such a station has effected a great change in the fertilizer business, so that farmers there now buy their fertilizers at twenty-five per cent. cheaper than before the station was established. $500,000 are probably expended annually in Maine for commercial manures. A saving of ten per cent. of their value would result in a total saving of $50,000. I believe a greater saving than that could be made. One-tenth of that sum would pay the expenses of the station that would be able to look after our fertilizers and do much more other valuable work for agriculture. Such a supervision would give farmers more confidence in the fertilizers offered them."

In order to substantiate the above statements, I insert the following, taken from the First Annual Report of the Connecticut Experiment Station, (1876).*

"Among the commercial fertilizers analyzed during the past year were some 35 samples of articles sold outside of the supervision of the Station, mostly in 1875, before its establishment, and some 77 samples sold in 1876, under its supervision. The number of these articles seems ample, and the range in quality is certainly wide enough to afford a fair exhibit of the effect of the supervision exercised by the Station. Basing the comparison upon the cost of the valuable ingredients, as determined from composition and selling prices, it stands as follows:

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*By Prof. W. O. Atwater.

Valuable Ingredients.	Average Cost per Pound,	
	In fertilizers sold before establishment of Station.	In fertilizers sold under supervision of Station.
Nitrogen	47.00 cents.	23.00 cents.
Soluble Phosphoric Acid	18.00 cents.	13.98 cents.
Insoluble Phosphoric Acid	11.36 cents.	5.51 cents.

If, instead of taking the fertilizers all together, we select a single class, and one of the most important ones, the nitrogenous (ammoniated) phosphates, the comparison will stand as follows:

Valuable Ingredients.	Average Cost per Pound.	
	In fertilizers sold before establishment of Station.	In fertilizers sold under supervision of Station.
Nitrogen	59.4 cents.	24.9 cents.
Soluble Phosphoric Acid	19.5 cents.	15.1 cents.
Insoluble Phosphoric Acid	21.1 cents.	5.6 cents.

In brief, the average actual cost of the fertilizers sold under the supervision of the Station is less than half that of those sold before the Station was established."

The above shows how sadly the farmers of Connecticut were being defrauded by the dealers in commercial manures. At that time a similar state of affairs probably existed in the fertilizer trade in Maine, and though the work of the Connecticut station has probably had an indirect effect in causing a better quality of fertilizers to be sold in our own State, yet there is no doubt but that a similar station in Maine would effect a great saving to its farmers.

Just how valuations are made by experiment stations, and what are the advantages derived from them, I can best show in part, by some extracts from the Connecticut Experiment Station report for 1879.*

I insert first a list of prices which are as near as possible to those ruling with standard articles sold at fair prices.

"The average trade-values or cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as recently found in the Connecticut and New York markets, and employed by the station during 1879 and which it is proposed to use in 1880, are as follows:

*By Dr. S. W. Johnson.

TRADE-VALUES FOR 1879 and 1880.

	Cts. per lb.
Nitrogen in nitrates	26
" ammonia salts	22½
" Peruvian Guano, fine steamed bone, dried and fine ground blood, meat and fish	20
" fine ground bone, horn and wool dust	18
" fine medium bone	17¼
" medium bone	16½
" coarse medium bone	15¾
" coarse bone, horn shavings, hair and fish scrap	15
Phosphoric acid soluble in water	12½
" "reverted" and in Peruvian Guano	9
" insoluble, in fine bone and fish guano	7
" " fine medium bone	6½
" " medium bone	6
" " coarse medium bone	5½
" " coarse bone, bone ash and bone black	5
" " fine ground rock phosphate	3½
Potash in high grade sulphate	7½
" low grade sulphate and kainite	6
" muriate or potassium chloride	4½

These "trade-values" of the elements of fertilizers are not fixed, but vary with the state of the market, and are from time to time subject to revision. They are not exact to the cent or its fractions, because the same article sells cheaper at commercial or manufacturing centers than in country towns, cheaper in large lots than in small, cheaper for cash than on time. These values are high enough to do no injustice to the dealer, and accurate enough to serve the object of the consumer.

To estimate the value of a fertilizer we multiply the per cent. of nitrogen, &c., by the trade-value per pound, and that product by 20, we thus get the values per ton of the several ingredients, and adding them together we obtain the total estimated value per ton."

"The uses of the 'Valuation' are, 1st, to show whether a given lot or brand of fertilizer is worth as a commodity of trade what it costs. If the selling price is no higher than the estimated value, the purchaser may be quite sure that the price is reasonable. If the selling price is but $2 to $3 per ton more than the estimated value it may still be a fair price, but if the cost per ton is $5 or more over the estimated value, it would be well to look further. 2d. comparisons of the estimated values and selling prices, of a number of fertilizers, will generally indicate fairly which is the best for the money. But the 'estimated value' is not to be too literally construed, for analysis cannot always decide accurately what is the form of nitrogen, &c., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated."

My excuse for making such copious extracts from Dr. Johnson's report is, that the matter is one of importance, and I wish to show that there is a legitimate and effectual method of controlling the prices of commercial manures, so as to keep them within reasonable limits. In most cases where the price asked for a fertilizer is too large, it is only by a few dollars per ton. Occasionally monstrous frauds are detected. In the report for the Connecticut Experiment Station, for 1876, an analysis of one fertilizer is given where the nitrogen it contained was costing the consumers $1.90 per pound and the phosphoric acid, 54 cents. Another fertilizer, costing $48 per ton, was found to be worth not far from $13.

How soon are Maine farmers going to protect themselves from fraud?

I do not wish what I have written to prevent any farmer from buying commercial fertilizers, because afraid of getting cheated. A much more sensible act is to set about procuring a means of protection. As it is, buy only of reliable parties those fertilizers that have stood the test of examination by our experiment stations. There is no doubt, but that the compounded fertilizers of some particular firm are more costly, than when the ingredients are purchased separately and compounded by the farmer.

The Use of Commercial Manures.

The question, is it profitable to purchase commercial fertilizers, is a very common one. In attempting a partial answer, I shall first make the statement that the profits of raising crops by the use of such manures, depend very much upon the kind of fertilizers purchased, and the methods adopted in their application. It is hard to understand, why the valuable ingredients of plant food, as applied in the manures called commercial, should be any less valuable or effective, than when carried to the soil in manures manufactured on the farm. There is no reason why phosphoric acid that is available in a superphosphate should be worth very much more or less than that which is available in the fermented excrement of animals. The same would hold true in comparing nitrogen and potash as contained in the two kinds of manures. But is there no difference between yard manure and commercial fertilizers? Now, so long as farmers must use manure of some kind, and as many can buy it, either as made from the excrement of animals, or in the form of concentrated fertilizers, an answer to this inquiry is deemed pertinent to the question of the profits resulting from the use of the latter.

1. Farm manures contain all, while commercial fertilizers may contain only a portion of the ingredients which plants use for food. Stable manure can thus be seen to be one that is pretty sure to meet the demands of plants, which is in one sense, an advantage. But if a farmer were to find it profitable for him to apply large quantities of phosphates to his fields, as is often the case, he would probably get that material more cheaply by purchasing a superphosphate or bone meal, than by getting horse manure from city stables. This would be true, especially if the phosphate and horse manure were valued according to their composition, for in the case of the latter the farmer would have to purchase a larger percentage of nitrogen and potash than he desired. It is undoubtedly a fact, that if any special ingredient is lacking in a soil, that want can be most cheaply met by purchasing some commercial fertilizer that contains chiefly the substance needed, provided, the manure must in either case be bought.

2. The excrements of animals contain a large percentage of organic material that commercial fertilizers do not. This is undoubtedly a point in favor of stable manure, not that the carbonaceous compounds of the latter are needed to supply any deficiencies of plant food. They can furnish only water and carbonic acid, both of which the soil and air can supply in abundance. The chief benefits arising from applying organic material to any soil, results from a change in its physical conditions, and the effecting of a more abundant use of its natural fertility. The addition of decaying vegetable material to the soil, often brings about a favorable change in texture and color, while the liberation of so much carbonic acid as comes from the decomposing manure, accelerates the disintegration of the soil itself. We have seen how the valuable plant food which is latent in a soil may be made useful through disintegration. These two distinct effects are not to be disregarded, when we compare the manures made on the farm and those found in the markets, and they constitute a strong argument in favor of the former.

3. It costs more to handle the same amount of plant food in stable manure than in commercial fertilizers. This is obvious, when we consider the bulky nature of the former.

Although there are instances of the successful maintainance of the fertility of the soil by the use of commercial fertilizers alone, the basis of good farming in Maine, consists in the manufacture of manure from the food of cattle. I believe the most profitable use that Maine farmers can make of the fertilizers of the markets, consists in making them an amendment of those produced on the farm; as such, they may often be made a paying investment. It is no argument against their use, that the purchasers do not always get their money back. The same would undoubtedly hold true of the purchasing of stable manure in an equal number of cases.

Let us now return to a consideration of what fertilizers to buy and how to use them. The first principle to be laid down is that a farmer can only buy fertilizers with profit, when he buys what he needs. Let me illustrate what I mean by citing two cases reported by Professor W. O. Atwater:

Chester Sage, Esq., of Middletown, Conn., raised corn at the rate of 62 bushels per acre, by the application of four and a-half dollars worth of potash manures, a gain of 51 bushels over the corn, that had no manure. Superphosphate produced no increase of crops with him. W. J. Bartholomew of the same State found potash useless on his land, while superphosphate caused an increased production of 13 bushels of corn per acre. Would any sane person advise both of these farmers to manure their farms alike? We think not. It is not to be expected, that soils differing in origin and treatment, will each call for the same fertilizer. Practice proves that such is not the case.

Neither are we safe in assuming that the various farm crops should all receive the same kind of manuring. It is not wise to furnish a plant with what it can get for itself. No shrewd farmer would ever think of applying nitrogeneous fertilizers to clover, for clover can get its own nitrogen. Plants have different capacities for gathering the various substances they need for food, and we must recognize these differences.

But some one asks,—How am I to discover what my soil and the various crops I grow most need? My answer would be: Make a study of your soil and crops; you know about the different fertilizers in the markets, or ought to; you know when you are buying largely of nitrogen, phosphoric acid or potash, or a mixture of these,—at least you should know. Now apply them separately and mixed, and if you are a close observer, you will not fail to discover which insures you the greatest profit, or if there is any profit in the use of any kind. The chances are that you will find that one kind has a much better effect on your corn or wheat than another. Do not watch your neighbor, and judge from his results, what you had better do. try for yourself. We have already learned some facts that may serve as hints, nothing more. All other things being equal, save the difference in the crops growing, good results are most likely to follow from the use of nitrogeneous fertilizers on grain or grass; potash on potatoes and roots, while phosphates seem in general, to come in well with all crops. Generally, a mixture of the three valuable ingredients, with one or two greatly preponderating, is best. Prof. Atwater's efforts have pretty clearly brought out the fact that it does not pay to use much nitrogen in growing corn, but that phosphoric acid and potash, one or both, with a small quantity of nitrogeneous manures can most safely be applied if a profit is desired.

In the case of sugar beets, manured solely with commercial fertilizers, a mixture of the three valuable ingredients is wisest when the interests of both the farmer and sugar manufacturer are considered. The application of phosphoric acid tends to increase the percentage of sugar in the beets, but if superphosphate alone be used, they stop growing and ripen too early. To counteract this tendency to early ripening and keep them growing until they are large, nitrogenous manures should also be used. The large quantity of potash, which beets extract from the soil, would cause the soil to become "beet-sick," (as the Germans say) after a while, if no potash was in the manure. As before stated, no nitrogen compounds need be applied to clover, and this doubtless holds true for all leguminous plants, such as peas and beans. I will again quote from former remarks:

"Is it well for farmers to buy commercial fertilizers? The profits of so doing will depend largely upon three conditions:

1. Some reliable guarantee of the quality of the fertilizer bought, should be furnished.

2. Farmers should be sufficiently informed about commercial manures to understand how to buy the ingredients they desire.

3. Farmers should be sufficiently acquainted with the needs of their farm to know what ingredients the soil needs in order to give a profitable increase of any particular crop."

Many manuring formulas have been concocted, such as the "Stockbridge Manures," "Mapes Complete Manures," &c.

The principle underlying these formulas is scientifically and practically wrong. The assumption that a universal system of manuring can be made most profitable, is of the barest kind, and is not supported by facts of any sort. Why apply 72 pounds of nitrogen to an acre of corn, as Prof. Stockbridge's formula demands, when in no case out of over ninety accurate trials, has such a proceeding failed to result in loss? The Stockbridge manures were at first compounded according to the theory that we must apply to the soil all the nitrogen, phosphoric acid and potash, that the expected increase of crops would contain. What a theory by which to manure clover, a plant that contains a large percentage of nitrogen, but does not trouble the farmer to furnish any of it.

The Production of Farm Manures.

No one will dispute me when I state that it is an essential thing for each farmer to see that his manure heap attains the maximum in quantity and quality. There should be as much as possible, as good as possible. Farm manures still constitute the basis of successful farming in Maine.

The relation of Manure to the Food producing it.—I wish first to impress the fact that primarily the value of a manure heap depends upon the food from which it was produced. It is not enough to say that the more food the more manure. The differences in the manure made from two kinds of cattle food are as broad as the differences in the foods themselves. This is a fact that I believe farmers have generally failed to appreciate. Let us consider the matter more in detail.

We have seen that any substance called manure has a value that corresponds to its contents of nitrogen, phosphoric acid and potash, so that it is easy to understand that the manurial value of any cattle food must depend upon what that food is able to contribute to the manure heap of one, two or all of the above named valuable ingredients. Now the materials in common use as food for cattle vary greatly in the amounts of nitrogen, phosphoric acid and potash they contain, as can be seen from the following table:*

* Taken from Wolff's Praktische Dungerlehre.

Kind of Cattle Food.	Quantities of valuable ingredients in one ton of each cattle food.		
	Nitrogen. lbs.*	Phosphoric acid. lbs.	Potash. lbs.
English hay	31.	8.2	26.4
Clover hay	39.4	11.2	36.6
Young grass	11.2	4.4	23.2
Green fodder corn	3.8	2.6	8.6
Potatoes	6.8	3.2	11.4
Fodder beets	3.6	1.2	8.2
Sugar beets	3.2	1.6	7.8
Turnips	3.6	1.8	6.6
Sugar beet pulp	5.8	2.2	7.8
Wheat straw	11.2	4.	22
Rye straw	11.2	6.	22.4
Barley straw	12.8	3.8	18.8
Oat straw	11.2	3.8	17.8
Corn	32.	11.8	7.4
Barley	32.	15.4	9.
Oats	38.4	12.4	8.8
Buckwheat	28.8	11.4	5.4
Peas	71.6	17.2	19.6
Beans	81.6	23.8	26.2
Wheat bran	44.8	54.6	28.6
Cotton-seed cake	78.†	56.2	29.2
Linseed cake	90.6	32.2	24.8

* German pounds equal 1.1 English pounds.
† This seems to be a smaller quantity than is being found by American analysis.

Now if all of the ingredients contained in the various cattle foods were to find their way into the solid and liquid excrements of the animals fed, we could use the above figures for calculating the manurial value obtained by feeding the materials mentioned. But there is a loss incurred by feeding. A certain amount of the nitrogen, phosphoric acid and potash contained in the food consumed goes in other directions than into the manure heap, and the quantities thus turned into other channels depend upon the kind and use of the animal fed. A large amount of scientific work has been done in order to determine how much of the nitrogen, &c., of any kind of food is found in the manure it produces, and thanks to such investigation, we can make statements that approximate very closely to the truth.

The average percentage of the nitrogen of the food that goes into the solid and liquid excrements of the cow, ox, sheep and horse is approximately 83 per cent., the lowest being that for the cow, 64 per cent., and the highest that for the sheep, 95.5 per cent. Of the mineral substances, phosphoric acid and potash, nearly all is found in the manure, with no animal falling below 97 per cent. of that in the food. The following table* shows for itself:

* Taken from Wolff's Praktische Dungerlehre.

		Percentages of the valuable manurial ingredients of the cattle foods that pass into the manure they produce, determined for the common farm animals.				
		Cow.	Ox.	Sheep.	Horse.	Average.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
NITROGEN	In solids	45.5	51.	43.7	56.1	49.1
	In urine	18.3	38.6	51.8	27.3	34
	Total	63.8	89.6	95.5	83.4	83.1
MINERAL SUBSTANCES	In solids	53.9	70.8	63.2	85.6	68.4
	In urine	43.1	46.7	40.3	16.3	35.1
	Total	97.	117.5	103.5	101.9	*103.5

It is seen that different species of farm animals do not make equally valuable manure from the same kind of food. Other things being equal, a growing animal makes poorer manure than one full grown, because of the demands made upon the food for the formation of bone and muscle. With the same feed a cow giving milk makes less valuable manure than one that does not, for the milk takes up quite an amount of nitrogen and mineral substances. The cattle withdrawing the least manurial value from the food they eat are fattening animals, and those standing still and making no growth or producing nothing.

We are quite safe in assuming that on the average 80 per cent. of the nitrogen and 95 per cent. of the phosphoric acid and potash that are fed to farm animals pass into the solid and liquid excrements. Taking these figures as a basis, and knowing the composition of any cattle food, we can easily calculate the relative money value of the manure it is capable of producing, provided one can settle upon a fair price per pound for the valuable ingredients. Now we have a list of prices from which commercial manures are valued, that is, it costs so much to obtain a pound of nitrogen according to the form in which it exists, and the same for phosphoric acid and potash. The nitrogen of fish can be bought for twenty cents per pound, and probably has about the same value as that of stable manure. The real value of the nitrogen in manure depends somewhat upon the digestibility of the food from which it came. All the nitrogen that is contained in the digested nitrogenous compounds and not used by the animal passes out in the urine, while the undigested nitrogen passes into the solid excrements. The nitrogenous compounds of the urine are much more easily decom-

* More than 100 per cent. because of the mineral substances in the water drank, and that accidentally get into the food.

posed and made over into plant food than those of the solid excrements, therefore are more valuable. Now, while not over 50 per cent. of the nitrogenous substances contained in straw would be digested, as much as 85 per cent. of the same compounds in corn meal would pass through the process of digestion. A larger per centage of the nitrogen of the latter would therefore be found in the urine, consequently ten pounds of that element as existing in manure produced by corn would be more valuable than the same quantity in manure made from hay. In general, it can be said that the valuable constituents of the excrements from concentrated cattle foods have a higher value, pound for pound, than do those from coarse fodder. However, in calculating the money value of manure made in the various ways these differences cannot easily be taken into account. We will take the above-mentioned price of the nitrogen of fish as a basis for calculation. Soluble phosphoric acid is worth 12½ cents per pound. Only a portion of that even in well rotted manure is soluble, so that 9 cents may be assumed as a fair price for the phosphoric acid of stable manure. The alkalies are to quite an extent soluble, as they go out largely in the urine, and can probably be considered as worth 4 cents in the total excrement.

The money values given in the following table are calculated on the basis given above, viz: 80 per cent. of the nitrogen, and 95 per cent. of the phosphoric acid and potash of the food are considered as passing into the manure, these three ingredients being estimated as worth 20, 9, and 4 cents per pound, respectively. From the values thus obtained 20 per cent. is deducted on account of greater bulk and larger dilution of farm compared with commercial manures. The greater bulk causes more expense in handling, and the dilution causes slower action, the returns from invested capital not being so immediate as is the case with concentrated fertilizers.

Kind of Cattle Food.	Money value of manure from 1 ton.	Kind of Cattle Food.	Money value of manure from 1 ton.
English hay	$5 86	Barley straw	$2 71
Clover hay	7 60	Oat straw	2 46
Young grass	2 67	Corn	5 55
Green fodder corn	1 04	Barley	5 95
Potatoes	1 58	Oats	6 63
Fodder beets	0 87	Buckwheat	5 10
Sugar beets	0 84	Peas	12 00
Turnips	0 87	Beans	14 15
Sugar beet pulp	1 26	Wheat bran	11 37
Wheat straw	2 61	Cotton-seed cake	16 18
Rye straw	2 77	Linseed cake	16 00

I believe that if a farmer can afford to buy commercial fertilizers he can safely make use of the above estimates in calculating the manure value of purchased cattle foods, even if the food stuffs are fed to milch cows or growing animals. When fed to fattening animals, still higher values could rightfully be used. The table plainly indicates that when any material is bought to feed to cattle the purchaser desires profit from two sources. He gets an increased production of meat or milk, and also is able to raise larger crops because of the greater amount of fertilizing material he is enabled to apply to his land. Is it not a fact that the cheapest way to buy fertilizers is to purchase them in the form of wheat bran, corn meal, or cotton-seed meal?

The weight of fresh manure that would be produced by a ton of any food stuff can be approximately determined. About 50 per cent. of the solids of the food passes into the solid and liquid excrements. The mixed excrements contain about three-fourths water. Taking one-half of the solid matter in a ton of hay, which would be half of about 1760 lbs. and multiplying that weight by four, we should have 3520 lbs. as the weight of manure from one ton of hay. To this must be added the litter, bringing the quantity up to about two tons. A cow wintered upon two tons and a half of hay would therefore produce not far from five tons of manure, provided she be well littered and none of the excrements be wasted.

If the hay be first class, according to the estimates of the previous table the above five tons of manure made from two tons and a half of hay would be worth about $14.65, no account being made of the value of the litter. What, over $14.00 worth of manure from one cow in one winter, when she eats nothing but good hay? Yes, at the present prices paid for fertilizers it would cost that sum to replace the nitrogen, phosporic acid and potash in that manure if it were sold from the farm.

It might possibly be of some interest to estimate the money value of a cord of stable manure, basing the calculations upon its chemical composition. Such manure varies so, however, in the amount of water it contains, and because of the food that may have produced it, that the value placed upon any given sample would apply only to manure produced under like conditions of food and treatment. The excrements of A's animals, that eat nothing but hay and straw, are much inferior to those from B's cattle that consume large quantities of corn meal, bran and cotton seed. When one purchases stable manure, it is well to know what the animals that produce it have eaten. Partially rotted stable manure is worth more than fresh, because, as it decomposes, it tends to become more concentrated.

The Preservation of Farm Manures.

It is not enough to convert food into manure. The latter must be economically preserved, in order that the best results may be obtained. The estimates made in the previous tables only hold where *all* of the solid and liquid excrements are saved. Successful farming demands that this be done. But is it generally done in Maine? I fear not. Let me mention some of the ruinous practices that many Maine farmers are still following.

How many manure heaps there are that lie under the eaves of a barn, in a barn-yard, from which a stream of black water flows after every rain. Do you know, farmer, that the compounds of nitrogen, phosphoric acid and potash that give your manure heap the larger part of its value are, to quite an extent, soluble in water, and that they can easily be leached out, thereby causing you, indirectly, a loss of dollars and cents?

What more conclusive proof of the above statements do you want than the sight of the luxurient grass growing in the track of the leachings from the barn-yard. If such leachings could all be taken up by your mowing fields it would be another matter, but very often this is not the case. Dr. Völcker, of England, carried on an investigation that led to a satisfactory demonstration of the effect of exposure and leaching upon a heap of yard manure. He exposed manure under four different conditions, and by weighings and analyses at stated periods, was able to take account of the changes and loss that were taking place. The manure was submitted to the various conditions for nearly a year, which were as follows:

No. 1. Fresh manure exposed in a heap against a wall.

No. 2. Fresh manure kept under a shed.

No. 3. Fresh manure spread in open yard.

No. 4. Well rotted manure exposed in a heap against a wall.

When the manure was first placed under the above named conditions, it was weighed and analyzed, and during the year's time that it remained where it was placed, was weighed and analyzed four more times, in order to discover the changes that were going on. In the following tables are given the dates at which the weighings and analyses were made, and the composition, and percentage of loss by weight:

The manure was first exposed to the various conditions November 3d, 1854.

No. 1. Fresh manure exposed in a heap against a wall:

	Nov. 3, 1854	Feb. 14, 1855.	Apr. 30, 1855.	Aug. 23, 1855.	Nov. 15, 1855.
Water	66.17	69.83	65.95	75.49	74.29
Soluble organic substance	2.48	3.86	4.27	2.95	2.74
Soluble inorganic substance	1.54	2.97	2.86	1.97	1.87
Containing nitrogen	.149	.27	.30	.19	.18
Per cent. of loss in weight	–	–	28.6	29.7	30.4

No. 2. Fresh manure kept under a shed:

	Nov. 3, 1854.	Feb. 14, 1855.	Apr. 30, 1855.	Aug. 23, 1855.	Nov. 15, 1855.
Water	66.17	67.32	56.89	43.43	41.66
Soluble organic substance	2.48	2.63	4.63	4.13	5.37
Soluble inorganic substance	1.54	2.12	3.38	3.05	4.43
Containing nitrogen	.149	.17	.27	.26	.42
Per cent. of loss in weight	–	–	50.4	60.0	62.1

No. 3. Fresh manure spread in open yard:

	Nov. 3, 1854.	Feb. 14, 1855.	Apr. 30, 1855.	Aug. 23, 1855.	Nov. 15, 1855.
Water	66.17	–	80.02	70.09	65.56
Soluble organic substance	2.48	–	1.16	.49	.42
Soluble inorganic substance	1.54	–	1.01	.64	.57
Containing nitrogen	.149	–	.08	.06	.03
Per cent. of loss in weight	–	–	13.04	38.07	42.4

No. 4. Rotted manure exposed in a heap against a wall:

	Dec. 5, 1854.	Feb. 14, 1855.	Apr. 30, 1855.	Aug. 23, 1855.	Nov. 15, 1855.
Water	75.42	73.90	68.93	72.25	71.55
Soluble organic substance	3.71	2.70	2.21	1.50	1.13
Soluble inorganic substance	1.47	2.06	1.68	1.10	1.04
Containing nitrogen	.297	.149	.14	.09	.09
Per cent. of loss in weight	–	–	26.50	36.5	37.8

These tables need studying in order to get at the facts they teach. The tendency of farm manure in fermenting is to lose weight, and to increase its per centage of soluble material. If no leaching takes place this soluble material ought to accumulate in the heap, that is, the heap become more concentrated in soluble matter. This is seen to be the case in the pile of manure kept under a shed. Of the fresh manure kept out of doors that in heap suffered least. The heap that was rotted in the start suffered more than the fresh. It is to be noticed that the manure kept under a shed lost considerable in weight, but the loss was largely in water which dried out, and in carbonic acid which resulted from the combustion going on in the heap. A little calculation shows that there was more soluble nitrogen in the covered pile at the end of the year than at the beginning, while in all the other samples of manure there was considerable loss of valable material. The following table may be interesting in showing the relative actual loss of organic material and nitrogen by keeping manure under various conditions, also in giving a hint as to whether there is a loss in fermenting manure under favorable conditions. If any valuable ingredient would be lost from manure decomposing under a shed, it would be nitrogen.

		Total quantities of organic matter and nitrogen in manure at beginning of experiment, Nov. 3d, 1854.	Total quantities of organic matter and nitrogen in manure at end of experiment, Nov. 15th, 1855.	Percentage of loss of organic matter and nitrogen by the various methods of keeping the manure.
No. 1.	Organic matter	801 lbs.	268 lbs.	66.6 per ct.
	Nitrogen......	18.2	13.	28.5 "
No. 2.	Organic matter	919	408	55.5 "
	Nitrogen......	20	18.8	6. "
No. 3.	Organic matter	466	98	78.6 "
	Nitrogen......	9.5	3.9	59. "
No. 4.	Organic matter	266	135	49.2 "
	Nitrogen......	9.8	6.6	32.7 "

Are not these figures sufficiently striking to induce a careless farmer to take some pains to prevent loss from his manure heaps? Only six per cent. of nitrogen lost when the manure was covered, and fifty-nine per cent, when it was spread out and allowed to leach! Even when in a pile out of doors thirty per cent. nearly of the nitrogen was lost. There is no reason to doubt but that a corresponding loss occurred with the valuable mineral ingredients from the careless management.

Again, there is often a careless waste of the urine. I have seen lots of barns where the floor of the tie-up was either full of cracks, or else had holes bored in it to allow the escape of the liquids, while the solid excrements were thrown out of a window into the open yard. In that way the urine was almost entirely lost, unless very large quantities of absorbents were used.

Now, the liquid excrements are valuable. We have seen that all the nitrogen compounds which pass through the processes of digestion and are not used by the animal, pass out in the urine. The potash goes out in the same channel, while the phosphoric acid is retained with the solid excrement. The manurial ingredients of the liquid excrement are more valuable, pound for pound, than those of the same kind existing in the solid. Then why not save them?

Until farmers avoid the wastes incurred in the two ways mentioned above, let them not complain of hard times or the barrenness of their fields. What foolishness, also, to buy commercial fertilizers and pay for what might be obtained much more cheaply by the exercise of a little care!

What is the best method of preserving manure? Use plenty of absorbents, unless you have water-tight tanks in the cellar. It seems to me that dry loam or muck is better for that purpose than straw, for the reason that strawy manure cannot easily be distributed in the soil in an even and finely divided condition. Have a good barn cellar, with water-tight tanks, if possible; if not, then build a manure shed. In the latter case, or if the manure *must* be thrown into an open yard, have the floor behind the cattle water-tight, so that all the liquid can be taken up by the absorbent used.

Some suggestions with reference to the differences of treatment demanded by the manure from the different farm animals, may not be amiss. It is well known to farmers that horse and sheep manure, under certain conditions, are very liable to ferment so rapidly as to get hot. When this occurs the manure grows white, and seems to have been burned. The question is often asked me, Does it cause any loss to have such a thing happen? I answer, Yes. Almost the entire amount of nitrogen in a heap of manure may thus be driven out largely in the form of ammonia. The reason why horse manure "heats" so much more readily than that from cows, is, that it is coarser and not so wet. This coarseness allows a free circulation of air through the heap, while the dryness admits of a more rapid rise of temperature than would be possible if it contained more moisture. A larger amount of water would also increase the capacity of the manure to absorb and retain its products of decomposition. The more compact and moist a pile of horse manure can be kept, the less danger there is of loss from heating. It is an admirable plan to throw the excrements of horses and cows together, where they can become thoroughly mixed, the mutual effect of the two kinds upon one another causing a saving in the case of the one and an increased activity of the other. The manure of sheep had better be trodden under their feet, to lie in a compact condition until about the time it is used.

The Treatment and Application of Farm Manures to the Soil.

The questions most commonly asked in regard to how to treat and use farm manures, are:

(1) Is it better to ferment manure or apply it green? and

(2) When it is applied, is top dressing, or working manure into the soil, the better method?

In answering the first inquiry, let us first consider the differences between rotted manure and "green" manure.

When the excrements first come from the animal the manurial ingredients, especially in the undigested portions or solids, exist in the same form that they did in the plant. Now, one plant, unless parisitic, cannot feed upon the material that exists in another until such material has undergone certain changes. In order that the ingredients contained in vegetable fabric may become plant food, a decomposition or combination must take place. The phosphoric acid needs to be liberated from its organic combinations, and the nitrogenous substances in the vegetable material must be broken down so that the nitrogen can be converted into ammonia and nitric acid. Now, when manure is rotted there occurs a partial, and to a certain extent a complete breaking down of the vegetable compounds in the excrements, and an additional decomposition of the substances in the urine, which are chiefly the result of a previous partial breaking down of the albuminoids in the animal.

While but little ammonia and nitric acid may be formed in fermented manure, the decomposition that has taken place has carried the valuable ingredients of the fresh excrements quite a long distance in the direction of the forms into which they must finally come in order to serve the purposes of the plant. Consequently, rotted manure can more quickly produce a vigorous effect upon growing crops than that which is fresh. Farmers recognize this fact when they put well rotted manure under a hill of corn instead of green.

But the question of the availability of the plant food in stable manure at the time it enters the soil is not the only one that must be considered. It is essential for us to know whether, in fermenting manure, or in making its nitrogen, phosphoric acid and potash more available to plants, there is not a loss of these substances. Again, is there reason for believing that any beneficial effects result from having the manure go through its chemical changes in contact with the soil rather than before it is applied to the land?

As to the matter of loss from fermenting manure, I will again refer to the table showing the results of Dr. Völeker's investigations when he found that only six per cent. of nitrogen was lost from the manure fermented under a shed. I presume it is safe to assume that there would not be an appreciable loss of the mineral ingrediants of animal excrements during a process of decomposition providing no leaching takes place.

Manure fermented under proper conditions doubtless does not suffer a very large loss. And I mean by proper conditions, the keeping of the heap moist after the excrements have received a mixture of absorbents. If manure be allowed to rot, great care should be taken to secure a complete absorption of the products of decomposition, and to this end it should not be too rapid and should be accompanied by moisture. With manure largely from concentrated food, there is no doubt but that the use of absorbents tends also to insure against loss from the chemical changes that take place. Granting that rotted manure is more efficient at first, and can be obtained without much loss, it is to be said on the other hand that the excrements of animals cannot be put through a thorough process of decomposition without involving an extra expense, and this is especially true of manure treated so as to ferment without loss. The factor of expense must be allowed.

The other question to be considered is that of the benefit coming from having the manure go through the chemical changes necessary to convert it into plant food, when in contact with the soil. Although it is to a certain extent still a matter of theory, yet we have no doubt but that the decomposition of stable manure after it is mixed with the soil causes an increased disintegration of the latter.

Previous figures show the large amounts of inert plant food that may exist in even run-out fields. When we have brought this into a condition for plants to use we have added so much more to the capital applied to our farming operations. Our soils are still a storehouse of plant food, and there is every reason to believe that the decay of the organic material of animal excrements after its application to the land is an efficient agent in forcing into service the inactive mineral substances.

Now, in all I have written I have not answered the question—Is it best to decompose manure out of the soil, or in it? I have simply presented some of the arguments pro and con. The special circumstances of a market gardener would seem to indicate that he can best use rotted manure, while it might be equally wise for a farmer on a light, loose soil to apply it in a fresh state. At the same time no exact experimental work has been done to determine the relative profits from the use of stable manures in the two conditions. It is a somewhat complicated question, and one that demands further investigation.

The matter of top dressing as compared with working manure into the soil, is one of importance. And here we cannot appeal to definite results to establish the correctness of either method of practice. I have not the slightest doubt but that so far as theoretical arguments are concerned, they are strongly against top dressing. This is especially true if horse manure be the one used. By putting fresh manure on the surface of the land we lose the good effect that would result from its decomposition in the soil, we stand in danger of a certain amount of loss of manurial value, and when the manure is in a coarse, lumpy condition, as it is likely to be when not rotted, we get a poor distribution and slow returns. Do not say that it costs something to mix manure with the soil. Cultivation pays for itself in the greater utilization of the natural fertility of your fields.

Nevertheless, in spite of the weight of evidence furnished by theory, we are not prepared to assert that top dressing is always less profitable than some other method of applying manure. We are waiting for accurate facts.

It is not claimed that this paper approaches anything like completeness as a presentation of the facts bearing upon the manuring of land. It does contain facts enough, when heeded, to greatly improve the condition and profits of Maine agriculture.

EXTENSIVE FARMING FOR SUCCESS;

BY PROF. J. W. SANBORN,

Of the New Hampshire College of Agriculture.

We are living in a decisive period in the history of New England farming—at the parting of two systems of husbandry, standing in marked contrast to each other. The watchword of the old has been "Small areas well tilled." The new for profit will exact large areas well tilled. The old was based upon a limited supply of yard manure and limited use of hired labor; assumed that labor could not be profitably employed, and exacted the farmer's fullest capacity to toil. The new, upon an unlimited supply of plant food, the free employment of machinery in supplementing labor in extended tillage. The old, made hay the leading crop and reaped a gross income but little above a satisfactory net income. It had all the marks of a low type of farming. We have rallied around "small areas well tilled" to the tune of lower-priced farms, and have rallied again to smaller ones to be answered by still declining values, and this has gone on for thirty to forty years. No business for so long a period of time ever sold its original property for less than cost of improvements and was considered prosperous. Prosperous bank, manufacturing or railroad stocks never, for extended periods, under paying dividends sell for fifty cents on the dollar. Unpleasant as it may be to measure the prosperity of farming by this axiomatic fact, yet the interest of true men are best served by looking facts squarely in the face. Only then can they act to best advantage. The facts are, then, that western products aided by cheap freights have given a low price to our products; that cheap products of a small business can give only small gross profits.

Large Profits

Are the product only of an extended business under low prices, in farming as elsewhere. Large leases have given a rich tenantry to England, while ten acre farms have clothed the French peasants with wooden shoes. The policy by which we have lost for a long period is obviously not the one to pursue further. I would till, instead of ten to fifteen per cent. of the possible arable land of the farm, fifty per cent. at lowest, and thence on, governed by circumstances, up to sixty, seventy, eighty, ninety, or even one hundred per cent. of such land, always including clover as one of the rotation crops. In order to secure the materials of fertility I would feed well bred early maturity animals on home grown and purchased foods, rich in the elements of plant food. I would use large amounts of purchased chemicals; give thorough tillage; adopt a system of rotation of crops, and substitute machinery for hand labor so far as practicable. This policy will multiply the gross revenue of our farms from three to five times or from an average of $500 or $600, as is now realized by many farmers in Maine to from $1500 to $2500.

The gross revenue of an acre of hoed or grain crop may vary from $40 for a grain crop to $75 for a hoed crop, per acre. As it now stands in Maine, an acre of grass will average one ton, worth on average for all qualities, seasons and localities, say $10 per ton. The average profit of a hoed or grain crop may be made to double the gross receipts of an acre of grass. The point is made that large crops on large areas is vetoed in the want of plant food. For 1879, England had of its 32,102,000 acres of field and pasture land, only 14,427,000 acres to permanent pasture and grass, or 45 per cent. of total; 8,876,000 were in grain, wheat being the principal grain crop, selling in Liverpool for but little more than in central Maine, 3,477,000 in green crops, 812,000 bare fallow, and 4,434,000 in clover and rotation crops. France and other continental countries had a large proportion of tillage, in one case amounting to 69 per cent. of total arable land. Multitudes of English farms of from 200 to 500 acres sell from $10,000 to $25,000 in products annually. I would not copy English practice but simply draw inspiration from it. If the change proposed can be carried to success it will make a complete revolution in the standing of New England farming, and in the social position of the farmer.

Principles in Farming.

The system of farming mostly pursued at present, is perhaps, considering the soil and situation of New England, coupled with the information at the command of the masses, the most rational that could be devised for the conditions that have existed. Thanks to the combined work of modern investigators enough is now known of many of the laws that underlie or should underlie farm practices, not only to warrant but to demand a change in our methods, aside from the strong reasons that arise from purely commercial changes. Farming is now rapidly becoming a profession. And other things being equal, he who works nearest in consonance with its known (not conjectured) principles works most effectively.

It shall be my purpose to briefly review some of the principles of agriculture that rest upon reliable data not now known, or practiced only to a limited extent, by the farming masses. I shall only touch those principles of agriculture and illustrate by facts of practice to enforce them, that to me seem to afford a logical inducement to enter boldly into broader tillage.

Plant Food a Necessity,

and large amounts required. We wish to draw heaviest upon its cheapest source. At present I believe that source to be animal manures. If so, true policy requires us to use animals for manure manufacturers in the most effective way possible. This policy I consider of prime importance. It is well known that the quality of manure depends mainly, although not entirely, upon the character of the food. The chemical materials, nitrogen (at 20 cents), phosphoric acid (at 10 cents), and potash (at 4 cents) recognized as deficient in our soils, and in natural supply in quantities in sufficient abundance for maximum plant growth, would cost, at the prices named, in the following foods, as follows, per ton:

Swedish turnips	$ 1 14
Oat straw	3 58
Corn meal	8 51
Good hay	8 00
Clover hay	12 19
Bran	18 67
Middlings	18 41
Peas	19 13
Linseed cake	24 66
Cotton seed cake	34 93

The values I have used are less than those given to nitrogen in sulphate of ammonia; and to soluble phosphoric acid and potash in their commercial forms. The values used may be slightly high for these materials for plant nutrition as they occur in these foods.

They are an approximation that will serve the purpose desired to show the relative values of different foods for manure. Professor Collier analyzed for me a sample of cotton seed meal, richer than the one given. In feeding, it is said to require twelve pounds of hay to produce one of growth. Not so much of the concentrated foods would be required. Dr. Lawes estimated that after allowance for materials that enter into the growth of the animal and slight unavoidable losses, the manure left after feeding these foods would stand as follows:

Swedish turnips	$ 0 91
Corn meal	6 65
Good hay	6 43
Clover hay	9 64
Bran	14 59
Middlings	14 36
Peas	13 38
Linseed cake	19 72
Cotton seed meal	27 86
Oat straw	2 90

In American practice, I do not believe that these values will be found low enough by at least one-third. Nitrogen is not of so much moment in our practice as in English farming, for reasons noted further along. Whatever the absolute values of manures from these foods in practice, it is clearly the fact that the manure from a ton of cotton seed meal is worth four times as much as from a ton of corn meal, and bran twice as much. The proportions in which the minerals and nitrogen exist in each food, will modify these theoretical data in application to diverse soils and even crops, yet they will be close approximations in practice, to their relative values. All theories are worthless that will not stand, or do not rest upon the crucial test of practice. The one great question with English feeders is the manurial value of food purchased. They have long bought our linseed meal and are now importing heavily of our cotton seed meal. Much of it is fed to stock in pastures, to enrich them. Lawes and Gilbert, in an exact experiment, fed a given number of sheep on two acres of ground, one ton of cotton seed meal. On two adjoining acres they fed the same number with one ton of corn meal. They cut two crops of hay the first year. These, with the first crop of the next year, gave 1,500 lbs. more of hay for ground receiving the droppings from cotton seed meal than from that covered with manure from corn meal. They, and others, long used rape cake as a manure. This food is a good cattle food. Gentlemen in our State have used both cotton seed meal and bran as fertilizers. I have done the same. I received at the rate of 49.4 bushels of corn and 6,900 lbs. of stover from 1,000 lbs. of this meal, where no manure gave 21.9 bushels corn and 2,180 lbs. stover per acre. A great many car loads of bran have been used direct as a manure in one section of New Hampshire, and the users tell me that it is cheaper than superphosphates, the bran costing $15 per ton. There has been each year a time when it could be thus bought. A little chemistry will throw some light on this opinion of our farmers. One ton of superphosphate will ordinarily contain 50 to 60 lbs. of nitrogen and 200 lbs. of phosphoric acid, and cost $45. Three tons of bran will contain 153 lbs. of nitrogen, 87 lbs. of potash, and 219 lbs. of phosphoric acid, costing $45. After crediting to cotton seed meal the phosphoric acid and potash it contains, this food remains one of the cheapest sources of nitrogen in the market. Blood meal, meal scraps and fish are now used directly as manures. It will be soon seen that I have used these manures profitably as foods, and still had the great bulk left after so feeding, as manure. With farm animals túrning to growth, or otherwise diverting from the excrement but about ten per cent. of the materials of the food of use in plant nutrition; with foods in the market worth their cost for fertilization, it follows that feeding domestic animals foods rich in the element of plant food, is our cheapest source of manure, and that our true policy consists in the purchase of such foods. Such a policy has almost no footing in American farming, although it is rapidly becoming a practice.

Science and Practice of Feeding.

Fortunately these food materials named perform a double office on the farm. The class of foods having the highest value for manure have the highest value as animal foods when rationally fed. Feeding is a science resting for its data upon the facts gathered by the actual experiments of a corps of trained investigators whose work covers years of enquiry. As another will present this matter to you I will only say on the science side of the question that all foods are made up of materials that go to make flesh, and to produce work, and are called albuminoids or flesh formers; of materials that go to support heat and perhaps to make fat, called carbohydrates; of materials that go to make fat and heat, called fats or oils. The fact that interests us the most is that the heat producers or carbohydrates, or fats can not produce flesh, and that an animal can not grow unless flesh is produced, and that some foods are quite deficient in flesh makers, like straw, corn fodder and swale hay, while others have an excess of flesh formers, like bran, cotton seed meal, blood, fish and oil cake meal. German investigators have told us that growing cattle require 14 lbs. of digestible flesh formers per day for a 700 lb. beast, for best results. I find that I cannot induce such an animal to consume over 13 lbs. per day of straw. This would contain, by the same authorities, only .18 lbs., or but barely $\frac{1}{8}$ of the quantity required. The animal would have to consume 100 lbs. in order to get flesh formers enough. I have had samples of cotton seed meal that would give 1.4 lbs of flesh formers for 4 lbs. of the meal, or when fed with the oat straw 3 lbs. would make a well-balanced ration.

Presuming that the facts in full will be presented to you, with digestion tables, &c., I pass the subject with a brief review of a table of one winter's feeding trials, of the four made by me at our College Farm.

The swale hay, ground meal and cotton seed meal were analyzed by Prof. Collier of Department of Agriculture at Washington, and the good hay by Prof. Johnson of the Connecticut Experiment Station.

I have resorted to Wolff's tables for my computations relating to the other foods used:

Lots.	Time in Feeding.	Foods Given.	Amount of Food.	Digestible Albuminoids.	Digestible Carbohydrates.	Digestible Fats.	Ratio of Albuminoids to Carbohydrates.	Gain.	Cost of Food for Seventy Days.	Value of Straw compared with Hay as Result.	Value of Swale Hay compared with Good.	Manure Value.
	days		lbs.	lbs.	lbs.	lbs.		lbs	$		per ct.	$
1	70	Swale hay.	2496	79.87	1239	31.20	1 to 5.1	167	15.04	–	86	12.80
		C. S. meal.	560	207.00	74	49.00						
2	70	Good hay.	3536	146.00	1803	34.00	1 to 12.9	185	21.21	–	–	11.36
3	70	Straw.	2423	34.00	971	17.00	1 to 21.3	120	9.53	1.26	–	4.60
		Corn meal.	347	25.00	237	9.00						
4	70	Oat straw.	2310	31.00	926	16.00	1 to 6.3	81	12.74	.96	–	8.60
		Meat scraps.	280	134.00	–	11.00						
		Corn meal.	67	5.00	46	1.70						
5	70	Oat straw.	2450	34.00	982	17.00	1 to 5.8	133	13.88	1.00	–	9.08
		Blood.	280	151.00	–	1.40						
		Corn meal.	146	11.00	100	3.70						
*6	77	Clover rowen.	1694	118.00	645	20.00	1 to 9.1	144	12.21	1.65	–	10.55
		Oat straw.	1309	18.00	525	9.00						
7	56	Clover rowen.	1400	98.00	533	17.00	1 to 8.4	120	5.60	3.00	–	6.79
		Oat straw.	840	12.00	337	6.00						
8	70	Good hay.	3266	135.00	1666	32.00	1 to 12.9	63	19.59	–	–	10.49
9	70	Good hay.	2688	111.00	1118	26.00	1 to 10.5	114	22.03	–	–	10.61
		Meal.	591	43.00	403	15.00						

Prices of Foods in the above Table.—Meat scraps and dried meat, $45 per ton; dried blood, $45 per ton; straw, $5 per ton; corn meal, $20 per ton; good hay, $12 per ton; clover hay $12 per ton; swale hay, $6 per ton.

The basis of the column of amounts of digestible food was derived from per centages given by Wolff, as the result of feeding trials.

The corn meal eaten by lots 4 and 5 was for the purpose of teaching those lots to eat their blood and meat.

The amount of digestible materials given for meat scraps is assumed to be about the same as in the case of fish scraps, as given by Prof. Johnson in the report of the Connecticut Experimental Station.

For 1880, the best gain I received was from fish and damaged oat straw fed together.

*Average of several experiments of lots of from two to six steers, covering time of from 21 to 77 days; for comparison it is figured in lot of two, as the others.

It will be seen from a study of the table that good hay for the gain made was the most costly food given, excepting where corn meal was added to lot 5. These experiments were especially designed to test and to elucidate this theory of food combinations in American practice. In every case but one flesh forming foods were joined to carbonaceous foods, and with economy. Lot 2, on good hay, consumed 50 lbs. hay daily, costing 30 cents, while lot 1, on cotton seed meal ate but 35 lbs. swale hay per day and 8 lbs. cotton seed meal costing but 21½ cents, and gave a more valuable manure. The cotton seed meal, has not only returned every dollar it cost and more, but it has nearly doubled the market value of swale hay and left a manure equal to nearly its cost in value. The dried blood that I have usually paid $40 to $45 per ton for, for a manure for profit, has, for 3 lbs. a day, in conjunction with 2 lbs. corn meal daily, given a good growth to our steers where only 35 lbs. of straw have been eaten in the place of 50 lbs. of hay. The cost being but 20 cents per day or only ⅔ as much as on good hay. Now if we have paid $45 for blood as a fertilizer, and made it pay, how much better the hay, or how much cheaper the source of nitrogen, to make it as in this case, first bring more than cost as a cattle food and then return, say 4-5 of its original amount in the manure heap, or $36 worth of manure for nothing. I value clover hay higher than I do good English hay. It contains a large proportion of flesh formers, and hence, when fed in combination with those foods deficient in flesh formers it takes on a value unknown to it when fed alone.

The average result of several experiments has been, that I have made as good growth on clover hay and oat straw mixed as with good hay, less food of the former ration being required than of the hay ration. These facts in food combination are given to illustrate a general law—a law that, observed in Maine practice, would add perhaps 20 per cent. to the value of the food fed by your farmers. It may be well to observe that the animals fed were of the same age, weight, and breed. You can grow with proper food combinations with your oat straw, swale hay or corn fodder, an animal as fast as on good hay and do it for less money.

If these statements are accepted as facts well proven, then we are led into the practice of wide tillage quite naturally, for we can dispense with hay quite largely. The feeding as proposed, will not cut down the amount of stock kept but increase it; more stock being kept from an acre of straw or corn fodder than is now kept.

The grain being sold direct gives us a cash crop, or one quickly returned through pigs and the manure saved to the farm if so fed. If sold a large cash return is made to the acre, and yet more cattle kept per acre by using cotton seed meal. If 60 bushels of meal is sold per acre it will require the feeding of but 750 lbs. of cotton seed meal to replace the manure of 3,360 lbs. of corn sold; but little more than half as much to replace 30 bushels of wheat or barley, and 300 lbs. of cotton seed meal will furnish as much nitrogen and nearly as much phosphoric acid as 100 bushels of potatoes would if fed, but not quite as much potash. These are good crops to sell, oats and hay seldom are.

The Animal to Feed.

Cheap beef, cheap manure; as well as cheap manure, cheap crops. I have laid so much stress upon purchased foods for manure, fed in proper proportions that I beg to be allowed to name some of the conditions under which it must be consumed. I believe in large breeds against small breeds, because large animals expose less surface for heat radiation in proportion to weight than small ones. Large breeds require less food to make a pound of growth than small. (Although I have experimented some, I express this as an opinion.) Objection is made that pastures will not admit of large animals. The time has come to Spring and Fall feed grain in part. Such a policy will improve the pastures and cheapen growth. The animal fed must have large capacity for consumption, digestion and assimilation. Successful feeding cannot be carried on with a low type animal any more than successful cotton manufacturing can be carried on with old machinery in use thirty years ago. I find a steer weighing 1000 lbs. will consume 17 to 20 lbs. of hay a day and neither gain nor lose. All that is eaten above this amount goes to growth. Other things being equal the steer that eats 7 lbs. more than this amount is a very much more economical feeder than one that eats but 5 lbs. more. Again, a certain class of stock may eat this food because palatable and yet have a capacity for digestion and assimilation so low as to make poor use of it. Indeed they may, for maintenance fodder, require more than a well-fed steer. It is a familiar fact that a class of cows eating a given amount of food will not make one-half of the milk that another class will on the same food. So familiar is this fact that I need not illustrate it from an accumulation of statistics of our stable. For cheap beef or pork, and cheap manure as a resultant, well bred animals must be had. These will come chiefly by female selections and the use of males having desired qualities.

Early Maturity.

Early beef is cheap beef. Young pork is cheap pork. If our animal machines to make manure are not to do their best work we should abandon this source of plant food in despair. Four year old steers and eighteen months hogs would bankrupt this part of the scheme and leave chemicals our only sufficient resource. No beef beyond two to two and one-half years can be made at other than a loss, or pork that is over six to eight months old.

In three experiments covering 16 to 59 days, I found that calves averaging 425 lbs. ate 3.3 part of live weight daily and required 10 lbs. of hay to make 1 lb. of growth. With younger calves 7.7 lbs. have given 1 lb. of growth. With cattle averaging 750 lbs, in five experiments 2.6 per cent. of live weight was eaten daily, and 19½ lbs. of hay required to make 1 lb. of growth. With steers weighing 1000 to 1100 lbs. each, in eight experiments 2.16 per cent. of live weight was eaten daily, and 26 lbs. of hay were required to make 1 lb. of growth; the gain per day averaging .85 lbs. I fed two calves in five periods of two weeks each. The amount of food for first period was 20 quarts skim milk daily. After the first period it required a constantly increasing amount of grain and hay to maintain the first growth made per day. Two pigs, on skim milk alone, required for the first period of 28 days 9.8 quarts to make one pound of growth. At the end of the third period, when they were five months old, it required 15 quarts to make one of growth. Last summer it required more food to make a pound of growth on a shote than on a pig in a set of comparative experiments. Professors Stewart and Miles have found the same facts in their practice. The large show yards of England and the Chicago live stock show have brought out the same facts very prominently. In these shows it was a universal result that the older an animal grew the less it grew per day. As they grew older, of course the more food it required to make a lessened growth. We sell a steer, say at 1500 lbs. weight; it can be made in two winters and three summers, or two and one-half years. Suppose it is made in four winters and five summers, or at four and one-half years, then it has eaten maintenance fodder for two winters more than is required. I find that it requires approximately 14 lbs. hay a day to maintain an 800 lb. steer without gain or loss. The steer in question will have an average weight of nearly 800 lbs. for the period of his growth. If matured in four and one-half instead of two and one-half years he will have eaten maintenance fodder (14 lbs. daily) for two winters more than is required, or for 330 days, or 4620 lbs. of hay worth, at $12 per ton, $27.72, and two summerings, worth $9 more, or total of $36.20. Yet I am told by farmers that it pays best to feed heavy steers and shotes, over pigs. No mistake is more fatal in feeding; and no wonder that such men, who are often in the majority, complain that farming don't pay. Then the position taken is, that if cheap manure is to be obtained, well bred animals, quickly matured upon home grown and upon purchased foods rich in the elements of plant nutrition, fed in rations in accordance with principles of recent investigation, must be fed.

Cost of Animal Products.

Can the manure of cattle, sheep and pigs, be got for attendance? If so, the whole question of profitable farming for New England is answered, for an unlimited supply of manure is at our command by purchase of foods and feeding. I have weighed constantly for four winters the food to animals of different ages in a herd of fifty head, and have given all of the foods, coarse and concentrated, commonly fed in New England. The same has been done in summers with pigs. And a few experiments made with sheep. Basing my opinion upon those results and those of careful men that I have met, I believe it can be done. Very many are putting calves upon the market in weights varying from 400 to 800 lbs., at good compensation. F. F. Fisk of Webster, N. H., sold a calf weighing 1200 lbs. at 364 days old, and dressing 902 lbs. He says it was done at a satisfactory cost on skim milk, bran and green fodders in summer and hay in winter. A fair statement and results of nursing calves to pasture may be made from four calves turned to pasture by G. W. Sanborn, Gilmanton, N. H., for 1880. I name this gentleman because he is a free user of scales, and I am personally familiar with his methods of feeding and with his stock. The four young mothers averaged in round numbers 700 lbs. each, and were fed entirely on corn fodder, oat straw, swale hay, and 3 lbs. each of mixed cob meal and cotton seed meal daily. They ate not over two per cent. of live weight daily, or 14 lbs. at $6 per ton, and 480 lbs. mixed meal at 1 1-16 cts. per lb., or $5.40, or total of $12.15, plus pasturing $5 more, or total of $17.15. The first of November they averaged 500 lbs. at 4 cents per lb. The mothers were worth more than the fall before by growth, and the two or three months of milking remaining. Spring calves could be fed undoubtedly to better advantage on skim milk, grain and pasture crops up to 400 or 500 lbs., and then sold for veal. I weighed everything for two calves in barn and on costlier winter food; skim milk at 4 mills, hay at $10 per ton, and mixed corn and cotton seed meal and bran. The gain for 86 days ending February 24, was 4⅛ lbs. daily. The average cost 3 1-17 cents per lb. They were worth some over 4 cents per lb. I do not know how extensive a market can be found for such baby beef. It is quite easy to carry a March calf over to eighteen months of age or in early September, and obtain 1000 lbs. of nice beef, at 4 cents per lb., live weight, if the quality is made what it may be made. Cost, 20 days to 7 quarts new milk at 2 cents, $2.80, sixty days more until pasturing, 8 quarts skim milk daily, and total of hay 60 lbs., and 75 lbs. of mixed meal. Hay is rated at $10 per ton and mixed meal at 1 ¼ cents per lb. Cost, 60 days to June 1st, $3.16. To November 1st, pasturing $1.00, 6 quarts skim milk daily and 2 lbs. mixed grains at pasture, cost $8.35. The calf will then weigh 550 lbs., at a cost of $14.37. The skim milk is rated at 4 mills a quart. It will require 1½ tons of hay to winter, and 3 lbs. mixed grains, at a cost of $21.75. It will require at pasture 3 lbs. of grain daily. This, coupled with pasture at $4.00 will make a cost of $10.75. The steer will gain for the year 1¾ lbs. daily and will, September 1st, weigh 1189 lbs., and be easily saleable at 4 cents per lb. or $47.56. Cost $46.87. The gain of 2 lbs. the first summer is moderate, and 1¾ for the next year not excessive on a young thrifty beast, grained the year round and six months at the barn. Poorer goods have sold to go to Boston frequently in my section this fall, and I regard the price as below the probable selling value. I sold several grade Durham steers this fall, averaging 1100 each, at two years of age fed by a slower process, from the fact that I am obliged to hire pasturing from home. They had very much of their food weighed, and hence with them I can make very close calculation. The first three weeks they were fed on new milk. The following nine weeks on skim milk and grain. I paid $1.00 for pasturing. They came to the barn weighing 422 lbs. and costing $6.73. They were wintered with 10 lbs. of hay and 3 of grain daily, costing 9 cents, or for 160 days, $14.40; second summer at pasture, $2.00. They were wintered the second winter on mixed clover and straw, 20 lbs. daily, for $12.00, and pastured till sold for $3, or total of $38.13. They were sold in a lot of other cattle and probably should fairly be rated at 4 cents per lb., or $44. Evidently there is no great profit in feeding stock for direct flesh sales. If we can sell our produce at home and much purchased food at market rates, we certainly know of a direct way to fatten our farms and make them pay.

Feeding Pigs.

Feeding pigs, except for the purpose of disposing of waste from house, or skim milk, has nearly gone out of practice in New England. The cost of a pound of pork is vastly overrated by our farmers. The average of three years' experiments with middlings and corn meal fed with nothing but cold water whatever, has been that to grow a 200 lbs. pig (live weight) it required but 100 lbs. of middlings to make 28.4 lbs. growth on average, and 26.1 lbs. have been made from 100 lbs of corn meal. I have made as good returns with 100 lbs. of cob meal. During the first half of the periods I have frequently got over 30 lbs. growth for 100 lbs. grain and over that, and in one case 40 lbs. The value of pig pork has averaged to give for these growths more than the cost of the foods named. This work was accurate and continued for three years, and is good proof that manure from pigs is cheap manure. It is worthy of note that the middlings have been worth nine per cent. more than the corn meal, and that the manure from middlings is worth twice as much as from the corn meal, and theoretically more than one-half of the cost of the pork made. The amount of cheap rich manure thus made is limited only by our ambition.

A well managed flock of mutton-wool sheep will pay better than either class of animals named. The profit is so certain for such a flock that time may not be required to review the cost of a pound of wool or mutton. They will give a profit. Thus, good animals, quick fed on purchased foods rich in nitrogen matter—this purchased food being fed in conjunction with the coarse foods of the farm—make cheap manure. Baby beef, cheap beef,—cheap beef, cheap manure,—and cheap manure, cheap crops.

Chemicals.

The policy outlined will surely and with moderate rapidity allow of broader and better culture. The farmer, like the business man, should push his business to its utmost verge of prosperity. Why should the farmer, alone of all the industries, be content with a narrow business when plainly greater possibilities lie within his reach? Why? In our day three years of former existence is crowded into one; and it is not enough to know how to accomplish a given result, but how to accomplish that result the quickest way consistent with economy. While yard manures may be the cheaper source of manure, yet, if in addition to this source it can be shown that chemicals can be used at a good profit, then they are most welcome aids to the slow methods of New England farming. With a small per cent. of exceptions the most successful farming cannot be carried on in N. England without chemicals. Yard manure and chemicals combined will give more and cheaper crops than either alone. Chemical manures have a popular reputation among farmers of being stimulants, exciting the soil to give up of its stores of nourishment, and that the growth made is made at the expense of the soil and not of the fertilizer. Science has demonstrated that ninety to ninety-eight per cent. of the weight of a crop is drawn from the air and water. The small bulk of chemicals used to grow large crops in contrast with the large amounts of yard manure used, has given color to the opinion that chemicals are stimulants. Science has shown that of this two to ten per cent. not gathered from the air and water, one ton of yard manure contains but 31 lbs. of matter that we value, and that this 31 lbs. can be supplied in 133 lbs. of chemicals. There is no jugglery in nature. Law has no exceptions. If one wheat plant can be grown in pure water with added chemicals then a million can. The growth of one by pure chemicals in pure water proves chemicals plant food. Plants have been frequently so grown and also in calcined sand. What say field tests? For thirty-five years a farm in Germany has grown its crops by chemicals alone, and to-day cuts more of oats and rye than a neighboring farm well treated with yard manure. Ville, of France, has used them for I think over thirty years, and holds a low opinion of yard manure. For forty years the world's benefactor, Dr. Lawes, who has expended fortunes in experimenting for the world's good, has used chemicals in various combinations in competition with yard manure. For twenty-seven years wheat after wheat has been grown by chemicals, and so on another piece by its side wheat after wheat has been grown with fourteen tons of yard manure annually, yet to-day the chemicals are yielding the larger crop, although the average per acre from the yard manure, $\frac{1}{4}$ acre, is $34\frac{1}{4}$ bushels. Far the larger crops have been taken from chemicals than where yard manure was used. Dr. Nichols has brought up a worn out farm by chemicals. A host of other instances might be given from shorter experiences. No fact is better established in agriculture than that chemicals are plant food. Eminent men headed by Liebig, Ville, Stockbridge, and perhaps Sturtevant, have looked upon yard manures as waste products, good and to be used when had, but needless and unprofitable to feed for. Two points in chemical fertilization may be considered as established. First, that they are efficacious plant food, and second, that they are profitable plant food when rightly bought and used. Otherwise, uncertain.

To buy right is first to buy at the market rates. Its importance will be seen when it is found that 99 cent goods have been sold for \$35 to \$40, and \$30 goods for \$40, while \$40 goods are sometimes sold for \$35. Those facts can be verified by consulting any of our experiment stations, or chemists employed in fertilizer analyses. Our State laws compel dealers to state upon each bag or barrel of fertilizer its contents of nitrogen, phosphoric acid and potash. These are commercial terms and have commercial values. We should banish any feeling that they are mysterious terms, and learn their values as we learn the value of any article of trade. Obtain the circulars of all dealers and buy of the cheapest, provided they stand well with the experiment stations. I had fully intended to buy a car load of goods of a firm, but shall not, because I find their goods are constantly analyzing poorly or of a less value than their price. The time is coming when many of us will buy by the car load or loads. Until then, buy together.

In buying last spring a car load lot I found a difference in dealers' prices, varying on different materials from 12 to 25 per cent., or 2 cents for muriate of potash by one, and $2\frac{1}{2}$ by another, but not in the same market.

What Shall We Buy.

Chemists find that all plants contain twelve to fourteen different materials in their structure. You are familiar with some of them like potash, sulphur, and lime. A plant would not grow in a soil and air lacking one of these materials. No soil has been found entirely wanting any one of these materials, but so nearly deficient in some one or more in an available form as to be practically valueless in their native condition. But fertilization does not consist in adding to a soil all of the materials found in a plant, for out of all the conflict of opinion in regard to chemical fertilizations, there stands out clearly this general agreement that the air and most soils furnish all of the fourteen materials that enter into the growth of plants in great abundance excepting potash, phosphoric acid, nitrogen and possibly in some or many cases magnesia, but no attention is given to the latter, perhaps unwisely.

Chemical fertilization, then, means adding to the soil materials containing potash, phosphoric acid and nitrogen. Pressing the matter a little closer we find that modern investigation has shown that some soils may be deficient in either potash or phosphoric acid, but only in them, and that either from the soil or air, or undoubtedly both, some plants have the power to get their nitrogen supply in part or in whole. I am personally inclined to the belief that none of our common field crops require heavy or full formula doses of nitrogen in our climate, although in England where three times the water leaches down to a four foot drain that does here, such quantities are required for many field crops, notably wheat.

Three or four years' use of nitrogen in varying amounts have thus far shown nitrogen in amounts based upon its relative amount in corn, potatoes, wheat, barley, and sorghum, when compared with amount of phosphoric acid and potash, has not paid. For corn, four proportions of nitrogen have been used with the following result for 1879: 64 lbs. per acre, yield corn 45.8 bushels; 48 lbs. nitrogen per acre, yield corn 61.1 bushels; 32 lbs. nitrogen applied per acre, yield corn 64.6 bushels; 16 lbs. nitrogen per acre, yield corn 69 bushels. Minerals alone, yield corn 67.4 bushels. Like results have been secured this year, although it is the third harvest of corn after corn on the same plats and under like fertilizers. Inasmuch as the nitrogen cost more than the minerals for our crops, the point is one of the very first moment in chemical fertilization. Professor Atwater has found like results. In sets put out among our farmers I am receiving like returns, although not so marked, perhaps because not continued on the same ground. The same observation may in part apply to the experiments of Professor Atwater, although some of his are continuous.

If it should ultimately be shown that we can in practice approximate to Leibig's mineral theory in our climate and on our soil, successful farming in New England of a very satisfactory order is assured. I do not dare rest too much hope upon three years' experiments, although a great many have been tried. Without time to discuss it at present, I would say when yard manure is supplemented by chemicals do not buy any nitrogenous manures. When chemicals are used alone for corn, 100 lbs. of sulphate of ammonia to the acre would be all that I would apply to corn, and less to potatoes.

Regarding the minerals, potash and phosphoric acid, I can only say, apply at the rate of 300 lbs. of dissolved bone-black per acre and weigh the products of corn and stover. Have an equal plat by its side with no fertilizer and note by weight—never by guess—the gain, if any, from the use of the dissolved bone-black. On a third use the bone-black, and in addition 150 lbs. per acre of muriate of potash of best quality. If this plat yields more than plat one the inference is that potash is needed in your soil. If no increase is made the plant has told you that out of that soil it can gather all of the potash it needs.

On the College Farm I find that phosphoric acid does not pay for use for corn. Three dollars and twenty-five cents expended for it gave for 1879 and 1880 less corn than the nothing plat, while $2.88 worth of potash gives a very large increase, in one case, of 29.9 bushels shelled corn. My crops rise and fall with the use of potash. On my private farm I have found that the presence of potash affects but slightly on its southern slope the amount of crop. Potatoes being increased by it but about 28 per cent., or not enough to pay, while phosphoric acid increased the crop 112 per cent., or for every dollar's worth of phosphoric acid 12.9 bushels. In experiment sets of fertilizers sent out both by myself and by Professor Atwater, the same class of facts are being constantly noted. No wonder that superphosphates, containing no potash, have given to a large class of farmers whose soil lacked potash, and could grow no good crop without it, unsavoring memories of it. Do we strengthen a chain with a weak link by incresing the strength of its strong link? To a soil lacking potash, potash becomes its weak link, and adding superphosphates we do not directly increase the producing capacity of the soil. Shall we add to a soil that which it does not need? Some say put them both in. On the same principle we would put in all the minerals. Some soils will show that both phosphoric acid and potash are needed, but there are a few only but what will show greater results from one than from the other for some of the crops. In such a case you would use the material most needed in largest quantity. Again, on a soil that would show no results from the use of phosphoric acid applied to corn, results might be noted when applied to potatoes. Such I found to be the case on our College Farm.

Each plant has its own special feeding characteristics, and according to Ville, who is father of this system of plant analysis of soils, has a dominant material that exerts a controling influence on its growth. Time will not admit its discussion, and in practice we are not ready to pursue the fine points involved. It is enough to know that chemical analysis does not afford any guide to a rational system of fertilization. The what to buy will depend, or should, upon your own experimental knowledge of your farm. In the absence of such knowledge buy 300 to 400 lbs. of dissolved bone-black, (or perhaps fine ground bone meal, an answer as to which can alone be given in the light of present controversy by a personal trial. On my own farm I find bone meal to be best to buy and am now using fine ground mineral phosphates as bedding for my stock as the cheapest way of phosphating my soil), 150 to 200 lbs. muriate of potash, and 100 to 125 lbs. sulphate of ammonia for an acre of corn alone to chemicals, or, as we are to go into expensive tillage, put your yard manure over twice or thrice the former ground and add two to three hundred pounds of the dissolved bone-black and one hundred of muriate of potash. Both lots may be safely increased and prudently. I advise the purchase of those materials for the following reasons: 1st, because they are more concentrated and thus save much in freight; 2d, because they can be bought twenty per cent. cheaper than in superphosphates, and because superphosphates contain no potash; 3d, because they are less subject to cheat; 4th, because more effective; 5th, because they can be adapted to the wants of the soil or crops, and can be used in constant tests of the soil. Superphosphates would not be worth five dollars a ton for our farm, and potash salts would be worth one hundred dollars a ton.

Do They Pay.

A gentleman (Mr. Prout) in England, gave $80,000 for a 480 acre farm and failed to make it pay by the use of yard manure. For fifteen years he has run it with chemicals alone, plowing four hundred and fifteen acres of it. Its valuation is now doubled, although the crops have been sold off. He has sold from $20,000 to $25,000 worth of crops annually. The crops for 1880 were estimated to give for 150 acres 40 bushels of wheat per acre; 80 acres of oats, 64 to 72 bushels per acre; 40 acres sanfoin, value $60 per acre, and 134 acres of barley, 48 bushels per acre. His tenant's income aside from landlords' income has averaged $3000.

In my practice I have often received 85 per cent. of applied fertilizers in first crop. Lawes and Gilbert rarely, in their moist climate which leaches rather than evaporates its moisture, received 50 per cent. return of fertilizer. This is a most encouraging fact for us. Mr. Prout's only stock is a cow and two pigs. Thousands of less brilliant instances might be named of profitable use of chemicals on a light scale in this country. I will name only a few instances that have come into my hands within a short time, from gentlemen with whom I had correspondence in the spring in regard to their use.

Mr. D. B. Wheelock of Barre, Vt., had several plats laid out. Sixteen 25-bushel cart loads of manure per acre gave 52 2-7 bushels ears of corn; the addition of $6.10 worth of dissolved bone-black and muriate of potash gave 83 2-7 bushels, or an increase of 31 2-7 bushels over the manured part, the fertilizers being added to the manure, or for $1 of fertilizer an increase of 5 bushels of corn and 300 lbs. of stover. Twelve dollars and twenty cents' worth of superphosphates as usually used gave but 76 5-7 bushels. J. A. Whitcher of Strafford, N. H., got 5 1-5 more bushels of corn and 1040 lbs. more of stover where he used 270 lbs. of dissolved bone-black and 150 lbs. muriate of potash than he did where he used 18 loads of yard manure. His were ox loads, I suppose, of 40 bushels. G. W. Sanborn of Gilmanton, N. H., got in a full experiment of 15 plats, with 21 tons of good strong yard manure, 58.45 bushels shelled corn per acre; with 400 lbs. of dissolved bone-black and 200 lbs. muriate of potash, 59 bushels per acre; best of chemicals, $12. Mr. Henry Hough of Lebanon, N. H., got 125 bushels of ears per acre with about $12 to $14 of chemicals per acre. Mr. Hough's statement of cost I lost, but know very nearly the cost. It was less than $14. He is a free user of yard manure—the amount I have lost—and got no more from its use on an adjoining acre. J. B. Potter of Goffstown, N. H., received on ground without manure 37½ bushels of shelled corn, on ground with 207 lbs. bone-black and 125 lbs. of muriate of potash, 66 bushels. In all of the above cases, except Mr. Hough's and Wheelock's, 80 lbs. is the basis of ears for one of shelled corn. For three years with potatoes following potatoes, treated to like fertilizers, my average crop has been,—no fertilizer, 72 bushels; 125 lbs. sulphate of ammonia, 73 lbs. dissolved bone-black, and 68 lbs. muriate of potash, have given 163 bushels; cost, $7.72. Plat 3, with one-half ration of nitrogen, cost $5.29; yield 155 bushels. Plat 4, no nitrogen, cost $2.80; yield 160 bushels. To corn, the average for $2.88 in potash salts has been 52 bushels of shelled corn. In the above cases I have given all the cases that have been returned to me for this year, so that these are not selections. I have more yet to come whose tenor I know nothing of.

Chemicals are efficacious plant food; chemicals are profitable plant food; chemicals and yard manure are more efficacious and profitable than either alone and should not be divorced in practice. With stock feeding, and chemicals inteligently bought and handled, the question of broad tillage is entirely in our own hands.

Tillage.

An analysis of good English wheat-soil by Dr. Anderson, showed .354 per cent. of potash and .43 per cent. of phosphoric acid. Good yard manure will contain but .65 per cent. of potash and but .33 per per cent. of phosphoric acid. A ton of this soil will contain 8 lbs. of potash, while a ton of yard manure will contain 13 lbs. This soil has 8.6 lbs. phosphoric acid and the yard manure but 6.6 lbs. Prof. Voelker in his celebrated analysis of clover roots and clover soils, found to the depth of a foot, that the soil investigated contained 5225 lbs. of nitrogen. Assuming 3,500,000 lbs. of soil to the acre, then the soil investigated by Dr. Anderson would contain 15,050 lbs. phosphoric acid. If this amount were to be bought in the market, at market rates of soluble acids, it would cost $1,881.25. It would also contain 12,390 lbs. of potash. In round numbers it would require 1000 loads of yard manure to furnish this potash to an acre of soil, and over 2000 loads to furnish the phosphoric acid. This soil once existed as solid rock, and has been broken down into soil by the forces of nature. Yet but a small part of it is available as plant food. Many of the agencies that have made a part of the soil available are still at work. By the art of tillage we may intensify or accelerate their work by opening the soil or producing a condition in which they have freer or fuller play. That which interests the proposed scheme of farming, is not only that there is an immense supply of the elements of plant food in the soil in part in insoluble compounds, that are gradually becoming soluble, but especially that by tillage we hasten the process by increasing the action of frosts and the circulation in the soil of oxygen and carbonic acid, the two chemical agents specially active under favorable conditions in soil decomposition.

Tillage is manuring. The increased tillage proposed will coax from the soil more plant food than it will yield by present processes, and alone will prove sufficient to increase our crops from fifteen to twenty per cent. That grand old Roman farmer, Cato, placed tillage of more importance than manuring. In fable, we find two brothers digging a farm completely over in search of a bag of gold only to find it in increased crops. The famous Jethro Tull and his disciple, the Rev. S. Smith, proclaimed tillage alone a sufficient source of plant nutritives, and for themselves, on their soils, succeeded well. The world, however, only accepts tillage as one of the sources and the cheapest source of fertility. The laws that underlie tillage we cannot stop to discuss. It exerts an influence on temperature and moisture of soil, and should be adapted to soils and seasons in so far as it may in practice. Tillage fits the soil also for the proper germination of plants and their excursion of roots for foods. While it fines the soil it also fines and distributes the manure in that area of soil where the roots must delight to grow, if properly conducted. While good tillage is one of the essentials for success in the present system of farming, and now sadly deficient in practice, yet I wish only to make the point that increased tillage is nursing our own soils to an increased extent for a part of the large stores of plant food they contain.

Rotation of Crops.

More crops can be grown on a given area under a system of rotation of crops than under a succession of like crops. This assertion is borne out by the experience of old countries for long periods. Practice asserts it, science corroborates it and exact experiments prove it. Here again, everything else remaining the same, New England farmers can, by introducing a system of rational crop succession, quite materially increase their total crop production. Suppose ten tons of good English hay to be fed over a good barn cellar to growing steers, then we should produce about twenty tons of yard manure. This applied to wheat would give very nearly 280 lbs. of potash per acre, and as the growing steers would take out more of the phosphoric acid from the hay than potash, 70 lbs. of phosphoric acid per acre. The growth of 30 bushels of wheat per acre would take from the soil 30 lbs. of potash and 24 lbs. of phosphoric acid. Three such crops would exhaust the applied phosphoric acid while but 90 lbs. of the 280 lbs. potash applied would be taken. Either one or two views present themselves as inevitable, either yard manure is not a perfect manure or such a spstem of cropping would be faulty.

Casting about for a good crop to follow this wheat crop we notice that potatoes takes three pounds of potash for every one of phosphoric acid, while beets require four to one. I name this as an illustration of the principle involved in one direction. Our attention is attracted in another direction in an emphatic way. We find a class of crops where feeding roots are mainly found near the surface of the ground and exhaust it mainly for food. Yet another class of our farm crops are deeper rooted and feed in a lower layer, while clover and its class feed very largely deeper still, or much in the subsoil. Again, some crops make a large root developement, while others only a small root growth. Also we find narrow and broad leaved plants, and plants that make their growth during the first half of the season while others maintain green leaves until frost, or nearly so. The latter two classes stand in different relations to the nitrogen supply as regards each other. The late developed plants being far more independent of nitrogen supply. During the summer by nitrification from the organic compounds of the soil nitrates are formed for these crops. The importance of clover in rotation is worthy of a brief notice. By its long tap-root clover goes down into the subsoil and gathers up and elaborates in growth the elements of plant nutrition that may have washed below the reach of the roots of ordinary plants. Its broad leaves gather, it is said, more largely from atmospheric sources of plant food. The roots and stubble of clover weigh very heavy, amounting to nearly or quite as much as the growth harvested. Dr. Voelker in his investigation of clover found 3½ tons of roots per acre, to the depth of six inches, containing as much nitrogen as is found in 37½ bushels of wheat or 61 lbs., and 180 lbs for total depth. This has been gathered from sources beyond the reach of the roots of ordinary crops. I can only find time to give the practical conclusions of Dr. Voelker, which were in substance in agreement with the popular opinion of farmers—that the clover crop actually enriched the surface soil, and that they were right in asserting that a larger crop of wheat could be grown after clover than before, without the intervention of manures. When the value of clover as a cattle food is weighed and coupled with its value as a renovating crop, especially to precede wheat, or indeed barley, corn or potatoes in rotation, little is risked in asserting that it is one of the most important of the crops grown in Maine, and that in rotation it should never be left out. I find very many sections where clover is little grown and poorly estimated. In rotation of crops we have the rules laid down by the English, as follows, in their more obvious bearing: "Broad-leaved plants to alternate with narrow-leaved plants. Those plants that require the same kind of food should be kept as far apart as possible. Plants of the same habit of growth and general character of growth should not follow each other." Whatever may be the theoretical or popular reasons for rotation of crops, we are glad to know that accurate experimenters have actually found in practice that large crops follow this practice. Upon this point Lawes and Gilbert will be accepted as authority. They and others have so found. Roots followed by barley, this by clover, and clover by wheat, was the famous Norfolk succession. This has been extended by many during late years. Markets, soils, and other reasons, will procure a strictly theoretic rotation of crops for home. Indeed, with chemicals, it is no longer so needed. In case of the illustration given in the wheat crop of the need of rotation of crops, an addition of a superphosphate would have supplied the needed phosphoric acid and maintained a proper balance for wheat between the two materials. So for any crop, potash for potatoes. Resting their opinions upon this basis of procedure many have proclaimed chemicals an antidote for needed rotations, in order to exhaust a soil in equal relative ratios of its elements of plant food. There are some deeper and more problematical reasons for rotation of crops, that chemicals do not meet in succession crops. Clover cannot be made to follow clover long on most lands by any known method of procedure. Lawes' experiments speak emphatically upon this point. While wheat followed wheat nicely, turnips would not. For thirty-eight years, to chemicals, a German farm maintained a yield superior to the yield from yard manure for rye and oats, but sadly failed to come up to this standard for clover and flax. Chemicals will release us from the strict letter of rotation law, but will not give the best result when entirely divorced from it. Just what crops shall enter into our rotation, each one must judge by his soil and market. I am quite decidedly in favor of corn in the place of the turnip crop in the Norfolk rotation. This may be followed by barley for sale, or oats and peas mixed, when sown for stock. then clover followed by wheat, or potatoes. If wheat, those who desire can seed to grass for two or three years, or continue some tillage crop; if potatoes, then some grain crop. In our extended cultivation it will be desirable to have in the rotation some cash crops for direct sale. These must be either crops of high selling value per pound, like wheat or the best barley, that is rarely less than a dollar a bushel, or a crop that takes but little nutrition from the soil per pound of growth, like potatoes that are seventy-five per cent water. Hay and oats are bad selling crops. So much plant food is taken from the soil per dollar of receipt for the resultant crop in these foods. These facts should never be lost sight of in arranging selling crops in our rotation.

Machinery Required.

We are living in an age when intense methods prevail in all other industries. It is sought to reduce muscular toil to its minimum everywhere that metal can replace muscle. The mechanism of the day is propelled by either brute force or some one of nature's agencies. It is said that the combined force of the steam engines of the world amounts to 46,000,000 horse-power, equal to twice the available working power of the entire population of the globe. This, and other agencies, has wonderfully enlarged the comforts and luxuries of civilized life. Inspired by the rapid and less wearied march of other industries, it will be hard to hold our boys and girls to the long dull trial of our machineless farms. Progress is in the air, and it will be harder still for our farmers if they are to continue to pit their brawn against the machinery of the virgin farms of the West, made a close neighbor to us by cheap freight. Our great problem is the production of cheap food by as inviting methods as possible.

Surely, ours is not to be the only industry whose motive force is the "sweat of the brow." Not that it is a misfortune to be forced to be industrious, or degrading to toil. It is belittling to an industry to use the muscle much and the mind little, when the mind could work through mechanism more effectually. This may seem something like a sentimental strain. Be that as it may, it forms in part the basis by means of which an industries' relative social position is measured, and, right or wrong, it has much to do with the attractiveness of our industry. If money, at any cost of muscular exertion or social or civil standing, is the only criterion, and New England farm life is to strike this level, then most assuredly our hopes of success hang heavily on farm mechanism. Especially does the capitalized extensive system of farming proposed, imperatively demand this aid. There is a feeling that machinery will not work well on our rocky hills. From personal knowledge I know that the machinery that I shall name, will; but first, let me premise that division walls in many cases should go, and boulders be removed. A field that ten to twenty dollars will clear, will pay richly for so doing. A field that will require twenty to fifty to clear is not worth one cent for cultivation in its present condition, for it will never pay a profit for cost of handling. Any acre that is fitted for machinery in New England, or Maine, within reasonable limits of railroads, and perhaps anywhere in your State, provided it has enough acres with it for a business, is worth one hundred dollars, and will pay six per cent. interest on this sum under modern methods. In my experience, the loose rocks of our hill farms, from the size of a man's head down, are of no special trouble to machine farming. On such a farm I find that two men and two yoke of oxen are required to plow three-fourths of an acre a day. A much faster speed is not desirable with an ordinary plow on rocky soils, as the quality of the work is impaired. One man, three horses and sulkly plow, or common plow with sulky attachment, will plow from two to two and one-half acres a day, and do better work. This makes about a fourfold saving and gives us a genteel farmer riding his sulky seat. Again, in his sulky seat he may scatter, with one horse, fertilizers or grain over fifteen acres in a day, and not soil his hands, and do the work better than by hand methods. Following comes the wheel harrows, the master riding, surveys the lifting, pulverizing work that is sure to be followed by better crops than the packing, square-toothed harrow. This in turn is followed by a two-rowed corn planter, good to open, drop and cover, for one man and horse, twelve to fifteen acres of corn in one day. Better work is done for less than one-twelfth of the expense than is done by hand work,—or for potatoes, the potato-planter will make as large a saving. After the corn-planter comes the Thomas smoothing harrow. With it I have hoed, better than twenty to twenty-five men would have done, sixteen acres of corn in a day for one man and pair of horses. This followed by the horse-hoe, completes the hoeing of the corn without the hand-hoe, or, at most, excepting one day's work or part of a day in pulling a few weeds that may have escaped. For potatoes the hand-hoe is absolutely unneeded.

Of the many machines used, or yet to be used in the various departments of our farm industry, these will serve to illustrate the absolute indispensibility of the full employment of mechanism on the farm. I hold it no exaggeration to say that one man can plow, fertilize, plant and tend thirty acres of corn alone up to harvesting. If in one department of farming all this is true, will it have nothing to do with the profits and with the attractiveness of farming? It is said that machinery cannot be afforded on our hill farms with narrow opportunities for use to the few crops grown. This objection would have some force provided our conditions were forced upon us. Our walls can be cheaply removed, thus removing one objection. But machinery for two, or five acres of corn, or potatoes or grain, we are not going to buy, but for many times those numbers. We are going into business now and get a full and fair yield for machinery.

But the smaller class of farms? says some one. Cöoperation—joint ownership of some machines is a clear way out. A two-rowed corn-planter will do the work of a neighborhood. The same with the fertilizer distributer, and some other machines. It is said that there is friction in this method. Necessity is a wonderful lubricator and will smooth this difficulty. But if we prefer to growl at each other like animals, and be so selfish that we cannot harmonize, then we have got to live one degree nearer their existence; hunt just for an existence. I am sorry that it is so, but am not responsible for the fact that, in agriculture as elsewhere, the tendency is towards centralization or largest success in largest operations. The old motto is reversed, and it is now large farms for profit. I do not refer to the top-heavy farms of the West, but to the larger farms East, that can till from one hundred to three hundred acres. In referring to machinery, I may be allowed to say a word of encouragement for the East against the West. Freight now, in December, is forty cents a hundred from Chicago, but the corn comes from beyond Chicago, and pays local freight into Chicago. We will assume it to be thirty cents a hundred. We have 39.2 cents on a bushel of freight, which is virtually a tariff in our favor. Then our corn stalks are worth (100 lbs. to the bushel) 50 per cent. more to us than to them, probably more, but this will give 12½ cents in our favor, or a total of 52 cents a bushel in our favor; 25 cents will pay for fertilizers to raise a bushel here and keep the farm good, and more, while theirs are depleting. Farming is certainly going to be more prosperous in the East than in the West, and I should prefer to own a good New England farm than a similar Western farm. Acting in this belief, I am now engaged in full faith in the system of farming proposed to you, and have not as yet been disappointed.

Capital Required.

Any occupation whose chief factor involved is muscular exertion, receives low compensation. The returns for the labor of the farmers of New England at $1.25, has far exceeded the returns of the capital invested in their farms. The amount of capital and skill involved in our low type of farming, has brought our condition and rewards very close to the pay of day laborers, and less than skilled labor. Our farmers look upon their business as an opening to put or expend their labor, rather than as a field for investment of capital. This policy is to be reversed if high social position or financial success is expected for our business. English farmers not infrequently have a personal capital of $75 to even $100 for every acre of their arable farm land, while, speaking from memory, their average is $50 per acre; and yet their tenant farmers pay from $5 to $15 rental per acre, and make interest on personal capital invested, yet the world-renowned English farmer (Mechi) says $100 to the acre, at least, is required. The more capital the more net returns, seems to be his motto, and a good one.

What is the value per acre of personal capital in Maine? I am everywhere met with the objection that they, the farmers, have not the capital to put in and can't get it. The trouble lies deeper—neither you nor capital have faith in the outlay. Millions of Maine farmer's capital is in your savings banks and elsewhere, yet these farmers that loan, pursue the same system of farming, or a worse one, than those do who borrow. Demonstrate to keen-eyed capital that has seen your farms sell lower at each auction sale for a generation, that farming will pay six per cent., as it will and more, on present valuation of land in farms ($18.93 per acre for 1870, by the census,) and hundreds of millions are at the command of our business. But the first start, the gaining of confidence for our business, must first be established.

There are in agriculture, as everywhere, men without business energy. Men of resolves but not of action, who have no confidence in their business, nor business in them; who are in a condition of semi-bankruptcy; who have all the year to figure their expenditures down to their small incomes, working when they feel like it. The freedom, and certainty of corn bread and pork, makes farming attractive to such men. Sheer necessity will keep such farmers, following by imitation, a generation in the rear. To all others, the question of capital is the smallest "lion in the way," and inherited methods the largest. Given, 50 acres of plow land, now producing 35 tons of hay; 2½ acres corn, 100 bushels shelled corn, and five tons stover; 1 acre potatoes, 100 bushels; and 125 bushels of oats and barley, worth in the barn $450. In the spring put your manure over 7 acres in place of 3½ acres, and add 250 to 300 lbs. dissolved bone-black, and 100 to 125 lbs. muriate of potash, costing $6.90 to $8.37 to the acre, for 6 acres corn, and 125 lbs. each dissolved bone-black and muriate potash, to 1 acre potatoes, costing $5.29; total cost. $46 to $55. You will now get 50 bushels shelled corn per acre or 300 bushels, 15 tons of stover, and 150 bushels of potatoes, but 2¼ tons of hay less. Your excess crop will cost but little more in labor, you having become full or part owner of a corn-planter, horse-hoe and hiller, for corn and potatoes; Thomas smoothing harrow, and disc harrow, whose total cost is but $75 or $100, if planter is two rowed. Value of excess crop over previous year with corn at 65 cents, potatoes, 40 cents, and corn fodder $6 per ton, less 2¼ tons of hay at $10 per ton, $187.75. This will more than pay for tools and fertilizer. During the summer you will want to feed $100 worth of middlings to pigs that will return the money in the fall. If you have capital or credit enough, the excess fodder grown will want to be fed, and a ton or two of cotton-seed meal fed with the corn fodder and straw, after the clover hay has given out, that should go with it. If capital is lacking then a part of the grain could be sold, but you will not probably be forced to this. The second year you will have very much more manure and better than before, and can break ten acres, using chemicals as before, and also on the grain ground, making seventeen acres to fertilize. Twenty dollars will now be wanted for a fertilizer distributer; and a sulky plow attachment costing $20 will pay. For another year more ground will be plowed. You will have the corn grown the previous year to fatten off your increasing herd of pigs that have been grown this season on middlings. Your money will now be coming back from excess crops of last year, in pork, butter, lambs or steers. This will more than pay for the $100 in chemicals that you will have to buy, and new tools, $40, or total, $140. So that the capital, as yet involved, is only the first year's outlay. An increase of stock will have to be made to feed the increased crops of this year, and to buy cotton seed to match, say fifteen acres of corn fodder and straw. Under such circumstances one's credit would be good for two hundred dollars. This would mean more manure and more plowing for the third year. Thus, in four to five years, the whole of plow land could be put under constant culture, excepting ten acres of clover, if the rotation was a five years' course. This ten acres of clover in two cuttings of one year only, would soon be good for the thirty-five tons of hay originally got.

It was not my purpose under the heading, Capital Required, to lay out a course of rotation, nor to pursue the matter to the end, indicating the amount finally required. I only wished to indicate that little was required to start for the first year or two, that the system would bring quick returns; and that while it increased the crops of the farm and business done, that it would substantially pay as we go. After having gone over the farm once, the continuous culture, rotation of crops and increased manure used, would increase the crops per acre until we should achieve 65 to 75 bushels of corn as an average, wheat 30, and other crops in proportion. Fifty dollars per acre would then be achieved for 50 acres, at a very handsome profit on present valuations. But land would not long remain at $18.93 per acre under these conditions. The farms are abundant where, out of the wood land and pasture could be carved a total, with the field now in use, of 100 to 150 acres of tillage. Upon such farms steam power for threshing and grinding will find their place, along with a full line of machinery and heavy stock, all of which will require a degree of capital and skill, and will yield an income that will give to our business a rank second to none in attractiveness. Our farming is going through its transition state rapidly in the directions named. Intelligence, business energy and capital will carry it to a successful issue. The farmers of Maine, in common with those of New England, have the energy and native ability, and will command the capital and acquire the developing facts that will, with our favorable markets, make of New England farming the most successful, and New England farm life the most attractive of any section of the country.

APPLES FOR AROOSTOOK.

By Dr. T. H. Hoskins, of Newport, Vermont.

[At the request of Secretary Gilbert the following article is prepared for this Report, as containing the substance of my extemporaneous address upon Fruit Growing, at Houlton and Presque Isle, October 24 and 26, 1880. T. H. H.]

Fourteen years ago, when I first settled myself to farming upon the shore of Lake Memphremagog, in Northeastern Vermont, it was generally believed that apples, with the exception of Siberian crabs, could not be successfully grown in that elevated and bleak locality. The range of mountains forming the water shed, summit, or "divide" between the upper Connecticut and the valley of the lower St. Lawrence, is probably, in winter, the coldest locality on the Atlantic slope south of the Lawrentian chain, which forms the northern boundary of the St. Lawrence valley. Lake Memphremagog lies among those mountains which stretch across the Connecticut valley and connect the White Mountains of New Hampshire with the Green Mountains of Vermont. The surface of the lake is 700 feet above the sea, and the country around it, though fertile, and a fine dairy region, rises to more than double that height, some of the best dairy farms standing at least 1400 feet above the ocean level. Above these the wooded summits of the hills rise as much higher, Owl's Head and Bear Mountain, which stand before my west windows, six and ten miles away, being respectively 2,800 and 2,600 feet high, while Mt. Hor, Mt. Pisgah, Burke Mountain, and the Sheffield and Sutton Hills rise in the south and southeast to at least an equal height. Fourteen miles to the southwest stands the Green Mountain range, whose highest summits rise 4,600 feet. This ampitheatre of hills opens unprotected to the north and northeast, and in winter the mercury is kept, even in the milder times, pretty constantly below zero. I have known three weeks to pass in which the themometer was not once above zero; and hardly a night during the time in which it was not at least twenty degrees below that point. Exceptional temperatures range downwards to the freezing point of mercury, and below. This severe and long-continued cold has seemed to make it impossible to grow any kinds of tree fruits. The intense and persistent frost destroys the vitality of even such tough and enduring sorts as the Tolman Sweet and Red Astrachan apples. No cultivated stone fruits except the old-fashioned red pie cherry and the red Canada plum have as yet succeeded, and none, even of the hardiest pears, have been brought to bearing.

Notwithstanding this very unpromising outlook, I could not abandon the idea of producing my own fruits. Born among the abounding orchards of Kennebec county, I would not give up the hope of sitting under my own apple trees in the country where my lot was cast. There were few grounds for encouragement, yet there were a few. A single "English apple," as it was called, (though it proved to be a French one,) had been found hardy enough to resist the winters' cold. This, known as the "Peach Apple," but unlike any recorded variety of that name, had been brought from Montreal, and was a decided success. I could not but hope that as there was *one* such, there might be others found, when a partial search was made. To begin with, I ordered one hundred and eighty trees of some thirty varieties of the hardiest sorts known in Maine. These included Sops of Wine, Red Astrachan, Williams' Favorite, Porter, Moses Wood, Gravenstein, Fairbanks, Northern Sweet, Duchess of Oldenburgh, Winthrop Greening, Morgan Sweet, Franklin Sweet, Canada Reinette, Fameuse, Rockwood, Jewett's Red, Black Oxford, Cathead, Blue Pearmain, Tolman Sweet, Yellow Bellflower, Cole's Quince, Westfield Seek no Further, Ribstone Pippin, and several less known sorts. Though a few of these still survive and produce fruit, only one of them proved to be entirely hardy and safe to set as an orchard apple. This was the Duchess of Oldenburgh, of the same season (early September) as my Montreal Peach apple. The next entirely hardy apple which I obtained was the Tetofsky, a Russian variety, imported at the same time as the Duchess of Oldenburgh, by Manning of Massachusetts. It is an August fruit. Thus I had supplied myself with apples for summer and early fall.

Meantime, I had been searching in my rides about the country for native seedlings that might prove to be of value. I had also reached out to the great North-West, to Wisconsin, Iowa and Minnesota for help, and also to the adjoining Province of Quebec. Many varieties from these localities were tested, and some progress made. Plumb's

Cider, a good late fall sort from Wisconsin, proved hardy. The Alexander, another Russian, came to me from Canada. The St. Lawrence was yet another hardy sort received from my provincial neighbors. Both of these are fall fruits, the latter being an October, and the former a November apple. These were the few successes among many failures. At last I found two genuine winter apples near home, which had come up and grown to successful bearing along the western shore of our lake. I have had the honor of naming and of being the first to propagate both of these. One, the Magog Red Streak, is in season from January to April, and the other from March to July. From just over the "divide" to the south came to me my first successful early winter sweet, known as the St. Johnsbury Sweet. Later, among our native seedlings on the lake shore, I have found a late keeper of the same class, which has received the name of Newport Sweet. From a friend in the Champlain valley came a small but excellent September sweet apple, called the Pringle Sweet. Among recent importations from Russia that have succeeded with me, are a fall sweet called the Prolific Sweeting. From the same importation came my best early apple, the Yellow Transparent, which is eating all through August. But probably the most valuable of all my acquisitions has come from northern Minnesota, in the form of the Wealthy, an early winter sort (sometimes keeping until April) of high quality, good size, great beauty and bountiful productiveness.

Thus I may say that in apples I have now about all that I could wish, and far more than I could reasonably have expected in so short a time. More than a hundred other varieties, many of them very promising, have come to me and are under trial. Probably there are some among them that will more profitably replace varieties named above. If life is spared to me I shall not fail to report their merits to my friends in Maine.

A little more particular description of the best varieties named above, with others, such as form a succession for all seasons, will no doubt be acceptable to readers in northern Maine, who have not yet found success in orcharding with varieties known to them. I will therefore now name and describe them in order, as follows:

Summer Apples.

Tetofsky.—Tree a slow, upright grower, with strong, rigid branches. Fruit borne upon stout spurs, after the manner of most pears. Four or five set upon each spur, and as they grow they crowd one another off, until only one, or sometimes none, is left. The fruit is from small to large medium in size, being very uneven in this particular. It is of a straw yellow color with faint pinkish stripes, and sometimes a blush upon the sunny side. Flesh firm, even when fully ripe, with a mild, pleasant, sub-acid flavor. Would be desirable were it not for dropping the fruit and the uneven size. Owing to its slow growth this variety may be planted quite close, but should have a rich soil. Succeeds best in the garden. The dropped fruit is good for sauce or pies. Season, the last half of August.

Yellow Transparent.—Tree a free, rather upright grower. Fruit abundant in alternate years, with but few in the intermediate seasons; light straw yellow in color, with a waxy delicacy of tint. Flesh tender and melting, with much perfume but not a very high flavor, and but little acidity. It resembles the well-known Early Harvest, but is not quite so good. Will mature well if picked green, which makes it a good shipping apple. Season, the first half of August.

St. Peters.—This is a small apple of the same season as Tetofsky. It resembles the early Joe. The tree is a free, slender grower, and though upright at first it becomes drooping after reaching bearing age. The fruit is about two inches in diameter, mostly of a dull red, and of excellent flavor. This is a good apple for home use, but too small for market. Season, August. This and the Yellow Transparent were among the Russian varieties imported by the U. S. Department in 1870. The Tetofsky is also a Russian, but of an earlier importation. Another of these, almost identical in tree and fruit with the Yellow Transparent, is called the Grand Sultan. It is a little larger and a little higher flavored than the Yellow Transparent, and sometimes has a faint red cheek. The tree is, however, a poorer grower and less hardy.

Fall Apples.

Duchess of Oldenburgh.—This variety, (which has been disseminated in Aroostook under the name of New Brunswicker,) is a general favorite in all cold localities. The thrift and hardiness of the tree, its early and profuse productiveness, large size and fine color, are considered full compensation for its only moderate quality.

It must be said of it, however, that it becomes better in quality the further north it is planted, and with me it is accepted as a very fair eating apple of its season, which is the first two weeks in September. It is a very profitable market apple. Nearly all are perfect and of good size. It is a good pie fruit when only half grown. Picked early it ships and keeps well for an early fruit. It is a profitable apple to dry. I have over two hundred bearing trees, and find a quick sale for the fruit at good prices. This is a variety which succeeds well under neglect, and is therefore recommended to the lazy and shiftless planter as his "best hold" for apples. It is a Russian.

Peach of Montreal.—Tree a strong, but rather straggling grower when young, becoming more symmetrical with age. Somewhat subject to bark blight on the trunk, but usually outgrowing it. Fruit, medium to large, in form like the Porter, but not quite so conical. Buff yellow in color, with a fine rich red cheek, which makes a small specimen at a short distance look like a Crawford peach. Quality very good if allowed to mature fully on the tree. If gathered before maturity it does not ripen. This, with the tenderness of the fully ripe fruit, renders the variety of little value as a market apple, but for home use it is a good deal better than Duchess. It is a heavy bearer alternate years. The fruit ripens along all through September and into October. It is tart enough to cook well, except when dead ripe.

St. Lawrence.—This is a first class dessert apple of large size and great beauty. The tree is not strictly "iron clad," yet I have never had one killed, or very badly injured. Its chief fault is that it is very long coming to bearing, and is never a profuse bearer. A Duchess or a Peach Apple tree will bear a dozen barrels before a St. Lawrence will produce one barrel. Yet I would not be without this variety, both on account of its excellent quality and its season, which is October. It is a large greenish yellow apple, covered with broad bright red stripes, being very distinct in its appearance from any other apple of its season.

Alexander.—This variety, (also called Emperor, or Emperor Alexander) is one of the earlier importations from Russia. It is an imperial apple in appearance, being very large and beautiful to look upon, but rather "woodeny" to eat. The tree is about with St. Lawrence in hardiness,—not "iron clad," but doing pretty well, being hardier than Red Astrachan. It is a good bearer; the fruit hangs on remarkably, considering its size, and sells well in market. With care it will keep all through November, and sometimes longer. It is not tart enough for a good cooking apple, nor good enough for dessert, but is just the thing to get the first premium on at a fair, from an average "Fruit Committee." It is a Russian, imported many years ago.

Riabinouka.—This is another Russian, of the Department of Agriculture's importation in 1870. When my two trees of it first bore I thought it the Alexander, which it resembles in size and color. It proves, however, to be distinct, the shape being different and the quality much better. The tree seems to be entirely hardy, thrifty and productive. Season, October and November.

Plumb's Cider.—This is a large yellow apple, faintly striped with red on the sunny side. The tree is hardy and a very vigorous grower, but at twelve years old has not shown much productiveness with me. It is, however, regarded as a profitable variety in Wisconsin, whence I obtained it, and is well spoken of in the report of the Iowa Horticultural Society. I suppose cider could be made from it, but it is not a cider apple in the ordinary use of the term. It is a mild, pleasant flavored, late fall apple, sometimes keeping till January.

Wolf River, is another Wisconsin apple, perfectly "iron clad" as regards the winter's cold, a strong grower, and reported to be productive. It is as large and handsome as the Alexander, and, says the honest gentleman who sent it to me, "not much better." Season, late fall and early winter. It has not yet fruited with me.

Winter Apples.

Fameuse, (or "Snow apple,") is a Canadian apple, which we all try to grow, but in the severest localities with only moderate success. It is one of the best of desert apples, and though small, one of the handsomest and most salable. The tree is more tender in the nursery, and after being transplanted, than when it gets larger. I have lost no trees after they have come to bearing, but a good many before. I grow them most successfully by scattering them through the nursery at proper distances, and letting them remain when the rest of the nursery is taken up. Season, early winter. Further south it is a late fall apple, and in warm seasons the same with me. Occasionally it will keep nearly all winter.

Wealthy.—This Minnesota seedling, (grown from seed sent, 20 years ago, to Peter M. Gideon of that State from Bangor, Me., by Albert Emerson) is, for an early winter apple, all that the Duchess of Oldenburgh is for an early fall apple, with the addition of first rate quality as a dessert fruit. Trees seven years old bore for me the past year over half a bushel of beautiful apples, perfect in form, large and even in size, of a clear bright red color, and at this time (December) most delicious for eating. The tree is thoroughly hardy, a handsome, thrifty grower, with a spreading upright top,—in short, all that could be desired in an appletree. Last year the fruit kept in perfect order until April, but this season it does not seem likely to keep long after New Years. I am so pleased with this variety that I have already 400 trees of it growing in orchard.

McIntosh Red.—This Canadian variety is very similar to the Wealthy, in all respects, so far as I can see, except that the tree is not quite so hardy, being, however, hardier than the Fameuse. The fruit is of the highest quality, much larger than the Fameuse, but having such similarity of flavor as to cause me to regard it as a seedling from that variety. I have not yet had a good opportunity to test its keeping qualities, but think it about with the Wealthy in this respect.

Magog Red Streak.—This is the first of the two native seedlings found growing on the shore of Lake Memphremagog that I have thought to be worthy of propagation. It is a large yellow apple, somewhat like the Yellow Bellflower in shape, but with more or less distinct stripes of red upon the sunny side. It has a yellow, fine-grained flesh, and a mild sub-acid taste, with a rich and rather peculiar flavor. It is a superior cooking apple, and a very good eating apple. The tree is quite hardy, a vigorous grower, and a fairly productive annual bearer. In keeping quality it is about with the Baldwin. Specimens can often be kept until July, but it loses quality after the first of May.

Scott's Winter.—This, which is the second of my two native seedlings, is an exceptionally strong grower, and hardy as a crab, but needing careful pruning when young, otherwise it makes too close a head. It comes into bearing about as soon as the Duchess and Wealthy, and is an equally profuse and constant bearer. The fruit is heavily striped, and sometimes covered with shades of red. It is of medium size, becoming quite large under good treatment. It is rather a spring than a winter apple, being useful only for culinary purposes during the winter months. It keeps in prime condition quite as long as the Roxbury Russet, and is a far better apple, being crisp, spicy and refreshing up to the last. It is a *good* keeper as well as a *long* keeper, very few decayed specimens being found even as late as the middle of June, when kept in a cool, dark cellar. I have already 350 trees of Scott's Winter in my orchard.

Bethel of Vermont.—This a first rate, hardy, large, handsome, long-keeping red apple, whose only fault is its uncertainty as a cropper. In some places it is a profuse bearer, while in others it has the contrary reputation. It seems to be most at home in valley lands that are rich, deep, and moist without being wet, and I should expect it to be successful in many places in Aroostook County.

I have not included sweet apples in this list, because they are the most difficult class in which to find thoroughly hardy and otherwise satisfactory varieties. For a while I almost despaired of finding a series of sweet apples adapted to my location; and now, though I think I have them, I have not had them long enough to speak positively in regard to them. Those of which I am most hopeful are,—

Pringle's Sweet, a strong growing, profuse bearing, and perfectly hardy sort, two inches in diameter, ripe in September. Baked, it is equal to a fig in richness, and it is a fair eating apple. It is attractive, being of a rich yellow color with a red cheek, but its small size greatly lessens its value as a market fruit, except with those who know it.

Prolific Sweeting.—One of the newer Russian varieties that is quite hardy and promises to be productive. It is of large size, yellow in color, and in season during all of October. Excellent for cooking, a fair eating apple, and valuable for market.

St. Johnsbury Sweet.—A very handsome and excellent early winter variety. It is richly striped with red on a yellow ground, medium to large in size, excellent for eating or cooking, and keeps till February. The tree is productive and hardy.

Newport Winter Sweet.—This is a home grown seedling, only the original tree having as yet produced fruit. It is a long keeper, of good size, productive, and in color and quality like the Tolman, but flatter in shape. The tree is hardy and thrifty.

Mountain Sweet.—This is a Maine apple, received by me from Wisconsin. I can only say that the tree is hardy. I am informed by Secretary Gilbert that it is a fine apple of dessert quality, and a keeper. This will make it very valuable.

I will conclude by giving a brief account of my method of growing nursery trees and planting an orchard. To begin with, I am particular about my stocks, growing them from seed of the hardiest varieties of native apples, but never from crabs. The crab stock has been thoroughly tried and found not to produce good orchard trees, though fair looking *young* trees can be grown upon them. Crab stocks have been tried in this vicinity for twenty-five years under the idea that they would impart their hardiness to varieties grafted upon them. The experiment has proved a perfect failure. The crab stock gives no hardiness to a tender variety, and shortens the life of hardy sorts grafted upon it. I use only yearling stocks, sorting out those which are of strong growth, and throwing the rest away. For several years I grafted with short cions upon long roots. Now I have reversed the practice, and graft long cions on short roots, setting so as to leave but one or two buds above ground. In this way, with almost all varieties, I get good roots from the cion, which take the lead of the "nurse-root" upon which it is grafted and give me a tree at three years old which is practically upon its own roots, and is therefore as hardy in root as in top. I do not bud, or top-graft, as is the custom so generally in Maine, for the following reasons: First, no matter how carefully you may select your seed from hardy fruit, a large proportion of the seedlings are not hardy, and will winter-kill, more or less, if allowed to grow above ground. Second, no matter how carefully top-grafting may be done, there is, in our severe climate, more or less injury done to the stock in the operation, and the union is never as perfect between stock and cion as in milder climates. Thirdly, stock for budding must be a year older, at least, than for grafting, and the union being above ground the stock, when cut off above the bud, is at least two years in healing over, and there is almost sure to be an unsound spot in the tree at that point. Fourthly, you cannot get a tree on its own roots by that method. This getting roots from the cion is as practicable with apples as with pears, and my very best trees have been grown in that way. I was strongly prejudiced against it at first, but the "logic of wants" has convinced me that for my climate it is the true way.

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The trees being grafted as above are set in good soil in rows four feet apart, the grafts being twelve inches apart. They are carefully cultivated and allowed to grow as they will the first year. Very few are lost, and the growth averages eighteen inches. The next spring they are pruned to one stem when more than one has grown, and after the buds have opened all but one strong one, as near the top as may be, are rubbed off. At the close of the second season the average height is about four feet. The next spring five or six strong buds at the top are allowed to grow for branches, those below being rubbed off as soon as they are opened, and all that start subsequently during the season, are carefully removed in the same way as fast as they show themselves. The trees at the end of this, (the third) season, will be from five to six feet high. This is the age at which they are usually transplanted, or sold. Many of mine, however, have been transplanted when two years old, and allowed to branch where they are to stand. Some varieties (particularly Scott's Winter) do not, however, transplant well until three years old, owing to the fineness of their root growth.

The subsequent management consists in keeping the ground between the trees cultivated in low hoed crops until the trees come well to bearing. My orchards are set out in rows 24 feet apart, the trees being 12 feet asunder in the rows. My intention is to cut out every other tree in the row as soon as they appear to crowd, leaving the orchard 24 feet each way. These intermediate trees produce many barrels of fruit before it is necessary to remove them. With varieties like the Duchess, Wealthy and Scott's Winter, which bear young and abundantly, and do not grow fast after beginning to bear, it would probably pay, when the available area for one orchard is limited, to plant the young trees 12 feet apart each way. But the soil should be good, well tilled, and well fed to make this method successful, and as soon as the trees begin to interlock their branches every alternate row must be relentlessly dug up, or the orchard will be ruined.

In severe climates even the hardiest trees are injured by cutting off limbs so large that the wounds do not heal the first year. This necessitates careful and thorough removal of superfluous growth in the young tree before it reaches a size beyond half an inch in diameter. With all trees disposed to grow bushy this penknife pruning must be relentless during the first four or five years after setting. With the best care some superfluous branches will escape our notice until too large. These should be removed with a fine saw and the wound cemented. The best cement I have ever used is made by simmering a quart of pine tar over a slow fire for three hours, then adding 3 ounces of tallow, ½ a pound of beeswax and ¾ of a pound of rosin. When these are thoroughly melted and mixed by stirring, the dish should be taken from the fire and the contents allowed to partially cool. Then have ready 1½ pounds of dry and finely powdered clay, which must be gradually stirred into the melted wax, continuing the stirring until it becomes so thick by cooling that the clay will not settle. This cement is soft at ordinary temperatures during the spring, summer and fall, and can be spread with the point of a knife. It remains soft and pliable for many years, yielding to the growth of the young wood, and can be pushed back into any crevice with the end of the finger. It forms a perfect protection from the air and external moisture until the wound is healed. I should have mentioned that with trees as I grow them, properly dug with plenty of roots, and properly set out, there is no need of cutting back the limbs when transplanted. I object to cutting a tree at that time as more injurious than at any other, and with the small top of five or six branches of only a single year's growth, it is quite unnecessary.

Any reader of this who wishes further information by letter I shall be glad to oblige if he will write to me and enclose in his letter a stamped and directed return envelope.

BUTTER DAIRYING.

By G. M. Gowell, President of the Board.

When considering the propriety of pursuing any course of stock or crop production, there are, or should be, two objective points, never to be lost sight of. First, the influence of the course upon the condition and welfare of the farm. Second, its influence upon the farmer and his receipts. It is perfectly safe to be guided by the assertion, that any course which does not tend to the building up or increased productiveness of the farm should be avoided. I do not wish to draw comparisons between the different methods of utilizing the grass and hay crop, by producing beef, wool, mutton, cheese or butter; for, practically, it makes but little difference to the fertility of the farm, so long as the crop is consumed upon, or the resulting manure returned to the land that produced the crop.

Accepting it as a fact, that in the management of our farms some one branch must be pursued as a leading specialty, attended by others of minor importance, if desired, we come at once to consider the subject of Butter Dairying as an important interest, and one worthy of our attention, where surroundings and circumstances are favorable to its pursuit. The demand for butter in the markets at home and abroad, and the location of our State, with its cool climate, pure water, and natural grass producing capacity, are strong arguments in favor of supplying not only our own wants, but exporting largely of the finest quality of dairy goods.

There are but few farms in Maine, comparatively, that are not adapted to the production of butter. Any land that furnishes good qualities of cultivated or natural grasses, with an abundance of pure cool water, can be used successfully for dairying. It has been, and still seems to be quite generally supposed, that unless a farm contained an extensive pasture, producing an abundance of grass, and not liable to be affected by summer droughts, it could not be used to advantage as a dairy farm. This is accounted for, probably, by the prevailing idea that no other food furnishes so good a quality of butter as grass, and that hay, and the cool weather of other portions of the year are not conducive to its production. By growing crops, especially for forage, and feeding to the cows, nights and mornings, the difference between poor and good pastures can be readily supplied. I do not propose in this connection to lay down rules for a complete course of soiling; neither do I advocate exclusive soiling, for portions of the areas of nearly all farms seem peculiarly fitted for grazing, by reason of producing a close, fine growth of nutritious grass, the soil being of such composition as not to be seriously injured by the tramping of the feeding animals, while other parts which are too rough or rocky to be readily made into mowing fields, but which are sufficiently fertile to produce a good sod, should of course be kept in permanent pasture.

But in most cases our pastures do not furnish food enough, easily gathered, to admit of cows feeding exclusively upon them, producing such quantities of milk as they are capable of doing, on more generous rations. By having a few acres devoted to the growth of orchard grass, oats, and Hungarian grass, the pasture food can be supplemented from the first of June until September with green fodder from the fields, after which, cured fodder and hay from the barn can be fed. By no means understand me as speaking lightly of the value of a good pasture, for he is fortunate indeed who possesses one; but I do wish to show that it is not indispensible and its absence not a good reason why a person who has a good "grass farm," with a poor or ordinary pasture, should hesitate to engage in dairying if he desire to do so. Of course the cows should have the benefit of the best pasture the farm can furnish; but even with the best, there is but a small part of the year, when additional food will not be consumed, and will not be accounted for by the increased milk.

I am fully aware of the reluctance entertained by most farmers, to use dry hay so long as it can possibly be avoided; but what is the difference whether we feed out our hay in summer or winter, so long as we receive for it its full value? Dairying can not be made profitable, unless each cow receives all the food she can utilize. It should be supplied regularly, and in uniform quantities. It is economy to give concentrated food, in the form of bran and corn meal or cotton seed meal throughout the whole time the cow is giving milk, withholding it only when she goes dry, and for a few days after coming into milk again.

The winter quarters of animals should be as comfortable as it is possible to make them, with the temperature never so low as the freezing point, and the free admission of sunlight should be provided for, by means of glazed windows. Within these comfortable living rooms, the animals should be kept from fall until spring. excepting the few moments daily in which they are turned to the yard for water and exercise. Warm and clean, they are in condition to make satisfactory returns for the food and care bestowed upon them. One rule covers the whole ground of successful management, viz :—See that no animal in the herd has a single unsupplied want. As they come crowding from the pasture to the yard at night, see that the weak as well as the strong have an opportunity to take an additional swallow of water from the overflowing trough, before going to their stanchions in the barn for the night. Teach them that you are their friend—they will readily understand it, and come crowding around for a friendly word and a gentle pat that will cause them to chew the cud of contentment and peace. Of course the cows are to be kept in the barn nights throughout the year, and bedded with cut straw, sawdust, sand, or some convenient material, sufficient to keep them clean. Thus provided for, a few moments use of the card and brush daily, frees them from loose hair and adhering filth. Of all customs so common, I might say almost universal, there is none that calls so loudy for condemnation, as that which compels milch cows to become encased in armors of their own voidings, from which they cannot free themselves until the approach of spring, when kind Nature gives them new clean coats in exchange.

The average annual production of butter from each cow in many herds is from two hundred and fifty to three hundred pounds or over, and there is no good and sufficient reason why a single cow should be kept that falls below these figures. But the present actual average production is far below this amount; people with an opportunity to judge, claim it not to exceed one hundred pounds. With this amount as the standard, is it any wonder that dairying is unpopular, and the poorest paying business one can engage in?

Let us look for a moment at practices still too common, as showing some of the causes of this low average. The idea generally prevailing, that the profits of the business come mostly during the grazing season, the cows are allowed to breed early in spring, so as to be fresh with the starting grass, and in the best possible condition to convert the abundant growth of June pasturage into milk. Little or no provision being made for the summer droughts, except a few rods of fodder corn, they are nearly dry when turned into the mowing fields in autumn, there to be surfeited with the surplus growth of clover aftermath. As the cold fall rains come on, we find them huddled in fence corners, or seeking shelter beneath the branches of some isolated tree; and as the season advances they are still turned out in the early morning, to graze the frozen grass that breaks under their feet like icicles, and contains about as much nutriment, there to remain, rain or shine, until they are wanted for the night milking; and this course goes on until the snow of winter hides the last leaf of grass from the sight of their avaricious owners. During winter they are kept in cold, dark barns, in dampness and filth, varied by standing all day in the open yard, and eating their dinner of straw or over-ripe hay from off the muddy ground or knee-deep snow.

Gentlemen, you may claim this statement overdrawn, but take the State together, from the coast to the northern border, and there are still too many such examples to be found.

It is not my duty at this time to extol the qualities of any one breed of cows, to the detriment of others, for butter of good quality is made from all the breeds and also from their grades. Some cows, or families of cows, are especially adapted to its production, while others are worthless for that purpose, and it is only by actual tests that their value can be ascertained. The records of careful tests of a cow and her ancestry, are of much more practical value than a very long pedigree. It is claimed that not more than one or two pounds in one hundred of the whole amount of butter made, is of good quality, and really fit to eat. While this statement seems incredible, and reflects upon our intelligence and skill, and wounds our pride, yet, if the whole product could be put upon the wholesale market and sold upon its merits, it is doubtful if a larger percentage than is indicated would sell as a really first-class article, while the great bulk of it would go as fair, ordinary, poor, and—grease. Yet, while so small a proportion of it is good, it is probably in keeping with the number of consumers that know the difference between a fine and common article. But the public taste is being rapidly educated to a higher standard, and the demand is made by the masses for a better article than they have previously been satisfied with. The time is not far distant when poor butter will be forced from the market by a better, more satisfactory, higher priced article, the result of greater skill in manufacture, and more fastidiousness on the part of consumers.

Butter has been slow in arriving at a high degree of perfection in quality; and it is only within a few years that the firm, fine-grained, rich colored, delicately flavored kind, known as "gilt edge," has been produced. The city market of Philadelphia was first furnished with it, from makers in that vicinity, and it is but just to admit that the wonderful improvement in its manufacture is largely due to that section. But there it was not long confined. Some of the most progressive butter makers of New England, influenced by the desire to excel, availed themselves of the necessary knowledge, and put upon the market a perfect article; and we have within our own State as notable examples of success as are furnished by any other part of the country, and our best butter, when examined by critics, is pronounced perfect, and is selling to retailers and private consumers in the towns and cities of Maine and Massachusetts, at prices which, although not fancy, are above the general market. Do not understand me as advocating the attempt to obtain "fancy prices." Reasonable return for investment and labor, is what should first be sought for. Fancy prices, although they may be obtained in a few instances, are no guides, but apt to mislead and disappoint the enthusiastic novice. Perhaps it is well for us to consider what the prices are that we can actually obtain for all the perfect butter we can produce. The answer is obvious; our surplus will seek the wholesale market of Boston, and we must only be satisfied when its quality is such as to secure for it the highest quotations in that market.

So much has been said in regard to cleanliness in milking, that it hardly seems necessary to refer to it; but, reminded as we so frequently are by observation of the impurities of freshly drawn milk, it becomes a most important point, upon which too much is not likely to be said. To mention in detail all the points that offend against cleanliness would be tedious. They must for the most part be left to the milker's sense of neatness, which certainly ought to be of an appreciative character. If all the milk of which butter is made could be taken to the dairy-room as pure as it exists in the udder, the quality of that luxury would be at once materially improved.

There is at the present time much diversity of opinion and practice in relation to the setting of milk to secure the cream. The controversy upon deep and shallow setting, which for several years was carried on through some of our leading agricultural journals, by the ablest supporters of both theories, resulted, not in the defeat of either, but rather in establishing the fact that the quantity and quality of the product in either case, was not superior to the other, where circumstances were alike favorable to each. Until within three or four years, deep setting had been confined to dairies where cold running spring water could be had, with which to surround the cans. Hardin first conceived the idea of deep setting in refrigerators by aid of ice. He was closely followed by others using ice and water, until we have at the present time several patented "Creameries," many of which are in use, all of them claiming to separate the cream in twelve or twenty-four hours. In the hands of careful dairymen they have quite generally given satisfaction, and their adoption seems to warrant a more uniform butter throughout the year; yet, after careful investigation, I am unable to discover any superiority in quality, over that from pans, when the same care and skill are employed in both cases.

The advantage of creameries over pans, in those dairies where the temperature cannot be controlled and kept low enough during the extreme heat of summer, to allow the cream to separate and rise before the milk tends to ascidity, must be admitted. In deep, cool cellars or dairy rooms, when common pans are used, very little trouble need be experienced in ordinary seasons, and the labor in caring for a dairy furnished with pans, is not much greater than when a creamery is used, although it is somewhat different in kind. With the creamery the labor consists in handling cans, water and ice, while with pans, the work lies in the skimming which, when done as it should be, by turning off the cream, instead of dipping or skimming, requires but a short time, even in a large dairy. If small pans are used, a cool, dry cellar, or part of the cellar of the farm-house partitioned off, and thoroughly whitewashed each year, is a good place in which to keep milk at all seasons. A dairy room either in the farm-house, or adjoining it for the exclusive purpose of dairy work, and the storage of dairy fixtures, is necessary. It should be supplied with water, and provided with means for maintaining a uniform temperature during winter. This can most economically be done by means of a small brick furnace, built upon a hearth, or stone foundation. It is cheaply constructed,—six or eight dollars will build one in any locality,—and by looking after the fire four or five times daily, an even temperature, suited to the ripening of cream, can be easily maintained throughout the whole winter, night and day, at an expenditure of not more than two cords of good wood. If deep setting is to be practiced, and a creamery used, it should be placed in this dairy room. The ice-house should be handy, that unnecessary work be avoided.

The temperature at which milk is to be set is a much mooted question; sixty degrees or thereabouts is claimed by many as the best, and that cooler setting results in loss of color and flavor. I think I can say, without prejudice, that I have seen for several winters past, milk set in a cellar at an unvarying temperature of forty degrees, skimmed at forty-eight and sixty hours setting, cream ripened at sixty-four degrees, producing as fine grained, nicely flavored butter, as the same dairy furnished in June, with an even temperature of sixty-two degrees, with the exception of a slight falling off in color, which is accounted for by the difference between winter and summer feed. If set in shallow pans, the milk should remain twenty-four to thirty-six hours before skimming, and in winter longer. A safe rule is to skim while the milk is perfectly sweet. The cream should be kept at an even temperature of from sixty to sixty-five degrees, according to the season of the year, stirred two or three times daily, that the ripening may be uniform throughout, and when slightly acid, churned at sixty-two to sixty-four degrees, varying somewhat with the breed of cows, their condition, and the season of the year.

That dairyman who boasts of accuracy of his forefinger, when dipped in the ripening cream, as an infallible indicator of the temperature, when a good dairy thermometer costs less than a dollar, is, to say the least, willing to take more risk on the quality of his products, than the profits of the business will warrant.

The work should be systematized from first to last, the skimming done in morning, the churning on stated days, two or three times weekly, and the curing of the cream regulated by time and temperature, so as to be in condition for churning at the appointed hour.

With very few exceptions butter falls off in color during fall, winter and spring, and no matter how firm the grain, or delicious the flavor, if it lacks color it goes begging for a market. People have accepted the color of June butter as the standard, and whatever falls below it, to them is imperfect. Probably not one pound in one hundred of the fancy, high priced butter, made in the cooler part of the year, but has received additional color at the hands of the maker. Coloring when properly done does not detract from the flavor, texture, or keeping qualities of butter, and so long as the markets demand a butter of nearly as high color in winter as summer, that dairyman whose product is satisfactory in texture and flavor, but deficient in color, should correct the fault by the use of some of the preparations for that purpose, to the use of which there can be no possible objection.

Before discussing the process of churning and working, a brief explanation of what is understood by the grain of butter, seems appropriate, and in this connection, I can use no language of my own to so fully illustrate the point, as that of Prof. Arnold: Butter is made up of the fat globules in milk which adhere, after having been divested of their delicate membraneous envelopes by churning, and that these little atoms of fat are themselves made up of several varieties of fatty elements. These elements have in each globule, not only a definite composition, but also a definite organization.

When butter can be churned and worked so as to leave the disrobed granules of fat whole, or nearly so, if a piece of it at sixty degrees or below is broken in two it will show a clear and distinct fracture like broken cast iron, and when the fracture is viewed it will show a granular structure. This unbroken, and undisturbed condition of the granules of fat is what constitutes the grain of butter. In this condition butter has its best flavor, and best keeping qualities. If the churning, working, and handling has been such as to mash and break the granules, the fatty elements composing them become mixed, and the oily parts spread, and give the whole a greasy appearance, and the fracture instead of being distinct like that of cast iron, will be more like a fracture of lard, green putty, or salve. The more the atoms of fat are marked and broken the more the flavor is depressed, and the sooner the butter spoils. The difference in the keeping of butter, whether the grain is broken or not, is very great. When the grain is all right, butter may be kept under great disadvantages, and almost anywhere. If the grain is spoiled it will hardly keep long under any circumstances, and the flavor is about as much affected as the keeping. In all the processes, therefore, of making and handling butter, the preservation of the grain should be kept constantly in view, and those methods adopted which will do it the least violence, and have the least tendency to make it appear greasy. The right temperature too must be observed, for if too cold when manipulated the granules will grind against each other and be injured by friction, and if too warm the grain is spoiled by the too easy mixing of the softened fats. The object of churning is to divest the milk globules of their delicate membraneous coverings, without breaking or disturbing the granules of fat within them. This is best done by a force in which motion and pressure are combined. Such a power is much better than motion and friction. From forty to eighty minutes is the most approved time in which to bring butter. If brought in a much shorter time the grain is liable to be injured by the too violent agitation required. Devices for churning are very numerous. The old dash churn, although it operates very hard, produces as good butter as any patent with inside gear or floats, and much better than most of them. The objection against it is that the butter must be gathered in a mass, and is not easily left in granules. The Oscillating and Barrel churns, without inside gear, are easily operated, and by stopping the churn at the proper time the butter is left in granules the size of half grains of wheat. The buttermilk being drawn off, and the granules rinsed several times with water or brine, they are entirely free from milk, and upon their removal to the "worker" a few minute's use of the lever frees the lot from remaining water, and presses it into a compact mass. When butter is gathered in the churning it is filled with more or less milk, and must be separated and torn apart, and the buttermilk washed, or worked out with the liability of injury to the grain. The amount of salt to be used varies from one-half, to one ounce, per pound of butter, less, if the market desires it, but *never* more than that quantity. If one ounce of salt will not preserve butter, a greater quantity will not, although it may conceal some of its defects by making it so salt that nothing else can be discovered. Some makers finish the butter off, and print, or pack, at the time of churning; others, set the lot by and work a second time, in twelve or twenty-four hours, thinking thereby to secure a more thorough incorporation of the salt. While there is no great objection to working a second time, and coarse salt, like the "Ashton" or "Eureka" is used, it is necessary that it have time to dissolve before the butter is finished off, yet, there is liability of injury to the grain, by breaking down and working a second time; especially if it is firm and hard. If it is finished and packed at once, which I prefer, a fine salt should be used, and no difficulty need be experienced in securing an even mixture throughout without undue working.

So much is being done in the manufacture of butter packages and carriers that we have little left to ask for in that direction. If consumers or retailers in the markets near home are to be supplied, carriers for prints, lumps, or rolls, are desirable for packing solid, for the same markets where the packages can be easily returned, the stone jars in common use are among the best. When sent to a distant market tubs or firkins made from hard wood are cheap, and continue to be the chief means for storing and transporting butter. To prepare tubs for use they should be soaked with strong brine two or three days, then this brine turned out, and boiling hot brine turned in, filling the packages to the brim; when this gets cold the tub is fit for use.

By all means avoid storing butter in damp cellars, no matter how much care may be exercised, it cannot remain long without injury.

I have thus briefly touched upon some of the leading points of butter making; the fear alone of wearying you forbids my entering more fully into the details, but an omission of their discussion here, an idea of their unimportance is *not* to be conveyed, for it is only by the closest attention to every minute operation, from beginning to end, that we can hope to succeed.

The great objection to dairying as a pursuit, entertained by people generally, is the vast amount of labor and the life of drudgery it entails upon its followers. The attempt is too frequently made by farmers to do as much labor upon the farm as though they have no dairy work depending upon them. This they attempt to accomplish in two ways. The ambitious, hard-working man, rising early, milking, and choring till breakfast call, doing as much work in the field during the day as his neighbor over the fence, returns to his chores at night, only to finish them by lantern light, and go tired and discouraged to bed. His neighbor reverses the order of things; and finishing his supper, enquires of a passer if he has any news from the election returns, lights his pipe, leans over the barnyard fence and watches his wife and daughters milk the cows among the whole herd of frolicking farm stock.

Is it any wonder "the boys leave the farm," or the girls marry men that don't keep cows? All this must be changed, and the care of the stock and dairy become a part of the regular day work, and those whose work it is should stop labor in the field at an hour early enough to warrant the completion of all chores by sunset. They will be done better and more cheerfully, and an opportunity for social intercourse afforded. Nothing so completely robs farm life of its enthusiasm as persistently dragging day into night.

Butter dairying, conducted with intelligence and zeal in all its details, made a business and science of, will furnish an income sufficient to satisfy the reasonable demands of any one, and afford the means to hire additional help upon the heavier work of the farm and in the farm-house. Thus the dairyman will feel that his time is not lost, but that he is in his proper place when he devotes the time required in the dairy-room to the assistance of his wife in extracting from the cans of ripened cream the lumps of golden butter.

Indeed, there is no reason why the dairy farmer should not conduct his business with less labor and have more leisure time than he who pursues crop or mixed farming, for in his case the land is nearly all in grass and forage crops, which require comparatively little work. And thus the means and opportunities are afforded for higher mental culture, for more neighborly intercourse, and greater benefits of social life.

The enthusiastic young Kentuckian, when boasting of his native State, claims for it,—the richest bluegrass pastures, the finest thoroughbred cattle, the fastest horses, and the most beautiful women in the world. While we cannot allow his claim in full; while we deny that our sisters have superiors in point of beauty in any part of the land, yet the question presents itself, in what can we proudly claim that we excel? We have gained a national notoriety in producing some of the finest horses. Our herds of blooded cattle have no superiors. We have flocks of sheep with which no critic can find fault. Of all these we are justly proud. Let us labor to elevate all our flocks and herds to equality with these samples, and by our works refute the charge, that the agriculture of our State is of low standard,—that she exports only crude materials. Let us induce our sons and daughters to remain at home and apply their intelligence and skill to the transfer of their raw material to finer forms. Instead of sending hay from the farm to market, let it be used to grow herds of Jerseys, Ayrshires, and Shorthorns. And then our brothers and sons, that *do* go out from us to business and homes in distant lands, may turn their thoughts to their native State with the pride and satisfaction that upon her green hills and in her fertile valleys, beside her cool springs and babbling meadow brooks, are a people of culture and refinement, who are devoting their physical and mental energies to the production of the nicest luxury that ever graced the table of civilized man,—Golden Butter.

The Scientific Principles of Cattle Feeding;

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Before entering into a discussion of the feeding of cattle, it will perhaps be well to glance at the composition and properties of the important compounds which make up the bulk of the animal, as well as that of the fodder.

The Animal Body.

The body is composed of the following substances:

1. Water. 2. Nitrogenized substances, called albuminoids.
3. Fatty substances (fats). 4. Carbohydrates in small quantity.
5. Mineral substances.

Albuminoids. Of the nitrogenized substances, or albuminoids, albumin, fibrin and casein are the most important. The best common representative of *albumin* is the white of the egg, which coagulates upon being heated, is soluble in cold water before coagulation, but not so after. It is found in the serum of the blood, from which it can be separated by heating.

Fibrin is found in blood, and can be obtained by thoroughly washing the clot. It separates from healthy blood when it leaves the living body. It is insoluble in water and forms a stringy mass. By washing the flesh of animals until it becomes colorless, or nearly so, another form of fibrin is obtained called flesh fibrin. Its properties greatly resemble those of blood fibrin.

Casein can only be obtained from milk by the addition of rennet, or an acid. It forms the greater part of the curd. It is not coagulable by heat. All the above bodies contain carbon, oxygen, hydrogen and nitrogen, in very nearly the same proportions as the following analyses show:

	Albumin.	Fibrin.	Casein.	Average.
Carbon......	53.5 per ct.	52.8 per ct.	53.5 per ct.	53.3 per ct.
Hydrogen...	7.1 "	7.0 "	7.0 "	7.0 "
Oxygen.....	23.6 "	23.0 "	23.7 "	23.7 "
Nitrogen....	15.8 "	16.5 "	15.8 "	16.0 "

All these bodies are quite unstable and undergo many changes in the living animal.

Fats. The fats are, next to the albuminoids, the most important substances found in the animal body. Most of the fats are compounds of glycerine, with the fatty acids of which stearic, palmitic, oleic and butyric are the most common. Fat is quite universally found in the tissues of an animal, and providing the food supplied be of good quality and sufficient in quantity, it will accumulate in masses in some parts of the body, and gives the rounded outlines which bespeak a good and healthy condition of the individual. In animals which have been starved to death, small quantities have still been found at the base of the heart, and in the orbits of the eyes.

The fat of the different animals, or the fat obtained from different parts of the same individual has the same composition as is shown in the following table:

	Fat of Sheep.	Ox.	Pig.
Carbon.......	76.61 per ct.	76.5 per ct.	76.51 per ct.
Hydrogen... .	12.03 "	11.91 "	11.91 "
Oxygen.......	11.36 "	11.59 "	11.52 "

It will be observed that fats contain carbon, hydrogen and oxygen only.

Carbohydrates. These are found in comparatively small quantities in the animal body, and need not be specially described.

Mineral or inorganic substances. These are found in the body in varying proportions; generally the organic substances are in far greater proportion than are the mineral compounds; the bones form a notable exception, for here we have a very great percentage of mineral substances, about 68 per cent. of the bones being of inorganic origin. Phosphate and carbonate of lime form the greater part of the inorganic portion of bone. The metallic salts found in the animal body are mostly combinations of potash, soda, lime, magnesia and iron, with chlorine and phosphoric and sulphuric acids.

By looking over the composition of the living animal it becomes apparent that, in proper feeding he must be furnished with a proper quantity of water, albuminoids, fat, or fat forming substances, carbohydrates, which, though they do not occur to any extent in the body are still very useful in fodder, and lastly mineral compounds. All these bodies must of course be in an assimilable condition.

THE PLANT.

By a rapid survey of the proximate composition of most of the products of the vegetable kingdom, we can easily convince ourselves of the great fitness of plants as the food of animals.

Albuminoids. By expressing the juice from the potato, for example, and heating it, we coagulate a substance called *vegetable albumin*, which has properties very closely resembling those of the albumin of the egg.

By taking the flour of some cereal, especially wheat, and kneading the dough obtained from it under running water, we will obtain after sometime, a yellowish, tough mass, called gluten or vegetable fibrin, and which closely resembles, both in properties and composition, animal fibrin. The meal of leguminous plants, such as peas and beans, when treated with cold water gives a solution which is coagulated by the addition of an acid. This coagulum is called vegetable casein or legumin, and compares closely with the casein of milk. All these varieties of vegetable albuminoids bear a strong resemblance to one another; their chemical composition is nearly the same as shown by the following table:

	Vegetable Albumin.	Veg. Fibrin.	Veg. Casein.	Average.
Carbon	53.7 per ct.	53.2 per ct.	53.5 per ct.	53.5 per ct.
Hydrogen ...	7.1 "	7.0 "	7.1 "	7.1 "
Oxygen	23.5 "	23.3 "	23.4 "	23.4 "
Nitrogen	15.7 "	16.5 "	16.0 "	16.0 "

By comparing this table with that giving the composition of the animal albuminoids, one is immediately struck by their great similarity. From this it would seem probable that the vegetable albuminoids need not be greatly changed by the animal organism in order to be fit for its use. All these bodies are very important, as they are necessary for nearly every animal production which is of value, and it is only to be regretted that they generally exist in such small quantities in plants; as the vegetable kingdom is the great source of albuminous food for most of our domestic animals.

Carbohydrates. Substances containing carbon, hydrogen, and oxygen, the two last in the same ratio as they exist in water, that is twice as many hydrogen atoms as there are oxygen atoms.

These may be divided into two classes. The first containing woody fibre or lignin or cellulose, in a more or less incrusted condition. The second contains bodies more easily digestible, and have been termed extractive carbohydrates.

Woody fibre is cellulose more or less pure, and is that part of the plant which is left after it has been treated with a series of solvents, as dilute sulphuric acid, weak solution of potash, ether, alcohol, etc. The substance thus obtained, contains more or less cellulose accompanied by an incrusted hard substance called lignin, which contains 55 per cent. of carbon while cellulose only contains 44 per cent.

It was thought that woody fibre was not at all digestible, but this has been proved an error, as no inconsiderable amount of it can be utilized by animals, especially the ruminants. Cellulose in the early stages of growth is indeed nearly as useful as substances belonging to the second class. The second class comprises extractive carbohydrates, which are represented in plants by starch and sugar. They are all more or less readily attacked by chemical reagents, and are digested with facility. In composition they are nearly identical. All these bodies are easily converted into glucose, a kind of sugar.

Fats. The fatty substances found in plants have a composition which closely resembles that of animal fats. Fat does not exist in large quantities in most fodder material; varying between about one to three per cent. The amount of fatty substance indicated in analyses as being present in a plant is generally somewhat exaggerated, as the ordinary method employed for its determination gives results which are too large.

Mineral Substances. The salts found in plants are generally those most needed by the animal. It may sometimes happen that they are deficient in quantity. Phosphates of lime must at times be added to the rations for growing animals; powdered bone-ash is very good for this purpose.

Digestibility of Fodder.

It has been found by numerous experiments, for which we are mostly indebted to German chemists and physiologists, that the various substances found in the ordinary fodder given to animals are not totally digestible. The digestibility of food varies, for several reasons: our domestic animals have different digestive aptitudes; the ruminants, for instance, can utilize more easily coarse woody fibre than animals having a simpler digestive apparatus.

This difference of digestive aptitude holds true for the other constituents of fodder as well as for woody fibre. Making the digestive faculty of the sheep equal to one hundred for all substances, we would have the following approximations for our domestic animals. Kind of animal—Digestive aptitude for:

	Albuminoids.	Fats.	Ext. Carbohydrates.	Woody fibre.
Sheep	100	100	100	100
Horse	122	97	94	56
Cow	100	109	97	105
Ox	113	105	92	103

It must not be forgotten that the age of the individual greatly affects the digestive faculties; that various races of the same animal show powers of digestion which vary considerably, and that the temperament of the individual itself has much to do with the food digested and assimilated. The physical condition of the food has also considerable influence upon its digestibility, the older and tougher parts of plants being much less useful than the younger parts. Great care must be exercised in the harvesting of fodder crops, both as regards the period of growth of the plants and the influence of inclement weather upon the harvest. It is well known that rain is very injurious to drying hay, as it washes away a large quantity of very valuable nutrient matter. The influence of one constituent upon the digestibility of the others is very great; this can easily be shown by the following experiment due to Haubner. He fed sheep with one kilogramme (about 2 1-5 pounds) of cooked potatoes, and one kilogramme, 250 grammes (about 2 $\frac{3}{4}$ pounds) of wheat straw, each. All the starch contained in the potatoes was fully utilized by every animal. To the above ration he added $\frac{1}{2}$ kilogramme (about 1 1-10 lbs.) more of potatoes, he then found that a part of the starch was not assimilated and passed into the excrement. By the addition of 125 grammes (a little over $\frac{1}{4}$ lb.) of pea meal to the mixture, he obtained a complete digestion of all the starch present. The pea meal is rich in nitrogen, and in increasing the quantity of albuminoids in the ration it increased the digestibility of the carbohydrates, (starch, etc).

The digestive relation of a fodder is the relation between the albumioids and the carbohydrates it contains. The general formula for the digestive relation is $\frac{P}{H}$ or P : H in which P = albuminoids and H carbohydrates. We see in Haubner's experiment the effect of increasing the numerator of the fraction. Before taking up the digestibility of each constituent of fodder material, we will examine what is meant by mean coefficient of digestibility. E. Wolff found by experiment that there was a relation between the composition of fodder and the quantity of proximate nutritive principles which were digested. This relation may be put in the form of a convenient formula which may serve as an indication of the value of a fodder. The formula, though reliable enough, must be used with reserve, as the alimentation of stock is surrounded by so many difficulties and the nature of the digestive and assimilative process so complex that one must be guided by practice as well as theory. Experience in the manipulation of fodder and the feeding of stock is very necessary to make the formula as valuable as it may be. The mean coefficient of digestibility according to Wolff, is equal to the quotient of the sum of the albuminoids, extractive carbohydrates and fat, by the total amount of organic substance of the fodder.

Taking examples of various fodders of average composition we have the following mean coefficients of digestibility:

Hay, about	.62
Aftermath	.70
Clover hay	.57
Luzerne hay	.56
Sainfoin	.60

Giving a coefficient of about .60 for the common varieties of hay.

For the various straws, we have a coefficient of about .40, as can be seen from the following table:

Wheat straw	.39
Rye straw	.37
Barleystraw	.43
Oat straw	.49
Bean straw	.52

Digestibility of Albuminoids. The digestibility of the albuminoids in the various kinds of fodder varies greatly. In the same kind of fodder its variations are also very great, being influenced by its condition and state of preservation. The albuminoids found in hay and clover hay may vary in digestibility from 35 per cent. to 75 per cent. The greater the quantity of albuminoids in fodder the more completely will they be digested. Various mathematical formulas for the determination of the digestibility of the albuminoids have been proposed; they give us a coefficient of digestibility upon which we must not too much rely, as the variations are very great, and in all cases considerable latitude should be allowed for inaccuracy. One of the simplest of these formulas, though not as accurate as some others, is the one proposed by Henneberg:

Digestibility of albuminoids $= \dfrac{E + f}{\dfrac{A + C}{2}}$. In which E = extractive carbohydrates — f = *fats* — C = total carbohydrates — A = albuminoids.

Digestibility of Fats. This constituent also is subject to great variations when we investigate its rate of digestibility. One reason of these variations is undoubtedly due to the fact that the waxy and resinous substances which are generally put down in the analyses with true fats are not digestible to any extent.

The digestibility of the fatty substance in young plants is generally greater than that of older plants. The fat found in clover hay and the stems of leguminous plants has for its coefficient of digestibility from 40 to 60 per cent., while that of the fatty substance found in hay and the cereal straws varies from 30 to 45 per cent.

Digestibility of Carbohydrates. Crude or woody fibre is digested by our domestic animals to a greater or less extent; the amount digested varies greatly with the different kinds of fodder, being from 25 to 70 per cent. of the total quantity. Fibrous and coarse food can be more completely utilized by the ruminants than by the other animals, as they digest crude fibre more readily. The pig, for instance, seems only to utilize cellulose in its most tender and delicate forms, as found in young plants and roots. The crude fibre digested by animals is cellulose and not lignin. The cellulose of grains and concentrated foods are digested about equally by our domestic animals. Experiments by Henneberg and Stohmann upon the digestibility of fibre by the ruminants gave the following results:

Straw of oats................	55	per cent.,	digested.
Straw of wheat..............	52	"	"
Straw of beans	36	"	"
Hay.......	39	"	"
Clover Hay.................	60	"	"

Although a part of this insoluble crude fibre is digested, we may be surprised to find that some of the more soluble carbohydrates, called extractive carbohydrates, are lost in the process of digestion. A sort of balance is however established between the fibre digested and the carbohydrates undigested, so that the amount of extractive carbohydrates found in a fodder represents about the quantity of mixed fibre and extractive carbohydrates which will be digested.

The amount of extractive carbohydrates present in a ration would give us a rough indication of the amount of total carbohydrates an animal could utilize. This method cannot be considered very exact, the amount indicated by it being sometimes as much as 20 per cent. too large or too small.

For young plants in which woody fibre is not present in very large quantities, and in which it is comparatively tender, the method above given seems quite valueless, as the amount of carbohydrates digested is nearly invariably more than the amount of extractive carbohydrates found in the fodder. From experiments by Henneberg and Stohmann it would seem that the amount of substance in coarse fodder which is soluble in boiling water is about equivalent to the amount of digestible carbohydrates.

The following table gives the results arrived at:

Kinds of fodder.	Soluble in boiling water.	Digested carbohydrates.	Difference.
Oat Straw...	3.25	3.17	+ .08
Wheat straw	.94	1.07	— .13
Bean straw....	5.18	5.34	— .16
Clover hay	11.24	11.30	— .06
Hay	6.42	6.36	+ .06

It must be borne in mind that this method can only be used when rough approximations are sufficient. Comparative experiments have shown the results to be far from accurate. The undigested carbohydrates are generally richer in carbon than the digested part, containing 55 to 56 per cent., while the digested portion only contains 44.4 per cent.; these carbohydrates are probably all converted into sugar during the process of digestion and assimilation.

Mineral Substances. These are generally offered in sufficient quantity to animals in their rations. The salts necessary to the animal are easily taken up, provided they be in a somewhat soluble condition. The addition of phosphate of lime to the rations of growing stock is sometimes very useful. The presence of phosphoric acid is of utility in nearly all kinds of animal production. Nearly all the alkaline salts of the fodder pass out, 95 to 97 per cent. being voided by the urine, 20 to 30 per cent of the magnesia is eliminated in the same way, lime only 2 to 5 per cent., and nearly all of the sulphuric acid and chlorine.

Having studied the digestibility of the various proximate constituents of the fodder, we may now see what effect an increase or a decrease of one of them will exert upon the digestibility of the others contained in the ration. The digestibility of the coarser kinds of fodder, such as the varieties of hay and straw, is determined more by the physical condition of the dry substance which is more or less due to the climate, the manure used, etc., while the effect of the weight of the ration, the race, the kind and age of the animals seems to exert less influence upon the digestibility of the food offered.

The addition of albuminoids to the coarse fodders does not exercise a depressive influence upon their digestion. At the agricultural station of Weende, sheep fed with one kilogramme (2 1-5 lbs.) of meadow hay per day, received in addition 120 grammes (4 1-5 ounces about) of gluten; this was subsequently increased to 262 grammes, (about 9 1-5 ounces). The dry gluten contained 78 per cent. of albuminoids. No depression in the rate of digestibility of the proximate principles of the mixture was noticed. Numerous experiments at Hohenheim, Möckern, Halle, and elsewhere, have put the same fact in evidence, that the addition of highly nitrogenized substances to the ration of animals does not act prejudicially upon the digestibility of the fodder. It must, however, be remembered that the digestibility of the albuminoids in these (nitrogenized) condimental foods differs considerably, as for example: about 90 per cent. of the albuminoids in the fruit of the leguminious plants is digestible, 85 per cent. of those contained in linseed cake, 78 per cent. of those in rape seed cake and wheat bran, 74 per cent. of those in cotton seed cake. The addition of cereal grains having a mean coefficient of digestibility of from 1 : 5 to 1 : 8 does not have a depressing effect upon the digestion of coarse fodder.

At Hohenheim experiments were made in the alimentation of sheep with a mixture of meadow hay and oats; the proportion of the food being the following: 1 to 1.76 in one experiment, 1 to 3.09 in another, and 1 to 3.30 in a third experiment; these experiments showed that the amount of albuminoids of the oats digested was 78 per cent. — 78.4 per cent. — 77.5 per cent. respectively in the above experiments. The same experiment was tried at Dresden, but in this case the relative amount of oats was smaller than in that performed at Hohenheim. The amount of albuminoids digested varied between 74.1 and 67.3 per cent. It must, however, be added that the oats used at Hohenheim were considerably richer in albuminoids than those used at Dresden.

Starch. Numerous experiments upon our different kinds of domestics animals prove that the addition of starch to crude fodder, providing the quantity of starch introduced into the ration represent at least 10 per cent. of the total weight of the dry substance, lowers the digestibility of the albuminoids of the coarse fodders, and in a slight degree that of the hydrocarbons therein. When the quantity of starchy substance amounts to 1-7 of the weight of the dry fodder, the digestibility of the albuminoids decreases 5 per cent. ; if it be 1-6 the weight, the digestibility decreases 10 per cent. ; 1-5 decreases it 15 per cent. ; 1-4 decreases it somewhat less than 20 per cent. In fodders containing large quantities of albuminoids, the depressing effect is not so great as in fodder poor in nitrogen.

The effect of starch upon fodder may be counteracted by the addition of some food rich in albuminoids. The effect of sugar is the same as that of starch, but it is less depressing in its effect upon the digestibility of albuminoids. The digestion of the fats and extractive carbohydrates is not appreciably lessened by the addition of starch or sugar to a ration, provided the quantity added be not too great. It is hardly necessary to add, that starch is very rarely added to rations in actual practice, but there are many of our agricultural root crops that furnish products which contain large quantities of starch and sugar ; prominent among these is the potato and beet.

From a series of experiments made at the Agricultural Station at Hohenheim, it would seem that in a mixture of hay of excellent quality and potatoes or beets, the quantity of digested albuminoids does not decrease, provided the dried potatoes or beets do not form much more than 1-8 of the ration. Potatoes have a more depressive action on the digestibility of the albuminoids than do beets, and it is, therefore, well to avoid in any rations an excess of potatoes ; at any rate, the proportion should never be above 1-8 of the total dry matter. These foods should be mixed with substances rich in albuminoids, in order to counteract the depressive influence of starch and sugar.

Fatty substance. There can be but little doubt that many plant fats are directly and easily assimilated by animals, and that the quantity contained in fodder eaten has an important effect on its nutritive value. It does not seem proved that the addition of oil or fats to a ration increases to any great extent the digestibility of its other constituents. Some authorities, however, advance the idea that the addition of fats increases the quantity of digested albuminoids and carbohydrates, especially cellulose. Most of the experiments have given such contradictory results that it would seem safer to take a contrary view.

One must be guarded against mixing fats or oil for any length of time in the rations of ruminants, as it lessens the appetite and disturbs the digestive processes. Fatty substance, when given in some naturally combined form, such as cotton seed or linseed cake, seems much less injurious than when added to rations in the shape of oil or fats.

Common salt is recognized by everybody as a useful adjunct in the feeding of cattle. It does not seem to increase the digestibility of fodder, except in, perhaps, a single instance in which the amount of digested albuminoids was increased by the addition of salt to the ration. Its action generally, seems to be as an appetizer, giving the food taken by the animal greater relish, and inducing it to eat a larger quantity. Salt in small quantity is absolutely necessary for the life of the animal; it is found in all parts of the body and seems to aid in the diffusion of the nutritive elements of food throughout the system.

Potash in small quantity seems quite necessary for the health of the animal. This is generally found abundantly enough in common fodder. As before noted, the presence of phosphate of lime is absolutely necessary in the rations of our domestic stock. Its presence does not seem to affect the digestibility of the fodder to any extent, but unless present in sufficient quantity the animal is sure to suffer. It is especially necessary for growing animals and milch cows.

An experiment made at Proskau upon two milch goats, shows the importance of giving a sufficiency of phosphoric acid and lime to stock. One goat was fed with fodder poor in phosphoric acid, and the other with fodder poor in lime; at the end of fifty days both died. The bones were found to be normal, therefore the phosphoric acid and lime which were found in the milk, urine, etc. of the goats, must have been taken from the liquids and soft parts of the body, thus giving rise to an abnormal condition from which death resulted.

When fodder is rich in phosphoric acid, lime may be added in the shape of pulverized chalk.

Effect of Steaming, Fermenting, etc., Fodder.

The cooking or steaming of food is greatly recommended by some as increasing its nutritive effect, in other words, increasing its digestbility. It is stated by an author that cows fed with cooked or steamed potatoes gave a milk richer in butter than cows fed with raw potatoes, though the quantity of milk was less. Experiments on this subject have given conflicting results, and it would seem that the good effect of steamed food be ascribed to its better flavor rather than to any change which has taken place in its digestibility. The same may be said of fermentation. The question seems at present to be somewhat an open one, though there may be reasons why steaming or fermenting food could at times be economically resorted to.

At the State College farm, pigs fed with uncooked corn meal fatted more rapidly than did pigs fed with cooked meal. The question is a rather difficult one to decide, as the taste of fodder undoubtedly has a great influence upon its effect in the feeding of cattle. The mechanical division of fodder is of importance in insuring its most complete utilization by animals, this being especially true for the monogastric animals.

The chopping of hay and straw permits their being intimately mixed with other fodder materials in the making up of a composite ration. The slicing of roots is beneficial, as is the cracking of grain.

Notes upon different Fodders.

Meadow Hay—Aftermath. Hay rich in albuminoids, generally contains less crude woody fibre than does hay poorer in albuminoids. The quantity of extractive carbohydrates remains about the same while the ash and fatty substance is often found in larger quantity in good than in poor hay.

It is well known that an increased quantity of albuminoids gives an increased digestibility of the same as well as a greater digestibility of the extractive carbohydrates. The digestibility of the albuminoids may vary in hay from 39 to 70 per cent., according to quality of the fodder.

The time at which hay is made is of the greatest importance, as the young plant always contains a larger per cent. of albuminoids, and less crude fibre than when they are at a more advanced stage of growth. Oxen were fed at Möckern with clover cut before flowering, May 20th; then with clover cut after flowering, June 7th and June 20th, they digested respectively 71 per cent., 65 and 59 per cent. of the albuminoids, and 51 per cent., 47 and 40 per cent. of the crude fibre. The digestibility of the extractive carbohydrates was not greatly affected. At Hohenheim the same effect was noticed in feeding sheep with clover cut at four different periods; the proportion of digested albuminoids falling from 75 to 59 per cent., and that of crude fibre from 60 to 39 per cent. Many other experiments showing the same fact might be adduced. The greater digestibility of aftermath is undoubtedly due to the more or less tender condition of the nutritive principles.

The practice of avoiding the action of water upon hay, of choosing as dry weather as possible while hay making, is proved a very rational one by actual experiments made at the station of Tharand. A specimen of hay which had been exposed to rainy weather contained, upon analysis, 2.1 per cent. albuminoids and 10.4 per cent. of carbohydrates and mineral salts less than hay from the same field, and cut the same day, which had not been exposed to such weather.

It is well known that grass grown on manured land gives a more nutritive fodder, richer, especially in albuminoids, than that grown upon unmanured or poorly manured land; the difference being sometimes as great as 10 per cent.

Clover. In the process of drying clover it is of great importance to be very careful, as large quantities of the most nutritive elements may be lost by careless management. The quantity of albuminoids varies considerably, though not as much as in ordinary hay, being 12 to 18 per cent.; very young clover may contain as high as 30 per cent. of albuminoids. An increase in the quantity of albuminoids gives rise to an increase of their digestibility, that of the extractive carbohydrates does not seem greatly affected by the quantity of carbohydrates present, while that of crude fibre is increased by a higher per cent. of them.

Rainy weather is even more harmful to the preparation of clover hay than to that of ordinary hay, the loss in nutritive elements being far greater. It would seem that the most economical use of clover is as a green fodder.

Corn. Green corn is rather poor in albuminoids, and in order to obtain the completest digestion of its constituents it is well to add some fodder richer in albuminoids, and thus have a better digestive relation.

Beet Tops—Though quite watery, are comparatively rich in albuminoids. Their use must be restricted, as they are liable to occasion diarrhœa. The same may be said of carrot and rutabaga tops. Cabbage leaves are good fodder, especially for milk cows.

Cereal Straws. As a general rule, the straw of summer cereals is poorer in cellulose and richer in albuminoids than that of winter varieties. Experiments upon the digestibility of the constituents of these straws are not very numerous.

Leguminous Straws, contain a larger per cent. of albuminoids than do cereal straws. The crude fibre of leguminous straws is difficult to digest, while the extractive carbohydrates have a relatively high digestibility.

Cereal Grains. Their composition is variable. The influence of the conditions of vegetation is very great, especially in the quantity of albuminoids which the grains may contain. Wheat and oats seem to be more easily influenced by the conditions of vegetation than barley or rye.

The influence of manuring is well illustrated by the following experiment tried at Poppelsdorff. The per cent. of albuminoids in wheat cultivated without manure was 16.3 per cent. ; by a manuring with superphosphates it was increased to 17.6 per cent. ; by the application of a highly nitrogenized manure, such as salts of ammonia and nitrates, the per cent. of albuminoids was raised to 21.4 per cent. By the use of a manure containing the above compounds of nitrogen together with phosphates, 22.4 per ct. of albuminoids was obtained. The straw gave the following per centages of albuminoids: 3.4 per cent., 3.7 and 5.2 per cent.

It is probable that about 90 to 95 per cent. of the albuminoids in wheat and rye are digestible ; 95 to 97 per cent. of the extractive carbohydrates are digestible.

The average of a number of experiments has given 75 per cent. as the quantity of albuminoids and extractive carbohydrates which are digestible in oats ; in barley about 79 per cent. of the albuminoids and 90 per cent. of the extractive carbohydrates.

Wheat bran is well digested by ruminants—78 per cent. of the albuminoids and 82 per cent. of the extractive carbohydrates being digested.

Corn. Eighty-four per cent. of the albuminoids and 93 per cent. of the extractive carbohydrates of corn are digested. The percentage of albuminoids is lower than in the cereals, and it is well to add to it a supplementary food, rich in nitrogenized compounds. Corn contains as much as 5 to 9 per cent. of fatty substance, which renders it valuable in fattening.

Brewery Slump. It contains about 24 per cent. of dry matter which is rich in albuminoids.

Bean meal is quite rich in albuminoids, and is often useful as a supplementary food to increase the quantity of nitrogen in a ration which is deficient in albuminoids. About 90 per cent. of the albuminoids are digestible, and 95 per cent. of the extractive carbohydrates.

Lupins are very rich in albuminods, containing 32 to 43 per cent. They are not, however, generally relished by cattle on account of a bitter principle which they contain.

Cake of the Oleaginous Grains. On account of the high commercial value of oleaginous grains, they are not, with the exception of cotton seed cake, much used as a part of fodder for cattle, though experiment has repeatedly proved their great value as an addition to fodder poor in fats. As before noticed, the amount of fatty or oily substance must not be too large if we wish to avoid any disturbance in the digestive process of cattle.

Linseed Cake. The digestibilty of the albuminoids is 84 per cent., fats 89 per cent., and extractive carbohydrates 78 per cent. These are the results of experiments in feeding tried at Hohenheim upon sheep, at Halle upon goats, and at Möckern upon oxen.

Rape-seed Cake. Experiments tried at Dresden with sheep, and at Möckern with cows, gave the albuminoids a digestibility of 80 per cent., as also to the extractive carbohydrates. More recent experiments with oxen at Möckern gave 86 per cent. for albuminoids, and 75 per cent. for extractive carbohydrates.

Cotton-seed Cake. The digestibility of the albuminoids is 74 per cent., and 46 per cent. for the extractive carbohydrates, as determined by experiments upon sheep at Hohenheim.

Cocoanut Cake. The digestibility of the constituents was determined by experiments upon pigs, at Hohenheim, and gave for albuminoids 73 per cent., and for extractive carbohydrates 88 per cent.

Palm-nut Cake, gave in an experiment, made at Möckern upon oxen, 100 per cent. for the digestibility of the albuminoids, and 92 per cent. for that of the extractive carbohydrates.

Whey. The product of cheese making has a very low digestive relation; its dilution is also very great. On an average, it contains about one per cent. of albuminoids, and 4 to 6 per cent. of sugar of milk, and .3 to .6 per cent. of fats. It is, however, very good food for hogs, especially when thickened with barley or oat meal or bran.

Skimmed milk is of much greater nutritive value than buttermilk or whey, and can be used as an addition to food containing small quantities of nitrogen, such as potatoes.

Whole milk is most digestible, and it is only when it is given alone that some of it may be lost.

Potatoes. The value of potatoes as fodder varies greatly with the conditions of vegetation. The potato may contain from 18 to 30 per cent. of dry matter, 1.3 to 4.5 per cent. of albuminoids, and 12 to 27 per cent. of starch. The richer potatoes are in starch, the poorer they may be in albuminoids. The relation of the albuminoids to the carbohydrates varies from 1 : 10 to 1 : 12. In a watery potato we generally have a decreased amount of starch, but an increase in albuminoids and mineral matters. The influence of manures upon their composition is very great, especially upon the quantity of albuminoids. The same variety of potato, similarly cultivated, but one patch manured with potash salts and lime, the other with carbonate of ammonia, gave in the first case 2.27 per cent. of albuminoids, and in the second 4.44 per cent.

The value of cooked or steamed potatoes seems to be somewhat greater than raw; at any rate, their action is less debilitating. It is stated by some authors, that cows fed on cooked or steamed potatoes yield richer milk than those fed on raw ones, though the quantity of milk is less. Potatoes must never be given alone, but mixed with other fodder containing more albuminoids; the dry substance of such a ration should not contain more than one-quarter potato. It should be remembered, that though potatoes are rich in potash, and contain considerable phosphoric acid, they are deficient in soda and lime; this latter substance should be supplied in feeding milch cows, but more especially in the feeding of young and growing stock, when a proper proportion of lime is absolutely necessary for the fullest development of the bony structures.

Jerusalem artichoke produces tubers which are more watery but richer in albuminoids than potatoes, the relation being 1 : 8.

With root crops we find that the quantity of nitrogenized manure used in their cultivation has a great influence upon the quantity of albuminoids they contain, the greater the quantity of nitrogenized manure used, the greater the quantity of albuminoids formed. Large and well-appearing roots are often less valuable than smaller ones, on account of the large quantity of water and small quantity of nutritive dry matter they may contain. The nutritive relation of fodder beets and carrots is about 1 : 7; for rutabagas about 1 : 8, and 1 : 4 or 1 : 5 for turnips, heavily manured with nitrogenized manures.

Of all varieties of beets, sugar beets contain the largest total amount of dry matter, but smallest of albuminoids. When heavily manured, and allowed to grow large and partly out of ground, their composition becomes more like that of the ordinary fodder beet. Beets may be given to milch cows with good results. It is generally best to slice the beets and mix them with other fodder. Large quantities can be fed to cattle, providing they be mixed with supplementary fodder rich in albuminoids.

Carrots are considered very healthful food, exerting a good influence upon the digestive apparatus, and diminishing plethora. They can be fed with good results to milch cows and horses which are being fed with other food rich in albuminoids.

Rutabagas are probably more nutritive than common fodder beets. It is well to bear in mind, that the feed of young cattle and of fattening cattle should not be too watery. Of two varieties of equally watery beets, the one containing the largest per cent. of albuminoids will be the least injurious.

Sugar beet pulp or pomace. The old method of expressing the beet juice by the means of presses, gave a pulp containing 30 per cent. of dry matter, of which the nutritive relation was 1 : 10 or 1 : 12. By the extraction of the juice by the use of centrifugal machines, a residue is left containing about 18 per cent. of dry matter, having the same nutritive relation as the above. By the use of the diffusion process for the extraction of sugar from beets, we obtain a pomace, the relation of which is about $1:5\frac{1}{2}$ or $1:6\frac{1}{2}$. Generally the dry substance amounts to only 5.5 per cent. By a slight pressure a quantity of water may be expressed so that the dry substance may increase from 7 to 14.5 per cent. By submitting this pulp to fermentation water is also lost; this is proved by the fact that pulp containing 5.4 per cent. of dry matter, after fermenting in silo contained 6.8 per cent. Beet pomace when mixed with other fodder gives us an excellent food for most of our domestic animals.

Having now briefly reviewed the principal points in regard to the constitution of the various fodder materials, the relative digestibility of their nutritive elements, and glanced at some special points in regard to the principal foods used for animals, it will be well, before going on to the determination of the rations for special animal production, to get an idea of the part which the various principles contained in fodder play in the formation of animal produce.

Formation of muscle, (lean meat). It must be the endeavor of the stock raiser to hasten the fixation of albuminoids, that is, he must try to fix as much albumin to the organs of the body as possible, as it then has considerable stability, while the albumin found in the liquids of the body is continually undergoing changes and decomposition; 70 to 80 per cent. of the albumin being excreted in the course of twenty-four hours, while organs only lose .8 per cent. in the same time. An over or exaggerated production of muscular tissue is not to be advised, for it only leads to a rapid transformation of albumin, and when a change in the fodder occurs from a highly albuminous one to one poorer in albuminoids, it is noticed that a certain quantity of the albumin of the organs is excreted, which would not be the case had the feeding been more scientific.

The addition of common salt to fodder seems to increase the rapidity of transformations, and it is only in cases in which such rapid changes are necessary that it is advisable to increase the dose. In the alimentation of working oxen and horses, as well as in that of males used for stud purposes, its use is, however, injurious. In the case of fattening cattle, just enough may be given to add to the savor of the fodder and aid in a normal rate of organic exchange or transformation. Salt increases the sensation of thirst in animals, and where water is at their disposal they will drink large quantities of it; it is known that the increased absorption of water increases the quantity of albumin which suffers decomposition.

Substances acting as nervous excitants do not seem to have very much influence on the decomposition and excretion of albumin. A large quantity of fodder will not only give a more abundant production than a smaller quantity of the same fodder, but the nutritive elements will also be more thoroughly utilized. This has been proved by experiment, one tried at Weende may be cited as an example; the total quantity of nutritive elements in the ration of two oxen was raised from 8.93 kilogrammes (about 19.64 lbs.) to 9.73 kilogrammes (about 21.½ lbs.), the nutritive relation remaining the same. After the increased amount was fed to the oxen, 32 per cent. of the albuminoids was fixed, while previously only 18 per cent. had been fixed.

When the quantity of albuminoids in fodder is increased without a relative increase of the other constituents, an increased quantity of albumin is rendered available for organic exchange, changes in the body become more rapid, nevertheless some of the albumin is generally fixed by the animal. It is only after some time that the equilibrium of exchange is established, and that a part of the albuminoids are fixed. An excessive increase of albuminoids is rarely economical as the quantity deposited is comparatively small.

The fat deposited in the animal tissues hinders the rapid transformations of albumin and therefore acts as a preservative agent against its destruction and favors the formation of mucular fibre, (flesh). Animals that are somewhat fat will therefore more rapidly take on flesh than those that are less so. From this it is seen that the most suitable fodder for cattle already in good condition will have a composition quite different from that most useful for animals in poor condition. In order to feed animals economically it is necessary to see that the nutritive principles of the fodder should present a proper relation to one another, that is, the relation of the digestible albuminoids to the digestible carbohydrates. A proper quantity of fats in a fodder has the effect of slightly checking the transformation of albuminoids, and in aiding the formation of muscular tissue; the action of fats in this relation does not seem very well established, and it is probably in the long run only, that its influence is at all felt. The effect of fats in food is less observable in herbivorous than in carnivorous animals.

The amount of fat contained in fodder must not be too great, as its influence upon digestion is on the whole injurious; small quantities may exert a favorable influence upon the animal's progress in

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flesh formation. From experiments it would seem that the best proportion of fat as compared with the albuminoids is as 1 (fat) to 2.2 (albuminoids) or 1 (fat) to 3 (albuminoids). The carbohydrates in fodder lessen the transformations of the albuminoids to a greater degree than do the fats. Experiments upon carnivorous animals showed that the carbohydrates of the fodder decreased the decomposition of albumin 9 per cent., while fats only diminished it by 7 per cent.

The different varieties of carbohydrates are present in nearly all fodder to quite a large extent, and are therefore more important generally for nitrogen than the fats which are only present in small proportion. It must be remembered that fodder is only economically utilized by cattle when a certain amount of albuminoids are present, and without their presence the digestion of nutritive principles is imperfect.

Formation of Fat. There can be no doubt but that the fatty substances of fodder are assimilated by animals, and without change deposited in the various organs.

At Munich, a dog that had been subjected to a fast of thirty days, was fed for five days with large quantities of fat, it was found at the end of that time that there must have been a daily deposition of fat in the organs of the body to the amount of 250 grammes (about ½ lb.) per day. Many other experiments in which a more normal ration was used gave similar results, proving conclusively that the fats in food, providing they be somewhat similar to the animal fats, are directly assimilated without undergoing much change.

As a general thing, the rations of our domestic animals are not rich enough in fatty substance to account for the quantity found in their bodies; it therefore becomes an important question to decide which of the constituents, other than fats, in fodder, can by their transformations give rise to the formation of fat in the animal economy.

Most of the physiologists of to-day are in favor of the view which considers the albuminoids as the chief fat formers in fodder. It is well known that the albuminoids in cheese are transformed into fatty substance as it ripens. The eggs of the common fly when deposited upon blood give larvæ which contain from seven to eleven times more fat than did the blood or unhatched eggs.

Many experiments have been tried. By feeding dogs with perfectly lean meat it was found that from 42.1 grammes to 42.7 grammes (about 1-10 lb.) of carbon were retained by the animals daily. The nitrogen of the food was entirely accounted for by excretions, while the carbon had, as fat, been deposited in the bodies of the animals.

The study of cases of phosphorus poisoning have proved beyond a reasonable doubt that albuminoids, by their decomposition, give rise to fatty substances. The matter has been studied at the Physiological Institute of Munich, where the fat found in a dog submitted to slow phosphorus poisoning could only be accounted for by assuming that the albuminoids had been decomposed and furnished the elements for the formation of fat.

The action of alkalies and oxydizing agents upon albuminoids transforms them partly into fatty bodies. It must, however, be added, that though the question seems settled in favor of the theory that fats are formed from albuminoids, yet there are some scientists who still consider the carbohydrates as fat producers, and it may be that in some cases they do to some extent act as such. It seems probable that the albuminoids decomposed in the body give rise to the formation of fat, 51 parts being formed for every 100 of dry albumin, which may be oxydized in the natural processes, or else deposited as fat in the organs, or used for the production of fat globules of milk.

In case the quantity of fat assimilated by an animal is greater than that which could be accounted for by the decomposition of the albuminoids, and the fat contained in the fodder, it becomes evident that some other constituent than the albuminoids must by transformation yield fatty substance. By a series of experiments made upon milch cows, at Munich and at Hohenheim, it was found that all the fat in the milk produced by them could have been entirely furnished by the fats and the decomposition of the albuminoids present in the fodder used. At Möckern an experiment with cows gave a quantity of milk-fats slightly larger than that which could have been furnished by the fats and albuminoids of the fodder. This slight excess of fat can be explained, by assuming that a part of the animal's own fat was used in the formation of the fat globules of milk. The experiment was not perfectly complete, and the over production of fatty substance cannot be explained in this case with scientific exactitude.

The influence of the quantity of albuminoids in determining the formation of fat, is set forth in the following table:

No. of experiments.	Elements of the fodder which have been digested daily by each animal.		Relation of albuminoids to carbohydrates in fodder.	Increase of live weight per day for each individual.	Weight at the time of slaughtr'g.	Wgt of fat or tallow of mesentery & kidneys.
	Kilogram.	Kilogram.		Kilogram.	Kilogram.	Kilogram.
7	0.110	0.824	1: 7.49	0.055	48.0	7.2
13	0.134	0.778	1: 5.81	0.099	51.9	9.9
20	0.164	0.794	1: 4.7	0.094	53.5	10.9
19	0.192	0.769	1: 4.01	0.103	54.9	11.2

One kilogramme is equal to 2.2 lbs. avoirdupois.

Most of the experiments were tried on sheep. It will be noticed that the quantity of carbohydrates remains about the same, and that the increase of albuminoids alone is sufficient to determine an increased formation of fat. The quantity of fat in the fodder varied from 0.015 to 0.060 kilogrammes per day for each individual.

Experiments with oxen have given the same results, showing the probability that the formation of fats is due to the fat and albuminoids in the ration. This, though true enough for our domestic ruminants, does not hold for the pig, as an increase of the live weight of this animal of a hundred kilogrammes (220 lbs.) has been obtained by the use of fodder containing from 10 to 15 kilogrammes (22 to 33 lbs.) of fats, and 50 to 70 kilogrammes (110 to 154 lbs.) of albuminoids. It does in this case, therefore, seem highly probable that the carbohydrates take part in the production of fat as well as the albuminoids. Experiments made upon dogs tend to prove that with them the carbohydrates of the food are not transferred into fats, the increase of albuminoids in their rations gave an increased formation of adipose tissue.

It has been asserted that the wax of bees, which resembles in its composition some fats, is formed from saccharine substances, (carbohydrates). Experiment has, however, proven that when bees are fed upon pure carbohydrates their faculty for making wax soon ceases, and the bee dies unless normal food be supplied.

Although most of our knowledge of the matter tends to prove that carbohydrates are not directly transformed into fat, yet they exercise an influence upon its formation and deposition in the animal. They may be considered as economic agents, by their presence helping the transformations necessary to its production, and when once formed preventing any unnecessary waste.

Conditions that effect the formation and the accumulation or depositions of Fat. By increasing the quantity of fat in a ration a larger quantity of it is submitted to process of transformation, and a part of it will be deposited in the organs if present in large enough quantity, especially so, if the ration contain at the same time a large proportion of albuminoids. Fat formed in the body by the transformation of albuminoids is more easily destroyed by vital processes than the ready formed fat furnished by the fodder. The presence of a large quantity of albuminoids in a ration prevents the decomposition of the fat. Fats suffer decomposition more easily in a fat organism than in a lean one; in this latter, fat is easily deposited whether it exist in fodder or be formed by the transformation of the albuminoids present.

The drinking of large quantities of water does not favor the accumulation of fats in the organism; it increases the decomposition of the albuminoids and the elimination of carbonic acid. The temperature of a stable or barn has considerable influence upon the accumulation of fat; if the temperature be too low the process of oxidation becomes more rapid in order to produce the normal bodily heat, while if the temperature be too high, the animals drink too much water, are more restless, and the appetite becomes more or less capricious. A temperature varying between 54° Fahr. and 66° Fahr. is the best calculated to favor the production and deposition of fat. All violent exercise must be guarded against as it greatly increases the decomposition of fat. Cattle undergoing a fattening process, as well as those kept for the production of milk, should enjoy the greatest possible amount of rest. Bleeding increases the decomposition of the albuminoids and reduces the quantity of carbonic acid eliminated, (owing to the diminution of blood corpuscles); this would diminish the quantity of fat destroyed, and therefore favor an accumulation of it in the organism. The smaller the proportion of blood corpuscles the greater is the tendency of an animal to fatten readily. The influence which the carbohydrates exert upon the production and accumulation of fat is very marked in the herbiverous animals. They suspend the destruction of the fat already deposited in the organism, and when they are present in sufficient quantity in the fodder they economize the fat so that all coming directly from the fodder and that formed by the transformation of the albuminoids is accumulated by the animal. No matter how great the increase of carbohydrates may be, it seems, as far as most domestic animals are concerned (except perhaps the pig and a few others), that the quantity of fat formed will always be proportional to the amount of albuminoids present. If now, having a large quantity of carbohydrates present we increase the albuminoids somewhat, immediately an increased formation and deposition of fat takes place. It is found that the fat formed in the body is not usually greater than that which could be formed by the transformation of the albuminoids present. In order to have a thoroughly economical use of a ration it is not sufficient to give large quantities of albuminoids and carbohydrates, but a proper relation must exist between them unless we wish to lose a part of either one of the nutritive constituents. If there is any lack of albuminoids but little fat can be formed on account of the absence of the fat forming principle, if they be present too abundantly, the transformations in the organism becomes too rapid and some of them are destroyed without aiding in the formation of fat. By poverty in carbohydrates the decomposition of albuminoids is not sufficiently hindered and not all of the fat formed is accumulated.

Production of Muscular Power.

The old theory that muscular activity had a wearing effect upon the organs employed, due to an increased decomposition of albumin, has been invalidated by the experiments which have been carried on at the Physiological Institute of Munich, proving that work does not induce a greater wasting of the albumin of the organs than does rest. The organs in use during muscular exercise, may, owing to an influx of blood, induce an increased decomposition of albuminoids, but the passive state of the rest of the body re-establishes an equilibrium, so that the quantity of albuminoids decomposed during activity or rest is about the same. On the other hand, there is a greater destruction of fats and carbohydrates when at work than when at rest, more oxygen is absorbed by respiration, the production of animal heat is increased, a great amount of which is lost owing to the active evaporation of water from the body. Experiments made upon a strong dog, subject to quite a large amount of work, showed that the quantities of decomposed albumin were only slightly greater during this labor than when at rest, and this small increase in the amount of albumin decomposed is to be accounted for not as the result of activity, but on account of the large quantities of water drunk by the animal, which as we have seen facilitates the decomposition of the albumin.

Experiments were tried on a vigorous and healthy man, which gave results that show conclusively that the fatty substances suffer oxidation, and that albumin is not destroyed when at work, though it be severe. The man performed mechanical work during nine hours of the day, and the following table gives the results while at work or at rest, under different conditions of alimentation:

1. While fasting.	Albumin decomps'd.	Fats lost by oxidation.	Carbonic acid expired.	Oxygen absorbed.	Water eliminated. By urine.	Water eliminated. By evap'rn frm body.
	*grammes.	grammes.	grammes.	grammes.	grammes.	grammes.
At Rest........	79	209	716	762	844	821
At Work.......	75	380	1187	1072	746	1777
2. While fed.						
At Rest........	137	219	928	832	1056	931
At Work.......	137	320	1209	1006	1155	1727

* One gramme is equal to 15.43 grains.

A glance at these figures reveals the fact that the quantity of albumin decomposed while at rest or at work is about the same, while it becomes evident that there is a great decomposition or oxidation of fat during work; the quantity of carbonic acid expelled by the lungs is greatly increased, as is the absorption of oxygen; and there is also a larger quantity of water eliminated by the lungs and skin. The quantity of carbonic acid expired is greater when the body is submitted to a fast than when it is being fed with normal rations.

It has been stated by some, that during work a certain amount of free nitrogen was expelled by the lungs, showing that the per cent. of nitrogen in the urine was not a true indication of the decomposition of the albuminoids of the body. A series of very exact experiments has shown this not to be the case.

Nobody at present contradicts the fact of the destruction of fat and the formation of large quantities of carbonic acid. The simple process of mastication increases the amount of carbonic acid formed when compared with that expired by animals in a more perfect state of inactivity.

From the above facts it becomes very evident that, in order to obtain the most rapid production of fat, animals must be permitted as little muscular activity as possible.

A very simple comparison has sometimes been made between animals at work and a steam engine properly fed with fuel and producing mechanical work by means of the heat produced by the combustion of the fuel. For the muscular activity of animals, however, a more complex reason exists than the mere oxidation or combustion of the fat, the phenomenon simply accompanies more profound changes going on in the body. The transformations that the albuminoids undergo in the body seem to be the primary cause of muscular power. This is practically recognized by the fact that animals from which work is expected are fed with food more or less rich in albuminoids. Oats are given to horses; sometimes bean meal may be mixed in the ration to increase the per cent. of nitrogen. A dog fed with carbohydrates and fat soon becomes obese and unfit for active work. Feed one with lean meat, a substance rich in albuminoids, and buoyancy of spirits and strength are the result. A large amount of muscular work cannot be expected from sickly or emaciated bodies, the animal must not only be properly fed but he must be in a perfectly sound state of health and fully developed.

A strong animal well fed with albuminous food is capable of performing a large amount of work; the ration must contain a proper amount of albuminoids in order to admit of the transformations which go on within the body during its activity. The ration should also be as rich as possible in fats in order that the body may remain in fine condition. It may often be necessary to add to rations some food rich in fats. Oats, for instance, are not only quite rich in albuminoids but contain also considerable fatty substance.

Rations.

Rations may be divided into two classes:

1. Rations of maintenance or sustenance.
2. Rations of production.

By ration of maintenance, is meant the ration allotted to an animal to keep it in good condition without increasing its weight to any extent, or of expecting of it any kind of production. For such purposes the coarser kinds of food and those rather poor in albuminoids are often used.

By ration of production, is meant a ration so constituted as regards the nutritive principles that the animal is not only kept in good condition, but the amount of nutritive constituents over and above that necessary to keep it thus is manufactured by the animal into something of utility, such as: fat, muscular force, milk, the building up and developing of the young organization.

In giving some generalities which will be useful in composing these various rations, the facts given in the former part of this paper will be freely used and applied.

Rations of Sustenance Maintenance. Rations of maintenance can only be fed to fully developed adult animals, as they are calculated not for any kind of production but simply to mainiain the animal in good condition. From experiments made at Weende, the condition and weight of oxen were found to remain essentially the same when fed with the following quantities of fodder for every 500 kilogrammes (about 1100 lbs.) of live weight.

1—9.750 kilogrammes (21.45 lbs.) of dried clover.

2—1.850 kilos (4.07 lbs.) dried clover, 6.500 kilos (14.3 lbs.) oat straw, .300 kilos (about 12 ozs.) rape seed cake.

3—1.300 kilos (2.86 lbs.) dried clover, 7.100 kilos (15.62 lbs.) oat straw, .250 kilos (about ½ lb.) rape seed cake.

4—1.900 kilos (4.18 lbs.) dried clover, 6.650 kilos (14.63 lbs.) rye straw, .300 kilos (about 12 ozs.) rape seed cake.

5—12.800 kilos (28.16 lbs.) beets, 6.300 kilos (13.86 lbs.) oat straw, 0.500 kilos (1.1 lb.) rape seed cake.

The quantity of albumen decomposed and assimilated for every 500 kilogrammes (1100 lbs.) of live weight varied from .205 kilos. (.451 lbs.) to 420 kilos (.924 lbs.) an average of .285 kilos (.627 lbs.) The digestible carbohydrates varied from 3.520 kilos (7.744 lbs.) to 3.885* kilos, or an average 3.700† kilos; giving the nutritive relation 1 : 13. By keeping the barn at from 62° Fahr. to 68° Fahr. there was a slight increase in weight; the animals were all maintained in an excellent condition.

In order to be sure of a good ration, it is, perhaps, best to increase the above quantities and to have about .350 kilogrammes (.77 lbs.) of albuminoids and 4.200 kilos (9.24 lbs.) of nutritive carbohydrates; giving a total of 4.550 kilos (10.01 lbs.) of nutritive substances, having the relation 1 : 12. Such a ration could very economically be composed of the cereal straws, to which would be added a fodder rich in nitrogen. Roots could also be mixed with the ration. These experiments have been applied in practice and the following examples may be given: The winter rations given to oxen were for ‡500 kilos, of live weight, daily:

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*3.885 kilos = 8.547 lbs. †3.700 kilos = 8.14 lbs. ‡500 kilos = 1100 lbs.

At Weende, 6.450 kilos (14.19 lbs.) of cereal straw, 3.550 kilos (7.81 lbs.) of esparcet hay, 0.200 kilos (.44 lb.) of bean meal, 0.200 kilos (44 lb.) of rape seed cake.

At Greene, 8.150 kilos (17.93 lbs.) of oat straw, 0.200 kilos (.44 lb.) of aftermath, 1.000 kilo (2.2 lbs.) of clover hay, 0.650 kilos (1.43 lbs.) of pea straw and 1.450 kilos (3.19 lbs.) of mixed barley and oat meal.

By referring to the analyses we find that in the first case the ration contained .500 kilo (1.1 lbs.) of albuminoids and 3.900 kilos (8.58 lbs.) of carbohydrates, a total of 4.400 kilos (9.68 lbs.) In the second case, 0.350 kilo (.77 lb.) of albuminoids, and 4.400 kilos. (9.68 lbs) of carbohydrates, a total of 4.750 kilos (10.45lbs.), and yet there was a slight production in both cases; at Weende, the oxen weighing about 700 kilos (1540 lbs.) increased by about 35 (77 lbs.) to 40 kilos (88 lbs.), while those at Greene were used every day for a small amount of work; they preserved their good condition throughout.

Great changes in the nutritive relation should be avoided. Increasing the amount of albumin greatly in a ration and decreasing the quantity of carbohydrates, will only have for effect the rapid decomposition of the albumin without its being beneficial to the animal: only a very small quantity of it being accumulated in the body. The same is true even to a greater degree of carbohydrates, the increase of which in a ration does in no way add to the animal's weight. Such a proceeding is a mere waste of valuable fodder.

When from a ration of maintenance one wishes to pass to a ration of production, the transition should be gradual; the quantity of carbohydrates and albuminoids must be increased, though not in the same ratio. The condition of the animal has considerable to do in deciding the proper ration; in fattening, if the animal be well developed in muscle but not so in fat, the ratio between the albuminoids and carbohydrates may advantageously be made greater than when the cattle to be fattened are already quite well advanced in fat.

The following data may be of use in preparing rations:

Kind of animal.	Ratio of albuminoids to carbohyd.	Ratio of fats to albuminoids.
Ox........	1 : 9 to 1 : 15	$\triangleleft$ 1 : 4
Sheep......	1 : 9 to 1 : 12	$\triangleleft$ 1 : 4
Horse......	1 : 10	$\triangleleft$ 1 : 3

The above figures must only be used as indications for the economical compounding of rations; deviations from them may often be advantageous. The same can be said of all these experimental determinations, they must be intelligently followed; they are simply guides for the agriculturist, and he is to use them to his best advantage.

The tables of analyses appended to the end of this short article will be of use, if the agriculturist will also use his common sense and experience as guides.

Rations for the production of Milk.

Before entering upon the subject of the most rational feeding of milk-giving animals, we must first know the mode of its elaboration. It is not a mere secretion of the mammary gland, it is really a product of the degeneration of the gland itself; a sort of fatty degeneration actually taking place, fat cells being actively generated within it.

The milk shortly after parturition is filled with cells of a special nature, and it is then called colostrum. These cells after awhile disappear entirely from the liquid and we have in their place the fat globules of milk. In colostrum we have no casein but albumin. It is only when the mammæ are in their fullest activity that the albumin and colostrum cells become casein and fat globules. The colostrum cells are more or less epithelial in their nature, and have not, or at most only partially, undergone fatty degeneration. The milk solids of a mineral nature show that milk is not what is commonly understood by a secretion, but that it partakes of the very composition of the generating gland; the salts most abundantly found in milk are those of potash and the phosphate of lime, while ordinary secretions are very rich in chloride of sodium or common salt.

The average composition of cow's milk is given in the following table:

Fat	4.03	per cent.
Casein	3.50	"
Albumin	0.58	"
Sugar of milk	4.60	"
Mineral salt	0.73	"
Water	86.56	"

The method of generation of milk makes it very evident that the quality and quantity of it depend greatly upon the composition of the gland and its development. It is well known that two cows placed under similar conditions and fed with exactly the same rations, may give large quantities of milk in the one case, and small quantities in the other; that the milk may in the one instance be rich, in the other poorer, in fat. An animal must be well selected in order to do what every agriculturist wants, that is, to give a paying return for the fodder which it consumes.

From the composition of milk we see that the albuminoid which occurs in largest quantity in it is casein, while the most important non-nitrogenous substance in it is the fat.

The feeding of milch cows with highly albuminous food has a very favorable effect upon the production of milk; cows fed in this way will yield a rich and abundant supply of milk longer than when fed with fodder poor in albuminoids. The production of milk will rapidly become less when there is a decrease in the amount of albuminoids in the fodder, although the amount of digestible albuminoids in the fodder may be quite large enough. Experiments of this kind were made at Möckern, and the production of milk was decreased by two litres (4.2 pints) per cow per day. At Hohenheim, there was a decreased daily production for each cow of five litres (10.5 pints). The rations were abnormal as well as the appearance of the animals, although they scarcely varied in weight during the experiments. Good milch cows will give large quantities of milk even when the fodder is rather poor in albuminoids; sometimes it even occurs that the body itself furnishes what may be lacking in very poor fodder. This cannot last long, however, nor must the fodder fall below a certain nutritive ratio. The best feeding will not make a good milch cow out of a poor one, and it is a waste of money to keep such.

The casein of milk is formed by the changes which the albuminoids of the fodder undergo, the fat is also produced in great part by the albuminoids together with that already existing in the fodder.

From experiments tried at Munich it would seem that sugar of milk is derived from the albuminoids and fats. Sugar of milk in the milk of carnivorous animals, subjected to a purely animal diet of flesh and fat, can only be formed by the transformation of albumin and fat; while it seems probable that for herbivorous animals the carbohydrates may take part in its formation also.

From numerous experiments which have been performed with great accuracy, it has been deduced that the daily quantity of digestible albuminoids necessary for milch cows is about 1.250 kilogrammes

(2.75 lbs.) for every 500 kilogrammes (1100 lbs.) of live weight, and that of the digestible carbohydrates 6.750 kilogrammes (14.85 lbs.)—200 grammes (.44 lb.) being fats. This gives the nutritive relation 1 : 5.4. Such a ration should contain about 12 kilogrammes (26.4 lbs.) dry substance.

In order to obtain the highest possible yield of milk when using hay of average quality, it is best to add an easily digestible fodder containing a high percentage of albuminoids. Although a smaller quantity of digestible albuminoids than 1.250 kilogrammes (2.75lbs.) for every 500 kilogrammes (1100 lbs.) of live weight per day, say 1 kilogramme (2.2 lbs.) will still give rise to a satisfactory production of milk, nevertheless it is far more economical to have rations rich in albuminoids as the quantity of milk will be greater and the period of milk production longer. It can easily be seen, that good milch cows fed with fodder containing less than 1.250 kilogrammes (2 75 lbs.) of albuminoids will utilize them largely for the production of milk, and very little will be left for other productions, although the quantity of fats in the fodder might be as high as 200 grammes (.44 lbs.)

From what has been said, it might be expected that by increasing the quantities of albuminoids and fats in a ration, the quantities of these substances would effect an increase in the milk. Experiments in this direction do not indicate this to be exactly the case; they have been tried at Hohenheim, Möckern, etc., and the result of adding a fatty substance, such as colza oil, linseed oil, to the ration has been in some, though not all cases, to slightly increase the quantity of milk produced without increasing the percentage of fat, in some instances the percentage of fat actually decreased.

From experiments upon goats it would seem that the mixing of fats (poppy oil) with their rations, will, provided the ration be very rich in albuminoids, increase the percentage of fat in the milk, while in a ration poor in albuminoids the opposite effect was noticed.

It must be remembered that a sudden change in the fodder of milch cows has an influence upon the quality of the milk, and especially upon its contents in fat, but it will be found that if the change from one kind of fodder to another be made, that the composition of the milk will remain nearly the same, or if some time be not allowed to pass after the sudden change of fodder has been made before the milk be examined, it will be found to have nearly the same composition it had before the fodder was changed. All experiments on the influence of fodder upon the composition of milk must be carried on for a long time in order to give reliable results. The fodder, undoubtedly, has an influence, more or less marked, upon the quality of milk, which can hardly be revealed by analysis. It is well known that butter is often affected by the kind of fodder the cows have had, varying greatly in taste and color. When poor fodder is fed to cows the milk is generally less rich in solids than when the fodder is of proper composition and given in sufficient quantity. Individual idiosyncracies undoubtedly have considerable to do in the production of milk of different qualities, though the fodder be the same in each case.

It is well known that certain plants containing volatile principles or oils of strong odor are very injurious to the quality of milk. Some plants, such as madder, impart a color to it. The production of milk may be greatly hindered if the fodder does not contain a sufficient quantity of phosphoric acid, lime and potash. In experiments made at Proskau, upon goats fed with fodder poor in these elements, the flow of milk rapidly ceased and the animals experimented upon lived only fifty days.

The daily ration of a milch cow should contain at least 0.045 kilogrammes (697 grains) of phosphoric acid, 0.065 kilogrammes (1012 grains) of lime, and 0.117 kilogrammes (1813 grains) of potash. This last substance is generally found in large enough quantities in fodder. Ordinary fodder generally contains large enough quantities of the other necessary mineral substances, but when husks, chaff, straw of cereals, and some roots form the basis of alimentation, it may be necessary to add lime as powdered chalk, and perhaps even phosphoric acid as phosphate of lime, for example.

Table showing the per centage of ash, phosphoric acid, alkalies and lime, contained in some of the most common fodders (dried).

Kind of Fodder.	Ash.	Phosphoric acid.	Alkalies.	Lime.
Wheat bran	6.19	3.159	1.676	0.194
Rape seed cake	6.42	2.256	1.675	0.799
Hay	6.02	0.482	1.803	1.007
Lucern hay	7.46	0.657	1.987	3.146
Clover hay	6.83	0.674	2.335	2.406
Green fodder corn	6.00	0.652	2.421	0.807
Beets	6.44	0.544	4.503	0.256
Carrots	5.58	0.695	3.197	0.637
Potatoes	3.77	0.653	2.375	0.097
Wheat straw	5.37	0.320	1.565	1.851
Barley straw	4.80	0.215	1.295	0.373
Oat straw	4.70	0.220	1.176	0.416

All milch cows should have salt mixed with their fodder. It acts upon the circulation of the nutritive matters in the body, increases the changes of the albuminoids, and also stimulates the appetite. Prof. Arnold cites the fact that cows which had not received any salt for five days (in June) gave 2 per cent. less milk, and the quality fell 7 per cent. From 15 to 30 grammes (232 to 465 grains) of salt per day is sufficient.

Production of Fat Meat. Fattening of Cattle.

If animals are already in good condition when the process of fattening is undertaken, it has been found that fat is accumulated in a ten times larger quantity than flesh; if the animal is thin, flesh is at first accumulated in somewhat larger proportion than it is in stock in good condition.

Oxen in poor condition are not easily fattened, and a preparatory ration must be given them for two or three weeks before the actual process of fattening commences. In this preparatory feeding is given for every 500 kilogrammes (1100 lbs.) of live weight, 1.250 kilos (2.75 lbs.) of albuminoids, and 6.250 kilos (13.75 lbs.) of carbohydrates, the nutritive relation being 1 : 5.

The true process of fattening begins when the animals have been put in good condition by the above-mentioned ration. The quantity of carbohydrates is now increased to 8.125 kilos (17.875 lbs.), while the quantity of albuminoids remains unchanged; the nutritive relation becomes 1 : 6½. In this way the transformation of albuminoids is lessened and a part of them accumulated, while the fat existing in the fodder and that derived from the albuminoids therein is protected against oxidation. When considerable fat, as well as some flesh has been accumulated, the process of fattening being then about one-third through, the proportion of albuminoids in the fodder is increased from 1.250 kilos (2.75 lbs.) to 1.500 kilos (3.3 lbs.), thus giving a nutritive relation of 1 : 5½. This gives us more material in the fodder from which fat may be formed, while there is but little danger of the destruction of albumin in the body, owing to the fact that fat organisms prevent the rapid transformation of albuminoids; at the same time it must be remembered that fat is deposited with more difficulty in an animal which has already accumulated considerable of it. This is the ration upon which the fattening process mostly depends, and it must be continued without change for some length of time.

It is customary to give, towards the end of the process, fodder slightly poorer in albuminoids; this is sometimes done by replacing the oil cake there may be in the ration by grain, this adds to the flavor of the food and exerts a beneficial effect upon the uncertain appetite of cattle in a fattened state. It may also give rise to a somewhat greater accumulation of albumin without decreasing that of the fats. It is to be recommended not to let the nutritive ratio fall below 1 : 6.

The increase of the quantity of fat in the ration by the addition of 250 grammes (about 9 ounces) to 500 grammes (1.1 lbs.) of colza oil for oxen, or 30 to 40 grammes (about 1 to 1⅓ ounces) for pigs, has been shown to occasion a rapid increase in live weight provided the fodder be rich in albuminoids; such an addition is most profitable at the first and second stage of the fattening process. The high price of the oils and fats is an objection to their use, as well as the fact that they disturb the digestion of cattle; it is, however, very useful at times to increase the proportion of fatty substance in fodder, and this can be most economically done by the addition of the various oil cakes.

It must be one's aim during the fattening process to induce the animals to eat the largest possible amount of rich and easily digested food; to this end common salt is often added, as it gives flavor to the fodder, and when used in small quantities does not act injuriously. Too much of it should be avoided, as it induces thirst, and if considerable water is taken by the animal it accelerates the changes of the albuminoids and thus occasions a loss of some of the nutritive elements of the fodder. The use of fodder containing large quantities of water, is to be avoided if one wishes to utilize it as completely as possible, especially in fattening animals of the bovine race. It is well to have from four to five parts of dry substance to one of water. The ration for fattening sheep must be rich in albuminoids; such feeding will give a rapid accumulation of fat. The process of making fat sheep is conducted in much the same way as it is for oxen. It is hardly ever necessary, however, to give them a preparatory ration to put them in good condition so that fattening may be economically commenced. The ration upon which the process mainly depends, and which must be fed to the animal for the longest period, should have a nutritive ratio of from 1 : 5 to 1 : 4½; the ration previously given may have a relation of about 1 : 5½.

Sheep eat a larger quantity of dry substance proportionally to their weight than do oxen. At the beginning of the operation of fattening cattle it is best to give daily from 9 to 10 kilogrammes (19.8 to 22 lbs.) of nutritive elements for every 500 kilogrammes (1,100 lbs.) of live weight; an increase of about 10 to 12 kilos (22 to 26.4 lbs.) will be observed for every 100 kilos of fodder eaten,—sometimes a larger increase in the case of oxen.

It must not be forgotten that various breeds of our domestic animals have different aptitudes as regards the accumulation of fat. Sheep fatten most rapidly between the ages of 1½ years and 3 years. Much younger than 1½ years, they may still be economically fattened and yield meat which is more watery and less fat than when between 1½ to 3 years old. Above 4 years old, they may be fattened, but then the meat is far below that of younger sheep in tenderness or excellence of flavor.

The effect of shearing sheep upon the utilization of their fodder is very remarkable; numerous experiments having shown that they increase more rapidly in live weight after shearing. It is stated that a ration somewhat less rich in albuminoids produced, after shearing, the same increase in live weight that one richer in those constituents did before. These results may be explained by the fact that the appetite is somewhat increased, and that the quantity of water which the sheep need is generally less than when in full fleece; the quantity of water drunk being reduced, the nutritive elements of the fodder suffer decomposition less rapidly.

For pigs that are being fattened the food may be considerably poorer in albuminoids than in the cases previously mentioned, and as the fattening process goes on the proportion of albuminoids can be decreased until the end of the operation. This gives fat of greater consistency and better quality, and the animals are less liable to disease than when fed with feed richer in albuminoids. A pig will devour large quantities of food, 40 kilos (88 lbs.) and over of dry substance for every 1,000 kilos (2,200 lbs.) of live weight, and as they increase in size the consumption of feed becomes less and less, until finally it is hardly as great as in the case of fattening ruminants.

If the fattening of the pig be begun at a very early period (as soon as it is weaned), so that at the age of one year it weighs about 150 kilos (330 lbs.), it will, if it has an aptitude for accumulating fat, and is properly fed, increase 100 kilos (220 lbs.) for every 400 kilos (880 lbs.) of dry fodder. In case the pigs are old, it will take at least 500 to 600 kilos (1,100 lbs. to 1,320 lbs.) of dry fodder to produce a similar increase.

Although it is necessary at the beginning of the fattening process to give rations rich in albuminoids, it must be done with care and observation, as it often affects the health of the animals. It is well never to give fodder richer in albuminoids than that represented by the relation 1 : 4½ or 1 : 5, and to diminish that ration from the sixth month on until it becomes 1 : 6½. It is usually necessary to add smaller quantities of chalk to the ration, especially of young animals. Among the fodders used most successfully for pigs, must be mentioned barley meal, corn meal and pea meal. These can be given alone or mixed with steamed potatoes. Oat meal and different kinds of bran have not proved as valuable as the first mentioned. Skimmed, sour or butter milk are excellent additions to food for pigs, and often render accceptable that which without them would be rejected.

Rations for Working Horses and Cattle.

An animal to be used for work should have a vigorous constitution and great muscular development. In order to keep such an organism in good condition it is evident that it must be supplied with large quantities of fodder rich in albuminoids, especially while at work, for though albumin does not suffer decomposition more rapidly during work than when at rest, nevertheless it must be abundantly supplied, as the source of muscular activity is the change which albumin undergoes in the body, and it must be remembered that while the rapidity of the transformations of the albuminoids depends upon the quantity and condition of them supplied in the food, the oxidation of fat is increased by muscular effort.

As the loss of fatty substance is very great during protracted work, it becomes very necessary to give food rich in fats or in carbohydrates; the former are the most useful, being the most concentrated of the so-called respiratory elements of fodder. For working oxen the daily ration should contain for every 500 kilos (1100 lbs.) of live weight, 0.800 kilos (1.76 lbs.) of digestible albuminoids and 6 kilos (13.2 lbs.) of digestible carbohydrates, giving the nutritive ratio 1 : 7½. Hay of medium quality, to which small quantities of some concentrated food has been added, would give such a ration. A proper mixture of clover hay and straw, or a mixture of straw, roots and some highly albuminous food will give good results for the feeding of animals at work. Such rations would contain about 12 kilos (26.4 lbs.) of organic substance, and not more than about 0.150 kilos of fatty compounds, (.33 lbs., that is about ⅓ lb.).

When the work of oxen is of a very severe nature the amount of albuminoids is raised to 1.200 kilos (2.64 lbs.) and the carbohydrates to 7.200 kilos (15.84 lbs.), giving a nutritive relation of 1 : 6; some concentrated food rich in albuminoids and fat is generally used in such cases so as to increase the amount of fatty substance to 0.250 kilos (.55 lbs.). For the horse no fodder seems to be more universally used, nor any with better effect, than oats and hay, to which straw and meal are sometimes added. For a working horse oats are undoubtedly a most valuable and rational food. The daily ration should consist for every 500 kilos (1100 lbs.) live weight of 0.900 kilos (1.98 lbs.) of albuminoids and 6.300 kilos (13.86 lbs.) of carbohydrates. (Nutritive ratio = 1 : 7). Such a ration would contain about eleven kilos (24.2 lbs.) of organic substance and 0.300 kilos (.66 lb.) of fat, as oats are rich in fatty substance. This must be taken into consideration if oats are to be replaced by any other fodder. For heavy draught horses hard at work, the quantity of nutritive substances in the ration must be increased, the albuminoids to 1.400 kilos (3.08 lbs.), the carbohydrates to 7.700 kilos (16.94 lbs.), giving a total of 9.100 kilos (20.02 lbs.) of digestible substances having the nutritive relation 1 : 5½. Oats to which pea or bean meal are added give excellent rations of this description.

The feeding of Young and Growing Animals.

Many practical experiments upon the feeding of young stock have been made. In the feeding of the bovine race one experiment may be cited:

Three calves 14 days old, and weighing respectively 53, 59 and 52 kilogrammes (116.6, 129.8 and 114.4 lbs.), were fed during the third and fourth week in the following manner:—The first received daily a ration of 6 litres (6.3 qts.) of milk mixed with 6 litres of whey (6.3 qts.), the second had 10 litres (10.5 qts.) of skimmed milk, and the third 8 litres (8.4 qts.) of milk and 1¾ litres (1 4-5 qts.) of cream.

The result of the experiment is given in the following table:

Calf.	Substance eaten per week.				Nutritive ratio.	Increase of weight per week.	Contents of the food in organic substances for every kilo of increase.
	Organic Substance.	Albuminoids.	Sugar.	Fat.			
	Kilos.	Kilos.	Kilos.	Kilos.		Kilos.	Kilos.
No. 1...	7.400	1.700	4.100	1.600	1:4 47-100	6.000	0.615
	16.28 lbs.	3.74 lbs.	9.02 lbs.	3.52 lbs.		13.2 lbs.	1.35 lbs.
No. 2...	6.200	2.250	3.250	0.700	1: 2 5-100	3.650	0.855
	13.64 lbs.	4.95 lbs.	7.15 lbs.	1.54 lbs.		8.03 lbs.	1.88 lbs.
No 3...	9.45	2.300	3.250	3.900	1:5 4-10	10.750	0.440
	20.79 lbs.	5.06 lbs.	7.15 lbs.	8.58 lbs.		23.65 lbs.	.968 lbs.

It is seen that there is a great difference in the rate of increase of the young animals. It was thought that the fat in the ration exerted a great influence upon the increase in weight of young stock, but it seems probable that this is more influenced by the total quantity of organic substances in the fodder. It is to be observed that the fodder richest in albuminoids and having the nutritive relation or ratio 1 : 2 5-100 gave the least increase; the reason is that the exaggerated quantity of the albuminoids in the ration caused a rapid transformation and the destruction of these substances in the organism. It is probable that in the feeding of young animals a part of the fat may be advantageously replaced by some easily digestible carbohydrates, such as sugar of milk; thus admitting of the economical use of whey or skimmed milk, to which might be added a little sugar or starch.

Milk of normal composition is the natural food for young calves, and when any mixtures are made it should be with a view to obtain food, having as nearly as possible the digestive ratio 1 : 4½, which is the average ratio of milk, the extremes being 1 : 3.3 to 1 : 5.5. There will be an increase of about 1 kilogramme (2.2 lbs.) in the weight of the animals for every 10 kilos (22 lbs.) of milk fed them. It must be remembered that the calf should have the milk of its own mother immediately after parturition, and for sometime, as at that period it is colostrum and necessary to the young animal. When the process of weaning commences it is of the greatest importance to make the transition from the milk-diet to the other food as gradual as possible, so that there may be no falling off in the development of the organism. For this purpose cooked linseed meal, and, later, linseed cake are very appropriate, while we also have at our command oats, barley, pea and bean meal. It is well to furnish small quantities of the finest hay or clover to the animal as soon as it is old enough to utilize it. In the proper season putting the calves to pasture makes weaning comparatively easy. One must keep constantly in mind the fact that the fodder should have as nearly as possible the nutritive relation of milk 1 : 4½. The quantity of fat in the ration can be quite rapidly diminished and replaced by carbohydrates. By following out this line of feeding, calves can be entirely weaned by the ninth or tenth week, and will have arrived at a live weight of about 75 (165 lbs.) to 100 kilogrammes (220 lbs.). After this, they must be continued upon rich food having a ratio of 1 : 5 to 1 : 6. When they have arrived at the age of six to nine months, fodder which is more voluminous and less rich is offered them.

The alimentation of lambs must be carefully attended to, as their growth is easily checked by poor or insufficient food. Pasturage is best adapted to their wants. If fed in the fall they must have the best and the finest of hay, and if the quality is not good it must be mixed with some grain, such as oats, to which may be added a small quantity of fodder very rich in albuminoids.

It must not be forgotten that in order to have a well developed and strong skeleton, young stock must have a sufficient quantity of phosphoric acid and lime in their fodder. A year old calf weighing 350 kilos (770 lbs.) had accumulated during that time 6.750 kilos (14.85 lbs.) of phosphoric acid, and 7.500 kilos (16.5 lbs.) of lime; being a daily assimilation of 18.5 grammes (284.9 grains) of the first, and 20.5 grammes (315.7 grains) of the second, about the quantities present in 10 litres of milk (10½ qts.).

These substances must be supplied to the young animal if not present in sufficient quantity in the fodder. The lime which is sometimes somewhat lacking is easily furnished as powdered chalk. When both lime and phosphoric acid are wanting phosphate of lime may be added. Iron, potash, etc., are generally present in large enough quantities in fodder for the needs of animals.

In preparing the foregoing pages, I must acknowledge my indebtedness to the writings of Kuhn, Garola, Grandeau, and especially to the standard works of Wolff.

*Composition and Valuations of American Feeding Stuffs.**

Feeding Stuffs.	Water.	Ash.	Organic Substances. Albuminoids.	Fibre.	Other Carbohydrates.	Fat.	Digestible Nutrients. Albuminoids.	Carbohydrates.	Fat.	Nutritive Ratio.	Money Value. Dollars, per 100 lbs.	Compared with Meadow hay=1
Green Fodder.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	1:	$	
Norfolk White Maize......	85.7	0.8	0.9	4.9	7.4	0.3	0.5	7.4	0.1	14.9	0.09	0.14
Southern White Maize.....	85.7	1.1	1.3	4.6	7.1	0.2	0.9	7.6	0.1	9.2	0.11	0.17
Hungarian grass, early blos	75.0	2.2	3.2	8.7	10.5	0.5	1.8	11.5	0.2	6.7	0.19	0.30
" " in full "	75.0	1.3	2.4	8.3	12.6	0.5	1.2	11.0	0.2	9.4	0.16	0.25
Hay.												
Timothy, well headed out..	12.5	4 1	8.4	28.9	44.4	1.7	4.4	43.6	0.8	10.4	0.62	0.97
" in full blossom...	12.5	3.8	6.2	29.1	46.6	1.7	3.1	39.9	0.5	13.2	0.52	0.81
" out of blossom...	12.5	3.6	6.2	29.6	46.6	1.5	3.0	39.9	0.4	13.6	0.51	0.80
" nearly ripe......	12.5	3.2	5.5	31.0	45.7	1.7	2.7	40.2	0.5	15.3	0.50	0.78
Red clover, just before blos.	14.3	7.3	12.2	23.8	41.1	1.5	6.7	38.8	0.8	6.1	0.67	1.05
" in full blossom...	14.3	6.6	11.6	23.8	41.7	2.0	5.9	38.5	0.9	6.9	0.64	1.00
" nearly out of blos	14.3	6.3	11.3	25.6	41 0	1.6	5.7	38.8	0.7	7.1	0.63	0.98
" nearly ripe......	14.3	5.6	8.9	27.2	42.0	2.0	4.0	39.2	0.9	10.3	0.56	0.87
Hungarian, heads part. filled	16.7	7.2	10.7	28.9	34.8	2.0	6.0	38.3	0.7	6.7	0.64	1.00
" heads devel., seeds soft	16 7	4.3	8.0	27.6	41.9	1.7	4.0	36.7	0.5	9.4	0.52	0.81
" nearly ripe..........	16.7	5.3	5.7	29.9	41.9	1.6	2.8	37.7	0.5	14.1	0.48	0.75
Norfolk White Maize......	25.0	5.5	9.9	24.3	37.3	1.0	4.5	40.0	0.5	9.2	0.58	0.90
Southern White Maize.....	25.0	4.3	4.5	25.7	39.1	1.4	2.7	38.9	0.6	14.9	0.49	0.76
Salt Marsh Hay.												
Better quality mixed......	10.0	6.9	7.3	32.1	40.8	2.9	3.7	38.7	0.9	11.1	0.54	0.84
Black Grass..............	10.0	5.1	6.7	32.7	43.2	2.3	3.4	40.3	0.7	12.5	0.54	0.84
Rush Salt Grass...........	10.0	6.6	4.6	32.8	44.2	1.7	2.2	40.5	0.5	19.1	0.48	0.75
Coarse Salt Marsh Grass....	12.5	10.8	5.3	30.6	38.3	2.4	2.5	36.3	0.7	15.0	0.48	0.74
Fresh Marsh Hay.												
Bog hay—cut in June.....	10.0	6.2	9.6	32.8	39.3	2.1	4.8	38.4	0.6	8.3	0.58	0.90
" " August...	10.0	5.4	6.7	32.8	42.7	2.4	3.4	40.0	0.7	12.4	0.54	0.84
Weeds.												
Whiteweed, (Ox-eye Daisy).	10.9	6.4	7.0	31.0	42.3	2.4	?	?	?	?	?	?
Buttercups...............	8.2	5.2	10.7	30.7	41.6	3.6	?	?	?	?	?	?
Beach Pea Vines..........	7.9	7.0	23.3	29.4	27.6	5.0	?	?	?	?	?	?
Straw and Cobs.												
Oat	12.5	1.8	2.3	60.0	26.4	1.0	0.8	38.7	0.3	49.4	0.40	0.62
Rye	12.5	8.0	6.9	34.2	35.7	2.7	1.6	37.1	0.8	24.8	0.44	0.69
Buckwheat	10.4	5.1	3.9	45.9	33.3	1.6	?	?	?	?	?	?
Corn cobs................	12.1	1.3	1.2	38.0	51.7	0.1	0.6	44.9	....	75.0	0.42	0.66
Grains and Fruits.												
Barley feed..............	9.9	3.8	12.7	7.0	63.5	3.2	10.1	57.1	2.1	6.2	1.05	1.64
Rice feed................	15.1	6.0	9.3	8.1	59.9	1.6	7.3	49.1	1.4	7.3	0 82	1.28
Oats, No. 1, White........	11.2	2.9	11.5	12.2	57.8	5.1	8.7	43.3	4.0	6.2	0.94	1.47
Oats.....................	12.4	3.0	8.0	12.9	59.0	4.7	6.0	44.3	3.7	8.9	0.82	1.28
Corn, N. E. Yellow, 8-rowed	12.7	1.4	10.0	1.7	69.3	4.9	8.4	65.8	3.7	8.6	1.09	1.67
" King Philip.........	9.8	1.6	11.9	2.2	70.1	4.5	10.0	66.7	3.4	7.5	1.18	1.84
" Mass. White Flint....	10.2	1.4	9.2	1.5	74.3	3.4	7.7	70.3	2.6	9.9	1.00	1.56
" Mass. Red Flint......	12.0	1.1	12.1	2.0	69.5	3.4	10.1	66.0	2.6	7.2	1.07	1.67
" Early Dutton.........	8.1	1.5	9.6	2.5	72.6	5.7	8.1	69.2	4.3	9.9	1.16	1.81
" Sweet...............	10.8	2.1	11.4	3.8	64.3	7.7	9.6	61.8	5.9	8.0	1.19	1.86
" Western Yellow......	13.0	1.2	8 9	2 0	70.8	4.1	7.5	67.3	3.1	10.0	1.04	1.62
" Southern White......	12.7	1.4	9.7	1.8	70.4	4.1	8.2	66.8	3.1	9.2	1.09	1.67
Apples...................	83.2	0.3	0.3	0.9	15.0	0.4	0.2	12.7	....	70.8	0.13	0.20

* These analyses were made by Profs. Johnson, Atwater and Storer, and Mr. Sharpless.

Composition, etc., of Feeding Stuffs—Concluded.

Feeding Stuffs.	Water.	Ash.	Organic Substances. Albuminoids.	Organic Substances. Fibre.	Organic Substances. Other Carbohydrates.	Organic Substances. Fat.	Digestible Nutrients. Albuminoids.	Digestible Nutrients. Carbohydrates.	Digestible Nutrients. Fat.	Nutritive Ratio.	Money Value. Dollars, per 100 lbs.	Money Value. Compared with Meadow hay=1
Milling & Waste Products.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	1:	$	
Coarse Wheat Bran........	11.4	5.1	12.9	8.1	59.1	3.5	10.0	48.5	3.1	5.6	1.01	1.58
Wheat Middlings..........	11.8	2.3	11.4	4.8	66.8	2.9	8.9	54.8	2.6	6.9	1.00	1.56
Corn Starch feed..........	72.2	0.1	3.6	3.4	18.8	2.0	3.2	19.3	1.8	7.4	0.39	0.60
Brewers' Grains...........	75.2	0.3	5.9	3.9	13.2	1.5	4.8	11.3	1.2	3.0	0.36	0.56
St. Louis Ship Stuff........	11.8	2.3	11.1	5.6	66.5	2.8	8.7	54.5	2.5	7.0	0.97	1.51
Rye Bran	12.9	2.9	12.6	2.5	67.0	2.2	10.6	50.0	2.3	5.3	1.00	1.56
Malt Sprouts..............	11.6	6.7	25.9	9.3	45.5	1.1	20.8	43.7	0.9	2.2	1.33	2.08
Oil-Cake and Meal.												
Linseed Cake..............	9.1	8.2	32.4	7.3	31.5	11.6	27.6	27.0	10.4	2.0	1.89	2.98
Cotton Seed Meal..........	7.2	5.8	41.5	3.1	24.4	18.0	33.2	17.6	16.2	1.8	2.30	3.60
Palm Nut Meal...........	7.9	4.0	13.5	18.8	41.1	14.8	12.9	56.8	14.0	7.2	1.67	2.61
Slaughter-House Waste.												
Dried Blood..............	7.2	....	63.0	....	....	6.4	42.2	....	5.7	0.3	2.08	3.25
Meat Scrap...............	4.2	....	47.3	....	....	2.1	45.0	....	2.0	0.1	2.03	3.17
Ground Dried Flesh.......	8.3	....	67.4	....	....	6.5	64.1	....	6.0	0.2	3.04	4.75
Fish Waste.												
Dry Ground Fish..........	12.5	....	49.6	....	....	9.5	44.6	....	8.6	0.5	2.30	3.60

Feeding Standards.

The feeding standards herewith are as given by Wolff, (M. & V. L. Landw. Kalendar, 1879). By total organic substance is meant the organic matter of the whole ration considered free from water and ash.

Per Day and per 1,000 lbs. Live Weight.	Total organic substance.	Nutritive (digest'bl) substances. Albuminoids.	Nutritive (digest'bl) substances. Carbohydrates.	Nutritive (digest'bl) substances. Fats.	Total nutritive substance.	Nutritive ratio.
	lbs.	lbs.	lbs.	lbs.	lbs.	
Oxen at rest in stall.....................	17.5	0.7	8.0	0.15	8.85	1 : 12.
Wool sheep, coarser breeds..............	20.0	1.2	10.3	0.20	11.70	1 : 9.
" " finer breeds................	22.5	1.5	11.4	0.25	13.15	1 : 8.
Oxen moderately worked..............	24.0	1.6	11.3	0.30	13.20	1 : 7.5
" heavily worked....................	26.0	2.4	13.2	0.50	16.10	1 : 6.
Horses moderately worked...............	22.5	1.8	11.2	0.60	13.60	1 : 7.
" heavily worked..................	25.5	2.8	13.4	0.80	17.00	1 : 5.5
Milch cows..............................	24.0	2.5	12.5	0.40	15.40	1 : 5.4
Fattening oxen, 1st period...............	27.0	2.5	15.0	0.50	18.00	1 : 6.5
" " 2d "	26.0	3.0	14.8	0.70	18.50	1 : 5.5
" " 3d "	25.0	2.7	14.8	0.60	18.10	1 : 6.0
Fattening sheep, 1st period..............	26.0	3.0	15.2	0.50	18.70	1 : 4.5
" " 2d "	25.0	3.5	14.4	0.60	18.50	1 : 4.5

Feeding Standards—Concluded.

Per Day and per 1,000 lbs. Live Weight.		Total organic substance.	Nutritive (digestible) substances. Albuminoids.	Carbohydrates.	Fats.	Total nutritive substances.	Nutritive ratio.
		lbs.	lbs.	lbs.	lbs.	lbs.	
Fattening swine, 1st period		36.0	5.0	27.5		32.50	1 : 5.5
" " 2d "		31.0	4.0	24.0		28.00	1 : 6.0
" " 3d "		23.5	2.7	17.5		20.20	1 : 6.5
Growing cattle:							
Age, months.	*Aver. live wt. per head.*						
2——3	150 lbs.	22.0	4.0	13.8	2.0	19.8	1 : 4.7
3——6	300 "	23.4	3.2	13.5	1.0	17.7	1 : 5.0
6——12	500 "	24.0	2.5	13.5	0.6	16.6	1 : 6.0
12——18	700 "	24.0	2.0	13.0	0.4	15.4	1 : 7.0
18——24	850 "	24.0	1.6	12.0	0.3	13.9	1 : 8.0
Growing sheep:							
5——6	56 "	28.0	3.2	15.6	0.8	19.6	1 : 5.5
6——8	67 "	25.0	2.7	13.3	0 6	16.6	1 : 5.5
8——11	76 "	23.0	2.1	11.4	0.5	14.0	1 : 6.0
11——15	82 "	22.5	1.7	10.9	0.4	13.0	1 : 7.0
15——20	85 "	22.0	1.4	10.4	0.3	12.1	1 : 8.0
Growing, fat pigs:							
2——3	50 "	42.0	7.5	30.0		37.5	1 : 4.0
3——5	100 "	34.0	5.0	25.0		30.0	1 : 5.0
5——6	125 "	31.5	4.3	23.7		28.0	1 : 5.5
6——8	170 "	27.0	3.4	20.4		23.8	1 : 6 0
8——12	250 "	21.0	2.5	16.2		18.7	1 : 6.5
Per Day and per Head.							
Growing cattle:							
2——3	150 lbs.	3.3	0.6	2.1	0.30	3.00	1 : 4.7
3——6	300 "	7.0	1.0	4.1	0.30	5.40	1 : 5.0
6——12	500 "	12.0	1.3	6.8	0.30	8.40	1 : 6.0
12——18	700 "	16.8	1.4	9.1	0.28	10.78	1 : 7.0
18——24	850 "	20.4	1.4	10.3	0.26	11.96	1 : 8.0
Growing sheep:							
5——6	56 "	1.6	0.18	0.87	0.045	1.095	1 : 5.5
6——8	67 "	1.7	0.17	0.85	0.040	1.060	1 : 5.5
8——11	75 "	1.7	0.16	0.85	0.037	1.047	1 : 6.0
11——15	82 "	1.8	0.14	0.89	0.032	1.062	1 : 7.0
15——20	85 "	1.9	0.12	0.88	0.025	1.047	1 : 8.0
Growing, fat swine:							
2——3	50 "	2.1	0.38	1.50		1.88	1 : 4.0
3——5	100 "	3.4	0.50	2.50		3.00	1 : 5.0
5——6	125 "	3.9	0.54	2.96		3.50	1 : 5.5
6——8	170 "	4.6	0.58	3.47		4.05	1 : 6.0
8——12	250 "	5.2	0.62	4.05		4.67	1 : 6.5

Sugar from Sorghum and Corn Stalks.

Lecture by Prof. PETER COLLIER, Chemist to the Department of Agriculture, delivered before a Farmers' Institute at Brunswick, Feb. 10, 1881.

I regret very much that there is not a larger number to hear concerning this matter. I have no doubt that, within a short time, they will be surprised at themselves to have regarded a matter of such extreme importance with comparative indifference.

I would say in advance, that concerning all this matter of which I propose to speak, I have no opinions to offer; I do not value them at all, comparatively. I shall not have much to do even with conclusions, but leave you to draw your own. I shall chiefly present facts which have been ascertained by the experiments of the past three years, and I wish you would give very careful attention to those facts so that if possible you may find some weak point upon which success shall depend; for I assure you, at the outset, of the points which I propose to make as my conclusions; and I think I cannot be more emphatic when I say I think that those facts make clear that, as a people, we are no more justified in importing sugar than we would be to import wheat or corn. Of course I think that is sufficiently radical. I have no doubt that many of you will be reminded of the admirable representation by Mr. Raymond of Colonel Sellers, where he talks about his eye water and declares that, in this matter—when he sells a couple of bottles to each of all the teeming millions of Asia, "there are millions in it." Now I am to present a subject that cannot be touched in any of its aspects without going into the millions; but I wish, if at any time any of you take exceptions or think I am speaking wildly, that you would at once interrupt me; it will be no interruption but a pleasure. I said we cannot touch this question in any of its aspects without going into the millions. It is almost incredible,—this question of sugar. Our annual supply of sugar, that we import into this country, would make a string of hogsheads as long as from Boston to Chicago, touching each other all the way. It takes approximately the entire gold supply of the world to pay for our sugars. We have expended as much for our sugars since 1848, when gold was discovered in California, as all the mines of gold and silver of the West have ever produced. Now, along with that, I say we are throwing away every year ten times as much sugar as we import; that is, while we are importing over a hundred million dollars' worth a year, we are throwing away annually the possibility of making, and I believe economically making, over a billion dollars' worth of sugar. These are the conclusions which these facts fully substantiate. These are no laboratory experiments. I have worked with success by the ton, and made a great many experiments in the manufacture of sugar. Deducting fifty per cent. from the results which I have secured in sugar, and then it will be clear that we throw away annually an amount in sugar equal in value to the entire agricultural productions of the United States, and that is a billion nine hundred million of dollars. Now, those are startling facts; but as I say, they are unquestionable. If any one does not so regard them I courteously but deliberately defy their contradiction. I will go briefly through, and allow you an opportunity to cross-question me, with the results of our experiments.

Two or three years ago I prepared about two or three hundred pounds of sugars from corn stalks by processes which did not forbid its being applied to thousands of tons, and I was satisfied that the method by which that was prepared, if followed out continiously, would give identical results. I know, as you all do, doubtless, that during the past twenty-five years there has hardly been an agricultural fair, in the West especially, where samples of sorghum sugar have not been shown on exhibition. I know, too, as you all do, that during the past twenty-five or thirty years there was almost one continuous failure to make sugar, but here and there were those who succeeded.. Now, of course it is obvious that if some one could discover the method, the conditions of success by which sugar was made once in a thousand times or once in a million times, they could make it a thousand times in succession—and I think we have done that. Now I am aware that a good many, whose authority we respect are committed against this matter; notably is Professor Goessman; he has given a good deal of attention to it, certainly, for one absorbed as he is in his other work; but I feel that my testimony should by all means outweigh his. You recollect the story of a Pennsylvania justice, who had a person brought before him for stealing into a hen-coop and robbing it, and two witnesses were brought who saw the fellow go into the coop and come out with the chickens, and the attorney for the defense called in ten witneses who testified that they had not seen him, and the justice acquitted him because the balance of testimony was in his favor. Now, this negative testimony of a cloud of witnesses really amounts to nothing as compared with positive testimony. I see no reason to doubt but that any of you can fully corroborate all my results. Year before last I experimented with four varieties of sorghum, and I must say the results were very surprising. They were all planted the same day, right along side of each other, on the 16th of May. So soon as the plants had begun to top out, the seed had begun to appear, they were then in a condition so that many farmers would have plucked them and worked them up for sugar or syrup. I question very much whether, for two months succeeding, they gained ten per cent. in weight,—they may have done so. It was practically a maximum crop at that time. Then the examinations were begun. Every two or three days I went into the field and cut two or three stalks from each row. The dimensions and weight of those stalks were taken, the juice expressed and the sugar determined by well known methods. Every two or three days this was repeated, and so on during the season. The result of these examinations it seems to me fully explains why we have failed, as I say, for the past twenty-five years; and it explains how we may expect to succeed in the future.

I have placed some charts on the wall in the rear of the stage which I will explain, for the whole matter is there so it speaks for itself.

On the 18th of July the juice of one variety of sorghum called "Early Amber," contains as you see, about $4\frac{1}{2}$ per cent. of sugar. That is, 100 lbs. of juice contained about $4\frac{1}{2}$ lbs. of sugar. Let us see what was true a month later. On the 18th of August this contained $14\frac{3}{4}$ per cent. of the sugar in the juice. On the 18th of July it contained $4\frac{1}{4}$ of crystallizable sugar in the juice, and it contained nearly $3\frac{3}{4}$ per cent. of uncrystallizable sugar; that is of the total sugars present in the juice nearly one-half were uncrystallizable. Now it would require extreme care to obtain even at the rate of ten pounds of sugar to the acre from that crop in that condition. On the 18th of August, however, this uncrystallizable sugar run clear down to about 13 per cent. In a month this uncrystallizable sugar had increased about 400 per cent. In that condition those juices were as good as the juices of the best Louisiana sugar cane. There is evidence of that. Here is a blue line which represents the average of nine analyses of three varieties of sugar cane grown in Louisiana, selected by and sent by the President of the Sugar Planting Association. They came in excellent condition. They were treated by precisely the same methods—by the same men who analyzed the sorghum, and as you see, the average of the nine analyses show that they were not quite so good as was this sorghum at that time. The same is true of another variety—White Siberian—on the 18th of July. It follows up very closely, almost as though it was a duplicate variety. You will observe that when it has obtained this maximum content of sugar it practically maintains it from the middle of August to the first of November. That is a matter of extreme importance. After it has reached that condition it maintains it almost indefinitely. In this case it was only cut off by a heavy frost and subsequent thaw.

Here is still another variety called the Chinese sorghum. When that was first examined on the 7th of August, it contained 7 per cent. of crystallizable sugar in the juice, and it contained $5\frac{1}{2}$ per cent. of uncrystallizable sugar in the juice. There is not a person on the earth, who from a thousand acres could produce a pound of sugar, the crop being in that condition. Here you see this crystallizable sugar rapidly increased, ran up and was approximately as good as the others, but with this difference, that while these reached their maximum or reached that average the middle of August, these did not get there till the first quarter of October, the first week in October.

Now the same is true of still another variety called the Honduras sorghum, which had but a little over one per cent. about the 20th of August, of crystallizable sugar, and contained about five and a quarter per cent. of uncrystallizable sugar,—even worse than the Chinese sorghum for making sugar.

Mr. Charles J. Gilman—When you speak of the one per cent. and five per cent., perhaps it would be a little more intelligible to the audience to indicate exactly the import of that. Do you mean to take it as a per cent. of something else?

Professor Collier—Certainly. When I say one per cent. of sugar I mean that one hundred pounds of juice contains one pound of sugar. Most of the other ninety-nine pounds was water, but not all water, bear in mind. These per cents. all have reference to the juice. This Honduras variety reached its maximum the 20th of October. Now we have here an explanation of most, I doubt not, of the failures of the past twenty-five or thirty years out West, and of nearly all of those in New England during the past year or two. What might be regarded as a sort of "boom" in sorghum sugar has arisen recently, and by many it is thought it is to suffer another decline. It will not go back again—it is bound to go ahead this time, and I think I will clearly point out the reason for that faith that is in me. The reason for this second boom, if we may so term it, is this: that a natural hybrid was discovered in some part of the country out West, to which the name Early Amber was given, from the fact it was a very early variety and I suppose gave a light colored syrup. The farmers in the ordinary routine of farm work found that the syrup made from the Early Amber granulated rapidly and readily. They made their syrup as they had been accustomed to make it for a quarter of a century. Now we have an explanation of it on this chart. The variety that they had ordinarily grown was a variety almost exact in its habit like this Chinese Sorghum, which goes under the name of Liberian Sorghum in Ohio and Indiana and Illinois. Now this Liberian Sorghum is just about a month behind the Early Amber. So that those farmers who have been accustomed to grow this variety, when they got this new seed and worked it up as they did, when it took its turn with the other farm work, when they were ready to work their sorghum the sorghum was ready for them—it had reached that degree of development that the content of sugar in the juice was so great that the syrup made from it crystallized readily, and that is all there was of it. I found that at the close of the season, when the examination day by day of these stocks had ceased, there was still remaining enough for several experiments. Those stocks were cut, the juice expressed, and it was treated precisely as sugar cane juices would be treated, and the result was that three of them gave me at the rate of two thousand pounds of sugar to the acre, and one of them gave me at the rate of four thousand pounds of sugar to the acre. So much confidence I have in the result of these experiments that I have not one shadow of doubt but that with ten acres of good land, such land as you would put sugar beets on for example, I could obtain ten tons of sugar. Now I have no idea the average farmer is going to secure such results. I know that in 1879 the average sugar receipts in Louisiana per acre were 1350 pounds, yet, in one of these varieties of sorghum, I obtained 4000 pounds, or at that rate. There has been obtained more than 2½ tons of sugar to the acre on some farming soils. I have here a few samples of the sugar, to which I will call your attention, that compare favorably with the best Muscavadoes that we import. Two of them are made from sorghum, and one from corn stalks. This last year examinations were made of thirty-eight varieties of sorghum, ostensibly such. There were, undoubtedly, about thirty of them that were distinct varieties. The seed was received from fourteen different States. They were all planted side by side, and the examinations were conducted with these thirty-eight precisely in the manner indicated with the four of the year before. The result is that each of these thirty-eight varieties of sorghum were shown to be approximately as valuable as the best sugar cane in Louisiana. The sugar was not taken from but four of them, simply because the mill I had used in my experiments the year before had been leased to a gentleman in Virginia, and I did not have opportunity to again obtain the sugar as I did the year before, but its presence was determined in the same way, and in the same quantity as the year before, and there is not one shadow of doubt but that it might have been extracted. I would call your attention to this chart where these results are depicted. I wish to call attention to the enormous amount of data we have here. These facts that I am presenting are the results of an amount of work that is almost incredible. There were made over thirty-six hundred separate analyses of stalks, and each lot of stalks had its weight determined, the percentage of juice, the specific gravity of the juice, the per cent. of the total solids in the juice, of the sucrose and glucose in the juice, and upon this chart are embodied the average results of the thirty-six hundred, excluding none. Now it is simply incredible that these figures can be incorrect to the extent of a hundreth of one per cent. Any one analysis may have erred possibly one-half per cent, though I doubt it; but the number of analyses is so great, one slight error correcting another, that the general result is unquestionably true to the hundredth of one per cent. What are the results? Here I have a chart similar to that depicted but more data embodied. This line represents the development of the juice, and along here instead of a calendar of dates as on the other, I have the stages rather arbitrarily assumed for the plant. This first stage means when the flower was just bursting from the upper blades of the stalk; the second stage when it had half or two-thirds emerged; the third, when it was fairly out, and no portion of the stem showing—and so on; but it only marks in brief the development of the plant till complete maturity, the perfect ripeness of the seed as indicated by its being as hard nearly as a filbert, certainly as a grain of thoroughly dried corn. You see there was an increase in the juice. There is a point that few would believe. One would suppose at this early stage, when it was so green, there was more juice than later on, but remember this is juice and not water. It probably did contain as much water at this early time as any other, we cannot say certain without some calculations, but this juice represents the water that was expressed by the mill and the solids that were dissolved in that water; the juice then slowly increased up to the eighth stage, then dropped off; but this does not represent much of a dropping off. I have placed below here the actual figures which represent what is graphically represented on the chart.

That is the average of one hundred sixty-six separate determinations. Here there were one hundred ninety-seven separate determinations which fixed the points on the chart of this successive line. Here were three hundred thirty-nine separate determinations which fixed the points that are there. That you may clearly understand,—here are the results of the examinations of thirty-eight varieties of sorghum; each of these thirty-eight were examined perhaps a dozen times, or ten times or five, while they were in the eighth stage. Now the average result of the examinations of all the sorghums while in their eighth stage, for juices, is represented here, and that was sixty-five per cent. of the weight of the stripped stalk. This is a matter of considerable importance, and I dwell upon it. Here we have the uncrystallizable sugar. You will observe the same is true that is true of all these broken lines, they are greatest early in the season and they run down towards the end. Here it begun 4.26 and ends 1.56. Now that is nearly the average of sugar cane in Louisiana. So that these thirty-eight sorghums have a content of glucose not appreciably greater than the sugar cane. A great many talk as though they knew a great deal about it and perhaps may know more than you,—talk that glucose is what prevents you from getting sugar. It is there they say, but that prevents your getting it out. You tell them there is no more glucose in the sorghum juice when it is in its best condition than there is in sugar cane juice; and that is the actual fact, or so near it that it is practically true. The specific gravity is represented by this line on the chart. You see here it was 1031 water, being 1000. It runs up gradually and gets up from 1031 to 1078, the average of the 197 determinations. Now what is this increase in specific gravity due to? It is due to the fact that the juice expressed is becoming, as the plants develop, richer and richer in soluble matter. What is the soluble matter which increases its density? To a great extent it is sucrose, that is crystallizble sugar. If that is so the curve that represents sucrose must closely correspond to the line that represents the specific gravity. You will observe they follow very closely along—here they cross. The sucrose increases a little more even than the specific gravity. The glucose runs down, and here are the other solids in the juice which are not sugar, which does not increase except towards the last, and it does increase then appreciably. There is still another point, and that is what we call the available sugar, and of course that is the practical point. I have said nothing about syrups. The amount of sugar that can be obtained from the saccharine juices depends upon two things. Obviously it depends upon the amount of sugar that is in the juice; the more there is the more you can recover, other things being equal. But it depends upon the amount of other things in the juice besides sugar; that is, the more of other things besides sugar that are present, the less of the sugar that is present can be recovered, because they will prevent the sugar from crystallizing. The available sugar in juice is determined by what is called the exponent; that is, it is the per cent. of sugar in the total solids; for instance, if one-half of the total solids in a juice is sugar, the exponent would be fifty; if three-fourths, the exponent would be seventy-five, and so on. Now, if the experiment is seventy-five it means that seventy-five per cent. of the sugar present can be recovered as sugar. So that multiplying the per cent. of sugar present in the juice by the exponent of that juice and we have a number representing the per cent. of available sugar in the juice, and that curve on the chart is represented by this line, which runs very low down. What is the numerical representation of that line? At this time the average result of these thirty-eight varieties of sorghum show that there were seventy-seven pounds of available sugar to the acre. Next, one hundred eighty-six pounds of available sugar. Next, two hundred forty-eight pounds. Then, three hundred sixty-three. Next, five hundred thirty-four. Next, six hundred seventy-four.

Next, eight hundred seventy. Next, nine hundred thirty-nine. Next, twelve hundred one. Next, fourteen hundred forty-one. Next, fifteen hundred eighty. Next, sixteen hundred sixty-two. Next, sixteen hundred ninety-seven. Next, seventeen hundred twenty-eight. Next, seventeen hundred thirty-nine. Next, nineteen hundred sixty-seven. That is, the average of about one hundred ninety-seven separate determinations of thirty-eight varieties of sorghum including every analysis made at that time, showed that there was approximately a ton of sugar to the acre available. I have no more doubt than I have of anything, other than my existence, but that a ton of sugar can be obtained from an acre of good stalks in that condition, and, as a matter of fact, although I have not obtained a ton of sugar, I have obtained at that rate, as I already have mentioned, with three of these varieties of sorghum, and at the rate of two tons of sugar from another variety of sorghum.

There are a few words I would like to say in regard to corn stalk sugar. The experiments with corn stalks have not been so thoroughly carried out as with the sorghum,—I mean so extensively carried out. It was simply a question of how much one could possibly do; but nine varieties of corn were planted, two of them were sweet corn, two of them were Flint corn, and five the common Dent corn, such as we have literally millions of acres of in the South and West. I presume few of you are aware of the numerous acreage of our corn crop; it occupies thirty-seven per cent. of the entire cultivated land of the United States. Now, the experiments with these corns were conducted in this way: When the ears on each variety had reached such a condition as we would say they were in good roasting-ear state, we took tags and labelled twenty stalks—say, for instance, the "20th of July—ear removed," was all that was written, and it was tied on the stalk. The ear was taken off; of course it was then in condition to feed or roast, or to can. The rest of the field was allowed to ripen its crop. The day we removed the roasting ear the stalks of each variety were taken and treated in the same way as the sorghum was treated, as has already been explained. A week after, another lot of those stalks from which the ears had been stripped the week before, were taken, and so on two weeks after, and three weeks after, and four and five. The ears had been removed and successive examinations in these stalks were made. Then, after the corn had thoroughly matured, some ears were taken off, the stalks were examined, and they were examined a week after they were taken off, and then what was left of the crop was worked out for sugar. You will see here that we had practically secured, in every case where we made the sugar test, a good crop. No stalk was examined that had not borne a good ear. Here we have the average results of nine kinds and twenty-six analyses made, showing that there was in those juices eleven and two-tenths per cent. of true sugar, and that seven and ninety-one one-hundredths of the juice was available sugar. Now let us compare that with some of the other results we have. I have here the average of four analyses of sugar cane in Louisiana made by myself, four analyses of sugar cane made by a chemist in New Orleans, Prof. Saunders, and analyses of sugar cane, six in number, made in India. You see there is an approximate agreement, showing that the method I pursued must have been correct, and I have not a shadow of doubt it was. This shows the approximate agreement in the content of sugar and in the available sugar, also in the juice.

We received two years ago, sixty or more samples of sugar beets, many of them from Maine, and one specimen from Idaho—from different parts of the North and East mainly. The average of the best fifteen of the sixty gave eleven and seventy-six one-hundredths per cent. of sugar in the juice; the second fifteen gave seven and eighteen one-hundredths. These nine varieties of corn-stalks gave eleven and twenty one-hundredths; that is, the corn stalks, weight for weight, were nearly as valuable as the best quarter of the sugar beets, and they were a great deal better than the best half of them. If you grow beets you can by no means be sure you are going to grow those that will come among the best quarter of those grown in the country. But this was from practically refuse material. I know it is not refuse material with you, nor, to any great extent, in New England. This sugar was only determined in the juice. You say it was there, but you cannot get it. Last year, that is, 1879, I made an experiment that I think has excited more interest than any other connected with this matter of sugar. I have received, literally, over fifty letters from parties who supposed I must have blundered when I spoke, or that there was some slip of the pen when I said, "the corn was ripe, after which the stalks were taken for making sugar." In the fall of 1879, after having grown a crop for another purpose entirely, having in mind another experiment, and when my whole object was to get the maximum yield of ripe corn, and I would have allowed it to have stood till Christmas if it would have given me another ear, I plucked this corn and shelled it. It was as good corn as was ever grown, so far as maturity was concerned. I had three varieties in 1879, and that furnished the seed for 1880; it was perfectly ripe. When it was desirable to clear up the ground, I assisted, myself, by cutting up the stalks, and they seemed so juicy and fresh I told the man he could throw a blanket over them so the workmen would not cart them away, and we would work them up for sugar the next day. And we did, and the result was, that I obtained at the rate of nine hundred and seventy pounds of sugar to the acre from the stalks, and I grew sixty-nine and one-tenth bushels of shelled corn to the acre on those stalks—perfectly ripe corn. Now that is more than twice the average crop of corn in the country, nearly three times, and yet the sugar that was obtained from those stalks, and it was obtained by an inexpensive process, was worth, as you see, more than twice what the grain would be worth. Now, our corn crop occupies thirty-seven per cent of our territory, and for a hundred years we have been growing it for the grain mainly; but it is perfectly clear, capable of demonstration, that we have thrown away at least two-thirds the value of this corn crop. This year, as I say, the rest of this crop of corn—of the nine varieties, was ripened; some of the lightest growing corn had dried up and was thrown out, but the coarser growing corn was all taken, and I obtained this year at the rate of one thousand pounds of sugar to the acre from stalks, approximately, as you see, just repeating the experiment of the previous year.

Now, I do not say to any one, go to any great expense in fitting up mills, etc. One swallow does not make a spring. But I did it twice. I see no reason to doubt but that it may be done a dozen times. I propose to follow the thing up. It is important that we should do so. There is a gentleman down near Frederick, Maryland, who grew last year twenty-five hundred acres of corn and canned it,—canned at the rate of seventy-five acres a day,—I believe the largest canning establishment in the world. I have no doubt it was possible to recover an amount of sugar from those stocks, and they are practically refuse with them, greater in value than the corn he canned. I am not prepared to say just how to go to work to do it, but I believe it can be done; these experiments seem to indicate it.

Here I have to show you some of the sugar that was made from those ripe corn-stalks. It is a fair quality of Muscavado sugar. It is a raw sugar and needs refining just as raw beet sugar does, but it could be sold in any market in Christendom. It has a little flavor of the corn which is not pleasant; but it is a sugar that could be sold as readily as the corn that grew upon the stalks.

There is another aspect of this matter. A year ago I examined the reports from the Western States of the acreage yield in our two cereals, corn and wheat, and contrasted them with the acreage yield of all our Eastern States for the years 1862 and 1877. I found what astonished me, viz., that although our recent years have been years of amazing fruitfulness as we learned day after day during the recent campaign, notwithstanding there has been a gradual falling off in fifteen years through the West, there has been a slight increase in the acreage yield in the East. I found, too, that we are to-day in the East (and I counted every New England State, all the Middle States, and the Northern Atlantic States, east of Ohio—I took all with Ohio and the West for Western States) raising more corn and more wheat to the acre than the average in the West. Recently I have calculated those results for the past eighteen years, from 1862 to 1880, and grouped them into two groups of nine years each, so there is no questioning the conclusion, and I find the same fact true. I could give you the exact figures. I found that there has been a gradual falling off in the production of the West and a slight increase in the East, and that we, in the East, are producing more of corn, more of wheat to the acre than in the West, and although the falling off is not so marked in per cent., still, owing to the enormous acreage it again brings us into the millions in consideration. For instance, at the prices at which wheat and corn sold through the West last year, the diminished number of bushels caused a loss of thirty-two millions of dollars in the Western States. That is an enormous sum. And, in the East, this slight increase, at the prices at which corn and wheat were sold in the East,—the slightly increased crop of the last year gave us for our wheat and corn four million two hundred and fifty thousand dollars more than if our acreage yield had been at a stand still for the past ten years. At every agricultural meeting we attend we hear of the exhaustless resources of the West, that it is the grainary which is to supply the teeming millions of the future. Now it seems to me the facts hardly justify such a sanguine view. I see no cause for alarm, but, as we were told this afternoon, prudence dictates that we be placed upon our guard in time. The time will come, if it has not come already, when the production of corn and wheat in the West at present prices cannot be maintained. At the West, they have for years been pursuing a wasteful, skimming process upon their lands, and the result is decreasing crops. Take this matter of corn, and, as I said, we shall find ourselves running into the millions.

We were told this afternoon, how the corn requires phosphoric acid and potash. An average of twenty-one analyses of corn, grown in different parts of the United States, shows that the percentage of mineral matter is almost exactly one and seven-tenths per cent., and nearly all this mineral matter, unfortunately, consists of phosphoric acid and potash; those two things you see that we especially desire in a fertilizer. At the prices we pay for those when we get our money's worth, seven cents per pound for potash and twelve cents for phosphoric acid,—the phosphoric acid and potash in our annual corn crop amounts to one hundred and fifteen million dollars, and our entire corn crop brings almost exactly five times that. So that we are selling annually in our corn crop an amount of these two constituents—which you in New England are buying, and which they at the West ultimately must buy—equal in value to one-fifth of what the crop brings. So that, if the time comes when to maintain the fertility of their lands they must return what the crop takes off, there comes off one slice of twenty per cent. for the fertilizers alone. Consequently, the importance of this sugar matter is manifest. As you doubtless know, all the sugar comes from the atmosphere. You cannot burn a grain of corn or kernel of rye or wheat without having a certain amount of mineral matter. You might burn a ton of pure sugar and not have a grain of mineral matter remain. So that, we could produce sugar for the world's supply for a thousand years and our land would increase in fertility.

Mr. C. J. Gilman—As far as you have advanced in your experiments have you been able to form a clear and well defined idea as to the expense per pound upon the present processes of the sorghum sugar and sugar from corn-stalks?

Prof. Collier—The processes I have used with entirely satisfactory results were identical with those processes used in the manufacture of sugar from sugar cane. Now, they claim in Louisiana and Cuba, that there is no trouble in producing sugars at three cents a pound. I see no reason to doubt but we could produce them even more cheaply than that. In that I am fully borne out by a letter received not a week ago from a large planter in Cuba, who said he saw no reason to doubt but that we could compete successfully with Cuba in view of our greater energy and other facilities, machinery, etc., in the production of sugar.

Among the many varieties of sorghum grown and examined, there are at least eight of them which could be grown in any latitude, where between corn planting time and frost there is a period of ninety days. Many of them would be as unsuccessful in Maine as sugar cane.

Mr. Gilman—I would ask what is your opinion of this Early Amber for this climate?

Prof. Collier.—Of ccurse it is an opinion, but I have no reason to doubt Early Amber would work well. These were grown on grounds of the Department in Washington. I have no reason to suppose that the ground was at all exceptional, or but that you can do as well here with several of these varieties as we did there. As matter of fact, in Central New York, I saw a crop of about twenty acres that was at least fifty per cent. heavier than our crop of the same variety—Early Amber.

I would like to call your attention to analyses of two syrups sent by Prof. Sanborn of New Hampshire, which show the same fact we found true in Washington. When he first sent these specimens of sorghum they contained three and twenty-six one-hundredths per cent. of crystallizable sugar—that was September 10th. And on September 22, they contained eight and fifty one-hundredths per cent. It was going right up.

Mr. Sanborn—If I had had another week it would probably have gone up higher, but in waiting a day or two longer I got frost on it.

Prof. Collier—Bear in mind, that in Louisiana they grow sugar cane with just the same embarrassment and risk that Professor Sanborn perhaps may be compelled to grow sorghum with at Hanover; they have never matured a stalk of sugar cane in Louisiana, nor will they ever; it requires twelve months for its maturity, and they can only give it about nine, consequently they are compelled to cut it and do cut it and work it up, when it is no better for making sugar than this Early Amber on the 22d of September, when sent to me. I have here a report of a convention of sugar growers at Minneapolis, with statistics for the growth of sorghum in Minnesota the past three years. In 1878 there were grown 3207 acres in Minnesota;

in 1879 there were 5033 acres; in 1880 there were 7317 acres, an increase of approximately fifty per cent each year. Those present at the convention on January 21st, had made the last year 115,816 gallons of syrup; and they had on hand at the time of the convention 14,600 gallons; practically it was all sold, and they had sold it at about fifty cents a gallon. So that if you make good syrups they are marketable, and there is still a wide field for that article. I would like to read more statistics. It is rather pleasant, with the numerous failures, to hear of occasional success; but I am reminded of that story that was told of the first Napoleon, who, when he proposed going over the Alps was ridiculed, and he sent out and found, upon inquiry, a mountaineer who had been over, and he called him to him and inquired, and at last learned of another in a neighboring hamlet who also had succeeded in getting over, and he is reported to have said, where two men have been twenty can go, where twenty can go I can take my army. And he did go over. It is a good story, and the point is well taken. What I have done, though ten thousand have failed, there is not a man in this room who is willing to admit he cannot do, nor would I be so conceited as to believe there was one here who could not do it; but you must attend to the fundamental principles, and that brings up another matter. I would like to tell you of a gentleman who is as much interested in this thing as I am if possible, who by repeated conversations with me and letters written, had had the thing dinged into his ears. He brought me four bottles of syrup made in one of the most favoring sections of the country, but they were not one-quarter as good, I will venture to say, as this syrup made at Hanover, one thousand miles north of his locality. He had taken the juice expressed from the stalks, emptied it into barrels, taken a dipper of milk of lime and dumped into one barrel after another in succession, and allowed it to stand there cold till it was ready to evaporate. It was then drawn bodily, lime and everything, into his evaporator, and boiled down, with what skimming was necessary. It seems almost incredible, yet he came anxiously desirous to know why he did not get sugar. I have a letter from another gentleman, and it is ludicrous, because he believes he follows directions. He, too, sends a sample of the syrup and wants to know why it does not crystallize. What did he do? I wish I had the letter. It is like this: I cut my corn the first of September, and being driven with work, stood it up in the barn. Just three months after—it was pretty thoroughly dried, he says—he put it in a water-trough and poured some water over it and let it stand about one-fourth of a day, and then squeezed it, and it would not granulate. Yet, he writes to know why he did not succeed. On the other hand, here is a young man, who, a year ago, had never seen a young stock of sorghum. He is about twenty-one, in Central New York, and he did follow directions. He did not know enough about it to know what was material and what was immaterial, and consequently he followed directions implicitly, and the result is he has sent half a dozen bottles down to Washington for examination, and they are as good syrups, and crystallize as readily as though they had been made from sugar cane. The specimens he sent showed that, of the total sugar in these samples, in one case 88.6 was crystallizable sugar, and in another case 85.3; in another case 85.9, in another case 82.8, and so on.

There was a point I was going to speak of out in Minnesota. A young gentleman had eleven acres and five rods of wheat from which he obtained one hundred twenty-two bushels, which at $1, the price at which he sold, and a good price at that time, he received $122. One acre of sorghum taken out of the same field, allowing twenty cents per gallon for its manufacture, which was a large price, gave him in syrup a profit of $45.50. The wheat gave him a profit of $42. He kept an accurate account of his expenses of sorghum and of his wheat. That is, a little over eleven acres of wheat gave him $42 profit, and one acre of sorghum, with a liberal allowance for manufacture, gave him $45,50 profit.

Mr. Gilman—Is this machinery expensive?

Prof. Collier—It is not.

Here is a report of the Commissioner of Agriculture to the President, just issued. In the back part of the report are some, perhaps, five thousand letters from those who have tried this sorghum during the last year, and their success is here recorded, and they got from forty to four hundred and forty gallons of syrup to the acre. It is just the difference between knowing how and not knowing; but I should say, on good land with these varieties which you can grow here, you ought not to be satisfied with less than two hundred gallons of syrup to the acre, and whether that shall be worth twenty cents a gallon or seventy-five, depends on the care with which it is made. In Massachusetts a man wrote to me that he had sold all his crop at seventy-five cents a gallon; another man met me in Hartford and said he would be glad if he could sell his at thirty cents; and they are not fifty miles apart. The same is true, I presume, in regard to butter. There is some butter that we would not care for at ten cents and other we would be glad to get at $1 a pound if we could afford it.

I have tried to refrain from uttering opinions in this matter. Do not take my say so on this. That has been the trouble for the past thirty years. You can find in the literature on the subject for the past thirty years authority for almost any statement you may choose to make, concerning the culture of sorghum, and it might be in certain localities, under certain conditions, each statement and each modification of statement was true; but let us try to find out what the general principles are. Let us patiently seek out the facts in regard to this matter, and rest assured that success is ultimately going to crown our efforts. I have no doubt we shall very soon make our own sugar. It seems incredible that we should continue to waste annually four times as much sugar as the world uses, but that is literally true; or else all these experiments must go for naught.

Remember that the first beet sugar was made at the expense of thirty cents a pound and more. And yet, now, to such success has it been brought that it competes with sugar cane in the market. That has a lesson for us. It behooves those of you who are engaged in this new enterprise to be on your guard. Certainly nobody in the world could wish you other than success in it; but of this thing you may rest assured that, as the old Cardinal said to the Arch Traitor in the play, you must not lose a trick; you must start full abreast with the most advanced in science and with improved machinery, improved quality of beets, improved methods of culture, or you will go by the board. On the other hand, here is sugar cane where at least forty per cent. of all the sugar, by wasteful process is lost. It is estimated that fifty per cent. of all the sugar grown in Louisiana has been lost, and at least forty per cent. now. There is a wide margin for somebody who shall enter upon this business, and I confidently believe that our work with sorghum is going to benefit largely the sugar cane industry. On the other hand look at the sugar beet. Such perfection have they attained, that at least nine-tenths if not eleven-twelfths of all the sugar in the beet is utilized.

Mr. Gilman—Will you be kind enough to state again, if agreeable, the process of treatment of corn in your experiments. Was the corn cut up? and was it after the ear had thoroughly ripened?

Prof. Collier—No. These ears were picked off of the stalks and the stalks were left standing, but they were immediately cut up and put through the mill, soon after the ears were ripe. Many think that when an ear of corn is ripe the stalk is dry; but as a matter of fact it is as juicy as at any other time. There is no use trying to make sugar from corn-stalks or sorghum if you can't press the juice. If there is no juice, there is no sugar. There are very few, apparently, of good farmers, who seem aware of the fact that a corn-stalk may be as juicy as though it was really in the silk, and yet have the ears perfectly ripe.

Mr. Gowell—Would not the sweet corn-stalk be better than the common yellow?

Prof. Collier—I do not know. As I remember there is not much difference, but the difference is not in favor of sweet corn. So far as my experiments went they showed that the sweet corn was not as good as the common corn.

After these stalks, whether corn or sorghum, have gone through the mill, and you have recovered all the sugar you can by your best mill (and by all means get a good mill) the pressed stalks are, weight for weight, as valuable for food as before pressing.

Dr. Lapham—Have any Western men made any sugar this year?

Prof. Collier—A man at Red Wing made five thousand pounds out of sorghum—merchantable sugar. They made seventy-five thousand at Crystal Lake last year, 1879. Here is another report in regard to the profits of it from Ontario. A company was established there, and they declared a dividend the first year of 33 per cent. They have increased their capital stock, and they say they see no reason why they should not double the dividend another year. That was syrup. But here is a Mr. Richmond of New York. He kept accurate account of several acres, and he made a profit of $21.50 a year the first year, with a good many unusual expenses.

WASHINGTON COUNTY FARMING.

By A. R. Lincoln, Member of the Board for Washington County.

[Read at a Farmers' Institute held at Pembroke.]

There is no romance in farming. It is work, hard work, that makes farming a success. "By the sweat of his face shall he eat his bread," is absolutely true of the husbandman, and the average farmer should never complain of eating his bread dry. There is no royal road to quick success in the life of a farmer. His whole business is one of waiting. He sows his seed in the spring, and waits until harvest. He starts his stock, and waits many long years before he can realize anything from it. I once heard an individual say that he did not like farming because it was too long credit.

We have some 70,000 farmers in the State of Maine, who wholly, or in part, realize their subsistance from farms. Yet we import immense amounts of agricultural products to supply our wants, when, through our own exertions, we have the means to be almost wholly independent. The questions that should occupy our minds are these: Is farming profitable? and, How can we make it more profitable? It is true that we have our seasons of despair, our late seed times, our wet haying seasons, our droughts, early frosts, and low prices for products. Yet, with all these drawbacks, there is a sturdy independence that no other calling in life can bring.

Well directed industry is the key note of successful farming. We may sow and plant, but if it is not done carefully, and in a workmanlike way, our harvesting will not meet our anticipations. Last year I heard a conversation between two farmers, Farmer A, and Farmer B, whose farms are adjoining. Says Farmer A, "I am going to raise wheat next year, and see if I can not raise my bread. You did so well with yours last year, that I believe I can get my bread cheaper and easier that way than any other." This fall I heard the result of Farmer A's experiment. The yield was eight bushels per acre, while Farmer B got twenty-four. The small yield of A's was attributed to the dry season, but the careful tillage of

Farmer B. made his yield three times that of A's. Take the dry statistics of the Agricultural Bureau at Washington, and look at the average of the crops of the State at large, and the average Washington County farmer will, I think, be dissatisfied with the figures: wheat, 14 bushels to the acre; corn, 30 bushels; oats, 28; barley, 21; potatoes, 107; hay 95-100 of a ton. These are the figures for 1875, and are the average of the whole State. Are they satisfactory? It would not be so on my farm. I do not think I could pay expenses if I could not raise more than the average shown. The question that comes home to our minds is, How can we increase this average, and will it be profitable? Perhaps I may be an enthusiast, but I believe that any acre of fair arable land in Washington County may be made to double the average shown without doubling the cost. That is, if it pays us for our labor to raise the average crop of 1876, all that we can increase that average, without more expense, is profit. Now how can it be done?

1st. *By a better working of our Lands.* I mean by better plowing, ditching and harrowing, working our lands when they are in a good condition to work. Many of us in the spring are in a hurry to get our crops in, and on our clayey soils are apt to work them before they are dry enough.

2d. *Better Fertilization.* The farmer's bank is his manure pile, and his constant aim should be to make it larger and better. I am sorry to say that a large majority of our farmers, (and some of them think they are pretty good farmers,) think the liquid excrements of our animals are of no value, or at least they make no effort to save them; and, often, their barns are built so as to have the quickest drainage. The solid manures are thrown out so as to catch the drippings of the eaves, which leach them to such an extent as to leave them almost valueless. It is with manure the farmer fertilizes his soil, and every method should be used to preserve it. The swamps should give us muck; the forest, leaves; the shores, muscle mud and sea-weed. The scraping of ditches, sawdust, in fact every thing of a fertilizing and absorbent nature should be gathered, and made to contribute to our wants. Special fertilizers can often be used to a great advantage, extending the manure pile, and contributing their share to the daily loss.

3d. *By better feeding of Stock.* The better the feed the richer the manure. The closest economy in saving fertilizers, and the greatest liberality in using them should be the practice. We must have also better stock. A great reform in stock is going on around us. A few years ago it was rare to see our splendid thoroughbred stock even at our State and County fairs, but now the noble Durham, and Hereford, the Ayrshire, the Devon and the Jersey are crowding out the old race of cattle, and the farmer can now raise any breed adapted to his wants. There is a rut in keeping cattle that we have followed long enough—that is, in feeding. We should feed for profit, and not try and see how little it takes to feed an animal through the winter, and have them shrink daily in their weight, but it should be our boast to see how much we can make them eat, and how much they will gain. Our animals are machines for converting our products into food suitable for man, and the better the machine, the more care in feeding, and the better character of the food given, the more satisfactory will be the results secured, and the larger the profits realized. If we work our teams hard, we feed them so they can stand hard labor, and we should feed our neat stock for the same result. If it costs us $25 to winter a cow that will make but 100 pounds of butter, worth $20, how long will it take us to get rich? An easy problem to answer, but such as many a farmer is trying to solve by practice. The figures for the cost and the result will not lie. But suppose you feed your animal to double the product without doubling the cost of keeping, the result over cost is profit. By an actual record of cost and product a good cow can be made to pay $36 profits. Now how can this be done? By better feeding—by feeding for profit. In doing this you will surely have an increased yield, and a better product, which will bring a better price. We are apt to be too economical in feeding. I believe that the great secret (I will call it a secret, for it looks like one,) in feeding stock of all kinds, is to keep our animals vigorous and growing. Never let them stop growing an instant, until they arrive to maturity; always bearing in mind that every pound of beef and every pound of dairy product is made from the food consumed. I saw in a Provincial paper a few days ago, an account of an excursion through New Brunswick of agricultural delegates from England. They expressed themselves very highly satisfied with everything but the cattle, which they condemned as not worthy of the country. Now, their cattle will average with ours, and we should feel cheap to have men of such character as these delegates tell us our cattle were not worthy of our country. We have good facilities for grazing, good grass lands, good water, plenty of lumber to build warm barns, plenty of help to take care of our cattle, and *we can have good cattle.*

The largest profits and the most successful results in our farming come from the dairy and from stock-raising. Neglect these, and we lose; be careful with them and we gain.

In this region where our farms are small, we are by necessity confined to mixed crops, and it is well that we are. One class of products can follow another, each drawing the elements of its growth in different proportions, from the soil, and thus yielding greater results than can be secured by devoting the land to a succession of the same product.

Marketing the products of the farm is a branch of our business that needs sharply to be looked after in Eastern Maine. We have no large towns, and our home market is small and easily supplied, and the question of what shall we do with our products is continually arising. Upon the sea-coast we are in direct communication with the great business centres, and we can market as readily from Maine as can be done in any other State. It costs no more to ship by steamer or vessel to Boston or New York from here than it does many times to ship fifty miles by rail in the vicinity of those places. In my vicinity, for a few years past, we have been in the habit of shipping our produce to Boston, by clubbing together and filling a vessel, and either giving the master a commission for selling, or consigning them for sale. This plan has worked well, and has given us the highest market rates for our products. There has always been a want of co-operation among the farmers, which has left them in their individuality a prey to the avarice of the traders who give what they have a mind to for our products, and ask their own prices for their goods. The whole trade has been one of barter, and it is rare for a farmer to get his cash for his labor, unless he sells at reduced rates. This must be remedied, and concert of action among us, and that alone, can remedy it. The most profitable farming is not done by the nail-keg farmer in the country store, but by the stalwart son of the soil, whose well directed industry, and well balanced business mind, keeps him constantly looking after all the little things, that, taken together, will give him large results.

IMPROVEMENT OF THE GRASS CROP.

By ERASTUS LERMOND, Member for Knox County.

[Read at a Farmers' Institute held at Rockland.]

This subject does not receive the attention and investigation which its importance demands. The hay crop is much more valuable than any other which we grow, and one on which the success of our other crops mainly depends. As valuable as this crop is, it is left to follow others as a matter of course, without special care or preparation for its growth or continuance.

Our grain and hoed crops, our horses, cattle, sheep, and their various products, all depend either directly or indirectly upon the grass crop, and there are also large shipments of hay from many sections of the State, and yet, upon the area under cultivation, we have not developed half of its productive capacity.

Our soil and climate are both favorable for growing grass; still, we fail to raise desirable crops on fields which are well adapted to the purpose. If we do not bring the yield up to a proper standard under favorable conditions, the cause must be improper cultivation. There are two prevailing customs which tend to dwarf our operations, and which are so closely connected that one in a measure necessitates the other. They are deep plowing, and the practice of planting land two or more years in succession.

Deeply plowed land is nature's order reversed, which seems to be fatal to a grass crop, as it brings to the surface a heavy, sour soil, nearly devoid of vegetable matter, and therefore unfit for plant growth, and it also buries the most fertile part below the reach of the general mass of the roots, and therefore requires more time and manure to prepare it for a crop. It is observable where rough land has been plowed that the places where the knolls had been are very unproductive. These places contrast so plainly with the land around them, that they illustrate very forcibly the injurious effects of deep plowing; for a piece of deeply plowed land will show the same effects over the whole piece, which characterize the patches where the knolls had been.

After it is sown to grass, the sod will appear as though the grass roots had collected together for mutual protection, and had left little bare spots which never heal over; and the result is that frost and dry weather affect it very badly. The custom of planting a piece of land two or more years in succession, is caused partly by the necessity which deep plowing requires, and partly by the habit which has prevailed from the time when this section of the State was settled to the present day. This section of the State was heavily wooded, and much of it rough and rocky, which made it slow and laborious clearing the land; therefore, when the settlers got the stumps and rocks from a piece, they planted it a number of years in succession, and we have continued the practice without having the difficulties which caused it.

With the exception of farm implements, we have made but very little progress generally, which should convince us that advancement will not attend our present practice. If farms are not so productive as formerly, it should prompt us to discover the cause, and apply the remedy. Fields, instead of decreasing, will increase in fertility if the hay product with the usual grain feed be fed upon the farm, and the manure carefully saved and judiciously applied to the soil.

It is poor economy to plant a piece of land more than one year. Even for special crops it is better to prepare land the first year, as we cannot afford to spend a life time on a few acres to the exclusion of the rest.

How many farmers have cultivated their whole fields during their forty years of active life? We are not advancing with the rest of the world, but are being left behind—chained to these few acres by the force of habit. We are influenced by custom to a greater extent than we realize sometimes.

Notice the varied customs, and the manner of doing all kinds of work in different countries, and in different sections of the same country, and see with what tenacity local customs are adhered to in the face and eyes of improvement.

It is a standing prediction, each year in early summer, that the grass crop on old fields will be light, and the prediction is generally correct. How much hay old fields average to the acre is hard to estimate, as the division between old and new is difficult to make, but there are many acres which yield no more than five hundred pounds of a very poor quality of hay, and the only comforting reflection is, there is no danger of having much hay out in a storm.

We don't want to be obliged to drive across a forty acre lot to get a load of hay, nor do we want to see a large part of our fields looking brown and bare till near haying time.

Worn out fields should not be top-dressed. Some farmers have made their first attempt at top-dressing on such land, and of course failed. The cause of the poor condition of the crop is not altogether lack of plant food in the soil, but the grass roots have become weak and exhausted by old age, and as we can not renew old age, only stimulate it to a certain extent, it is better to plough and re-seed. But it *will* pay to top dress grass land which is in fair condition—in October or about the time of the fall rains—with green manure or any substance which will fertilize; and it should be well pulverized before freezing weather to give the best results. This, if well done, will produce a heavy growth of well mixed grass of an improved quality. Top-dressing should not be applied in summer, as it dries so hard that it never can be made so fine as it should be, and is therefore partially unavailable. Nor should it be applied while the ground is frozen, for rains will leach and wash a large part of it into places where it will do no good.

The cheapest and most rapid method of renovating worn out land is to plough to the depth of five inches, completely inverting the sod, and applying a dressing of manure and thoroughly working it into, and mixing it with, the surface soil. This work may all be done in the early fall, and grass sowed without losing a grass crop, or it may be plowed in the spring and sowed to grass, or grain and grass, thus omitting but one grass crop, and getting a crop of grain instead. There need be no fear of ploughing too much worn out land which is paying nothing, for it will be an improvement even without dressing, but if a moderate quantity of manure be applied with thorough pulverization of the soil, which is an important factor in all tillage—there will be a great improvement which will give the farmer additional means for the next year. This makes a seed-bed, easily and cheaply prepared, which will produce good crops. In connection with the manure applied is the decaying sod which the roots penetrate and feed upon, and it also absorbs and retains a large amount of moisture which is a protection from drouth. It may be put down as a truism that a rich surface insures a crop.

For surface manuring, a large quantity of dressing may be collected which would be thought unsuitable for planting purposes.

Surface manuring in either form is much better than the adverse method, for the farmer can renovate a larger area with the same quantity of manure in much less time, which will enable him to multiply his stock and therefore his dressing with an increasing ratio. Such tillage makes rich surface, which is completely adapted to the growth of grasses or any other crop. The plant food is within easy reach of the roots, and where the rain, sun, and air can act upon it with the greatest force.

MAINE STATE AGRICULTURAL SOCIETY.

This Society held its Eighteenth Annual Fair at Lewiston, September 21, 22, 23, 24, 1880, in connection with the State Pomological Society. The attendance and interest manifested at the Fair were the best for several years. The show of fruit and manufactured goods was large, filling City Hall to repletion. Implements were shown under a tent in the Park, there being as many as could be exhibited under a tent 70 by 150 feet.

The receipts for the Fair were over $16,000; the premiums and expenses $11,000, leaving a surplus of over $5,000, the most of which has been used in paying the debts of the Society. It is now free from debt, and located at Lewiston for two years, on the most favorable terms, and the outlook of the Society is most promising.

The Coburn Cadets from the State Agricultural College were encamped on the Park during the entire Fair, and won much credit for themselves and the institution by their gentlemanly and soldierly conduct.

The officers of the Society have for several years encouraged camping by societies and families, and the same has been gaining in favor until now. The Park during the Fair has really become a "tented field," and is a source of much enjoyment to all participants.

Much credit for the success of the Fair is due to the superintendents of the several railroads in the State and neighboring Provinces for cheap fares, and trains run to accommodate the people desiring to visit the Fair. Especially is this due to Superintendent Tucker of the Maine Central Railroad, on the line of which the Lewiston Park is situated, for accommodations in this direction.

Appended to this report is a statement of the transactions, receipts and expenditures for the year, &c., prepared for the Society by its Treasurer, H. S. Osgood:

Statement A,

Showing the number of entries, together with amount of entry fees received and Premiums paid, at the Maine State Fair, 1880.

CLASS.	No. of Entries.	Amount of Entry Fees received.	Amount of Premiums paid.
Cattle.			
Shorthorn Stock	17	$23 50	$82 00
Devon "	none.	none.	none.
Ayrshire "	14	18 70	84 00
Hereford "	44	16 10	122 00
Jersey "	41	46 50	125 00
" " Maine Herd Book	15	16 10	87 00
Holstein "	8	13 20	63 00
Grade (or Native) Stock	36	28 50	66 00
Working Oxen	21	29 40	82 00
Trained Steers	4	4 80	12 00
Fat Cattle	5	6 80	38 00
Matched Oxen	8	12 80	29 00
Pulling Oxen and Town Teams	15	45 80	145 00
Bulls of any age or breed	13	15 00	15 00
	241	277 20	950 00
Horses.			
Stallions for general use	10	48 00	48 00
" four years old and under 5	4	12 00	30 00
" three years old and under 4	6	15 00	30 00
Best Draft Stallions	none.	none.	none.
Mares with foal	9	27 00	30 00
Geldings and Mares, 4 years old and over	21	63 00	30 00
Geldings and Fillies, 3 years old and under 4	8	12 00	20 00
Stallions, geldings & fillies, 2 yrs. old and under 3	8	12 80	*36 00
" " " 1 yr. " " 2	8	12 00	15 00
Draft Horses	6	11 40	46 00
Gents' Driving Horses	18	86 40	48 00
Matched Horses	7	21 00	30 00
Walking Horses	5	7 50	10 00
Trained Colts	2	2 40	6 00
Gen. Tilton's Special	6	none.	50 00
	118	330 50	429 00
Trotting Horses	78	1,525 00	2,385 00
Sheep.			
Long Wooled Sheep	18	25 20	118 00
Oxford Downs	3	4 20	24 00
South Downs	9	12 60	56 00
Merinos	9	12 60	76 00
Breeding Merino Ewes	1	1 30	11 00
Shropshires	6	not coll.	48 00
Bucks of any age or breed, Sweepstakes	2	2 00	10 00
	48	57 90	343 00
Swine.			
Large breeds	29	15 00	44 00
Small breeds	none.	none.	none.
Boars of any age or breed, Sweepstakes	3	2 40	8 00
	32	17 40	52 00
Agricultural Implements	170	none.	†42 00
Plowing Match	12	none.	15 00

* Diploma. † Diplomas and Bronze Medals.

STATEMENT A—*Concluded.*

RECAPITULATION.

PARK.	No. of Entry.	Entry Fees received.	Premiums paid.	Medals and Diplomas awarded.
Cattle	241	$227 20	$950 00	
Horses (for exhibition)	118	330 50	429 00	1 Diploma.
Trotting Horses	78	1,525 00	2,385 00	
Sheep	48	57 90	343 00	
Swine	32	17 40	52 00	
Agricultural Implements	170	none	42 00	7 Diplomas, 1 Brnz Md.
Plowing Match	12	none	15 00	
	699	2,208 00	4,216 00	8 Dip. 1 Med.

HALL.

CLASS.	Premiums paid.	Silver Medals.	Bronze Medals	Dipl'mas
Corn, Wheat, Oats, Grass-seed (raised in Maine, 1880)	$24 00			
Collections of Vegetables	37 00			
Butter, Cheese, and Dairy Implements	131 00			
Honey	5 00			1
Household Articles of Maine manufacture	3 00	1	1	2
Brass, Tin, Copper and Iron Work, and Stoves	19 00	1		6
Maine Corporation Manufactures	5 00	1		23
Needle and Fancy Work	105 50			4
Articles of Leather, Saddlery, etc., (Maine manuf.)	none	1		2
India Rubber Goods	none			1
Carriages and Sleighs	10 00			2
Hardware, Cutlery, Tools and Machinery	none			4
Bread and table luxuries	17 00			2
Canned Fruits, Preserves, Pickles, etc	18 50	1	1	
Printing and Binding	none			1
Pictorial and Industrial Arts (by Maine artists)	37 00			1
Household Furniture and Carpenters' work	3 50			
Millinery, Hats, Caps, Furs and Regalias	none			
Musical and Surgical Instruments, etc	5 00	4		
Mineral and Botanical displays	5 00			1
Miscellaneous and New Inventions	none	4		26
"Baby Show"	50 00			
Total number of entries, 616. No entry fees collected at the hall.	475 50	13	2	76

FINAL RECAPITULATION.

Number of entries, Park, 699; " " Hall, 616	1,315
Entry fees collected, Park only	$2,208
Premiums paid, Park, $4,216.00; " " Hall, 475 50	$4,691 50
Silver Medals awarded, Hall only	13
Bronze " " Park 1; " " " Hall 2	3
Diplomas awarded, Park, 8; " " Hall, 76	84

STATEMENT B,

Showing Expenditures and Income of the Maine State Agricultural Society on account of the Fair of 1880, and for bills of previous years assumed and paid.

EXPENDITURES FOR 1880.	ON PARK ACCOUNT.	ON HALL ACCOUNT.	GENERAL EXPENSE	TOTAL.
For Materials (Lumber, Hardware etc.).	$ 45 26	$ 158 18	$ 3 39	$206 83
Postage, Telegraphing and Express.		17 30	126 02	143 32
Stationery and Printing	61 91	34 67	281 89	378 47
Advertising			184 00	184 00
Hay, Grain and Straw............	850 35			850 35
Labor	687 73	519 58	92 00	1,299 31
Salaries........................			1,335 00	1,335 00
MISCELLANEOUS.				
Rent of Park....................	1,000 00			1,000 00
Transportation..................	73 30	5 00	17 20	95 50
Use of Large Tent, etc	151 10			151 10
" Furniture, Crockery, etc., Loss and damage on the same....	17 35	29 07		46 42
Music			125 00	125 00
Medals and Diplomas, except bill for engraving, etc , not ascertained..	5 00	69 00		74 00
Premium Ribbons................	27 25			27 25
Drivers' Caps..................	12 00			12 00
National Trotting Association	56 00			56 00
Bill of Maine State Pomological Society for exhibition of Fruit ..		200 00		200 00
Miscellaneous Expenses..........		21 25	40 63	61 88
	2,987 25	1,054 05	2,205 13	6,246 43
Premiums Paid	4,216 00	475 50		4,691 50
Total for 1880	7,203 25	1,529 55	2,205 13	10,937 93

TOTAL EXPENDITURES.

Amount of Bills and Premiums, 1880......................	$10,937 93	
Note, Bills and Premiums of former years..................	4,690 01	
		$15,627 94
Paid and to be paid in Cash as per vouchers and approved bills.	15,597 94	
Paid by credits on sundry bills..........................	30 00	
		$15,627 94

INCOME.	On Park Account.	On Hall Account.	On General Account.	Total.
From Sales of Tickets (single admission)	$5,920 90	$2,432 62		$8,353 52
" " (Railroad).......	2,400 74	455 61		2,856 35
" " (Exhibitors).....	46 00	147 00		193 00
" " (Grange)........	6 00			6 00
	8,373 64	3,035 23		11,408 87
215 Life Members................			2,150 00	2,150 00
Entry Fees (Ex. Horses and Stock)	683 00			683 00
Entry Fees (Trotting Horses)	1,525 00			1,525 00
Advertising in Prem. List.........			46 00	46 00
Ground Rents....................	486 75			486 75
Commissions on Sales............		20 00		20 00
Special Pr'm. refunded (W.S.Tilton)	50 00			50 00
Total Income 1880	11,118 39	3,055 23	2,196 00	16,369 62

STATEMENT B—*Concluded.*

Total Income for 1880	$16,369 62	
Balance from account 1879	48 12	
		$16,417 74

COMPARATIVE STATEMENT.

Excess of Receipts over Expenditures for Park, 1880	$3,915 14	
" " " Hall, "	1,525 68	
	5,440 82	
Less deficiency in "General account"	9 13	
Net gain 1880	5,431 69	
Balance from account of 1879	48 12	
	5,479 81	
Credit on sundry bills	30 00	
		$5,509 81
Amounts paid on bills, etc., of former years	4,690 01	
Balance carried to new account	819 80	
		$5,509 81

H. S. OSGOOD, TREASURER.

TREASURER'S OFFICE, PORTLAND, Jan. 26, 1881.

Financial Statement of Agricultural

SOCIETIES.	Amount received from State.	Amount raised by Society.	Total receipts for the year.	Total amount of Premiums and gratuities awarded.	Amount expended in Premiums on Wheat and Corn per order of Board of Agriculture.	Amount expended in aid of County Institutes.
Androscoggin	358 66	781 16	1,139 82	1,115 75	80 50	30 00
Aroostook	164 50	71 00	235 50	157 30	–	43 00
Aroostook, North	100 00	74 19	174 19	114 75	–	10 00
Cumberland	400 00	2,129 51	2,529 51		–	–
Franklin	105 72	769 46	875 18	500 00	–	–
Franklin, Central	15 93	127 35	143 23	80 42	–	–
Franklin, North	66 42	269 00	444 16	258 60	–	–
Kennebec	218 98	811 43	1,030 47	497 00	19 00	–
Kennebec, North	181 02	352 07	533 09	334 75	50 00	–
Knox	158 26	547 45	705 71	446 00	10 50	–
Knox, North	154 00	379 70	533 70	222 96	–	–
Lincoln	255 97	421 29	677 26	315 45	–	–
Ossipee Valley	–	811 90	811 90	567 85	–	–
Oxford	257 50	2,217 78	2,475 28	1,036 57	–	40 00
Oxford, West	77 38	727 37	804 75	346 85	10 00	–
Penobscot, Central	90 00	88 66	176 60	194 14	17 30	–
Penobscot, North	–	75 00	–	–	–	–
Penobscot, West	234 68	563 44	798 12	274 35	–	–
Penobscot and Aroostook	78 00	73 00	151 00	81 75	5 00	–
Piscataquis, Central	87 53	346 45	433 98	305 90	–	–
Piscataquis, East	31 40	39 50	70 90	65 20	–	–
Piscataquis, West	25 10	73 43	98 53	84 10	–	–
Pomological, State	231 00	281 05	512 05	452 25	–	–
Sagadahoc	252 39	1,778 98	2,032 37	538 00	–	–
Shapleigh and Acton	160 10	345 37	505 47	394 75	80 00	–
Somerset Central	–	452 50	452 50	348 50		–
Somerset, East	186 61	492 50	679 11	463 35	–	–
Somerset, West	34 50	73 43	107 93	221 17	–	–
Waldo and Penobscot	130 00	1,099 14	1,229 14	585 90	–	30 00
Waldo, North	215 22	300 50	515 72	390 65	–	–
Washington	204 50	852 15	1,056 65	540 90	24 00	2 50
Washington, West	195 50	821 83	1,017 33	652 97	50 00	–
York	239 90	612 18	852 08	665 50	–	–

Societies for the Year 1880.

Amount expended for encouragement of Dairying.	Total amount expended under direction of Board of Agriculture	Incidental Expenses for the year.	Whole amount of Disbursements for the year.	Value of Property belonging to the Society.	Amount of liabilities of the Society.	Awards for Plowing at Exhibition.	For Bulls and Bull Calves.	For Working Oxen, 4 years old and over	For Steers under 4 years old.	For Milk Cows.
85 00	165 50	479 53	–	–	–	–	7 50	37 00	36 00	55 00
–	43 00	21 90	222 20	–	–	–	6 00	3 00	12 00	20 00
–	–	55 10	179 85	–	–	–	4 00	–	4 00	12 00
–	–	1,614 96	2,986 96	–	457 45	–	80 00	65 00	20 00	151 00
–	–	418 13	734 87	–	204 00	–	16 00	74 50	56 50	35 00
6 40	–	30 70	131 46	700 00	500 00	–	2 50	2 75	60	2 90
–	–	50 00	425 00	–	–	–	3 25	30 50	23 50	9 50
35 50	54 50	–	1,047 21	450 00	45 00	–	13 00	55 00	32 50	24 00
30 00	80 00	119 13	590 38	1,500 00	57 29	–	25 00	27 00	7 00	25 00
36 00	46 50	314 01	–	–	–	–	20 00	34 50	12 00	22 00
–	6 00	439 62	663 58	–	39.00	–	5 25	11 50	–	35 00
2 25	–	427 91	743 36	125 00	70 00	–	9 75	6 00	3 50	6 00
20 00	–	130 27	539 12	3.000 00	500 00	–	15 00	41 00	18 00	12 00
37 00	77 00	773 74	1,574 95	4,600 00	366 26	6 00	54 00	95 00	65 00	16 00
–	10 00	194 00	540 85	1,800 00	557 20	–	15 00	38 00	25 00	15 00
9 25	26 55	16 95	146 75	–	–	–	12 50	11 00	13 75	4 50
–	–	–	–	–	–	–	–	6 00	5 00	8 00
21 00	21 00	300 00	819 95	3,000 00	1200 00	–	11 50	11 00	16 00	19 00
23 00	28 00	64 0	145 75	–	–	–	5 25	1 50	2 75	12 25
20 25	20 25	68 78	395 68	200 00	187 53	–	10 00	25 00	6 00	12 00
–	–	22 78	87 98	25 00	–	–	3 00	6 50	5 00	2 50
7 50	7 50	31 50	115 60	–	25 00	–	4 50	9 50	5 50	4 50
–	–	81 63	67 63	100 00	140 00	–	–	–	–	–
13 00	13 00	932 39	1,795 39	4,000 00	–	–	16 50	60 00	28 00	38 00
–	80 00	30 00	442 75	4,000 00	–	5 00	7 50	50 00	23 00	10 50
–	–	65 00	413 50	1,000 00	–	–	18 00	43 00	25 00	9 00
25 00	20 45	177 40	724 11	2,500 00	995 35	–	19 75	25 50	36 50	26 00
6 00	28 00	36 95	76 95	800 00	–	–	3 00	20 00	16 75	12 00
–	–	500 52	1,086 42	2,000 00	–	–	10 00	12 00	19 00	10 50
6 00	206 25	43 42	410 36	–	–	–	12 25	15 00	15 00	12 00
–	26 50	498 61	1,064 61	1,650 00	–	–	41 00	12 00	22 00	20 00
14 00	64 00	412 03	1,065 00		–	–	47 00	27 00	32 50	33 00
22 00	–	283 43	948 93	150 00	–	21 00	22 00	33 00	18 00	42 00

FINANCIAL STATEMENT OF AGRICULTURAL

SOCIETIES.	For Heifers and Heifer Calves	For Fat Cattle.	For Trials of Speed.	For Stallions.	For Breeding Mares.	For other Horses and Colts.	For Swine.
Androscoggin	30 00	6 00	340 00	15 00	6 50	35 00	24 50
Aroostook	8 50	-	-	-	6 00	27 00	13 00
Aroostook, North	4 00	-	-	40 00	2 00	16 00	2 00
Cumberland	27 00	15 00	385 00	50 00	15 00	55 00	25 00
Franklin	17 25	15 50	105 00	14 00	6 00	26 75	6 00
Franklin, Central	60	75	4 00	-	-	1 75	2 75
Franklin, North	2 15	3 50	61 00	-	4 50	18 70	5 00
Kennebec	33 90	7 50	81 00	16 00	6 00	27 00	8 00
Kennebec, North	37 00	5 00	42 00	12 00	5 00	20 00	9 00
Knox	14 25	8 50	-	6 00	3 00	40 50	9 50
Knox, North	19 00	2 00	-	3 00	4 00	10 00	3 25
Lincoln	6 50	3 00	60 00	4 00	-	11 00	7 50
Ossipee Valley	7 00	-	190 00	12 00	7 00	43 00	-
Oxford	20.00	12 00	315 00	33 00	10 00	21 50	29 00
Oxford, West	7 00	4 00	71 00	3 00	-	17 00	7 00
Penobscot, Central	10 75	-	-	5 00	4 50	25 75	-
Penobscot, North	6 00	1 00	4 00	5 00	6 00	2 00	3 00
Penobscot, West	21 75	-	-	14 50	6 00	23 00	10 00
Penobscot and Aroostook	2 00	8 00	-	-	1 50	3 00	8 00
Piscataquis, Central	15 00	-	88 00	-	6 00	18 00	9 00
Piscataquis, East	4 00	-	-	2 00	3 00	14 25	5 00
Piscataquis, West	1 50	-	-	2 00	3 00	15 50	1 00
Pomological, State	-	-	-	-	-	-	-
Sagadahoc	21 50	5 00	325 00	19 00	8 00	32 00	9 00
Shapleigh and Acton	4 75	6 00	10 50	-	3 50	22 25	9 00
Somerset, Central	15 00	-	-	21 00	7 00	18 50	5 00
Somerset, East	16 50	-	265 00	6 00	3 25	-	8 00
Somerset, West	10 00	4 00	25 00	4 00	7 00	25 00	7 50
Waldo and Penobscot	4 00	6 00	267 00	35 00	6 00	30 00	8 00
Waldo, North	4 50	5 00	140 00	16 00	6 00	22 75	1 50
Washington	31 00	6 00	165 00	8 00	9 00	22 50	10 00
Washington, West	17 50	-	138 00	10 00	9 50	31 50	11 00
York	18 00	5 00	143 00	15 00	16 00	34 00	5 00

SOCIETIES FOR THE YEAR 1880—*Continued.*

For Sheep.	For Poultry.	Total Amount awarded for Live Stock.	Total Amount awarded for Horses, not purses.	Am't awarded for Indian Corn	For Wheat.	For Rye.	For Barley.	For Oats.	For Buckwheat.	For Beans.	For Potatoes.
13 00	–	235 00	56 50	42 50	38 00	6 00	4 00	4 00	1 00	–	13 50
23 50	3 50	89 50	33 00	3 50	3 00	–	1 00	2 00	–	–	3 00
6 00	–	32 00	58 00	2 75	–		–	–	–	–	–
61 00	–	444 00	120 00	75 00	–	–	–	–	–	–	3 50
21 00	5 60	214 75	47 25	1 40	–	–	–	–	–	–	15
5 75	60	20 25	1 75	2 65	3 00	–	–	90	–	–	45
12 90	13 25	103 55	23 20	2 00	7 00	–	–	–	–	–	3 25
24 00	11 50	210 40	59 00	14 00	7 00	–	–	–	–	–	–
29 00	5 00	169 00	37 00	–	–	–	–	–	–	–	–
9 50	40 50	170 75	49 50	9 25	4 00	2 00	2 00	2 00	–	–	5 50
8 50	4 00	91 25	16 00	11 00	5 00	2 50	2 50	2 50	–	–	3 00
4 00	3 25	34 75	11 00	16 50	20 00	1 00	1 50	1 00	–	–	2 25
6 00	3 00	253 00	55 00	6 00	5 00	–	–	–	–	–	–
42 00	12 00	375 00	64 50	28 50	28 50	–	4 00	–	–	–	75
9 00	4 00	133 50	20 00	21 75	2 25	–	–	2 00	–	–	1 50
13 50	50	79 75	35 25	17 30	–	–	–	–	–	–	–
6 00	3 00	60 00	–	20 00	–	–	–	–	–	–	–
19 26	6 00	108 50	43 50	6 40	3 50	–	1 00	1 75	1 00	–	3 70
–	–	31 75	6 50	–	5 00	–	–	–	–	–	1 50
9 50	6 00	95 50	34 50	7 25	13 25	–	–	–	–	–	5 50
–	1 00	27 00	19 25	1 45	–	–	–	25	–	–	1 00
10 00	30	36 50	20 50	45	–	–	–	–	–	–	2 25
–	–	–	–	–	–	–	–	–	–	–	–
11 00	28 50	217 56	62 00	5 75	–	3 00	5 00	–	–	–	1 50
8 50	4 75	129 00	36 25	6 00	19 75	2 25	1 70	2 25	–	–	1 50
40 00	6 00	161 00	46 00	–	–	–	–	–	–	–	–
22 50	–	171 25	28 00	10 45	10 00	–	–	–	–	–	–
22 50	4 25	106 80	29 50	14 00	14 00	–	5 00	5 00	–	–	6 75
5 00	13 00	326 00	159 50	3 75	3 00	–	–	–	–	–	5 50
12 75	1 50	88 80	46 75	15 00	–	–	–	–	–	2 00	6 00
20 00	6 00	188 00	39 50	17 75	13 05	–	–	1 25	2 00	–	4 50
18 00	26 00	211 00	50 50	1 75	2 50	–	2 00	1 00	1 00	–	7 95
7 00	15 00	165 00	65 00	9 00	6 00	3 00	3 00	3 00	–	–	9 00

FINANCIAL STATEMENT OF AGRICULTURAL

SOCIETIES.	For Carrots.	For Beets.	For Turnips.	Farm Produce and Garden Vegetables.	Total amount awarded for Grain and Root Crops.
Androscoggin	1 50	16 00	6 50	20 00	153 00
Aroostook	–	1 00	2 00	–	15 50
Aroostook, North	–	–	–	–	6 25
Cumberland	3 50	3 50	3 50	–	–
Franklin	35	35	35	–	2 60
Franklin, Central	40	45	25	–	6 35
Franklin, North	45	45	45	–	13 60
Kennebec	–	–	–	–	21 00
Kennebec, North	–	–	–	–	–
Knox	1 50	4 50	1 00	–	48 75
Knox, North	–	–	1 50	–	32 50
Lincoln	50	2 00	1 00	–	45 25
Ossipee Valley	–	–	–	–	11 00
Oxford	75	10 75	75	–	73 75
Oxford, West	25	25	25	–	28 25
Penobscot, Central	–	25	–	–	–
Penobscot, North	–	–	–	–	
Penobscot, West	–	1 40	50	–	19 25
Penobscot and Aroostook	–	–	–	–	6 50
Piscataquis, Central	2 00	50	25	–	28 70
Piscataquis, East	50	1 50	75	–	5 45
Piscataquis, West	–	–	–	–	2 60
Pomological, State	–	–	–	–	–
Sagadahoc	75	75	75	–	50 00
Shapleigh and Acton	1 50	3 00	–	–	41 00
Somerset, Central	–	–	–	–	13 00
Somerset, East	–	–	–	–	10 00
Somerset, West	–	11 00	–	–	71 85
Waldo and Penobscot	1 00	2 00	1 50	–	16 75
Waldo, North	1 25	1 25	1 25	–	24 75
Washington	1 25	1 50	1 50	–	42 80
Washington, West	5 75	5 75	5 75	–	20 00
York	–	1 50	1 50	–	36 00

SOCIETIES FOR THE YEAR 1880—*Concluded.*

For any other cultivated Crops.	For Fruits and Flowers.	For Honey, Sugar and Syrup.	For Bread, Butter and Cheese	Agricultural Implements.	Household Manufactures and Needle Work.	Manufactures of Wood, Iron and Leather.	Other Mechanical Products.	All objects not enumerated above.
23 00	89 50	7 25	40 50	4 00	35 25	18 00	28 75	38 50
2 75	2 50	–	3 00	–	11 00	–	–	–
3 50	5 50	–	9 00	–	2 25	–	–	1 75
–	125 00	–	31 00	28 00	22 00	19 00	–	33 00
–	11 00	2 55	4 25	7 25	25 85	2 00	3 50	31 40
2 50	3 75	25	1 80	1 00	20 85	–	–	10 97
1 50	7 30	25	4 25	–	24 75	7 45	–	12 00
–	21 50	–	35 50	3 00	43 00	3 00	–	25 14
–	21 00	1 00	12 00	–	32 00	2 00	–	18 75
13 50	39 00	3 50	36 00	3 00	26 00	–	–	51 00
–	16 50	8 00	16 00	3 00	14 50	7 00	–	–
12 75	26 00	2 25	2 25	–	15 25	1 00	–	85 70
2 00	6 00	–	5 00	–	25 50	2 00	–	–
10 75	32 50	1 85	36 00	7 00	32 90	38 80	11 70	69 82
7 25	15 00	6 55	11 50	5 50	37 30	5 00	–	15 00
6 25	13 50	–	9 25	3 00	22 92	–	–	19 92
–	10 00	2 00	7 00	10 00	5 00	–	–	10 00
12 25	19 15	5 55	37 00	1 00	21 15	1 00	–	–
4 00	4 25	–	14 00	–	8 75	–	–	–
–	15 00	1 50	17 00	1 50	15 90	3 00	–	–
3 60	1 50	–	2 50	–	4 40	–	–	1 50
1 50	1 55	–	7 75	–	9 35	–	–	4 05
–	452 25	–	–	–	–	–	–	–
–	47 25	1 50	13 00	3 00	28 75	9 00	–	94 50
28 00	28 75	50	7 25	–	25 75	50	–	58 00
–	10 00	2 00	8 00	–	5 00	37 00	–	20 00
–	5 00	–	12 00	–	15 20	–	–	–
–	–	–	4 00	–	10 02	–	–	–
7 50	22 00	1 50	3 00	–	61 50	1 00	–	30 40
6 50	8 25	1 00	5 50	–	25 00	–	–	1 25
23 75	20 00	1 25	8 50	–	40 35	2 00	3 25	6 50
13 75	19 50	72	14 00	2 00	34 45	8 35	–	6 75
13 50	43 50	6 00	28 00	11 00	69 00	22 00	18 00	24 50

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