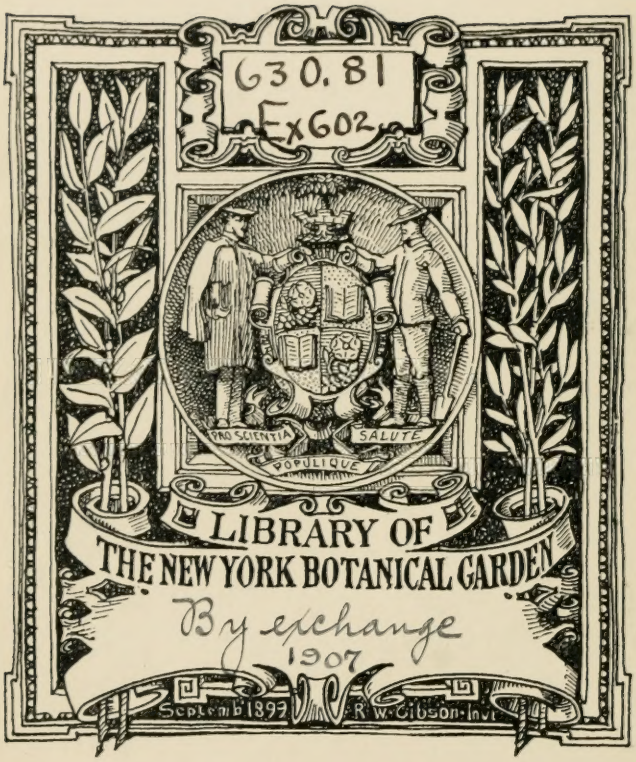
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U. S. DEPARTMENT OF AGRICULTURE.

ANNUAL REPORT

OF THE

OFFICE OF EXPERIMENT STATIONS

FOR THE

YEAR ENDED JUNE 30, 1905.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.

[No. 29.]

JOINT RESOLUTION providing for printing annually the Report of the Director of the Office of Experiment Stations, Department of Agriculture.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed eight thousand copies of the report of the Director of the Office of Experiment Stations, prepared under the supervision of the Secretary of Agriculture, on the work and expenditures of that office and of the agricultural experiment stations established in the several States and Territories under the act of Congress of March second, eighteen hundred and eighty-seven, for nineteen hundred and three, of which one thousand copies shall be for the use of the Senate, two thousand copies for the use of the House of Representatives, and five thousand copies for the use of the Department of Agriculture; and that annually hereafter a similar report shall be prepared and printed, the edition to be the same as for the report herein provided.

Approved, April 27, 1904.

THE OFFICE OF EXPERIMENT STATIONS.

STAFF.

A. C. True, Ph. D., Director.
E. W. Allen, Ph. D., Assistant Director and Editor of Experiment Station Record.
W. H. Beal, B. A., M. E., Chief of Editorial Division.
W. H. Evans, Ph. D., Chief of Division of Insular Stations.
Elwood Mead, D. E., Chief of Irrigation and Drainage Investigations.
John Hamilton, B. S., M. S. A., Farmers' Institute Specialist.
Mrs. C. E. Johnston, Chief Clerk.
Sarah L. Sommers, Record Clerk.
G. A. Harlow, Accountant.

EDITORIAL DEPARTMENTS.

W. H. Beal, B. A., M. E., Meteorology, soils, and fertilizers.
W. H. Evans, Ph. D., Agricultural botany and vegetable pathology.
J. I. Schulte, B. S., Field crops.
C. B. Smith, M. S., Horticulture and forestry.
C. F. Langworthy, Ph. D., Zootechny and human nutrition.
H. W. Lawson, M. S., M. D., Agrotechny, dairy farming, and dairying.
W. H. Beal, C. F. Langworthy, and H. W. Lawson, Agricultural chemistry.
E. V. Wilcox, Ph. D., Economic zoology, entomology, and veterinary medicine.
R. P. Teele, M. A., Rural engineering.
——— ———, Rural economics.
D. J. Crosby, M. S., Agricultural education.
William Henry, Indexing and proof reading.

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C. C. Georgeson, M. S., Special agent in charge, Sitka.
F. E. Rader, B. S., Assistant at Rampart.
R. W. De Armond, Assistant at Sitka.
P. H. Ross, B. S., Assistant at Kenai.
J. W. Neal, Assistant at Copper Center.

HAWAII EXPERIMENT STATION.

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D. L. Van Dine, B. S. A., Entomologist.
J. E. Higgins, B. A., M. S. A., Expert in horticulture.
F. G. Krauss, In charge of rice investigations.
F. G. Krauss, In charge of rice investigations.
C. R. Blacow, In charge of tobacco experiments.

PORTO RICO EXPERIMENT STATION.

D. W. May, M. Agr., Special agent in charge, Mayaguez.
W. V. Tower, M. S., Entomologist and botanist.
J. W. Van Leenhoff, Coffee expert.
H. C. Henricksen, B. Agr., Horticulturist.
E. F. Curt, Farm superintendent.

NUTRITION INVESTIGATIONS.

C. F. LANGWORTHY, Ph. D., Editor and expert in nutrition.

F. G. BENEDICT, Ph. D., In charge of respiration calorimeter experiments, Middletown, Conn.

R. D. MILNER, Ph. B., Editorial assistant, Middletown, Conn.

H. A. PRATT, B. A., Assistant in dietary studies, Middletown, Conn.

C. D. WOODS, Sc. D., Special agent at Orono, Me.

IRRIGATION AND DRAINAGE INVESTIGATIONS.

ELWOOD MEAD, D. E., Chief of irrigation and drainage investigations.

C. G. ELLIOTT, C. E., Engineer in charge of drainage investigations.

S. M. WOODWARD, M. S., M. A., Engineer in charge of irrigation investigations.

R. P. TEELE, M. A., Expert in irrigation institutions.

C. J. ZINTHEO, B. S., Expert in farm mechanics.

SAMUEL FORTIER, M. E., Engineer in charge of Pacific district.

F. C. HERRMANN, B. S., Expert in irrigation as related to dry farming.

LETTER OF TRANSMITTAL.

OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., March 12, 1906.

SIR: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, the publication of which is authorized by joint resolution of the Fifty-eighth Congress, second session. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March 2, 1887, for the fiscal year ended June 30, 1905, in compliance with the following provision of the act making appropriations for this Department for the said fiscal year:

> The Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of the said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of the said act, and shall make report thereon to Congress.

Very respectfully,

A. C. TRUE, *Director.*

Hon. JAMES WILSON,
Secretary of Agriculture.

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ILLUSTRATIONS.

ANNUAL REPORT OF OFFICE OF EXPERIMENT STATIONS, JUNE 30, 1905.

SUMMARY.

By A. C. True and Dick J. Crosby.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories and, under special appropriation acts, in Alaska, Hawaii, and Porto Rico. In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of stations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the act of 1887 during 1905 was $1,525,489.18, of which $718,163.45 was received from the National Government, and the remainder, $797,571.02, from State governments, individuals, and communities, fees for analyses of fertilizers, sales of farm products, and miscellaneous sources. In addition to this, the Office of Experiment Stations had an appropriation of $177,500 for the past fiscal year, including $15,000 for the Alaska experiment stations, $15,000 for the Hawaii Experiment Station, $15,000 for the Porto Rico Experiment Station, $20,000 for nutrition investigations, $67,500 for irrigation investigations, and $5,000 for farmers' institutes. The total value of additions to the equipment of the stations in 1905 is estimated to be $155,619.72.

DISSEMINATION OF INFORMATION.

The activity of the stations in disseminating the results of their investigations continues unabated. Of the 845 persons employed in station work last year, 423 did more or less teaching in the colleges with which the stations are connected, and 393 assisted in farmers' institutes, contributing a total of two thousand six hundred and eighty-nine days to this work. In this way the results of investi-

gations in agriculture were brought directly to the attention of nearly 10,000 students in agricultural colleges and probably 300,000 attendants at farmers' institutes. A much larger number of farmers has been reached and a wider influence has been extended by means of the publications of the stations. These publications during the past year aggregated 403 annual reports and bulletins, and a total of more than 5,400,000 copies of them were distributed to over 731,000 addresses on the regular mailing lists. The stations also published and distributed nearly 1,150,000 copies of circulars, leaflets, press bulletins, and other special publications. Many of them report rapidly growing mailing lists and correspondence, and in some cases the demands of this nature have been more than the stations could meet. Considering their limited resources, these institutions are accomplishing a large amount of useful work and giving wide publicity to the results attained.

PROGRESS OF THE STATIONS.

In the last report of this Office attention was called to the work of the experiment stations in the field of agronomic research, and especially to the results attained by a few of the stations in plant-breeding experiments. The remarkable success which has attended the work of some of the stations in breeding and selecting special-purpose varieties of corn and wheat has led to the rapid extension of this class of investigations. Many of the stations are now engaging in this kind of work, and, in cooperation with this Department, are breeding and selecting forage plants and cereals for greater production, for drought resistance, and for alkali resistance; cotton for longer staple and for resistance to insect pests and diseases; cowpeas for yield and resistance to drought and disease; sweet corn and sugar beets for increased sugar content; fruits and cereals for greater resistance to cold; tobacco for quality and form, and numerous other field and garden crops for special qualities. In the same way new varieties secured by crossing are being so handled as to fix their desirable qualities. It now appears entirely feasible to secure as marked results in originating and fixing desirable characteristics in plants as in animals.

Success in these lines of investigation has stimulated the station men to greater activity along other important lines of research. In the animal-husbandry work, for example, greater activity is apparent in the study of breeding problems. Several of the stations are studying fundamental breeding problems concerning the application of Mendel's law to the origination of new types of animals, while others are breeding and selecting for special performance. Cattle are being bred for milk or beef production, chickens for egg production, swine for lean meat, mutton sheep for early maturity, etc., and quite re-

cently two stations in cooperation with this Department have undertaken breeding experiments with horses, in one case to produce an American carriage horse from the American trotter as foundation stock and in the other to improve the Morgan breed of horses.

Another indication of the recent development of interest in systematic breeding investigations is found in the organization of the American Breeders' Association, with members in this Department and in every agricultural experiment station in the United States. The purposes of this association, as stated in its constitution, are "to study the laws of breeding and to promote the improvement of plants and animals by the development of expert methods of breeding."

But the attention here directed to the breeding work of the stations is not to be taken as an indication that their other work has been allowed to drift or that the investigators in other lines of research are in the slightest degree relaxing their efforts to add to the sum of knowledge concerning the science of agriculture or to bring about needed improvements in all lines of agricultural practice. On the contrary, the examples cited are merely indications of a growing appreciation by station men in each line of research of the need of more thorough studies of the broader and more fundamental problems in agriculture. The well-directed enthusiasm which everywhere pervades this work augurs well for the future of agricultural research in this country.

The vastness of agricultural problems, when considered in the aggregate, is almost beyond comprehension. When account is taken of the fact that the production of wealth on farms in the United States in 1905 reached the stupendous aggregate of $6,415,000,000, and that this represents an increase of $256,000,000 over the production in 1904, the importance of any one discovery affecting favorably the production of agricultural wealth is apparent. And this vast increase in productive capacity is due primarily to improved methods in farm practice. In the period covered by this report no considerable new areas have been brought under cultivation except where cultivation has been made possible by investigations showing the possibility of reclaiming arid or semiarid lands by irrigation or dry-farming operations. Credit for this additional wealth-producing power must therefore be given mainly to the use of improved field crops, fruits, and animals; to better methods of cultivating, fertilizing, harvesting, and marketing crops; to more rational practice in feeding and caring for farm animals, and to the more general and successful use of preventives and remedies for diseases and insect pests of plants and animals. If, now, credit for one-hundredth part of the improvement in farm practice can be given to the influence exerted by the experiment stations through the 6,400,000 publications

distributed during the previous year, through correspondence with hundreds of thousands of farmers, and through demonstrations and lectures reaching other hundreds of thousands, the total expense of maintaining these stations during 1905 will have been paid nearly twice over.

There is abundant evidence that in several States the farmers themselves are beginning to give the experiment stations a large share of credit for improved conditions of agriculture. One indication of this is found in the greater demands made upon the stations by the farmers for advice and assistance, but a stronger mark of approval is found in the recent liberal appropriations for the investigation of special problems of more or less local application. Noteworthy among the appropriations of this nature now being used by the stations are the following: Illinois has $95,000 for investigations in soils, live stock, dairying, field crops, and orchards; California, $60,000 for the study of plant diseases and the improvement of wheat; Michigan, $20,000 for live-stock work; Utah, $25,000 for experiments in arid farming, irrigation, and drainage; New Jersey, $16,000 for investigations and aid to local communities in the eradication of mosquitoes; Indiana, $15,000 for studies in beef production, dairying, and the improvement of crops and soils; Minnesota, $10,000 for plant breeding and soil investigations; North Dakota, $9,000 for investigating the milling qualities of wheat and for inspection work; and Colorado, $7,000 for work with live stock, grains, forage crops, and root crops.

The different States are also providing more liberally for the general maintenance of the stations and expending larger sums than formerly for suitable buildings and equipment and for substations to be conducted under the control of the stations receiving Federal aid. The stations now receive, in the aggregate, nearly $100,000 more from the States and other sources than from the Hatch fund.

NEEDS OF THE STATIONS.

The liberality of some of the States has a tendency to accentuate rather than alleviate certain difficulties under which the stations are laboring. It gives them, to be sure, better buildings and equipment, more and better salaried investigators, and funds for special work partaking largely of the nature of demonstrations, but it does not provide adequately for the concomitant increase of investigations of a more strictly scientific nature. Furthermore, while the funds given by the States are large in the aggregate, the stations that are liberally provided for are relatively few. Many of the stations in the less highly developed agricultural regions have to pay practically all their expenses from the Hatch fund, and the demands made by

the people for information are of such diverse nature that when a staff of experts capable of dealing intelligently with the different questions that arise is employed, practically all of the station's funds are expended for salaries, labor, and publications, leaving very little for research work.

Relief such as the stations need is not likely soon to come from the States. There is now a widespread movement for the introduction of instruction in agriculture in the secondary and elementary public schools, together with the enlargement of the higher instruction offered in the agricultural colleges. The States will undoubtedly be called upon to provide larger funds for agricultural education of a more popular character, and in many parts of the country this will prevent their increasing to any material extent the resources of the experiment stations.

These facts made it highly desirable that the Congress of the United States should enact a law giving additional aid to all of the agricultural experiment stations, and that the funds thus appropriated should be devoted strictly to the carrying on of scientific investigations in agriculture.

There is an evident purpose on the part of the station managers to differentiate more fully the work of research from that of instruction, but in a considerable number of States it has been impracticable to make much progress in this direction owing to lack of resources permitting the employment of a staff more completely devoted to the business of the experiment station. The changes which have been made in the organization of the stations during the past year have almost uniformly increased their efficiency. The directorship of several of the stations has been separated from the president's office, and greater supervisory and directing power has been conferred upon the director. Florida, Massachusetts, and South Carolina have recently separated the two offices, leaving the joint arrangement only in Nevada, New Hampshire, New Mexico, North Dakota, and Washington.

STATISTICS OF THE LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, are now in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. The total number of these institutions is 65, of which 63 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1905 is estimated to be $81,251,764.42. The income of these institutions in 1905, exclusive of the funds received from the United States for agricultural experiment stations, was $11,767,154.54.

The value of the additions to their permanent endowment and equipment in 1905 is estimated to be $3,501,513.19. The number of persons in the faculties of the colleges of agriculture and the mechanic arts was 2,672, and in other departments 1,889, making a grand total of 4,561. The number of students in 1905 was 59,812, of whom 2,638 were white students in four-year courses in agriculture, 4,634 white students in shorter courses in agriculture, dairying, horticulture, and veterinary science, and 1,624 negro students in agricultural courses. The graduates in 1905 were 5,061, and since the organization of these institutions, 62,081.

PROGRESS IN AGRICULTURAL EDUCATION.

The year 1905 marks the semicentennial of the founding of agricultural colleges in this country, and it has been a year of great progress in agricultural education, not only in the United States, but throughout the civilized world. The most notable event of the year in this connection was the holding of two international congresses at Liège, Belgium, namely, the Second International Congress of Agricultural Education and the First International Congress of Agricultural Mechanics. At both of these congresses this Office was represented.

In the United States progress has been manifested in a material way by more liberal appropriations for the equipment and current expenses of the agricultural colleges, and in a less tangible but no less hopeful and wholesome way by the attitude of the general public toward agricultural education. At no time in the history of the Republic has there been such free and favorable discussion of ways and means for developing and extending the various phases of agricultural education as during the past year. At the recent convention of the Association of American Agricultural Colleges and Experiment Stations in Washington the section on college work discussed very fully and freely the field and functions of the land-grant colleges. This discussion indicated quite clearly a better understanding and a closer agreement concerning the nature of technical courses, as well as a growing belief that the agricultural colleges should do more to aid secondary and elementary instruction in agriculture through the preparation of courses of study and the training of teachers. The association decided to assume responsibility for the future sessions of the Graduate School of Agriculture, the second session of which will be held at the University of Illinois in July, 1906, and instructed its executive committee to take steps to secure the establishment of a department of rural and agricultural education in the National Educational Association.

The latter association has already shown considerable interest in the subject of elementary agricultural education, which formed a

prominent topic of discussion at its last convention. The president of the association in his annual adress, delivered before thousands of teachers, commended the teaching of agriculture in public schools in strong terms, pointing out its advantages to the people in rural communities, and to the nation as well, in the greater efficiency of its agricultural population. The subject was also referred to in a report upon the educational progress of the year, and was the main subject considered in the report of a special committee on industrial education in schools for rural communities. In this report it was maintained that the rural schools should recognize the fact that the major portion of their pupils will continue to live upon the farm, and should provide specific, definite, technical training fitting them for the activities of farm life.

The reports of many other educational meetings have contained numerous papers and discussions on the subject of agricultural education and so, too, have the columns of hundreds of newspapers and magazines. Three elementary text-books of agriculture and many bulletins, pamphlets, and circulars, containing courses of study and exercises in agriculture, nature study, and school gardens suitable for secondary and elementary schools have been prepared during the year by teachers in our agricultural colleges and schools. But the demand for agricultural literature suitable for the common schools has not been satisfied. Book publishers are seeking for men who can prepare the right kind of elementary agricultural text-books, and many county newspapers have been printing syndicated lessons in elementary agriculture. School courses in agriculture have been conducted in a few localities with such a degree of success as to give a strong impetus to the establishment of special schools of agriculture and the inauguration of agricultural courses in the public elementary and secondary schools. During the past year at least a dozen States have entered the list of those giving encouragement to work of this nature, so that now more than thirty States either encourage or permit the teaching of agriculture in public schools. In two States high school work in agriculture is now recognized in requirements for admission to college and university courses. Children's garden work has made such a strong appeal to educators in cities that three large cities have given it definite recognition by appropriating public funds for its support and appointing officers to supervise it.

With the rapid growth in sentiment and action toward placing the benefits of an agricultural education within easy reach of all people in rural communities have come demands upon the Office of Experiment Stations for assistance in many forms which, with its present income and staff, it is impossible to give. The Office has continued, however, to represent this Department in matters relating to agri-

cultural education and to follow and record the progress in agricultural education. In order to do this more effectively it has established a department of agricultural education in the Experiment Station Record. It has also prepared a number of publications relating to agricultural education, conducted a large correspondence on this subject, and upon request sent representatives to many meetings of farmers and educators. The Office is in a position to render much more effective aid in the promotion of agricultural education as soon as better facilities for this work are available.

THE FARMERS' INSTITUTES.

The statistics of farmers' institutes in the United States, as compiled by the Farmers' Institute Specialist of this Office, are included in a report given on page 359. According to these statistics, institutes were held in all but three of the States and in all Territories, except Alaska, Indian Territory, and Porto Rico. The total number of institutes held was 3,271, and the total number of sessions 10,555. The total attendance at these institutes was over 995,000, an increase of 153,000 over that of the previous year. The appropriations for institute purposes amounted to $225,700. The number of institute lecturers employed regularly on the State force increased from 953 to 995. Twenty States held round-up institutes, comprising 192 sessions, with an attendance of 30,000. Six States report 167 institutes for boys, and nine States 454 institutes for women.

A school of methods in institute teaching, schools of instruction for institute workers, more institutes for women, more institutes for boys, a large number of railroad trains run as institute specials, and greater concentration of effort on single topics of instruction were among the leading features of progress in the institute work of 1905. The principal needs of the institutes are more efficient lecturers, a wider distribution of agricultural literature among farmers, and better organization.

The tenth annual convention of the American Association of Farmers' Institute Workers was held in Washington, D. C., November 9–11, 1905, and was attended by 92 delegates, representing 29 States and 3 of the Provinces of Canada. The proceedings of this convention have been published as Bulletin 165 of this Office, and a brief account of the meeting is given on page 369 of this report.

The work of this Office in relation to farmers' institutes has been continued as heretofore. The Farmers' Institute Specialist has continued to aid the State directors by distributing literature, attending meetings of representative farmers, delivering addresses before farm organizations, aiding in the preparation of publications, perfecting the organization of the work of the Office, and conducting correspondence. During the year 10 States and the Province of Ontario

were visited and 17 addresses were delivered. A bulletin on Agricultural Instruction for Adults in the British Empire and six illustrated lectures, prepared by expert scientists and edited by the Farmers' Institute Specialist, were published, and arrangements were completed with a number of experts for the preparation of courses of study, with practicums suited to each, for use in movable schools of agriculture.

From the work already done by the Farmers' Institute Specialist and from the opinions he has gathered concerning the needs of the institutes it is apparent that this Department could much more effectively aid the institute movement if it were in a position to engage more actively in the dissemination of information concerning the results of its investigations and those of the experiment stations by means of lectures, charts, lantern slides, and special publications.

THE ASSOCIATION OF COLLEGES AND STATIONS.

The nineteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held in Washington, November 14–16, 1905. Upon suggestion of the executive committee the standing committees of the association were reduced to four, namely (1) instruction in agriculture, (2) graduate study, (3) extension work, and (4) experiment station organization and policy. In the section on college work and administration the general theme for all the papers and discussions was the field and functions of the land-grant colleges. In the section on experiment station work two subjects were considered, (1) soil investigations and (2) how much demonstration work and what kind should the experiment station undertake. The convention was largely attended and the interest well maintained throughout. The wisdom of confining the discussions to one or two topics of general importance was quite fully demonstrated.

THE OFFICE OF EXPERIMENT STATIONS.

The work of the Office of Experiment Stations has included no new enterprises, except investigations on the application of power to farm work, but it has grown in extent and importance in all lines. In the supervision of station expenditures and the advisory relations with the stations a closer study of the needs of these institutions has been made with a view of rendering them more efficient aid in strengthening their organization and systematizing and developing their investigations.

The collection and dissemination of information regarding the progress of agricultural investigation and research throughout the world have been put upon a better basis through changes in the Experiment Station Record and additions to its staff, which will make

it possible to give more attention to publications relating to rural engineering, rural economics, and agricultural education. The Office has also arranged to render more efficient aid to the Association of American Agricultural Colleges and Experiment Stations in its studies relating to instruction in agriculture and extension work.

The experiment stations in Alaska, Hawaii, and Porto Rico have been conducted, as heretofore, under the direction of this Office, and the special investigations on the nutrition of man and on irrigation and drainage have been continued largely in cooperation with the experiment stations, educational institutions, and other agencies in different States and Territories. The educational work of the Office in promoting farmers' institutes and instruction in agriculture in secondary and elementary public schools has grown beyond the resources of the Office. The work of the year has shown clearly that there are several ways in which the Office can be of much greater assistance in the extension of educational facilities for farmers and farmers' children as soon as funds are provided for this work.

The Office transferred the major portion of its exhibit in the Government building at the Louisiana Purchase Exposition to the Government building at the Lewis and Clark Exposition, Portland, Oreg.

The demand for the publications of this Office is shown in the report of the Chief of the Division of Publications for 1905, who states that 184 publications of this Office were reprinted during that year, in editions aggregating 1,788,050 copies.

EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

In Alaska experiment stations were maintained at Sitka, Kenai, Copper Center, and Rampart, and cooperative experiments were conducted at a number of points. The results of the year, while somewhat disappointing in the interior on account of an unfavorable season, were nevertheless generally encouraging. Vegetables of excellent quality have been matured in many parts of Alaska. Encouraging results were had in growing early maturing fruit trees at Sitka. Barley, oats, and rye matured in latitude 65° 40′ N., and some progress was made in starting animal-husbandry work at Kenai.

In Hawaii much progress was made in the erection of buildings and the improvement of facilities for station work. Experiments with forage crops and tobacco have been so successful that work along these lines will be extended, and it is apparent that there are new possibilities in the agriculture of Hawaii in this direction. The investigations of this station in chemistry and entomology have been important and have attracted much favorable attention.

In Porto Rico repeated experiments with vegetables have resulted in splendid success with crops that were formerly failures. The work with citrus fruits, cacao, and rubber is being continued and extended, as are also the experiments with coffee. The experiments

with native coffees and in improving methods of culture have been highly successful. Some attention is now being directed to arousing an interest in improved breeds of cattle and to starting experimental work with domestic animals. The experiment station farm has been greatly improved and an adjoining tract of about 7 acres, formerly the Agronomic Station under Spanish rule, has been turned over to the station for its use.

NUTRITION INVESTIGATIONS.

The chief object of the investigations on the nutrition of man, which have been carried on during the past year under the auspices of this Office upon much the same general lines as heretofore, is to learn the nutritive value of agricultural food products of animal and vegetable origin and the proportions in which food materials of different kinds may be most intelligently used to the advantage of both producer and consumer. Such work involves a study of digestibility, effects of cooking on composition and related matter, as well as of the fundamental laws of nutrition and the practical application of these laws to the health and well-being of man. Particular attention is given in this work to the physiology, hygiene, pedagogics, and economics of nutrition, with special reference to improving the diet of people of different age and sex living under varied conditions of work, climate, and surroundings.

Attention has been paid during the past year particularly to dietary studies, cooking experiments, digestion experiments, and experiments with the respiration calorimeter. Some pedagogical work has also been undertaken with special reference to formulating consistent courses in nutrition from available data. In addition to the experimental work a large amount of editorial work has been required for the calculation of the results of the experiments, for the preparation of experimental data for publication in technical and in popular form, and in other ways.

The method of cooperation by which the work of investigation has been distributed among various educational, scientific, and similar institutions throughout the country has, as heretofore, given most excellent results, and a large amount of investigation has been carried on. In a considerable measure this has been made possible by the generous support of the cooperating institutions. These have contributed in some cases money, and in practically all cases the use of laboratories, apparatus, and libraries, the advice and counsel of skilled experts, and similar assistance, so that the Department funds available for nutrition work have been much extended. Had funds permitted, it would have been possible to extend considerably the cooperative investigations, as other institutions have expressed a readiness to join in such enterprises provided a comparatively small amount could be allotted to them.

THE WORK AT DIFFERENT PLACES.

The Office of Experiment Stations has had the general supervision of the plans and expenditures of the nutrition investigations during the past year, and, in cooperation with the collaborators, has made detailed plans for the various experiments which have been undertaken. The editorial work of the Washington office, as in the past, has included the final preparation of reports of investigations for publication and also the preparation of popular bulletins and summaries. The collection of bibliographical data relating to nutrition has been continued, as well as the preparation of abstracts and reviews of the current literature of the subject, partly for use in the Experiment Station Record and partly for such other purposes as seemed desirable in connection with the general inquiry. In addition, many teachers, students, and specialists have been supplied by correspondence and in other ways with information and data which were not readily accessible in printed form. The increase in correspondence, the growing demand for nutrition publications, and the large number of requests for lectures and informal talks on these subjects indicate that popular interest in the work is growing. The nutrition work of the Washington office is in charge of Dr. C. F. Langworthy.

At the University of California Prof. M. E. Jaffa and associates have continued investigations on the digestibility of fruits and nuts and their nutritive value when forming a part of a mixed diet, as well as the amounts consumed under a variety of circumstances, with a view of learning how thoroughly these important foods are utilized in the body and their relative value in the diet. The importance of the fruit and nut industry in California and the great variety obtainable in that section make the University of California a particularly favorable place for these investigations. In carrying on this work Professor Jaffa has made nine digestion experiments, including studies of the income and outgo of nitrogen, and has devoted considerable time to tabulating and editing the results of 35 metabolism experiments and 2 dietary studies previously conducted. As a whole, the work indicates that fruits and nuts have a higher dietetic value when intelligently used than is commonly supposed, and that the wise use of such foods would add to the attractiveness and wholesomeness of the diet.

The work at Middletown, Conn., in which Wesleyan University cooperated with this Department, has been conducted under the direction of Prof. F. G. Benedict, and has included experiments with the respiration calorimeter on the effects of severe muscular exercise and of mental work on the output of carbon dioxid and heat and on the intake of oxygen; that is to say, upon the comparative demands

upon the body made by severe muscular and mental work. The experiments in which muscular work was the feature were made with a professional athlete, and from the recorded data it is possible to compute the mechanical efficiency of the body as a machine.

The subjects for the experiments on mental work were students of Wesleyan University, who took their college examinations in the respiration chamber of the calorimeter, spending there a period of not less than three hours per day. For purposes of comparison a control experiment was made with each student in which the subject passed the same period of time in the respiration calorimeter chamber without mental work of any special kind or amount.

A considerable number of experiments were also made to study the normal food and energy requirements of individuals of different physique. The subjects were two tall, thin, young men, both over 6 feet in height. Five experiments of this nature were also conducted with women. Experiments such as these are admirably adapted for showing the normal physiological factors for water, carbon dioxid, and oxygen requirement for different individuals, and furnish data for establishing certain definite standards based upon weight, sex, height, and general physique which are more accurate than those commonly in use at the present time.

A number of improvements have been made in the construction and operation of the respiration calorimeter and in the study of experimental methods.

Cooperating with the Bureau of Animal Industry of this Department, an extended series of experiments on the digestibility and nutritive value of cheese has been undertaken. This work has so far progressed that it is fair to conclude that cheese may be eaten in large amounts without digestive disturbances and that it is very thoroughly assimilated and a cheap and useful source of protein.

The Carnegie Institution, of Washington, has continued grants for research with the respiration calorimeter, by which the apparatus has been developed in such a way that the income and outgo of oxygen may be directly measured, and a number of metabolism experiments have been made with the improved apparatus, both for the Office of Experiment Stations and for the Carnegie Institution.

A considerable amount of editorial work is carried on at Middletown, including calculations, verifications of results obtained in the cooperative investigations, the collating of the results of the work of other investigators, and the preparation for publication of the results of the experimental work at Middletown and at cooperating institutions. This editorial work has been in charge of R. D. Milner.

Dietary studies have been conducted at the Hawaii Agricultural Experiment Station, under the direction of Dr. Edmund C. Shorey, in the family of a professional man and with pupils of a native

school. The results of these studies will prove of special value, as they have been made with residents of the Tropics, a class of people not previously studied in the Department investigations. Furthermore, some of the food materials used have not been included in previous work of this nature.

The investigations with meat at the University of Illinois, in charge of Prof. H. S. Grindley, have been conducted under very favorable conditions. The university has furnished the use of an especially well equipped laboratory and, in addition, contributed a considerable sum toward the nutrition investigations. The meat used in the investigations was contributed free of cost by the Illinois Experiment Station, and the animals from which the material was taken were bred, grown, and fattened under known conditions. The department of household science of the university has also rendered valuable assistance in the investigations. Beef, veal, mutton, and pork were the meats studied.

During the past year 45 cooking experiments have been completed, in which the inner temperature, flavors, losses, and other changes resulting from the boiling, roasting, frying, and broiling of different meats were determined, with special reference to the effect of these factors upon the digestibility and nutritive value of meat. In addition to the cooking experiments, 12 experiments were carried on to determine the relative toughness and tenderness of raw and cooked meats by means of a special machine which Professor Grindley has recently perfected.

Prof. C. D. Woods, at the University of Maine, has made 30 digestion experiments with cereal breakfast foods, the investigations being intended to form a part of the general investigation of the food value and relative importance of cereal foods of different kinds carried on at the universities of Maine and Minnesota. Professor Woods has been studying in particular the breakfast foods made from oats, wheat, and corn, and has also made studies of the metabolic products of feces, with a view of securing information regarding the effect of different methods of manufacture on the nutritive value of cereal breakfast foods, the relative amount of nutrients supplied by different sorts for a given sum, and the food value of the class of goods as compared with bread.

In cooperation with the Baltimore board of charities a series of dietary studies was conducted in the spring of 1905 at Bayview Asylum, Baltimore, Md., by H. A. Pratt, of the Middletown office, and Dr. C. F. Langworthy, of this Office, and the results have been prepared for publication. The greater number of the persons included in the study were aged men and women. Hitherto data have been lacking regarding the amounts eaten under such circumstances, and the results are of great value. Much information has been obtained

of importance in discussion of the economical arrangement of institution dietetics and which is useful in other ways.

The investigations at the University of Minnesota under Prof. Harry Snyder have been made with cereals, being carried out in connection with those made at the University of Maine under Professor Woods. Professor Snyder has made 24 digestion experiments of four days each with men, using eight different kinds of cereal breakfast foods, to determine their relative digestibility.

Professor Snyder has also continued the experimental work with durum wheat, conducting one milling experiment and six digestion experiments of four days each with men, for the purpose of determining the digestibility of macaroni and breakfast foods prepared from durum wheat.

The investigations with cereal breakfast foods have demonstrated the high food value of this class of goods as a whole, considered both from the standpoint of the nutritive material which they contain and its digestibility. It has also been found that many of the high-priced specially prepared goods are not more nutritious than the ordinary cereal breakfast foods, and that they do not possess any special advantage except as pertains to flavor, appearance, or attractive form of marketing. As a whole, cereal breakfast foods compare favorably with whole-wheat bread as regards total nutritive value, and, like the coarser breads, are somewhat inferior to standard patent-flour bread when judged by the total amount of digestible nutrients supplied per pound.

Dr. H. C. Sherman, of Columbia University, has begun studies of the nutritive value of the ash constituents of food with a view of fixing upon values which will show the amount of the different important mineral constituents of food required per man per day under various circumstances.

Prof. C. E. Wait, of the University of Tennessee, at Knoxville, made six digestion experiments of four days each, three with a basal ration and three with a ration including legumes. In addition, Prof. A. F. Gilman, under the supervision of Professor Wait, has conducted 20 dietary studies in typical families of white people of limited means, especially those living in mountain districts. The digestion experiments continue earlier work on the nutritive value and digestibility of cowpeas, beans, peas, and other legumes, one of the very important groups of foods especially rich in vegetable protein. This work has shown that the cowpea, like the dried bean and pea, has a high food value and may serve as an important source of protein. The dietary studies are of value in fixing upon dietary standards, as the families studied live upon very simple rations.

FOOD AND NUTRITION PUBLICATIONS.

The food and nutrition publications issued during the past year have included three technical bulletins, one Farmers' Bulletin, an article for the Yearbook of the Department, and an article for the Annual Report of the Office of Experiment Stations. The subjects treated in these publications are as follows: Studies of the Food of Maine Lumbermen; Dietary Studies at the Government Hospital for the Insane, Washington, D. C.; Dietary Studies with Harvard University Students; Canned Fruit, Preserves, and Jellies: Household Methods of Preparation; The Respiration Calorimeter, and The Work of the Experiment Stations which Relates to Food.

In addition, four technical bulletins and two Farmers' Bulletins were prepared for publication, and three Farmers' Bulletins and one circular were extensively revised.

IRRIGATION AND DRAINAGE INVESTIGATIONS.

The work of the irrigation and drainage investigations of this Office includes irrigation, drainage, farm machinery, and general agricultural engineering. This work is under the general direction of Dr. Elwood Mead. The work of the Washington office is divided into four general classes, each assigned to one person, as follows: Drainage, C. G. Elliott; field work in irrigation, S. M. Woodward; irrigation institutions, R. P. Teele; and farm machinery, C. J. Zintheo, For the field work in irrigation, the arid region is divided into two sections—the central district, with headquarters at Cheyenne, Wyo., in charge of F. C. Herrmann, and the Pacific district, with headquarters at Berkeley, Cal., in charge of S. Fortier. Studies of irrigation in the humid States are directed from the Washington office.

IRRIGATION.

The season of 1905 was the eighth in which the irrigation investigations of this Office were carried on. The report of the work done in 1905 will be better understood if it is prefaced by a brief review of what has been done since the inauguration of this work.

At the time this work was begun there was no certain information as to how much water was needed to irrigate an acre of land and few measurements showing how much was being used. Engineers building canals made estimates of the quantities needed, varying from 1 acre-foot per acre to 7 acre-feet per acre, and judges in defining rights had no more information and no more definite standards. The first work of this investigation, therefore, was to measure the quantities of water used in general practice, in order to furnish to engineers,

courts, and irrigation officials generally, a standard for determining the size of canals to serve given areas, and the quantities of water which should be allotted to parties who had acquired rights to water. This work was continued for four years. The close agreement in the averages of our measurements for the four years showed that they correctly represented general practice and furnished a safe basis for engineers and officials. There is still a demand for such data for sections not included in our previous measurements, and this work is being continued. In 1905 measurements of the quantities of water used in general practice were made in Washington by Professor Waller, of the Washington Agricultural Experiment Station, and in Oregon by Mr. Stover, of this Office.

The facts brought out most prominently by our measurements are the great difference between the quantities of water diverted and the quantities received by the land, representing a large loss in conveyance; and the great difference in the quantities received by different tracts of land under apparently similar conditions, representing wasteful use on the part of those using the larger quantities. The work on the duty of water has therefore been developed along new lines—studies of the water requirements of crops, the most economical methods of supplying them with the necessary water; and methods of preventing losses from canals by seepage and from land surfaces by evaporation.

The studies of water requirements of crops are of two classes: (1) Tank experiments to determine the quantities of water consumed by plants in the process of growth. These were carried on in 1904 and 1905 in California by Professor Fortier; (2) plat and field experiments to determine the quantities of water which produce the largest returns. Work on this line was carried on in California, Utah, Nevada, Colorado, and New Mexico in 1905. In Utah this work included plat experiments at the State experiment station, where plats were irrigated according to regular programmes, giving them different quantities of water, and applying it at different intervals of time and different stages in the life of plants. In addition, agreements were made with farmers in different parts of the State, under which they irrigated a part of their land according to their own judgment, parts of the remainder receiving different proportions of the quantity received by the field irrigated according to the farmers' judgment. Records of the crops raised will show what quantity of water has produced the best results. These experiments should be continued several years before definite conclusions can be drawn. The work at the station was under the direction of Prof. W. W. McLaughlin, and that in other parts of the State under Mr. E. R. Morgan, of this Office. The work in Nevada was similar to that done at

the Utah Station, and was carried on by Prof. G. H. True, of that station, and Mr. A. E. Wright, of this Office. Professor Vernon did similar work at the New Mexico Station. The work at all of these stations included also applying like quantities of water by different methods.

In California the work done by Professor Fortier included also tank experiments to determine the effect of different methods of applying water and subsequent cultivation in checking losses of soil moisture by evaporation, the results being very strongly in favor of applying it in deep furrows where possible.

Further work on methods of irrigation in relation to the quantity of water used was done in 1905 in Colorado by Mr. F. W. Roeding, of this Office, in cooperation with sugar-beet growers near Loveland, and in the Arkansas Valley. The prevailing practice was to use water copiously for a brief period, which, with many crops, is correct practice, but with the beets it was objectionable from the fact that it muddied the surface soil, delaying or preventing cultivation, and failed to properly moisten the subsoil into which the roots of the beets reached. Our work last year involved a change in the construction of laterals, a slight change in the character of the furrows, and the using of a small stream of water for an average of eighteen hours, instead of a large stream for an average of six hours. The work done under the modified practice was carefully compared with the work of farmers irrigating by the usual methods, and showed that instead of using water enough to cover the land to a depth of 3 feet, the water used would have covered the land to a depth of only 1.5 feet, and that there was an average increase in the yield per acre of 3.5 tons.

Losses in conveying water are especially large in new canals, and in some sections the prevention of these losses is one of the most important problems in irrigation. In the fruit districts of California such losses have been prevented by lining the canals with cement or by carrying water in pipes; but this method is too expensive where ordinary farm crops are grown, and is not possible in cold climates. In 1905 Mr. A. P. Stover, of this Office, made some experiments in eastern Oregon, which proved quite successful. The method adopted was to place across the canal a heavy chain attached to a wagon and drag it along the canal. The rolling of the chain along the bottom puddled the silt sufficiently to check seepage losses to a considerable extent.

The great extension of the irrigated area which has been going on during the last three or four years has brought a great demand for practical directions as to the manner of preparing these lands for the application of water and the way in which water should be applied. Thirty-four million dollars have been appropriated by the

Government for the construction of irrigation works, and large sums are being expended by private parties. This expenditure of public money is made on the supposition that it is all to be repaid by the settlers within ten years after the completion of the works. It is on this promise of repayment that the act was passed, and it is on this that the success or failure of the act will in time be largely measured. The same necessity for repayment exists under private work, only in a greater degree, since failure on the part of farmers to make payments means financial disaster to both themselves and investors. A very large percentage of these farmers will come from the Eastern States and will know nothing about irrigation methods. No other influence is of as much benefit to these farmers as plain, practical instructions as to how to prepare their lands and how and when to water them. If they are compelled to find these things out by experience, the waste and loss inevitable from this kind of education largely absorb their earnings for the first three or four years and lead to discouragement and often financial ruin. To meet this need the Office published last year a manual [a] giving such plain directions.

Although there have been distributed gratuitously more copies of this bulletin than of any other ever published by the Irrigation and Drainage Investigations, a large number have been disposed of by the Superintendent of Documents, who receives pay for it. For the past two years all of our field agents have had instructions to keep this matter of irrigation practice in mind, and send in descriptions of methods successfully used in the sections visited by them, and further bulletins on this line will be issued from time to time. Mr. H. G. Raschbacher, of this Office, made studies of this kind in southern Idaho last year, and the results have been published.

Another method of helping beginners in irrigation has been adopted wherever possible. That is the employment of experts to give personal advice as to possibilities and methods. A part of Mr. Stover's work in Oregon in 1905 was of this nature, while Mr. Culbertson, who was working in western Texas, devoted his entire time to this line of work, with very favorable results.

The exhausting of surface streams has made resort to underground supplies more and more necessary until pumping has become an important means of securing a water supply. To determine the feasibility of pumping and the best types of machinery, kinds of fuel, and arrangements of plants, in 1904 we gave much attention to tests of pumping plants, a large part of the last annual report of the Irrigation and Drainage Investigations being made up of the results of this work. It was continued in 1905. Mr. C. E. Tait, of this Office,

[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 145.

made tests of a large number of pumps in use in southern California; Prof. J. N. Le Conte, of the University of California, made mechanical tests of pumps at that university; Prof. W. B. Gregory made similar tests at Tulane University in New Orleans, and Mr. A. J. Bowie, of this Office, collected data regarding pumps in use for irrigation in the Eastern States. We have in this way collected a vast amount of mechanical data which will be of great use to manufacturers of pumps and to purchasers, since it will show what types of pumps are best suited to various kinds of pumping.

Between the Rocky Mountains on the west and the line of an annual rainfall of 20 inches on the east is a strip of land known as the semi-arid region, which extends from Canada to the Gulf of Mexico and which has a total area of over 300,000,000 acres. A large settlement was made in this territory in 1884, 1885, and 1886. The cause was a series of years of more than average rainfall. This led to a belief, which was sedulously fostered by land boomers and real-estate agents, that the building of railroads and the cultivation of the lands of the East had brought about a change of climate and that the rain belt, as it was called, was steadily extending westward and would ultimately cause the rainfall of that country to be as abundant as it is in Illinois or Iowa. A series of dry years followed. The result was that in western Kansas and Nebraska and eastern Colorado and Wyoming nearly all of the settlers were compelled to abandon their homes, lands, and everything they had done with them and begin life over again after years of hardship and privation that have been unsurpassed at any era in the settlement of this country. Not only that, but many of these settlers, realizing that ultimate failure was inevitable, mortgaged their homes to eastern investors without any intention of ever paying back the money borrowed. The consequence was that hundreds of thousands of dollars of eastern money sent to that country was lost. Within the last two years a similar movement to people that region and to extend the settled territory far to the west of that heretofore attempted has been undertaken, and in some localities it has gone beyond the limits of safety if dependence is had on rainfall alone. The foundation for this new feeling of confidence is two or three years of more than average rainfall and the improvements which have been made in the past twenty years in methods of cultivating the soil and in the production of drought-resistant crops. There is every reason to believe that these improvements will permit of the extension of settlement and give a better chance for success than was had twenty years ago, but all of these will not permit of agriculture by rainfall alone in much of the country now being settled and in much more that it is proposed to settle.

In view of these facts it is believed that the creation of a permanently prosperous body of settlers in that region requires the de-

velopment of a peculiar kind of agriculture suited to its limitations. In the greater part of the region it must be a combination of farming and stock raising, with the latter as the foundation factor. This is the conclusion of a representative of the Colorado State Agricultural College, who spent three years in traveling through the whole of that semiarid territory studying what has been accomplished by the settlers who came into that country in 1884 and who are still there. The native grasses of that country are an evolution. Something superior to them as a forage crop may be found, but as yet there is no assurance of this. It is certain that by the protection of these grasses by harrowing and reseeding the surface and by changing stock from one area to another, thus relieving it from continuous cropping, the growth of grass can be largely increased. This has been demonstrated at the Hereford ranch, near Cheyenne, Wyo., and in a number of other places.

The question is, Can this region be made anything but a range country, and how far can the number of settlers be increased by combining cultivation with the pasturage of the grazing land? It is believed that a great deal can be done if provision can be made to irrigate a small tract of land in connection with each range holding.

There are three ways of providing for the irrigation of this limited area: (1) Pumping underground waters, (2) storing storm waters in reservoirs, and (3) diverting storm waters in fall, winter, and spring, so as to saturate the soil and subsoil of particular tracts.

Experiments were begun last year to work out the methods of providing water for these small areas and of using it to the best advantage. At Cheyenne, Wyo., a tract of land was secured for experimental purposes. Wells were put down, windmills installed, and a small reservoir constructed. Part of the land will be irrigated and part will be farmed dry, as a check on the irrigated fields. This station is under the direction of Mr. F. C. Herrmann and Mr. J. H. Gordon, of this Office, the funds being furnished jointly by this Office and the Union Pacific, Burlington, and Colorado and Southern railways. A similar station was established near Imperial, in Chase County, Nebr., Prof. O. V. P. Stout, of the University of Nebraska, being in charge, and the funds being furnished by this Office and the State of Nebraska. In the nature of things, such work must cover some years before conclusions can be reached.

In addition to conducting experiments, this Office began last year collecting information as to what had been done by settlers along the same line. Mr. F. C. Herrmann collected data as to the construction of small reservoirs for collecting storm waters and the crops raised by the use of this water, and Mr. A. P. Stover made a study in Oregon of the results of irrigation in the winter and spring, when streams are high, where no water is to be had during the sum-

mer. Good crops have been raised in this way for twenty-five years in the valley of Butter Creek, in Oregon, and it is believed that there are many sections on the arid plains where similar results can be secured.

The studies of irrigation practice in the rice fields of Louisiana and Texas, begun several years ago, were continued during 1905, as was the rice experiment begun at Lonoke, Ark., in 1904. The two years' work at Lonoke has demonstrated that rice can be grown at a profit on the prairie lands of Arkansas, and that there is a plentiful supply of water to be secured by pumping. A considerable area of land in the neighborhood of the experiment farm was planted to rice last year, and more will be planted next year. A company has been organized to construct a rice mill at Lonoke, and there is talk of putting in another at Little Rock. In all these rice districts there is a growing necessity for drainage to remove the surplus water when heavy rainfalls follow irrigation.

From the beginning of the irrigation work of this Office the study of irrigation laws and institutions has been an important feature. The use of water from streams in irrigation has necessitated the abandonment or modification of previous legal systems regarding water, and there is a constant evolution in water codes. This Office studies the operation of existing laws and points out wherein they have promoted or hindered development, and also the principles which should govern future legislation. Such studies have been made in California and Utah and reports published. A similar report on Montana is now being prepared for publication, and the field work for a report on Nevada has been done. In addition, last year a report on water rights on interstate streams, which is a study of the water laws of Colorado, Wyoming, and Nebraska, was published, and Mr. R. P. Teele made a study of the work of the State engineers and of the other means of public supervision of the use of water.

DRAINAGE.

The drainage work of this Office includes the reclaiming of lands now unused because of their swampy condition, and the improvement of lands already under cultivation, which fail to produce maximum crops because of an excess of moisture. It is under the direction of Mr. C. G. Elliott.

Drainage work in this country may be classified as follows:

(1) Providing outlets for surplus water from large, level areas, where natural outlets are insufficient to remove surplus water quickly enough to keep the lands in workable condition.

(2) Providing interior drainage for small tracts, where outlets either natural or artificial exist.

(3) Protection of river bottom lands from overflow and removing water from them after flood water has been shut out.

(4) Protection and reclamation of tidal lands.

(5) Protection of low lands in irrigated regions from seepage water from higher lands, and from the use of ground water, due to heavy irrigation or seepage water.

The work of this Office is not to construct drainage works, but to investigate and experiment as to methods where these have not been worked out; to give information as to methods, where landowners are not informed; to demonstrate the advantages of drainage where there is doubt as to its efficiency; to make surveys and plans where the benefits will be so widely diffused as to justify the expenditure of public money in their aid; and to make studies and give advice as to ways of organizing landowners and levying charges to meet the expense of drainage works.

Much work has been done in the way of assisting engineers to prepare plans and to unite the people to carry them out. The combined acreage of drainage districts in which such assistance has been rendered during the last three years is approximately 300,000 acres. Such service has been greatly appreciated, and there is reason to believe that it has been instrumental in securing better plans and more harmony in their execution. The engineers are often greatly benefited by assistance of this kind not only in the specific work on hand, but in other projects which come to them in their practice, so that the work of this Office reaches much farther than the district where the advice is given.

Preliminary drainage surveys and general plans have been made in a number of instances where large areas are involved. This was the case in Clay County, S. Dak., where plans for the main drainage of 70,000 acres of bottom lands were made and recommendations given which resulted in needed amendments to the State drainage law and later in the organization of a drainage district under its provisions. The same was done in a more extended and complete manner in four counties in North Dakota during the past season, the counties paying half the cost of the survey.

The leveeing of streams for the protection of the bottom land from overflow is a work of similar magnitude. This work has been characterized by many failures, and this Office has made careful investigations to determine the causes of breaks in levees and the best methods of relieving the inclosed areas of their surplus water. The last annual report of the drainage work of this Office contains much valuable information on this subject and recommendations as to the construction and protection of levees under different stream and soil conditions.

In the Kankakee Valley, in Indiana, there is an area 9 miles wide, extending from Momence, Ill., to South Bend, Ind., which needs drainage. It is reported that more than $500,000 has been expended

in efforts to reclaim this land, with but little success. For the past two years we have been studying this section to determine why the work already done has failed to relieve the adverse conditions, and to map out a plan which will do this.

Another large undertaking which has received attention is the drainage of the Everglades of Florida. It is estimated that there is an area of 6,000,000 acres now unfit for cultivation, 3,000,000 acres of which belong to the State and can be made fit for use by drainage.

After the construction of drainage outlets, underdrainage of farm lands is usually necessary if the lands are to be completely reclaimed. While much of this work has been done successfully in various parts of the country, in many places the efficiency of such drains is questioned, owing to the fact that they may not have been properly put in. In other sections there is still doubt as to whether underdrains will work satisfactorily. This is the case in the valley of the Red River, in Minnesota and the Dakotas, where the ground freezes to a depth of 6 feet. This question can be settled only by experiments, and these will be carried out at the State experiment farms at Crookston, Minn., and Fargo, N. Dak. Similar questions have arisen in Madison County, Ill., and in the Yazoo Delta, in Mississippi, and there experiments are being carried on.

Another problem in southern agriculture is the prevention of erosion on hillside farms. Three years ago experiments in the use of underdrains for this purpose were begun in Jackson County, Ga. These drains were placed across the slope in such a way as to pass through points where seepage from higher lands cropped out, and so far they have been successful, and the land which was previously filled with gullies is now cultivated without the usual terraces or ditches. Other methods of protection, particularly the various forms of terracing, have been investigated, to determine the adaptability of the various forms in use to different slopes and types of soil.

In most irrigated sections the reclaiming of lands which have been rendered unproductive by seepage water from higher lands is of great importance. The removal of this water is one of the most perplexing problems in drainage. The work of this Office on this line has been carried on in cooperation with the owners of the injured land, who have usually put in the drains according to our plans and under the direction of our agents. This class of work has been done in places throughout the arid region. In Utah and Nebraska experiments are being made in cooperation with the States. In both States experimental farms have been established, where the work, if successful, will serve as demonstrations for landowners in the neighborhood of these farms. Very favorable results have been attained, and this has proved one of the most valuable branches of our drainage work.

FARM MACHINERY.

During the season of 1905 the work of the Office on farm machinery was considerably enlarged, and Mr. C. J. Zintheo, formerly of the Iowa State College, was appointed to take charge of this work, under the direction of Doctor Mead. A bulletin on corn-harvesting machinery is being prepared, and also one on the use of cement in farm structures.

PUBLICATIONS.

Since June 30, 1904, there have been printed five bulletins and one document, the manuscript for which was prepared during the previous year. With one exception the reports prepared since that time are included in the Annual Report of the Irrigation and Drainage Investigations for 1904,[a] which was prepared for the printer, but not published before the close of the fiscal year.

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[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 158.

WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS.

This is the eleventh annual report on the work and expenditures of the agricultural experiment stations in the United States, made by the Director of the Office of Experiment Stations, under instructions from the Secretary of Agriculture. As heretofore, the report is based on three sources of information, viz, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, in accordance with the act of Congress; the printed reports and bulletins of the stations, and the reports of personal examinations of the work and expenditures of the stations made by the Director, the assistant director (E. W. Allen), W. H. Beal, and Walter H. Evans. The compilation of the statements regarding the individual stations has been made by Dick J. Crosby.

OFFICE OF EXPERIMENT STATIONS.

GENERAL OUTLOOK.

The work of the Office of Experiment Stations has continued to grow in amount and importance. Through its intimate relations with the agricultural experiment stations the Office has been able to assist these institutions in systematizing and strengthening their work and in recruiting their staffs. Plans are now being perfected to render still more efficient aid to the stations by a more thorough study of their operations, by keeping better records of their work, and by enlarging the information given them in the Experiment Station Record through additions to the staff of this journal, which will render it possible to introduce new and reorganize old departments in accordance with the most modern conception of the science of agriculture.

The greatly increased demands for aid in developing and extending courses of instruction in agriculture have been met so far as the resources of the Office would allow. The Office has thus come into much closer relation with educators, associations, and institutions interested in agricultural education, and in order to render more effective assistance in promoting the interests of rural communities it has recently established a department of agricultural education in the Experiment Station Record. The Office has continued to give aid to the States in developing and perfecting the farmers' institute

systems and in developing the institute work on a more rational and permanent basis. It has helped to conduct several schools for institute workers. Plans have been made for extending this feature of institute work and for inaugurating movable schools for farmers.

The work of the stations in Alaska, Hawaii, and Porto Rico has been successfully carried on and in several ways considerably extended by the special agents in charge. In Alaska some work in horticulture has been started at Sitka, and in animal husbandry and dairying at Kenai. In Hawaii special attention has been given to grasses and forage plants, coffee, and cane diseases, and tobacco. In Porto Rico good results have been obtained in the culture of coffee, and some work with rice and domestic animals has been undertaken.

The nutrition investigations of the Office are becoming increasingly important, and their results are given wider practical application in preparing dietaries for public institutions and courses in household science for schools and colleges. Since definite knowledge of the principles of nutrition is fundamental to the health and happiness of all, there is need not only for a continuation of thorough investigations, but also for a much wider dissemination of the results already obtained, and plans to secure this are being made. The Irrigation and Drainage Investigations of this Office now include the investigation of all phases of rural engineering carried on by this Department, except the good-roads inquiry. To the studies on irrigation and drainage have recently been added investigations on the application of power to farm work. With the rapidly changing industrial conditions in this country, resulting in great scarcity of farm labor, the investigation of problems relating to power machinery, farm implements and appliances, and materials used in erecting farm structures is of the greatest importance. The demands made on the Office for the extension of its work in irrigation, drainage, and other branches of rural engineering are greater than can be met at present, despite the fact that considerable financial aid has been given to this work by States and private organizations. A part of the exhibit of this Office in the Government building at the Louisiana Purchase Exposition was shipped to Portland, Oreg., and exhibited in the Government building at the Lewis and Clark Exposition.

LINES OF WORK.

The work of the Office of Experiment Stations during the past year, as heretofore, has included the supervision of the expenditures of the stations; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by

means of technical and popular bulletins; the management of the agricultural experiment stations in Alaska, Hawaii, and Porto Rico; special investigations on the nutrition of man and on irrigation and drainage, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories, and the promotion of the interests of farmers' institutes throughout the United States.

INCOME.

The income of the Office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

For the general business of the Office (including farmers' institutes)	$45,000
For the Alaska experiment stations	15,000
For the Hawaiian Experiment Station	15,000
For the Porto Rico Experiment Station	15,000
For nutrition investigations	20,000
For irrigation and drainage investigations	67,500
Total	177,500

PUBLICATIONS.

The publications of the Office may be conveniently grouped in four main classes: (1) Experiment Station Record, which gives a technical review of the current literature of agricultural investigation throughout the world; Experiment Station Work, which is published periodically in the Farmers' Bulletin series of the Department and gives a popular summary of some of the more salient practical results of the work of the experiment stations; and the Bimonthly List of Experiment Station Publications, which is now regularly published by the Office. (2) Publications relating to the food and nutrition of man, reporting or based upon the results of nutrition investigations conducted under the auspices of the Office. (3) Publications relating to irrigation and drainage, giving the results of the Irrigation and Drainage Investigations of the Office. (4) Miscellaneous publications, including those relating to agricultural education in general, including farmers' institutes, proceedings of the Association of American Agricultural Colleges and Experiment Stations and of the American Association of Farmers' Institute Workers, annual reports of the Director of the Office of Experiment Stations, the Card Index of Experiment Station Literature, and similar publications.

During the past fiscal year the Office published 55 documents, not including revised reprints, separates, etc., aggregating 4,576 pages. These documents include 12 numbers of the Experiment Station Record, 11 technical bulletins, 2 bulletins of the Porto Rico Experiment Station (English and Spanish editions), 1 bulletin of the

Hawaii Station, 1 report, 5 Farmers' Bulletins (including 4 numbers of the subseries Experiment Station Work), 6 circulars, and 3 articles for the Yearbook of the Department. One other number of the Experiment Station Record, 6 technical bulletins, 1 report, 1 Porto Rico Station bulletin, 1 Farmers' Bulletin, 1 farmers' institute lecture, 1 circular, and several miscellaneous documents containing about 2,400 pages were prepared and submitted for publication before the close of the fiscal year. Copy for 900 cards of the index of experiment station literature was prepared during the year. The number of index cards distributed has reached 25,600. The amount received from the sale of index cards during the year was $317.87. The policy of reprinting separates of individual articles contained in larger reports has been continued with satisfactory results. Thirty-five such separates, aggregating 807 pages, have been reprinted in editions of varying size to meet the actual demands for the articles. Several of the earlier technical and Farmers' Bulletins of the Office were exhausted during the year and were reprinted, in many cases with complete revision or more or less additions and corrections. Six of the earlier numbers of the Experiment Station Record were reprinted in limited editions to complete sets.

THE AGRICULTURAL EXPERIMENT STATIONS IN THE SEVERAL STATES AND TERRITORIES.

ALABAMA.

Agricultural Experiment Station of the Alabama Polytechnic Institute, *Auburn.*

Department of the Alabama Polytechnic Institute.

J. F. Duggar, M. S., *Director.*

GENERAL OUTLOOK.

The chemist of the Alabama Station has completed a study of methods of clarifying cane sirup, in which he found acid calcium phosphate satisfactory. The extensive variety tests with cotton, involving the use of some 200 varieties, have been closed, and the results are being prepared for publication. Among the investigations recently undertaken are experiments in curing hay artificially by means of a blower in an old tobacco barn; a study of the transmission of sorehead in chickens, which is thought to be carried by mosquitoes; corn-breeding experiments near Montgomery, and feeding experiments with hogs, a line of work which was suspended for a time. The study of cotton diseases by the botanist is being continued.

The station has started at each of the nine district agricultural schools in the State rotation experiments similar to those in progress at the station. This, it is believed, will be a fine object lesson. The station is cooperating with the Bureau of Plant Industry of this Department in testing vegetables; in studying the shedding of squares, blooms, and bolls of the cotton plant, and in studying problems in farm management in connection with the diversification farms. In cooperation with the Bureau of Animal Industry, the station is conducting feeding experiments with steers.

This station still needs a stronger organization to correlate its work in different departments and strengthen its attack upon leading agricultural problems of the State. It is also in need of larger funds, which will enable it to command a larger share of the time of men on its staff and to extend its work more widely about the State. The peculiar local conditions make this especially desirable. The station is maintaining a leadership in agricultural matters in the State, and in several lines is doing work of high value.

LINES OF WORK.

The principal lines of work conducted at the Alabama Station during the past year were as follows: Chemistry of fertilizers and farm crops, and methods of clarifying cane sirup; botany—grasses, native trees, and varieties of cotton; soils—renovation with manures and leguminous plants, inoculation experiments; analysis of fertilizers and food materials; field and pot experiments—fertilizers, leguminous plants as soil renovators, barnyard manures, cereals, cotton, forage crops, and vegetables; horticulture—varieties of strawberries and other fruits and asparagus, irrigation of garden vegetables; plant breeding—cotton, cowpeas, and corn; diseases of plants; feeding and pasturing experiments with beef and dairy animals and hogs; diseases of animals; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	6,073.24
Farm products	382.67
Miscellaneous	2,080.08
Total	23,535.99

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 128–130 and 132 and the Annual Report for 1904. The bulletins are on the following subjects: Feeding and grazing experiments with beef cattle; the Mexican cotton-boll weevil; tests of varieties of cotton in 1904; diseases of the apple, cherry, peach, pear, and plum, with methods of treatment.

Canebrake Agricultural Experiment Station, *Uniontown.*

J. F. Duggar, M. S., *Director, Auburn;* J. M. Richeson, M. S., *Assistant Director, Uniontown.*

GENERAL OUTLOOK.

For three years the Canebrake Station has been conducting experiments to determine whether the soils of that region are deficient in humus or in nitrogen. The results thus far indicate a lack of nitrogen. Corn and other crops following legume stubble plowed

under showed a marked increase over the same crops on land on which heavy crops of nonleguminous green manure have been used. Good results have been obtained with alfalfa and soy beans.

LINES OF WORK.

The principal lines of work conducted at the Canebrake Station during the past year were as follows: Soil improvement, field experiments, horticulture, floriculture, diseases of plants, and diseases of animals.

INCOME.

The income of the station during the past fiscal year was as follows:

State appropriation	$2,500.00
Farm products	610.39
Total	3,110.39

PUBLICATION.

Bulletin 22, on experiments with cotton, corn, and oats in 1904.

Tuskegee Agricultural Experiment Station, *Tuskegee Institute.*

Department of the Tuskegee Normal and Industrial Institute.

G. W. Carver, M. Agr., *Director.*

GENERAL OUTLOOK.

The Tuskegee Station has published the results of seven years of experiments to improve the tilth and productiveness of a wornout and eroded piece of land. All of the work was done with one horse, so that the conditions would be comparable with those on numerous small farms owned by negroes in Alabama. The results are very interesting and indicate that with proper cultivation and a rotation of crops, including some of the legumes, the poorest soil of that region can be made productive. The land under treatment, which was practically nonproductive, has been improved until it yields 24 bushels of rye, 35 bushels of wheat, 20 bushels of barley, or a 525-pound bale of lint cotton per acre. Experiments are being conducted with different varieties of soy beans and cotton, in feeding cattle, and with poultry. Ten acres have been added recently to the land under the control of the experiment station.

LINES OF WORK.

The principal lines of work conducted at the Tuskegee Station during the past year were as follows: Field experiments, horticulture, diseases of plants, animal industry—feeding experiments and poultry investigations, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

State appropriation $1,500

PUBLICATION.

Bulletin 6, on how to build up wornout soils, contains a discussion on this subject based upon the result of eight years' experiments.

ALASKA.

Alaska Agricultural Experiment Stations, *Sitka, Kenai, Copper Center,* and *Rampart.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

C. C. GEORGESON, M. S., *Special Agent in Charge, Sitka.*

GENERAL OUTLOOK.

The weather in Alaska is the determining factor which decides for or against the success of agricultural experiments. The past season was, on the whole, favorable. In the coast region the summer was warm and sunny, and, as a result, vegetable growing was a success and there were excellent gardens throughout that region. In the interior, on the other hand, the season was less favorable than usual in that the spring was late and wet and seeding was consequently late and growth slow in early summer. But in some sections of the interior there were no killing frosts until September. In other places, as, for instance, in the Copper River Valley, there was a killing frost on August 14 which practically destroyed all kinds of garden and field crops.

At the Sitka Station the lines of work heretofore reported were continued. Much work was done in the way of propagating nursery stock, draining and improving soil, and in experiments in horticulture. Early maturing apples and also some cherries, raspberries, and currants were distributed from this station to about 150 cooperators located in nearly all parts of the Territory. This work will be continued and extended in the future, the object being to ascertain if the tree fruits can be successfully grown in any part of Alaska. To this end all kinds of hardy, early-maturing varieties of fruit trees and fruit bushes are propagated, distributed, and tested. The station has also under way experiments with cabbage, cauliflower, potatoes, and peas to find varieties best suited to Alaska conditions. Some satisfactory results were obtained. It must be noted, however, that the soil at the Sitka Station has not yet been brought to a satisfac-

tory condition for horticultural crops, and comparative tests are unreliable because of the unevenness of the soil.

It is gratifying to be able to report that at the Rampart Station, in about latitude 65° 40′ N., several varieties of barley and oats, and also winter rye, matured. Spring wheat did not mature because of the late seeding, and winter wheat was nearly all winterkilled because of an unusually light snowfall. There were several light frosts in the latter part of August, but none of them injured the grains, the first killing frost occurring September 13. Two and a half acres were cleared, making 5 acres in all at this station. Lumber was purchased for the erection of a house the coming summer.

At the Copper Center Station 36 acres were cultivated in 46 varieties of grain, 8 of grasses, and all the common hardy vegetables comprising, with the fertilizer experiments, more than 200 plats. These experiments were cut short by a killing frost which occurred August 14. Some half dozen varieties of oats and barley matured, but the main crops were killed and cut for hay. The testing of varieties of cereals has been the main work at this station, and to this will now be added breeding and selection of grain to secure varieties suited to the region. The rainfall in the Copper River Valley is very light, and irrigation would be a great help. The total precipitation for the year was 10 inches, including melted snow. From the last snow in May to September 1 the rainfall was 3.05 inches. In case a railroad should penetrate the interior of Alaska this station should be moved to a suitable point on the road.

At the Kenai Station our efforts have been directed toward the development of a dairy farm. A few cows have been gotten together and the station has been supplied with dairy apparatus with a view of continuing this work. All the grain at that station was cut for hay. Some useful experiments with grasses and forage plants are under way at Kenai.

The small appropriation for the introduction of and experiments with live stock in Alaska it is planned to utilize in the purchase of Galloway cows with good milking qualities and place them temporarily at the Kenai Station. The object is to develop a breed which shall be at once hardy and also good dairy animals. None of the distinctive dairy breeds is hardy enough to meet the conditions. The Galloways are a hardy breed, and, although they are mainly beef animals, many of the cows are fine milkers. It is hoped to develop a general-purpose herd better suited to Alaska than any breed now extant. It is also planned to purchase some sheep from Iceland and some Blackfaced Scotch sheep. A beginning will probably be made with 10 or 12 cows and 25 sheep.

LINES OF WORK.

The principal lines of work conducted at the Alaska stations during the past fiscal year were as follows: Horticulture—the propagation and introduction of tree and bush fruits; field experiments—experiments with cereals, the testing of forage plants and grasses, and the improvement of soil by the addition of lime, fertilizers, and drainage; the beginning of experiments in animal husbandry and dairying; meteorology—the collection of data from some 26 stations in cooperation with the United States Weather Bureau, the Weather Bureau furnishing the instruments and the special agent in charge supervising the work; distribution of seeds to about 2,000 persons in all parts of the Territory in cooperation with the Bureau of Plant Industry.

INCOME.

The income of the stations during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	191.61
Total	15,191.61

ARIZONA.

Agricultural Experiment Station of the University of Arizona, *Tucson.*

Department of the University of Arizona.

R. H. Forbes, M. S., *Director.*

GENERAL OUTLOOK.

As a result of four years of feeding experiments with steers, the Arizona Station finds that alfalfa is probably the most valuable crop of the Southwest for beef production. A straight alfalfa ration, compared with an alfalfa and carbohydrate ration, gave in six sets of trials average results which were practically identical, and since alfalfa can be more cheaply produced in that region than carbohydrate feeds, such as sorghum, millet, and corn, the alfalfa ration is considered the more economical in beef production. The results of investigations relating to the cost of pumping for irrigation in Arizona were published in Bulletin 49, for which there has been great demand. The station has also published results of investigations in pickling olives, which, it is thought, will lead to the increased use of the olive in this country.

Among the investigations in progress during the year are a study of the injurious effects of mine tailings turned into the rivers used for irrigation purposes; a study of the chemistry of date ripening,

FIG. 1.—DATE PALMS.

FIG. 2.—PUMPING PLANT.

FIG. 3.—WORKMEN'S COTTAGE.

COOPERATIVE DATE ORCHARD, ARIZONA STATION.

including some experiments in the artificial ripening of some of the late varieties; a continued study of range problems, with special reference to the value of cacti as feed for cattle, in cooperation with the Bureau of Plant Industry of this Department, and the date palm investigations in cooperation with the same Bureau. (Pl. I, figs. 1, 2, and 3.) The latter investigations have now reached a stage where the distribution of date-palm suckers among the farmers of the State has been begun, and it is hoped that in this way the date-palm zone in the Southwest can be definitely determined.

Among the lines of work recently taken up are investigations in agriculture and horticulture to secure new crops suited to Arizona conditions, in which plant breeding will be a feature. Among the crops to be tested are alfalfa, small fruits, garden vegetables, and cereals. A determination of the duration of viability in seeds submerged under water and investigations in seed selection according to specific gravity are in progress. Attention will be given to farmers' institutes during the current year, funds amounting to $2,300 having been provided by the legislature for this work. The station also has $1,300 for the establishment of a date orchard in Yuma, and $1,500 for printing.

The station seems to be making distinct progress in its date-palm investigations, and with the new date orchard at Yuma it should soon be able to forecast the possibilities of date culture in the Territory. The range and forage plant studies will prove of great value to the stock industry of Arizona, and the cattle-feeding experiments are of immediate application to the whole southwestern region. The increased appropriations by the Territorial legislature indicate a growing appreciation of the station's work.

LINES OF WORK.

The principal lines of work conducted at the Arizona Station during the past year were as follows: Chemistry—study of irrigation waters and their effects upon irrigated soils, chemistry of date ripening; botany; field experiments—cereals, forage crops, small fruits, and garden vegetables; irrigation investigations; improvement of ranges; horticulture—date-palm growing, vegetables, fruits, etc.; plant breeding; dairying, and feeding experiments—beef and dairy cattle, sheep, and hogs.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	13,698.86
Fees	127.00
Farm products	807.56
Miscellaneous	105.85
Total	29,739.27

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 48, on relation of weather to crops; Bulletin 49, on cost of pumping for irrigation, and Bulletin 50, on steer-feeding experiments, and the Annual Report for 1904.

ARKANSAS.

Arkansas Agricultural Experiment Station, *Fayetteville.*

Department of the University of Arkansas.

W. G. VINCENHELLER, *Director.*

GENERAL OUTLOOK.

The experiments of the Arkansas Station relating to the toxic effect of cotton-seed meal fed to swine have been continued by the veterinarian with many variations, the effort being to find a way of utilizing cotton-seed meal profitably in pork production. Numerous efforts to remove the poison by fermenting the meal, making aqueous extracts of it, etc., have been made, but without marked success. The veterinarian is continuing his studies of tuberculosis and vaccination for hog cholera and swine plague, and is distributing blackleg vaccine. The horticulturist is carrying on experiments in the practical treatment of diseases of orchards, experiments with grapes, onions, potatoes, asparagus, rhubarb, and other truck crops. As a result of his work celery growing has been established in the State and is increasing, methods of fruit growing have been improved, the growing of muskmelons has become quite an industry, and the production of peaches is increasing. The station is cooperating with the Bureau of Plant Industry of this Department in growing Hungarian varieties of apples, and with this Office in rice experiments under irrigation at Lonoke.

A dairy department has been established during the year and a small herd of Brown Swiss cattle purchased jointly by the college and station. The dairyman is conducting experiments on summer soiling crops, the feeding of corn silage, and methods of raising calves—testing skim milk, whole milk, and calf meals. The station for the first time in its history has an appropriation from the State legislature, $35,000 for two years, a portion of which will be used for buildings and another portion for three cooperative farms in the cotton sections of the State. The additional funds will also make it possible to employ several additional men on the staff of the station.

The station is attacking the leading problems of the State, and the appropriations it has received will enable it to strengthen its work. In general the outlook for greater activity and efficiency is much improved.

LINES OF WORK.

The principal lines of work conducted at the Arkansas Station during the past year were as follows: Chemistry—adulteration of foods, effect of feeding cotton-seed meal, the effect of cotton-seed oil on the melting point of lard, and nutrition of man; field experiments—rotation of crops, testing and breeding cowpeas, corn culture, spring and fall sowing of alfalfa, soy beans, peanuts, and other forage-plant studies, broom corn, rice, etc.; horticultural investigations—testing varieties of apples, peaches, small fruits, and vegetables, asparagus culture, and plant diseases; entomology—injurious insects and means for their repression and inspection work; veterinary investigations—animal diseases, poisonous properties of cotton-seed products, preparation and distribution of blackleg vaccine, inspection work, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$13,163.45
Farm products	1,567.33
Total	14,730.78

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 83–86 and the Annual Report for 1904, the latter containing a financial statement for the fiscal year ended June 30, 1904, and reprints of Bulletins 77–82. The subjects of the bulletins issued

during the year are broom-corn suggestions; peanuts; cotton-seed products in hog feeding; asparagus and salt, and asparagus growing in Arkansas, and rhubarb in Arkansas.

CALIFORNIA.

Agricultural Experiment Station of the University of California, *Berkeley*.

Department of the University of California.

E. W. Hilgard, Ph. D., LL. D., *Director*.

GENERAL OUTLOOK.

The character of the investigations of the California Station has not changed materially during the past year. A circular and a bulletin on asparagus rust have been issued during the year, also bulletins on pear scab, fermentation, silk culture, olive oil, the hop aphis, tuberculosis in fowls, and poultry feeding. Work very similar to that reported on in these publications is being carried on by the different departments of the station. The department of entomology is giving special attention to the scale insects, aphides, and mosquitoes; the department of chemistry to digestion experiments and other nutrition work with poultry, and the department of veterinary science and bacteriology to poultry diseases. The work at the substations has been continued as heretofore, but the Pomona substation is to be closed at once, and the one at Tulare as soon as some of the alkali studies are completed.

The station and college are better provided than formerly with State funds for improvements and for special investigations. The last legislature appropriated $150,000 for the purchase and equipment of a farm, $30,000 for a pathological laboratory in southern California for the study of plant diseases, $20,000 for investigation of pear blight, walnut blight, and viticulture; $10,000 for the improvement of cereals; $12,000 for farmers' institutes; $4,000 for the poultry station, and $17,000 for printing. There were also appropriations to the university amounting to $22,675 for the restoration of the Santa Monica Forestry Station and forest fire protection. The director of the station has been given a year's leave of absence, and E. J. Wickson is acting director. Other changes with reference to the business and policy of the station are being made.

The changes in station management and policy it is believed will result in greater efficiency. The work of the station continues to be handicapped by a lack of adequate quarters and facilities for field work. The legislature, while quite generous to the college and station, still continues its policy of specific appropriations, which are often secured through the intervention of special interests, usually

of a local character. The problem of the purchase of a station farm has resulted in an agitation that is not favorable to the institution as now constituted, and until a decision is made the affairs of the station will continue in a disturbed condition.

LINES OF WORK.

The principal lines of work conducted at the California Station during the past year were as follows: Chemistry—foods, condimental feeds, feeding stuffs, fertilizers, fruits, and insecticides; physics, chemistry, and geographical distribution of soils; bacteriology; fertilizer control; field crops; horticulture, including date culture, viticulture, and zymology; sylviculture; botany; meteorology; animal husbandry; entomology—scale insects, aphides, grasshoppers, and other insects injurious to crops; dairying; irrigation and drainage; reclamation of alkali lands; plant and animal pathology; nutrition investigations, and poultry experiments.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 157–165 and the Annual Report for 1904. The bulletins are on the following subjects: Commercial fertilizers; California olive oil, its manufacture; contribution to the study of fermentation; the hop aphis; tuberculosis in fowls; commercial fertilizers; pear scab; poultry feeding and proprietary feeds, and asparagus and asparagus rust in California. Several circulars on asparagus-rust investigation and silk culture were also issued.

COLORADO.

Agricultural Experiment Station, *Fort Collins.*

Department of the State Agricultural College of Colorado.

L. G. Carpenter, M. S., *Director.*

GENERAL OUTLOOK.

Irrigation, horticulture, chemistry, entomology, and animal breeding and feeding continue to receive attention at the Colorado Station. During the past year publications have been issued giving the results

of some of the irrigation investigations, a study of the Idaho cricket, the relation of the honeybees to pear blight, and a number of other lines of work. An agronomist has been appointed who has undertaken considerable cooperative work among farmers in growing durum wheat at different altitudes and sown at different times. He is also testing varieties of oats and barley and conducting experiments in breeding spring grains. Grasses for pasturage are being tested in cooperation with the Bureau of Plant Industry of this Department. The chemist has conducted investigations on the rate of deterioration of manures, the commercial extraction of beeswax, the digestibility of Colorado hays, and the determination of alkali. The horticulturist is continuing his study on Rhizoctonia-resistant varieties of potatoes in cooperation with the Bureau of Plant Industry and has obtained good results in breeding disease-resistant cantaloupes.

An important line of work recently taken up is the horse-breeding experiment in cooperation with the Bureau of Animal Industry of this Department, to determine whether the American trotting horse can be used as foundation stock for the successful production of high-grade carriage horses. Up to the present time 19 mares and 1 stallion have been used in this experiment. There are also cooperative experiments with horses and cattle on loco, and irrigation investigations in cooperation with this Office. The last legislature made an appropriation of $5,000 annually for two years for livestock work, $1,500 for improvement of grains and grasses, and $500 for work with sugar beets and potatoes. The potato growers in the vicinity of Greeley are aiding in the latter work, and an attempt is being made to breed a Greeley potato in order to avoid the annual shipping in of seed. All of the plat experiments of the station are to be transferred to the new 73-acre farm secured last year. The staff has been considerably strengthened by the appointment of a veterinarian and assistants in irrigation, horticulture, agronomy, and animal husbandry.

The work of this station in several departments is being strengthened and expanded, and in others is being conducted in an efficient manner. The horse-breeding work is aided by the college, and the appropriations from the State will materially assist in other lines. The showing which the State's representatives were able to make in the important legal controversy with the State of Kansas, over the use of water for irrigation, is a tribute to the work of the station in that field.

LINES OF WORK.

The principal lines of work conducted at the Colorado Station during the past year were as follows: Chemistry—analysis of soils and irrigation waters, sugar-beet investigations, studies of methods

of analyzing feeding stuffs, etc.; meteorology; field experiments—variety tests of wheat and oats for different altitudes; breeding experiments; horticulture—diseases of plants, forestry; animal husbandry—breeding and feeding experiments with horses and cattle; entomology—study of the relation of honeybees to the spread of pear blight, studies of grasshoppers, various borers and leaf rollers, cutworms, and insects working on sugar beets and cantaloupes; irrigation—use of water, measurements of losses from ditches, studies of means for economizing water, measurements of seepage on the Platte, the Arkansas, the Rio Grande, and their tributaries.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Miscellaneous, including balance from previous year	967.75
Total	15,967.75

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 87–99 and 101, and the Annual Report for 1904. Bulletins 87–99 are a contribution to the studies of the great plains of Colorado, which have been carried on for a number of years by the station, and include notes on cattle raising, dairying, and wheat raising on the plains, and the growth of alfalfa without irrigation on the uplands. The other bulletins include the following subjects: Potato failures; large potato vines and no potatoes; digestion experiments with some Colorado hays and fodders; report of the entomologist; early cantaloupes; the shade trees of Denver; feeding steers on sugar-beet pulp, alfalfa hay, and farm grains; beet worms and their remedies; how can we maintain the fertility of our Colorado soils; the western cricket.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

EDWARD H. JENKINS, Ph. D., *Director.*

GENERAL OUTLOOK.

The Connecticut State Station has recently undertaken breeding and selection experiments for the improvement of corn—the flint varieties being raised chiefly for ears or shelled corn, the dent

varieties for silage, and the sweet varieties for the seed trade. E. M. East, a graduate of the University of Illinois, has been put in charge of this work. The botanist has devoted his time largely to a critical study of the life history of the fungus of potato blight and potato rot. Important investigations for the improvement of tobacco by selection and breeding from present types of tobacco are being conducted in cooperation with the Bureau of Plant Industry of this Department, and have already yielded interesting and valuable results. At Poquonock the station experiments with Sumatra tobacco under shade are being continued, and it is thought that a type suitable for that region is being developed.

A new two-story building with high basement is being erected at a cost of about $15,000, which will contain a chemical laboratory and quarters for the plant breeding and forestry work. During the year the station has added about 50 acres to its experimental forest tract and has planted a portion of this to chestnuts.

The station is pursuing its policy of laboratory investigations, with field work in cooperation with existing agencies, rather than operating a permanent farm or experimental field. Although its inspection work is increasingly heavy, it is maintaining its reputation for thorough investigation, and through the various agencies in the State it is in quite close touch with the farmers.

LINES OF WORK.

The principal lines of work conducted at the Connecticut State Station during the past year were as follows: Analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; chemistry—study of vegetable proteids; diseases of plants; forestry; field experiments—tobacco, breeding and selection of corn, grasses for turf making and pasture; and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$7,500.00
State appropriation, including balance of $450	15,950.00
Individuals	8,500.00
Fees, including balance from previous year	3,610.31
Miscellaneous	30.71
Total	35,591.02

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 146–151, on the following subjects: San José scale insect experiments in 1904, commercial feeding stuffs, the preparation of tobacco seed, a new and valuable cover crop for tobacco fields, the selection of tobacco seed plants, and the chief injurious scale insects of Connecticut.

Storrs Agricultural Experiment Station, *Storrs.*[a]

Department of the Connecticut Agricultural College.

L. A. CLINTON, M. S., *Director.*

GENERAL OUTLOOK.

The most important work recently undertaken at the Connecticut Storrs Station is that in cooperation with the Bureau of Animal Industry of this Department in soft-cheese making and in raising milch goats. A herd of 65 Maltese goats has been imported for the latter experiment. The poultry investigations of the station continue to be important and have attracted considerable attention among the farmers of the State. The dairy work consists of bacteriological investigations and practical work in the examination of stable conditions and milk with reference to sanitation. A remarkable variation in the bacterial content of different samples of milk has been revealed and the use of a covered pail at milking time has been found very desirable. Considerable valuable data have been secured in this connection and will be published in the near future. The investigations at Middletown on the food and nutrition of man have been continued as heretofore in cooperation with this Office, and have been aided by a special appropriation from the State.

The college with which the station is connected has an appropriation of $60,000 for the erection of a new dormitory. This is greatly needed, since the institution has for some time been unable to accommodate all applicants for admission. For a number of years the college has conducted summer schools for teachers in which nature-study work has been made prominent.

This station has of late made considerable progress in extending and strengthening its work. It has also come into closer touch with the farmers. It is now in a position to make good use of additional funds in the more thorough and complete investigation of problems of great importance to the agriculture of the State.

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[a] Telegraph address, *Storrs, via Willimantic;* railroad station, express, and freight address, *Eagleville.*

LINES OF WORK.

The principal lines of work conducted at the Connecticut Storrs Station during the past year were as follows: Food and nutrition of man and animals; bacteriology of dairy products; field experiments—fertilizers, soils tests, cover crops, nitrogen experiments; horticulture; poultry experiments; and dairying—soft cheese making.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$7,500.00
State appropriation	1,800.00
Miscellaneous	684.31
Total	9,984.31

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 31–35 and the Annual Report for 1904. The bulletins are on the following subjects: The food value of a pound of milk solids, protecting cows from flies, a successful brooder house, discussion of the amount of protein required in the ration for dairy cows, and the Camembert type of soft cheese in the United States.

DELAWARE.

The Delaware College Agricultural Experiment Station, *Newark.*

Department of Delaware College.

A. T. NEALE, A. M., Ph. D., *Director.*

GENERAL OUTLOOK.

The general conditions and the lines of work at the Delaware Station remain about the same as hitherto. The experiment on the production of sanitary milk on an economic basis has been continued and is yielding some interesting data. The horticulturist has been giving much attention to dust spraying as compared with liquid spraying for orchard fruits. Some of the dust sprays have given good results and may be applied more economically than the liquid sprays. The limoid and kerosene emulsion prepared by this station and experimented with by a number of other stations is attracting much attention, and it is believed that it will be found a useful addition to insecticides. The horticulturist has used it lately to destroy

a leaf miner, which preys on apple leaves. Experiments are being made in pruning Kieffer pear trees so as to bring fruit spurs lower down on the tree. Experiments in whip grafting young apple trees before planting have been quite successful, 90 per cent of the trees thus grafted having grown.

The chemist is giving much attention to a study of the nitrogen content of crimson clover grown under different conditions. An examination of winterkilled plants of crimson clover showed that considerable nitrogen is added to the soil even when the plants are thus killed. This is an important matter, as winterkilling of this crop often occurs. The nitrogen content of different samples of corn meal, as determined by analysts at different stations, showed great variation. This and other data along this line show the importance of caution in corn-breeding experiments, since the apparent increase in protein may simply be due to error in analysis. The bacteriologist is giving much attention to questions relating to nitrocultures. Efforts are being made through farmers' institutes, granges, and personal visits to farms to keep in close touch with the farmers in the State.

The Delaware Station, as well as the agricultural department of the college, is much restricted in its work by lack of adequate equipment and sufficient funds. Considering the opportunities for the advancement of its agricultural interests through appropriate education and research, it would seem as if the State should find a way to endow more completely its agricultural college and experiment station.

LINES OF WORK.

The principal lines of work conducted at the Delaware Station during the past year were as follows: Chemistry—study of nitrogen content of crimson clover; bacteriology—studies of nitrifying bacteria and nitrogen-assimilating bacteria; field experiments—cultural experiments with legumes and other forage and field crops, and breeding experiments with cereals; horticulture—study of sprays for orchard pests, pruning of orchards, and varieties of fruits; diseases of plants—study of blights and other diseases of cantaloupes, canker of pears and apples, asparagus rust and other fungus diseases of fruits and vegetables; feeding experiments; diseases of animals; entomology—studies of insects attacking fruit and shade trees, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–70, and an abridged edition of Bulletin 67, on the growth of crimson clover. The other bulletins are on the following subjects: Soil bacteria and nitrogen assimilation; the new K–L mixtures and San José scale; dust spraying in Delaware, top-grafting nursery apple trees; the study of the diseases of some truck crops in Delaware.

FLORIDA.

Agricultural Experiment Station of Florida, *Lake City.*

Department of University of Florida.

P. H. Rolfs, M. S., *Director.*

GENERAL OUTLOOK.

The Florida Station has completed studies on concentrated feeding stuffs offered for sale in the State, on some forage crops, and on feeding cassava and sweet potatoes to pigs. It is planned to make a careful experiment with hogs pastured on cassava roots compared with corn as a standard. Considerable attention is being given to investigations with Irish potatoes. The agriculturist is making fertilizer and variety tests of them both on the station farm and at different places in the State, and the horticulturist has undertaken potato breeding in cooperation with this Department. The latter has also begun a study of peach diseases. The station is cooperating with the Bureau of Plant Industry of this Department in testing varieties of corn, inoculating alfalfa on various types of Florida soils, and growing hybrid oranges. The hybrid orange trees set fruit this year. Locally the station is cooperating with growers in testing fertilizers for oranges and pineapples, spraying trees, and fumigating nursery stock to free it from bud worm.

The State legislature at its last session passed a bill abolishing the university and five other educational institutions, together with their boards of trustees and officers, and provided for the establishment of two institutions for higher education (a university and a female college), a normal school for colored students, and an institution for the deaf, dumb, and blind. A State board of control for all the institutions, consisting of five members appointed by the governor, was provided. This board, acting in conjunction with the State board of education in selecting localities for the different institutions, has decided upon Gainesville as the future site of the university. The legislative act appropriated $150,000 for the establishment and maintenance of the four institutions mentioned. It is understood that the change of the station from Lake City to Gaines-

ville will probably be postponed for a year in order to allow for the construction of buildings. The retirement of the veterinarian during the year will enable further concentration of the station's work, and the decision to appoint a director separate from the office of president will materially strengthen the station organization. Prof. P. H. Rolfs, who has accepted the directorship, has entered upon his duties. If the station's interests are fully conserved in moving the laboratories and offices to Gainesville, as has been assured, its outlook for increasing usefulness and efficiency seems very hopeful.

LINES OF WORK.

The prinicpal lines of work conducted at the Florida Station during the past year were as follows: Chemistry—fertilizer investigations and studies of citrus fruits; field experiments—cassava, corn, potatoes, and other farm crops; horticulture; diseases of plants; feeding experiments with hogs, steers, horses, and mules; veterinary science; entomology—mealy bug and insect enemies of citrus fruits and potatoes.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	2,183.14
Total	17,183.14

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 70-78 and 80, on the following subjects: Pineapple culture, varieties; Japanese persimmons; feeding horses and mules on home-grown feed stuffs; the honey peach group; anthracnose of the pomelo; potato disease; insecticides and fungicides; equine glanders and its eradication; forage crops, the silo; and the composition of some of the concentrated feeding stuffs on sale in Florida.

GEORGIA.

Georgia Experiment Station, *Experiment*.[a]

Department of Georgia State College of Agriculture and Mechanic Arts.

R. J. Redding, *Director*.

GENERAL OUTLOOK.

The investigations of the Georgia Station have been continued without material change. As a result of two years of observation on the pupation of the peach borer it has been found that in the locality of the station over 80 per cent of the larvæ pupate during the month of August, 15 per cent during the last half of July, and the remainder earlier in July or in September. The establishment of these facts will materially modify preventive treatment for this pest. This station is carrying on a large amount of work with fruit, including grapes, peaches, native persimmons, and figs from France and California.

An experiment has been made in feeding pigs on cotton-seed meal which had been fermented. The method was to mix the meal with middlings, make it into a slop, and then let it sour for eighteen hours. As much as 5 pounds of cotton-seed meal a day has been fed to a pen of three pigs without deleterious effect. The pigs gained faster than those on linseed meal or dried blood. In the greenhouse an experiment is being made in starting cotton in paper pots, the plants to be set out in the field later. The object is to see if a month or so can be gained in the season and an increased yield secured. This in view of the threatened boll-weevil invasion, and the better yield claimed from the longer season seems important. In the dairy comparisons are being made of highly nitrogenous feeds, and experiments made with cotton-seed meal to find the cause of the ill effects of the latter.

Among the investigations recently undertaken are plant breeding with corn, cotton, and oats; a general inquiry into the efficacy of commercial "nitrocultures" and into the power of the specific nitrobacterium of the cowpea to inoculate other legumes, and investigations in the life history of the cattle tick in cooperation with the Bureau of Entomology of this Department. The station is also cooperating with the Bureau of Plant Industry in diversification farm work and is carrying out its own work on such a scale as to show the practical application of the results. The title of the dairy department of the station has been changed to that of department of animal industry, and the work of the department will be extended to include experiments in feeding steers. There is opportunity for developing work in a number of other lines if funds could be secured for that purpose.

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[a] Telegraph, freight, and express address, *Griffin*.

LINES OF WORK.

The principal lines of work conducted at the Georgia Station during the past year were as follows: Field experiments—cultural and fertilizer tests; plant breeding—corn, cotton, and oats; horticulture—orchard and small fruits, celery, cantaloupes, and forcing vegetables; entomology; feeding experiments—soiling crops, concentrates, and various other feeds for dairy cattle and pigs, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	637.87
Farm products	1,735.26
Balance from previous year	2,857.62
Total	20,230.75

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 64–67 and the Annual Report for 1904. The bulletins are on cattle ticks and Texas fever, corn culture, cotton culture, and the plum in Georgia.

HAWAII.

Hawaii Agricultural Experiment Station, *Honolulu.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

JARED G. SMITH, B. S., M. A., *Special Agent in Charge.*

GENERAL OUTLOOK.

The work of the Hawaii Station during the past year has not changed materially. The station is devoting its efforts to the introduction of new agricultural industries to supplement the sugar industry, which now dominates the agriculture of the islands. Special efforts have been made to introduce more and better forage crops for the stock ranges, and very marked success has followed many of the introductions. The horticulturist has established nurseries for citrus fruits, alligator pears, mangoes, and bananas, and is studying some of the problems of propagation. Upon the lower portion of the station grounds the horticulturist has collected about 50 varieties of bananas and is carrying on some fertilizer tests with them. He

is also testing varieties of sorghum and Kafir corn, fiber plants, green manure crops, cotton, papayas, and vegetables. Two tracts, at the upper part of the station grounds, are planted to numerous tropical and Temperate Zone crops, special attention being given to garden vegetables and tropical fruits. The possibility of vegetable growing at this elevation has been demonstrated, and splendid trees of alligator pears, mangoes, papayas, coffee, etc., are growing there. The entomologist has carried on some work with silkworms and bees, and it seems probable that the culture of these important insects will be feasible and profitable in parts of the Hawaiian Islands. He continues to act in an advisory capacity to the committee of the board of health having in charge the mosquito problem. The chemist has been making a study of Hawaiian-grown fodders and feeding stuffs, and is continuing his soil studies with special reference to pyridin compounds. He is also studying nitrification, soil acidity, methods of applying fertilizers to prevent loss, and is giving some attention to dietary studies.

During the year experiments were carried on by the station at Hamakua, on the island of Hawaii, in growing tobacco. A suitable tract of land was secured, a number of varieties of tobacco were seeded, and the first systematic attempt was made to grow tobacco in a scientific way. The success attained with some types has led to the repetition of the experiment this year on a wider scale, and as the successes obtained last year were repeated, a new industry is added to Hawaii's agriculture. The cooperative experiments at Hilo with bananas from Central America and with cacao are flourishing. The number of banana plants has been considerably extended by propagation, and there are now about 500 plants under observation. It should be possible soon to make a small trial shipment of some of these fruits to compare them with those now marketed.

The Hawaii Station has about passed through its pioneer period and its work is beginning to be considered as of practical value. The station, as a source of information on general agriculture, is growing in importance, as appears from its correspondence. The success with forage crops and tobacco has been so marked that new possibilities in the agriculture of Hawaii are shown. The former local opposition to the station's policy seems to be giving way, and its influence in developing diversified agriculture is being recognized by fair-minded people. Its sphere of influence could be rapidly extended were more funds available.

LINES OF WORK.

The principal lines of work conducted at the Hawaii Station during the past year were as follows: Field experiments—varieties of cotton, tobacco, hemp, sorghum, potatoes, taro, cultural experiments,

and grasses and forage crops; horticulture—experiments with bananas, citrus fruits, alligator pears, and mangoes, and growing of grape cuttings; diseases of plants and animals—fusarium diseases of potatoes, taro rot; diseases of poultry; entomology—study of injurious insects and means for their repression.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Insular appropriation	7,236.00
Farm products	1,153.70
Total	23,389.70

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 7, on the banana in Hawaii, and Bulletin 8, on methods of milking.

Hawaiian Sugar Planters' Experiment Station, *Honolulu.*

C. F. Eckert, *Director of Division of Agriculture and Chemistry.*

GENERAL OUTLOOK.

The Hawaiian Sugar Planters' Station has continued its former lines of work in chemistry, entomology, soils, fertilizers, irrigation, and field plats with reference to sugar production, and has added a division of pathology and physiology. This division is under the directorship of N. A. Cobb, late pathologist for the department of agriculture of New South Wales, who is assisted by L. Lewton-Brain and E. M. Grosse. W. E. Chambers has been appointed illustrator of experiment station publications.

The division of agriculture and chemistry has been very successful during the past year in propagating new varieties of cane from seed, the object of this work being to secure varieties rich in sugar and resistant to diseases. The division of entomology has made a special effort to check the ravages of the cane leaf hopper, which has become a serious menace to the sugar industry of Hawaii, and is much encouraged by the successful introduction of insect enemies of the pest from Australia. The division of pathology and physiology has erected and equipped a laboratory building and is now in a position to study the fungus and bacteriological diseases of sugar cane.

LINES OF WORK.

The lines of work of the Hawaiian Sugar Planters' Station were as follows: Chemistry—sugar-house products, soils, fertilizers, and

irrigation waters; plant pathology and physiology—fungus and bacterial diseases of sugar cane; field experiments—fertilizer, cultural, and irrigation experiments with cane, variety tests of cane, and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

Hawaiian Sugar Planters' Association	$58,591.84
Fees	5,378.50
Total	63,970.34

IDAHO.

Agricultural Experiment Station of the University of Idaho, *Moscow*.

Department of the University of Idaho.

H. T. French, M. S., *Director*.

GENERAL OUTLOOK.

The new department of agronomy of the Idaho Station has undertaken considerable work with cereals and forage crops. There has been work with oats and corn to secure varieties earlier and better adapted to the high altitudes. About thirty varieties of corn have been tested, several of which matured and gave good yields. Seed has been selected from the best varieties and will be tested again at the station and by about twenty cooperating farmers. The director is cooperating with the agronomist in a study of rotation and crop management and is conducting some feeding experiments with cows and pigs. The problem of feeding pigs economically and well from April to August is an important one in Idaho, and it is this problem that the station is now working upon. The botanist has been relieved from college work and is now devoting his entire time to field work in entomology and plant diseases, including a study of tomato blight; the use of fungicides in the prevention of smut in grain, and other experiments in controlling pear blight, mildew in roses, and the codling moth. The chemist, before deciding to take up further studies at Yale, completed an examination of soil conditions in the Payette Valley, and spent considerable time in investigating the protein content of wheat grown at different altitudes and in determining the effect of minerals on waters used for irrigation. The horticulturist, after spending considerable time in studying horticultural conditions in the State, has undertaken quite extensive work with apples with the intention of studying matters concerning harvesting, storing, marketing, etc. He is also attempting to develop a variety of sweet corn suitable to Idaho conditions and to domesticate a number of native fruits and shrubs. He has some greenhouse work with carna-

tions. All members of the staff participate in farmers' institute work, and the agronomist has prepared two leaflets on elementary agriculture for use in the public schools. These are now placed on the regular list of subjects taught in the schools.

The work of the station in developing types of corn adapted to the climatic conditions of the State and in breeding and feeding farm animals is of distinct value to the agriculture of the State. The possibility of feeding beet pulp to cattle has opened a market for a considerable supply of this by-product of beet-sugar manufacture. The readiness with which the farmers have adopted the results of these experiments and their willingness to cooperate with the station are indications of an increasing appreciation of the station by its constituents.

LINES OF WORK.

The principal lines of work conducted at the Idaho Station during the past year were as follows: Chemistry—studies of wheats, irrigation waters, and foods, miscellaneous analytical work; physics; botany—studies of plant diseases and their remedies; field experiments—plant breeding, tests of various grasses and other forage crops for pasture and hay, experiments with cereals desirable for introduction, rotation experiments; horticulture—cultural and variety tests of garden crops, fruits, and forest trees; entomology; feeding experiments—cattle, sheep, and swine.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	867.15
Balance	583.77
Total	16,450.92

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 42–47 and the Annual Report for 1904. The bulletins are on the following subjects: Experiments in pig feeding, planting the apple orchard, alkali and the treatment of alkali lands, trap rocks of Palouse region as road material, the grape phylloxera, and pruning the apple orchard.

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, *Urbana.*

Department of the University of Illinois.

EUGENE DAVENPORT, M. Agr., *Director.*

GENERAL OUTLOOK.

The investigations of the Illinois Station have been continued along the same general lines noted in the last report of this Office, and the plan of supplementing studies in the station laboratories and fields with extensive experiments on rented fields in different parts of the State has been consistently pursued. The field work in horticulture and soil management has been very extensive, the former consisting of spraying, cultivation, pruning, and other work in orchards, and experiments with vegetables in southern Illinois; and the latter of cultivation, fertilizer, and crop experiments on typical soils in all parts of the State. During the year a number of circulars and bulletins bearing on these experiments have been published. (Pl. II, figs. 1, 2, and Pl. III, fig. 1.)

One of the most striking features of the animal-husbandry investigations of the past year was the study of market classes and grades of swine, the results of which have been published in a bulletin containing 41 half-tone engravings illustrating the different grades of swine sold on the markets. The department of animal husbandry is also investigating methods of beef production; economical feeds for calves, yearlings, and 2-year-olds; swine production, and the cost of maintaining pregnant brood mares. The dairy investigations are also conducted both at the station and in dairy herds and creameries in different parts of the State. A study of the milk supply of Chicago with reference to cleanliness is being made, and records of milk production of different herds are being kept. A special effort is being made to improve general conditions on dairy farms in different parts of the State.

During the year three of the field laboratories have been completed. These are for agronomy (Pl. III, fig. 2), horticulture and animal husbandry (beef cattle). The buildings are of brick, with slate roofs and stone trimmings, of the same general type of architecture, and cost from $12,000 to $25,000 each. A definite plan is being followed in the development of the organization of the college and station as its resources increase. The college of agriculture of the university, including the experiment station, is divided into a small number of departments, the heads of which both investigate and teach. As far as the station is concerned, it is thought best to keep the number of such departments small, and they do not at present include all the main divisions of agricultural science. One object of this restriction

FIG. 1.—UNTREATED PLAT.

FIG. 2.—PLAT TREATED WITH LIME AND PHOSPHORUS.

RED CLOVER ON PRAIRIE LAND, LOWER ILLINOIS GLACIATION.

Potassium. Nitrogen and phosphorus. Nitrogen and potassium.

FIG. 1.—EFFECT OF POTASSIUM ON YIELD OF CORN IN PEATY SWAMP SOIL IN ILLINOIS.

FIG. 2.—ILLINOIS STATION AGRONOMY BUILDING.

is to provide each of the existing departments with funds sufficient to enable them to conduct important and thorough investigations. The heads of departments give only about one-third of their time to college duties, and this is about equally divided between teaching and administrative duties. A relatively large number of specialists and assistants are employed in the several departments, who in many cases devote themselves exclusively to either college or station work. As the results of the investigations of the station develop, they are taught by the investigators. For the dissemination of information the station relies chiefly on its bulletins and the farmers' institutes. The station workers confine their outside lecturing to the farmers' institutes, and speak almost exclusively regarding their investigations. Meanwhile the more general extension work with schools, boys' and girls' clubs, etc., is being developed as a separate department of the college, under the direction of a special officer.

The thorough and harmonious organization of this college and station has resulted in great success. The departments of instruction are attracting a constantly increasing number of students, and their quality is also improving. The investigations of the station are more and more commending themselves to the farmers of the State, who are now ready to make active efforts to secure adequate financial support for the station. The college and station are generally recognized as important factors in the agricultural prosperity of the State.

LINES OF WORK.

The principal lines of work conducted at the Illinois Station during the past year were as follows: Chemistry—studies of the chemical composition of corn; bacteriology; pot and field experiments—pot experiments with type soils from different parts of the State, studies on management of soils conducted on type soils in different regions, inoculation experiments with alfalfa, experiments with sugar beets; horticulture—experiments in orchard management, renovation of orchards, cold storage investigations, experiments with garden vegetables and flowers; forestry; plant breeding—experiments in breeding and selecting corn to change the protein, oil, and starch contents; animal husbandry—study of dairy conditions in different parts of the State, study of market grades of swine, experiments on the cost of beef production, and on methods of housing cattle, feeding experiments with pigs; diseases of plants—study of bitter rot and other rots of apples, apple scabs and cankers; diseases of animals, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	85,000.00
Fees	522.50
Farm products	682.04
Balance from previous year	1,003.56
Total	102,208.10

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 95–101 and Circulars 75–89. The subjects of the bulletins are as follows: The more important insect injuries to Indian corn; the testing of corn for seed; market classes and grades of swine; the curculio and the apple; soil treatment for the lower Illinois glaciation; directions for the breeding of corn, including methods for the prevention of inbreeding; crops for the silo, cost of filling, and effect of silage on the flavor of milk. The circulars treat of investigations and topics of current interest to the people of the State.

INDIANA.

Agricultural Experiment Station of Indiana, *Lafayette.*

Department of Purdue University.

ARTHUR GOSS, M. S., A. C., *Director*

GENERAL OUTLOOK.

The Indiana Station has continued its former investigations, but has devoted much time during the past year to the inauguration of new work contemplated in an act of the legislature appropriating $5,000 for the year ended November 1, 1905, and $25,000 a year thereafter to the experiment station. The annual appropriation includes $10,000 for general purposes, $5,000 for investigations in live stock feeding, with special reference to beef production; $5,000 for soil and crop improvement, and $5,000 for the advancement of the dairy interests of the State. The act provides for an advisory committee of three, composed of representatives of the corn growers', dairymen's, and live stock associations of the State. The $5,000 avail-

able during the past year was used in the preparation of quarters for new assistants, the erection of feeding sheds, and the employment of assistants for the special investigations.

In the dairy division an assistant has been employed to visit the different creameries of the State, aid in the improvement of the methods employed, and arrange cooperative experiments.

In the soil and crop improvement division much work has already been done in the way of starting experiments in different parts of the State. Assistants have been provided for this work and the farmers of the State are taking great interest in it. No difficulty is being experienced in securing volunteers to conduct cooperative experiments and in several places the station has been fortunate in securing the active cooperation of former students of the university and other persons having the necessary scientific training and means to insure the success of such work. At the present time twelve corn-breeding experiments are being carried on in different parts of the State to test the adaptability of varieties bred at the station, and records of corn distributed by the station in from 150 to 200 different places are being kept.

In the division of animal husbandry barns, sheds, and other equipment have been arranged for feeding three carloads of cattle. Studies will also be made of breeding problems from records kept by breeders in the State.

The anticipated beneficial results from relieving the station of the care and management of the college farm and placing the business of the State chemist's office directly in charge of the station have been realized. Through these changes the station has been financially benefited during the past year to the extent of several thousand dollars.

The way in which the State and the university authorities have relieved the financial embarrassments of the station is especially gratifying because of the permanent character of the additional resources which the station has acquired. It will thus be able to plan and execute its new enterprises in a thorough and far-reaching manner, and the results should be of great value to the agricultural interests of the State.

LINES OF WORK.

The principal lines of work conducted at the Indiana Station during the past year were as follows: Chemistry—study of soils of the State, chemical composition of corn at different stages of growth, and corn breeding; pot and field experiments—breeding, cultural and fertilizer experiments with cereals and forage crops, rotation; pot experiments with legumes and cereals to test the efficiency of soil inoculation; horticulture; feeding experiments—comparison of tank-

age and other feeds for swine, feeding dairy cows, extensive feeding experiments with beef cattle; diseases of plants and animals—studies of diseases of cattle, sheep, and pigs, treatment of oats and wheat for smut, study of edible fungi, and rusts of sedges; breeding bacon hogs; dairying, and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Miscellaneous	10,828.05
Balance from previous year	1,052.73
Total	26,880.78

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 100–106 and the Annual Report for 1904. The bulletins are on the following subjects: Diseases of swine, alfalfa in Indiana, apple growing in Indiana, rapid method of removing smut from seed oats, a simple alkali test for ripeness of cream, corn improvement in Indiana, and commercial fertilizers.

IOWA.

Iowa Agricultural Experiment Station, *Ames.*

Department of Iowa State College of Agriculture and Mechanic Arts.

C. F. Curtiss, M. S. A., *Director.*

GENERAL OUTLOOK.

The Iowa Station has published during the past year the results of a series of extensive feeding experiments at Brookmont Farm, in which, among other things, a comparison of light, medium, and heavy grain rations for steers showed greater economy of meat production for the light ration, but greater profit for the heavy ration, owing to the better market condition of the steers and the higher prices they commanded. In another feeding experiment with grade steers of the Hereford and Angus breeds, representing the beef type, and grade steers of the Holstein and Jersey breeds, representing the dairy type, it was found that there was comparatively little difference in economy of gains made, but that there was a marked differ-

ence in favor of the beef type in the value of the product, as determined by the buyers for the market and by the slaughter and block tests conducted at the college. The station has also published the results of a study of commercial or creamery butter in Iowa, in which 55 creamery operators cooperated by furnishing regularly samples of butter for examination and gave information concerning the methods employed by them.

The station has continued the lines of work formerly in progress and has also enlarged the scope of its investigations, especially in dairying, horticulture, and agronomy. The new dairy building is now occupied and a dairy farm of about 300 acres has been purchased at a cost of $27,000. Extensive cooperative work in dairying (particularly in the keeping of butter) has been arranged between the station and the Bureau of Animal Industry of this Department. S. A. Beach, formerly of the New York State Station, has been made horticulturist of the station, and the horticultural work is to be enlarged, the State Horticultural Society cooperating with the station.

The work in agronomy is now assuming large proportions. "Corn trains" have been run over the whole State to arouse an interest in better seed corn; a study of the variation in the fertility of the soils of the State has been energetically prosecuted by means of chemical analyses, pot cultures, and field experiments; and experiments in improving corn and other cereal crops have been made in cooperation with the Bureau of Plant Industry of this Department. In this and similar work the station also cooperates with a number of county poor farms and with individual farmers. Increased attention is being given to forestry work in the cooperative arrangement with the Forest Service of this Department. Extensive forest plantations are being made under the direction of the forester, and tests of the durability of different kinds of soft woods for fence posts, as well as the effectiveness of various preservatives, are being carried on.

As in previous years, numerous lines of work in animal breeding and feeding are in progress with cattle, sheep, pigs, and horses, the breeding of range sheep being carried on in cooperation with the Bureau of Animal Industry.

The last legislature gave $3,500 for two years "for good roads experimentation." With the cooperation of the railroads of the State a "good-roads special" has been run over the State to awaken interest in the subject and to demonstrate the advantages of better methods of road making.

This station is in a highly prosperous condition and has a large amount of valuable work in progress and planned for the future. The results of its work are, moreover, being made immediately available to the farmers of the State.

LINES OF WORK.

The principal lines of work conducted at the Iowa Station during the past year were as follows: Chemistry—study of soils, cereals, feeding stuffs, farm water systems, renal calculi; botany; field experiments—cultural and breeding experiments with corn, wheat, and other cereals, flax, legumes, sorghum, teosinte, millet, Kafir corn, sugar beets, carrots, and potatoes; soils—pot and field experiments on type soils; horticulture—crossing of fruits, tests of cover crops, cross pollination of apples in different parts of the State, orchard management; diseases of plants; animal husbandry—feeding experiments with cattle, horses, and swine, breeding range sheep and horses; entomology; dairying—investigations in handling and storing butter; forestry; rural engineering, and good-roads investigations.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	28,125.00
Individuals	400.00
Farm products	6,723.34
Miscellaneous	1,323.48
Total	51,571.82

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 79, on experiments in beef production, and Bulletin 80, report of the Iowa educational butter contest.

KANSAS.

Kansas Agricultural Experiment Station, *Manhattan.*

Department of Kansas State Agricultural College.

J. T. WILLARD, M. S., *Director.*

GENERAL OUTLOOK.

There have been few changes in the organization or lines of work of the Kansas Station during the past year. The extensive breeding experiments with cereal and forage plants have been continued, and some crosses of wheat with rye, spelt, emmer, einkorn, and Polish wheat have been secured. The more promising hybrids and pure-bred cereals have been placed in increase plats and later will

be distributed among farmers of the State. Soy beans are in the third year of experiment, and a race of nonshattering beans has been secured. The station continues to cooperate with the Bureau of Plant Industry of this Department in the testing and improving of cereals on leased land at McPherson. The station is also cooperating with this Office in irrigation from wells at Fort Hays. In the horticultural department a special study is being made of vegetables suitable for canning, the maximum productive capacity of 50 square feet of land in garden truck, the cost of spraying, improving of native fruits, and the effect of fertilizers on the quality of strawberries. Important additions have been made to the equipment for work in animal husbandry, and a number of experiments in butter and cheese making and in beef production have been made. Feeding and performance tests with leading breeds of chickens have been undertaken in cooperation with an organization of poultry raisers.

At Fort Hays over 600 acres are now being used for farming operations, including tests of cereals and forage plants, fruits, evergreens, forest trees, etc. The appropriation provided for this work in 1906 is $11,300 and for 1907 $8,500. With improved organization and management the branch station at Fort Hays can do work of great value in the study of the agricultural problems typical of the extensive semiarid region of the United States.

The State legislature at its last session dealt liberally with the college and station, appropriating $50,000 for a horticultural building with greenhouses and equipment, $4,000 for a granary, $16,000 for other improvements, $90,000 for maintenance in 1906, and $100,000 for 1907. The station is doing much useful work, and a recent resolution passed by the board of regents gives promise of materially strengthening the organization of the station. By this resolution the duties of the director are extended and the functions of the council are better defined. The director is to have immediate charge of all the work of the station, including that of the branch station, and be held responsible for its execution. He is also to have charge of the expenditures of the station, the publications, and other business matters. Reports are to be made to the board annually, and a plan of the work and the expenditures for the year is to be submitted each spring. The new plan will materially strengthen the organization of the station.

LINES OF WORK.

The principal lines of work conducted at the Kansas Station during the past year were as follows: Chemistry—studies of cereals, soils, eggs, cattle dips, etc.; soils—moisture determinations, bacteriological investigations; horticulture—interpollinating apples, select-

ing and improving native fruits, spraying, and cold storage of fruit; plant breeding—with wheat, corn, cowpeas, and other crops; field experiments—growing drought-resistant crops, cultural and variety tests of grasses and numerous other crops; feeding and digestion experiments—steers, heifers, dairy cows, calves, swine, and sheep; poultry experiments; diseases of animals; entomology; dairying; irrigation, and extermination of prairie dogs and gophers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation for substations	7,650.00
Farm products	3,418.75
Balance from previous year	847.30
Total	26,916.05

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 124–128 and the Annual Report for 1904. The bulletins are on the following subjects: Experiments in feeding steers and in breeding and feeding pigs, experiments with dairy cows, experiments with hand-fed calves, the roots of plants, and experiments at Fort Hays branch station, 1902–1904.

KENTUCKY.

Kentucky Agricultural Experiment Station, *Lexington.*

Department of the Agricultural and Mechanical College of Kentucky.

M. A. Scovell, M. S., *Director.*

GENERAL OUTLOOK.

The Kentucky Station has closed its three years' experiments in raising Burley tobacco under shade with results indicating that the effect of shade is to produce a tobacco of finer texture, with little expense for cultivation and none for worming, and to increase the value from about 10 cents to about 25 cents a pound, but that the yield of tobacco under shade is less and the expense of shelter is too great to recommend this method of raising tobacco. Experiments have also been conducted in growing tobacco in the shade of growing corn (Pl. IV, fig. 1). An experiment in feeding dairy cows varying quantities of roughage shows that cows fed all they will eat of roughage

FIG. 1.—TOBACCO SHADED BY GROWING CORN.

FIG. 2.—TYPICAL PLANT OF BURLEY TOBACCO—DROOPING LEAVES.

FIG. 3.—RESULTS OF BREEDING AND SELECTION—MORE UPRIGHT HABITS.

KENTUCKY STATION EXPERIMENTS WITH BURLEY TOBACCO.

will consume more than is necessary for maintenance and a maximum flow of milk.

The investigations continued include, among others, those on the chemical analysis of soils to determine fertilizer needs; rotation of crops; experiments with wheat to increase the gluten content; breeding Burley tobacco to secure a type with more erect leaves and a more elastic staple (Pl. IV, figs. 2 and 3); study of insect pests and diseases of cucumbers and edible mushrooms grown in hothouses; study of cause of failure in growing red clover, in cooperation with farmers, and study of life histories of numerous insects. The station is cooperating to a considerable extent with farmers and with the Bureau of Plant Industry of this Department on rotation experiments and tests of forage plants.

Among the studies more recently inaugurated are those on the effect of artificial shade in preventing rust of celery and the mildew of the cucumber, the life history and remedies for seed insects, the effect of fumigation on the germination of seeds, nitrogen-fixing bacteria and their relations to leguminous plants, clover diseases and insect enemies, the effect of different ingredients of fertilizers on alfalfa, and the effect of inoculating the soil with nitrogen-fixing bacteria from various sources. The agriculturist resigned at the close of the year to accept the position of agriculturist and director of the South Carolina Experiment Station, and the assistant entomologist to accept a call from the department of agriculture of Ireland as expert on curing tobacco.

The facilities of the Kentucky Station for research work have been much improved by the completion of the new station building. This is a two-story and basement building, with offices, library, and four well-equipped chemical laboratories on the first floor, and with a suite of rooms for the department of entomology and botany, and offices for the agriculturist, animal husbandman, and horticulturist, and other rooms on the second floor. With its increased equipment and the systematization of its field experiments, the Kentucky Station is now in a better position than ever before to do useful work.

LINES OF WORK.

The principal lines of work conducted by the Kentucky Station during the past year were as follows: Chemistry; soils; analyses of fertilizers, foods, and feeding stuffs; inspection of orchards and nurseries; field experiments—hemp, tobacco, cereals, legumes, fertilizers; horticulture; plant breeding—wheat, corn, tobacco, and sorghum; breeding of animals; pig feeding; diseases of plants—tomato rot; entomology—the Hessian fly, seed insects, corn root-worm, tobacco worm, apple-tree measuring worm, strawberry leaf-roller and crown borer; apiculture, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	10,460.70
Balance from previous year	3,825.30
Fees	18,040.30
Farm products	5,282.55
Miscellaneous	32.22
Total	52,641.07

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 113–116, on the following subjects: Protein content of the wheat kernel, insects injurious to cabbage, wheat, and an injury to fruits by insects and birds, the apple-tree measuring worm, the Fall Beauty—a new apple.

LOUISIANA.

No. 1. Sugar Experiment Station, *Audubon Park, New Orleans.*
No. 2. State Experiment Station, *Baton Rouge.*
No. 3. North Louisiana Experiment Station, *Calhoun.*

Department of Louisiana State University and Agricultural and Mechanical College.

W. R. Dodson, A. B., B. S., *Director, Baton Rouge.*

GENERAL OUTLOOK.

The Louisiana stations are bringing to a close their investigations extending over a number of years on the changes in cane juice and its products in the process of manufacture. The results will throw considerable light upon the best methods of handling the juice; the influence of inaccuracy in the addition of clarifying agents; the influence of the clarifying agent on the sugar, molasses, granulation, etc., and of clarifying methods at different stages of maturity of the cane. Studies of the chemistry and physiology of the cane plant during all stages of growth are nearing completion. The rotation experiments, extending over sixteen years, have been closed with results of considerable value. The rotation which included cotton, corn and cowpeas, oats, cowpeas, and cotton gave results indicating that depleted soil can be fully restored without the addition of any commercial fertilizers except phosphoric acid. It has also shown that the crop of oats and cowpeas was the most valuable crop in the

system of rotation, and the next in value was cotton. The result of the stations' work showing that the ill effects of feeding rice bran were due to oil in the bran, led to the establishment of a factory for making an extracted bran and molasses feed. The work which the stations have done on molasses as a feeding stuff has resulted in a great saving of the feed bills on plantations. In one case the cost per mule per day was reduced from 19 to 13 cents by formulas suggested by the stations. Alfalfa is being quite generally introduced into the State as a result of investigations by the stations.

During the year fifty new varieties of sugar cane have been imported for trial. Some feeding experiments are being conducted with steers and with calves brought from Texas; also experiments in swine production and in truck growing, all for the purpose of encouraging diversified agriculture in the State. The stations are cooperating with the Bureau of Plant Industry of this Department in the fall planting of alfalfa and other legumes and in testing forage plants and several varieties of citrus fruits. The fertilizer laboratory has been moved from New Orleans to Baton Rouge, where an addition to the station building has been constructed to accommodate the fertilizer work. At Calhoun an office and library building, costing about $2,000, has been completed, and also a residence for the assistant director, costing about $2,500.

The work of the Louisiana stations is being reorganized to some extent, so as to concentrate the administrative and inspection functions at Baton Rouge, and to strengthen the investigation at that point in several lines. In place of some of the more practical phases at the North Louisiana Station, which have accomplished their mission, it is planned to take up more technical questions in a number of lines. Great as has been the value of these stations, there seems opportunity to develop the investigations in several lines, and thus extend the field of usefulness. The management is efficient and economical, and the outlook for the future is most encouraging.

LINES OF WORK.

The principal lines of work conducted at the Louisiana stations during the past year were as follows:

Sugar Station.—Chemistry; bacteriology; soils and soil physics; field experiments—tests of fodder plants and varieties of cane; horticulture—tests of home-grown *v.* northern-grown seeds; sugar making; drainage, and irrigation.

State Station.—Geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments—forage crops, legumes, rotations, varieties of cotton and sugar cane; horticulture; animal husbandry—breeding and feeding for beef production; diseases of animals—inoculation for Texas fever, study of the nodular

diseases of the intestines of sheep, anthrax, glanders, etc., and entomology.

NORTHERN STATION.—Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising, and dairying.

INCOME.

The income of the stations during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	15,000.00
Fees	6,000.00
Farm products	2,233.12
Miscellaneous, including balance from previous year	13,359.42
Total	51,592.54

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The only publication of these stations received during the past fiscal year was Bulletin 77 on rice. This is a revision of Bulletin 61 of the station, including additional information obtained in recent experiments, especially pertaining to the feeding value of the by-products of rice mills. The principal subjects discussed in this bulletin are history, preparation of soil, planting, flooding, harvesting, noxious weeds in the rice fields, feeding rice bran and rice polish, and determination of digestible nutrients.

MAINE.

Maine Agricultural Experiment Station, *Orono.*

Department of University of Maine.

C. D. WOODS, Sc. D., *Director.*

GENERAL OUTLOOK.

The most extensive experiments of the Maine Station and those which are attracting more attention than any of its other investigations are the experiments with poultry, a part of which are carried out in cooperation with the Bureau of Animal Industry of this Department. Some of the problems now under investigation are the amount of floor space each fowl should have; rations for egg production and meat production, growing chicks, etc., and breeding for egg production. In an investigation on the time required to establish fertility in eggs, one egg laid twenty-seven hours and another thirty hours after the male bird was put into a pen with females yielded

good chicks, and 10 chicks were obtained from 21 eggs laid on the third day after the males were put in the breeding pens. It was also found that hens will continue to yield fertile eggs for seventeen days after separation from the male.

The horticultural work of the station is being continued as outlined in previous reports. Some of the blueberry seedlings are now fruiting, and seed from the best individual plants has been planted. Orchard investigations are being conducted largely in a cooperative way at Manchester, New Gloucester, and other places. The horticulturist is also testing varieties of vegetables for the Bureau of Plant Industry of this Department. The station has also done some work with alfalfa and in testing cultures of nitrogen-fixing bacteria in cooperation with the Bureau of Plant Industry; in determining the effect of climate on sweet corn in cooperation with the Bureau of Chemistry, and is continuing its cooperation with this Office in nutrition investigations. There is no field work in agriculture at Orono, work of this nature being conducted in a cooperative way in Aroostook County, at Holton and other places in the State. The work in Aroostook County is with potatoes, and includes spraying, fertilizer experiments, and breeding to secure blight-resistant strains. The inspection work of the station has been added to by the requirements of a pure-food law, which puts the execution of all work, except that upon dairy products, in the hands of the station officials.

The station work is developing somewhat and the demands on it are increasing. Its correspondence grows and its demonstration work about the State is meeting with a good deal of success. For example, five years ago there were only two men in Aroostook County who sprayed their potatoes. Last year eighteen carloads of 20 tons each of copper sulphate were sold in that county for spraying potatoes. The credit for this undoubtedly belongs to the station. The station is in need of additional funds from the State in order that its work may be extended in a number of lines.

LINES OF WORK.

The principal lines of work conducted at the Maine Station during the past year were as follows: Chemistry—study of feeding stuffs and various fertilizers and miscellaneous analytical work; botany; inspection of fertilizers, foods, concentrated commercial feeding stuffs, seeds, and creamery glassware; horticulture—experiments in the selection, propagation, and improvement of blueberries, orchard experiments, and study of hardy fruits and vegetables; diseases of plants—fungus diseases of potatoes and other plants; food and nutrition of man and animals; poultry investigations—breeding, feeding, and housing experiments; diseases of animals; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,500.00
Fees	3,755.00
Farm products	1,760.52
Balance from previous year	54.07
Total	22,069.59

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 104–115, on the following subjects: A study of reciprocal crosses; fertilizer inspection; soy beans in Maine, feeding experiments with cows, alfalfa; home-mixed fertilizers; brown-tail moth and other orchard moths; apple maggot and other insects; digestion experiments with sheep and steers; finances, meteorology, index; potato experiments in 1904; summary of experiments in practical horticulture, red clover from various sources; and feeding-stuff inspection.

MARYLAND.

Maryland Agricultural Experiment Station, *College Park.*

Department of Maryland Agricultural College.

H. J. Patterson, B. S., *Director.*

GENERAL OUTLOOK.

During the past fiscal year the Maryland Station has enlarged its operations considerably by undertaking additional investigations in cooperation with this Department. It is now cooperating with the Bureau of Plant Industry in breeding experiments with wheat, oats, barley, and rye, in growing forage crops, and in selecting and breeding tobacco; with the Bureau of Entomology in spraying experiments for scale insects; with the Bureau of Animal Industry in experiments with milch goats, and with the Bureau of Chemistry in investigations on the sugar content of sweet corn. Both the departments of chemistry and agronomy are giving much attention to corn breeding for the purpose of obtaining varieties of sweet corn which will better fill the demands of the markets, and of increasing the yield and the protein content of field corn. The division of chemistry, in addition to its work with sweet corn, has recently taken up a study of the

extent of soil areas in the State which contain an excess of soluble salts, a matter which seems to have a similar bearing to the presence of alkali in western soils.

The horticulturist, who joined the station staff last year, has undertaken considerable work, both at the station and elsewhere in the State, giving special attention at the station to strawberries, carnations, and blight-resistant potatoes, and in western Maryland to apples. During the past year he has visited a considerable number of cities to which Maryland fruit is shipped, and studied methods of packing and marketing, for the purpose of pointing out to shippers ways in which they can improve their practices. A cherry orchard of 19 varieties was started last spring, and a nut orchard containing American and Japanese chestnuts, American and English walnuts, butternuts, hickory nuts, pecans, and filberts. In the dairy division the investigations previously started are being continued, and a study of the initial acidity of milk has been undertaken to fix a basis for determining when milk is too old for use. In the divisions of botany, plant pathology, and entomology the principal lines of work are connected with the inspection work of the State. At the same time there has been work in the study of plant diseases and investigations relating to the ravages of the root maggot on cabbage.

A progressive spirit pervades the operations of the Maryland Station, and the evidences of the better appreciation of the value of its work by the farmers of the State are multiplying. There is a constantly increasing demand for its publications, and representatives of important agricultural interests are seeking the advice and aid of the station.

LINES OF WORK.

The principal lines of work conducted at the Maryland Station during the past year were as follows: Chemistry—analytical work, study of cereals and soils; field experiments—tests of varieties of grasses, forage crops, soil renovators, corn, potatoes, and wheat, cultural, fertilizer, and inoculation experiments, breeding and selection of corn and wheat; horticulture—orchard management, variety tests, cover crops, cultural methods, breeding and selection of strawberries and carnations, rotation of vegetables in the forcing house, systematic study of fruit areas in Maryland; diseases of plants; feeding experiments; dairying; diseases of animals; entomology—inspection of orchards, and study of life history of injurious insects.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	5,000.00
Farm products	4,582.57
Balance from previous year	1,016.69
Total	25,599.26

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 94–99, and the Annual Report for 1904. The subjects treated in the bulletins include systems of keeping milk and butter records; the character of milk during the period of heat; sweet corn—breeding, growing, and curing for seed; the relative profits of selling milk, cream, and butter; home-grown protein as a substitute for purchased feeds and tests of soiling crops; and test of different spraying materials for the control of San José scale.

MASSACHUSETTS.

Hatch Experiment Station of the Massachusetts Agricultural College, *Amherst.*

Department of the Massachusetts Agricultural College.

W. P. Brooks, Ph. D., *Director.*

GENERAL OUTLOOK.

Most of the work of the Massachusetts Station has been noted in previous reports. In the department of agronomy the field and pot experiments have been continued. Soil and seed inoculation experiments with legumes were tried in both pots and field with results indicating that soil inoculation was more satisfactory. The fertilizer experiments with asparagus, which are now in their third year, are of considerable importance to asparagus growers, owing to the fact that the production of this crop involves the use of large amounts of fertilizer. In the department of foods and feeding stuffs there has been a continuation of experiments with dairy cows, sheep, horses, forage crops, and investigations of chemical problems connected with animal nutrition and dairying. The inspection work of this and other departments has been continued as heretofore. The botanical division has continued its work on electricity in relation to plant growth, and has undertaken studies of the relative efficiency of sun-

shine at different hours and seasons. Diseases of tomatoes, asters, and other plants are being studied. The horticulturist has continued the work outlined last year, and the entomologist also is following out investigations started some time ago. One important feature of his work is the study of broods of codling moths. He is also doing some advisory work for the State gypsy moth commission.

The facilities of the station have been improved in a number of ways and will be further improved through appropriations made by the last legislature to the college. These appropriations amount to $42,700, of which $39,500 is being used in the construction of a horticultural building and $3,200 for additions to the entomological laboratories. The college barn, erected in 1893, was totally destroyed by fire recently, together with much of its contents. Dr. Henry H. Goodell, president of the college and director of the station, and connected with both institutions since their organization, died April 23 on board ship en route from Savannah to Boston. Prof. William P. Brooks, agriculturist of the college and station, has since acted as president and director. Recently Kenyon L. Butterfield, president of the Rhode Island College of Agriculture and Mechanic Arts, has been elected president of the college. The work of the Massachusetts Station has steadily progressed during the past year and continues to be on a high plane of scientific and practical usefulness.

LINES OF WORK.

The principal lines of work conducted at the Massachusetts Station during the past year were as follows: Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments—soil inoculation, plat experiments with fertilizers, grasses and various farm crops, supplemented by similar pot experiments; horticulture—propagation of plants, pruning, systematic pomology; study of the effect of electricity and illuminating gas on plants and trees; diseases of plants, especially those of melons, cucumbers, and lettuce; digestion and feeding experiments; diseases of animals; entomology—study of the life history of economic insects and the use of insecticides; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	13,625.00
Fees	4,365.00
Farm products	1,512.95
Miscellaneous	3,463.70
Total	37,966.65

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 97–102, Technical Bulletin 2, Meteorological Bulletins 186–197, and the Annual Reports for 1903 and 1904. Bulletins 100 and 102 are concerned with the analyses of fertilizers and Bulletins 98 and 101 with concentrated feeds. The other two bulletins are on a farm wood lot, dried molasses-beet pulp, and the nutrition of horses. The technical bulletin treats of the graft union.

MICHIGAN.

Experiment Station of Michigan State Agricultural College, *Agricultural College.*[a]

Department of Michigan State Agricultural College.

C. D. Smith, M. S., *Director.*

GENERAL OUTLOOK.

The work of the Michigan Station during the past fiscal year has not differed materially from that outlined in the last report of this Office. In animal husbandry some new experiments have been started, notably in raising calves from cows of the beef type, to compare economy of production with (1) calves fed skim milk *v.* calves running with the dams and (2) calves from pure-bred sires *v.* calves from scrub sires. Experiments with grade dairy cows have been resumed. A new feeding experiment has for its purpose the securing of data concerning the economy of feeding whole grain as compared with ground feed when the cost of grinding is taken into account. There is considerable other work in feeding, including a study of economical rations for wintering horses not at work.

The work in agronomy is extensive, and includes many experiments with legumes, breeding wheat, study of the influence of different soils on the quality of wheat, and studies of the effect of nitrocultures on alfalfa and soy beans in cooperation with the bacteriologist. Some of the varieties of wheat developed at the station are now being distributed. In cooperation with the Bureau of Plant Industry of this Department the station is testing varieties of corn, alfalfa seed from different sources, and varieties of soy beans, and growing sugar-beet seed and flax. The field work at the Upper Peninsula substation has been continued with State funds, and $9,000 has been appropriated for buildings there.

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[a] Freight and express address, *Lansing.*

The horticultural work of the station is now divided between Professor Taft, who has charge of the work at South Haven, and Professor Fletcher, who has charge of the work at the college. The work in progress and that planned includes studies of pollination, renovation of old orchards, the commercial production and the diseases of lettuce, breeding experiments with potatoes with reference to starch content and blight resistance, selection of tomatoes for rot resistance, cold storage of apples and pears, fall spraying for San José scale, and the fall planting of hardy garden seeds.

The bacteriologist is studying the action of soil bacteria in rendering soil materials available for plants, and is also investigating the nodules of legumes, the use of cultures of nitrogen-fixing bacteria, and bacterial diseases of plants. The chemist is cooperating with other departments, and is studying in water cultures the hostility of crops to succeeding crops in a rotation. The entomologist is preparing a bulletin on insects affecting vegetables, which will embody original studies of a number of insects and methods of treatment. He is now studying greenhouse insects.

The last legislature dealt liberally with the college and station. It removed the limitation to the amount which the college might receive under the one-tenth mill tax, thus increasing the annual income from the State from $100,000 to $157,000. An appropriation of $55,000 was made to replace Wells Hall, which was destroyed by fire during the winter, $20,000 was appropriated for the purchase of live stock and the maintenance of experiments in animal husbandry, including at least $2,000 for poultry, and $10,000 for the removal of barns to a new location. The experimental work of the station has been increased, the organization has been improved, and the outlook for the future work of the station is promising.

LINES OF WORK.

The principal lines of work conducted at the Michigan Station during the past year were as follows: Chemistry: analysis and control of fertilizers and feeding stuffs; bacteriology—study of milk supply and the bacteria of the dairy, bacteria of soils and legumes; field experiments—fertilizer, cultural and variety tests with sugar beets and many other field crops, production of sugar-beet seed, rotation, experiments with cowpeas, soy beans, and other legumes, breeding and selection of wheat; horticulture—variety tests, orchard management, breeding and selection of potatoes and tomatoes, and cold storage; diseases of plants—fungus diseases of the sugar beet, clover, vegetables, and fruits; feeding experiments—utilization of cowpeas, soy beans, and other legumes, comparison of corn silage with dried corn fodder, and with beet pulp, feeding swine, calves, and dairy cows; diseases of animals; entomology; and stable hygiene.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation for substations	3,500.00
Fees	2,480.00
Farm products	1,718.51
Miscellaneous, including balance from previous year	5,021.98
Total	27,720.49

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 213–224, Special Bulletins 26–31, and the Annual Report for 1904. The bulletins were on the following subjects: Small fruits for 1904; tomatoes and potatoes; experiments with sugar beets in 1903; insect enemies of fruits in Michigan, fungus diseases of fruits in Michigan, spraying calendar; fertilizer analyses; some essential soil changes produced by micro-organisms; soil moisture—its importance and management; dried beet pulp and dried molasses-beet pulp for fattening sheep; the care and handling of milk; the codling moth in Michigan; equipment for breeding, feeding, care, and management of swine, preliminary report on forage crops for swine; observations on the influence of nodules on the roots upon the composition of soy beans and cowpeas. The special bulletins were a spraying calendar, report of the South Haven substation for 1903, report of the Upper Peninsula substation for the year 1903, additional work upon the associative action of bacteria in the souring of milk and in other milk fermentations, report of South Haven substation for 1904, and report of Upper Peninsula substation for 1904.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota, *St. Anthony Park, St. Paul.*

Department of the University of Minnesota.

W. M. Liggett, *Director.*

GENERAL OUTLOOK.

The rotation experiments inaugurated in 1894 by the Minnesota Station to determine the influence of crop rotation upon the fertility of the soil and the yield of crops, have been carried through the first period of twelve years, and the results are being prepared for publi-

cation. These results show the extent to which the decline of crop yields can be prevented by the judicious rotation of crops, the use of farm manures, and the production of leguminous crops. There has been notable development in work in animal husbandry along the line of individual feeding of cattle, sheep, and swine to compare individual and breeding variations and to determine the food requirements of animals from birth to maturity. Investigations on the protein requirements for milk production have been carried on for a number of years and show the extent to which rations must vary to meet the requirements for the production of different amounts of milk. These experiments have shown that excessive amounts of protein are frequently fed to cows, unnecessarily increasing the expense of the rations, and that farm grains are practically as valuable for milk production as many mill products.

In the nutrition investigations in cooperation with this Office the work on the comparative digestibility and food value of the three standard types of flour—graham, whole-wheat, and straight-grade flour—has been brought to a close, and the results have shown that while graham and entire wheat contain more nutritive materials than straight-grade flour they are less digestible, so that the body actually receives less nutritive material from these grades of flour than from the standard grade of white flour. The station is also cooperating with the Bureau of Plant Industry in plant breeding and tests of varieties of vegetables and clover seed and with the Bureau of Statistics in studies of farm statistics.

Experiments have been undertaken recently to determine the influence of various fertilizers upon the crop-producing power of the different soil types of the State. The last session of the legislature gave special appropriations for investigations in soils, live stock, and plant breeding. This work will be carried on both at the experiment station and in different parts of the State in cooperation with farmers, many of the present lines of investigation being extended. Investigations in forestry have been inaugurated to determine the rate of new growth of forest trees and the importance and value of reforesting the old stumpage.

The work of the station covers a wide range and has yielded valuable results in all lines. This is evidenced by the liberal appropriations which have been made for station purposes. The legislature recently adjourned made appropriations amounting in the aggregate to about $100,000 for the agricultural department of the university, exclusive of the substations. For the substation at Crookston $8,000 a year was provided for maintenance, besides $4,000 for drainage, $5,000 for house and farm buildings, and $15,000 for a building for the Crookston School of Agriculture. For the substation at Grand Rapids $4,000 a year was appropriated for maintenance and $2,000

for a dairy building and other minor farm equipment. The financial management of the institution has also been put on a better basis by the abolishment of the State board of control system inaugurated a few years ago. In its investigations in cooperation with this department on the cost of growing crops and on farm management this station is a leader in the scientific, systematic study of the important problems of farm economics now pressing for solution.

LINES OF WORK.

The principal lines of work conducted at the Minnesota Station during the past year were as follows: Chemistry of soils and farm crops; fertilizers; field experiments—rotations, tests of varieties of cereals and forage crops, time and depth of seeding grains and amount of seed, methods of seeding grasses; horticulture—tests of varieties of fruits and vegetables, use of wind-breaks, testing hardy stocks for apple trees, improvement of native fruits; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying; farm management, and farm statistics.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation, including substations	38,749.90
Farm products, including substations	8,138.50
Total	61,888.40

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 87–91, and the Annual Report for 1903. The bulletins are on the following subjects: Potatoes at university farm; injurious insects of 1904; soil investigations; heavy and light weight grains, starchy and glutenous grains, light and dark colored flaxseed, rusted wheat, and milling tests of wheat; and poultry culture in Minnesota.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College.*[a]

Department of Mississippi Agricultural and Mechanical College.

W. L. HUTCHINSON, M. S., *Director.*

GENERAL OUTLOOK.

The Mississippi Station has made marked progress in carrying on investigations bearing on the improvement of agricultural practice in the South. The feeding work of the station has been materially strengthened and is yielding important results. The station has demonstrated that a profit of $16.70 a head can be made on baby beef, including one year's keep of the dam, and that stockers can be produced at a profit of from $15 to $20 a head. This is one of the most important things the station has done in feeding. It has also demonstrated the need of good cattle for profitable work. Silage has been found cheaper and better than cotton-seed hulls. The station has been the pioneer in silo building in that section, and its work has led the farmers to take it up, especially for dairy work. In an experiment in grazing hogs on cowpeas last fall 483 pounds of pork was made to the acre of peas, without corn or any other feed. Alfalfa was tried, but not found so good. Experiments with cultures of nitrogen-fixing bacteria from this Department gave excellent results. The poultry work now includes feeding for egg and meat production with 10 breeds of chickens.

The horticulturist secured from the orchard last year the largest profit since it was planted, the shippers' net returns from the 6 acres being nearly $1,800. The agronomy work of the station is now better defined than formerly and includes breeding work with corn and cotton. The other investigations have been continued as formerly.

The college has built several new barns, some of which give the station better facilities. These include a $7,000 dairy barn, a $4,000 barn for beef cattle, and new barns for work animals and for implements. Work has been started on a new dairy building to cost about $10,000. Considerable interest in teaching agriculture in the rural schools is being taken by the college authorities. The professor of agriculture is devoting much time to this work. A summer school for teachers was held at the college in June and July with an enrollment of over 200 teachers, many of whom took courses in agriculture, horticulture, nature study, and school gardening.

Work has progressed at the three substations supported by State

[a] Telegraph address, *Starkville;* express and post-office address, *Agricultural College;* freight address, *A. and M. College Station.*

funds. At McNeill the variety and fertilizer tests with farm, garden, and orchard crops have been continued. At Holly Springs progress was made in reclaiming a portion of the 200 acres of badly eroded brown loam which was donated by the people in that vicinity, and plantations consisting of 7 acres of strawberries and 10 acres of Elberta peaches were put out. At Stoneville, where the people donated $15,000 for the purchase of a 200-acre experiment farm of delta land, the work was also of a preliminary nature.

The general conditions surrounding the Mississippi Station have been materially improved during the year, and the station work is in better shape than ever before. With the employment of more experienced assistants to the station men the work would be somewhat strengthened. The station has a strong hold on the people of the State, as was evidenced by the recent appropriation for two additional branch stations and by the increasing appeals to the station for assistance. The outlook for the future is exceptionally good.

LINES OF WORK.

The principal lines of work conducted by the Mississippi Station during the past year were as follows: Soils—restoring and maintaining fertility, study of artesian waters, methods of preventing erosion, and restoring washed soils; fertilizers; field experiments—growing pasturage and forage crops, testing varieties of wheat, oats, and cotton, selection and breeding of corn and cotton; horticulture; animal husbandry—beef production, combined with swine and sheep production, and poultry culture; dairying; diseases of animals—Texas fever and other diseases; entomology—boll weevil, chicken mite, and insects affecting the leading garden and farm products.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation for substations	20,000.00
Farm products	2,061.18
Miscellaneous, including balance from previous year	3,240.49
Total	40,301.67

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 82–84 and 86, and the Annual Report for 1904,

which includes a financial statement of the station and reports by the director and heads of departments reviewing the work of the year, as well as a financial statement of the McNeill branch station and a report of the work of that station by the assistant director. The bulletins were on the following subjects: Inspection and analyses of commerical fertilizers on sale in the State, report of work at McNeill branch station for 1903, report of field work done at the college station for 1903, and insects injurious to pecans. There were also issued circulars on the Mexican cotton-boll weevil, alfalfa, and strawberry culture in Mississippi.

MISSOURI.

Missouri Agricultural College Experiment Station, *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

H. J. WATERS, B. S. A., *Director.*

GENERAL OUTLOOK.

The Missouri Station has recently undertaken a systematic survey of the soils of the State to determine the present productive capacity of each type of soil, the best system of management, and the special or new crops desirable for each type. In addition to the conventional visitation and analysis of each type, cooperative experiments to extend over several years will be started with one or more farmers in each region. In the southern part of the State, for example, special attention will be paid to the adaptability of the land to fruit and grazing purposes, and an effort will be made to reforest those areas which are too rough and poor to produce either grass or fruit. The legislature has appropriated $3,000 to start this work.

The other work of the station has proceeded along well-established lines. The field work is growing; the experiments in feeding for beef have been continued in cooperation with the Bureau of Plant Industry of this Department, and include extensive experiments on the finishing of cattle on grass; the breeding experiments with rabbits are yielding some interesting results, and the work of the horticulturist to determine the relation of color to the effect of temperature on peach twigs has developed to the point where an attempt is being made to breed out the purple color of the buds and twigs which makes them more susceptible to cold.

Agricultural instruction is gaining ground in the university and in the State. In spite of raising the entrance requirements to the regular university standard, the freshman class last year was about 75 per cent larger than usual, and this year the largest class in agri-

culture in the history of the university was graduated. A year of agriculture in the high schools will now be accepted as part credit for entrance to the university. This, it is thought, will stimulate the putting of agriculture into the high schools, as credit can now be given for it. The last legislature appropriated $55,000 for the college of agriculture and the experiment station for the biennial period. Of this amount $15,000 is for the experiment station, $3,000 for inaugurating a soil survey, $5,000 for a cattle barn, $2,000 for a swine barn, and $5,000 for a laboratory building for farm machinery.

The station is doing a large amount of excellent work in all lines. Assistants have now been provided in all departments so that the men need do only a small amount of teaching. The station stands in very close relation to the farmers and has good support, as is shown by its appropriation which was reduced only a few hundred dollars below the estimates, whereas appropriations for all other departments of the university were cut down materially.

LINES OF WORK.

The principal lines of work conducted by the Missouri Station during the past year were as follows: Chemistry—inspection of fertilizers, study of food adulterants and fungicides; soil survey; botany; field experiments—cereal and forage crops, fertilizers, rotations, renovating worn-out soils; horticulture—experiments with apples, plums, grapes, peaches, pears, small fruits and nuts, breeding experiments with fruits, diseases of apples; animal breeding; feeding experiments with beef cattle, sheep, and swine; diseases of animals; entomology—study of ticks on cattle, parasites of sheep, insects affecting fruits; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	3,000.00
Fees	4,948.87
Farm products	5,073.14
Balance from previous year	110.86
Total	28,132.87

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 64, on the "sting" in the apple, and Bulletin 65, on

grain rations for dry-lot hog feeding, and Circulars of Information 17–19, on the planting and care of shade trees, the farmers' creamery in Missouri, and suggestions for Missouri corn growers.

Missouri State Fruit Experiment Station, *Mountain Grove.*

PAUL EVANS, *Director.*

GENERAL OUTLOOK.

The work of the Missouri State Fruit Experiment Station has been continued as heretofore, attention being given to the development of the fruit interests in the southern part of the State, studies of the conditions favorable or unfavorable to the development of the fruit industry, and the investigation of diseases and insect pests of fruit.

LINES OF WORK.

The principal lines of work conducted at the Missouri State Fruit Experiment Station during the past year were as follows: Horticulture—experiments with fertilizers and cover crops for orchards; breeding experiments with apples, peaches, and strawberries; orchard survey; tests of new land for orchard purposes; study of crown gall, bitter rot, root rot, and other diseases affecting fruits; experiments and studies of injurious insects; experiments with insecticides, and inspection of orchards and nurseries.

INCOME.

The station is supported entirely by State appropriations, the amount for the years 1905 and 1906 being $34,700. Of this amount, $14,050 was expended during the year 1905.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 11, on peach rosette; Bulletin 12, on the peach industry in south Missouri, and the Biennial Report, 1903–4.

MONTANA.

Montana Agricultural Experiment Station, *Bozeman.*

Department of the Montana College of Agriculture and Mechanic Arts.

F. B. LINFIELD, B. S. A., *Director.*

GENERAL OUTLOOK.

For a year or more the Montana Station has been in process of reorganization, involving several changes in the staff and the creation of some new positions. Greatly improved facilities for housing live-

stock have been provided with a State appropriation. The lines of investigation have been similar to those outlined in previous reports. The entomologist of the station has continued his investigations on the life history of grasshoppers, strawberry crown girdler, and several other insects. The strawberry crown girdler has become very troublesome locally, and a bulletin giving suggested methods of control has been issued. The entomologist found, in studying the life history of the blister beetles, that while the adults are destructive to alfalfa, sugar beets, etc., in the young stages they live very largely on grasshopper eggs.

Notable among the new investigations undertaken are those with a herd of dairy cows in the production and utilization of milk, a new series of rotation experiments, tests of many varieties of alfalfa, and tests of sugar beets in cooperation with farmers. Farmers are also lending their aid in the loco studies with sheep conducted in cooperation with the Bureau of Plant Industry of this Department and the dry farming experiments in cooperation with the Northern Pacific Railway. The State legislature gave $1,000 for the dry-farming experiments and continued the $5,000 maintenance appropriation and the $4,000 farmers' institute appropriation. The director is in charge of farmers' institutes and nearly all members of the staff assist in the work. The irrigation engineer resigned during the year and has been succeeded by E. T. Tannatt.

The requests received for cooperative investigations are greater than the station can undertake, showing that the feeling toward the station continues to be most cordial. The new buildings provided for by the last legislature have been completed and add greatly to the equipment of the station. These additions and the reorganization of the staff will enable the station to give consideration to a number of lines of investigations that have heretofore been only partly covered.

LINES OF WORK.

The principal lines of work conducted at the Montana Station during the past year were as follows: Chemistry—study of alkali soils, alkali limit of plant growth, poisonous plants, effect of various rotations on soils, sugar-beet investigations, food inspection, and miscellaneous analytical work; meteorology; botany; field experiments—rotations, improvement of cereals, cooperative sugar-beet tests, test of grasses and forage crops, and dry-farming experiments; horticulture—orchard and small fruits and forest trees; feeding experiments—cattle and sheep; poultry experiments; entomology—grasshoppers and other insects affecting fruits, vegetables, and shade trees; dairying; irrigation—duty of water, losses by evaporation, seepage, methods of application, study of water rights, and plant

and pot experiments to determine the water requirements of plants and methods of application.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	6,440.67
Farm products	4,581.86
Total	26,022.53

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 52–58 and the Annual Report for 1903, which gives summary accounts of the operations in the different departments of the station during the year. The bulletins are on the following subjects: Sugar beets; creameries and cheese factories—organization, building, and equipment; the alkali soils of Montana, and the second annual report of the State entomologist.

NEBRASKA.

Agricultural Experiment Station of Nebraska, *Lincoln.*

Department of the University of Nebraska.

E. A. Burnett, B. S., *Director.*

GENERAL OUTLOOK.

The organization and main lines of work at the Nebraska Station remain practically unchanged. As heretofore, prominence is given to work in agronomy and animal husbandry. During the past fiscal year the results of some important investigations have been published. Among these were feeding experiments, the results of which gave the following indications: That some feeding stuffs rich in protein, such as oil meal, added in small quantity to a ration of corn and prairie hay, lessen the amount of food required for a given gain and lessen the cost of gains under Nebraska conditions; that alfalfa hay and corn make a satisfactory ration without a commercial protein feed; that when oil meal is fed in the grain ration cornstalks make a satisfactory roughage. In an experiment comparing corn with corn and oil meal fed to cattle on pasture the cost of gains was 13 per cent greater where the corn alone was fed and indicated

that there is a liberal profit in feeding some protein-rich feed to cattle being fattened on pasture.

Among the investigations recently started is one comparing a proprietary calf meal with other rations in rearing calves; studies of noxious weeds in the State; the profits from spraying orchards, and seed and cultivation in potato growing.

Breeding and selection experiments for the improvement of winter wheat, oats, corn, and alfalfa are in progress and are yielding valuable results in developing varieties having well-defined qualities or suited to special purposes and conditions. The work of the station on field crops and forage plants is very extensive and continues to be done to a large extent in cooperation with the Bureau of Plant Industry of this Department and with over 1,800 farmers in different parts of the State. Cooperation is also in progress in spraying orchards in different parts of the State. Members of the station staff take part in the farmers' institute work and station and college men were the principal speakers on the educational trains known as "seed-corn specials," "potato specials," "pure-seed specials," and "dairy specials," which traversed the leading railroad lines of the State advocating improved methods in agricultural practice.

Experiments at the North Platte substation have been undertaken to test varieties of grains, grasses, and forage crops adapted to semi-arid conditions. Macaroni and winter wheats, Kherson, Sixty-day, and other early varieties of oats; varieties of barley, emmer, corn, sorghum, and Kafir corn are being grown. Much attention is also being given at the substation to the introduction of tame grasses, the improvement of pastures, the influence of tillage on soil moisture, etc. The last legislature appropriated $20,000 for the substation, $8,000 of which will be used for buildings and permanent improvements and $12,000 for maintenance for two years.

Both the State and the university are pursuing a liberal policy toward the station, and the latter is profiting in a general way by the rapid growth of the school of agriculture with which it is associated. The station is doing increasingly valuable work for agriculture, and through its cooperative experiments and the farmers' institutes it is widely disseminating the results among the farmers of the State.

LINES OF WORK.

The principal lines of work conducted at the Nebraska Station during the past year were as follows: Chemistry; botany; meteorology; soils—sources of moisture, moisture as affected by different crops, aeration, and fertilization; field experiments—rotations, breeding experiments, grasses and legumes, sugar beets, winter wheat, corn, soy beans, and imported grains; horticulture—development of hardy

varieties of fruits by hybridization, grafting, and selection and breeding of beans; diseases of plants; forestry; feeding and breeding experiments; diseases of animals—cholera in hogs, dysentery in calves, abortion, mange, sorghum poisoning, cornstalk disease; dairying; entomology—grasshopper fungus disease, chinch-bug disease; extermination of prairie dogs with Pintsch gas by-products; irrigation—records of water used on different crops, methods of cultivation, and records of discharge of several rivers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation for substation	15,000.00
Farm products	7,679.47
Balance from previous year	655.98
Total	38,335.45

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 85–88 and the Annual Reports for 1903 and 1904. The bulletins are on the following subjects: Feeding experiments with cattle, destroying prairie dogs, a test of calf rations, methods of controlling contamination of milk during milking, and apple scab and cedar rust.

NEVADA.

Reno Agricultural Experiment Station, *Reno.*

Department of Nevada State University.

J. E. Stubbs,[a] D. D., LL. D., *Director.*

GENERAL OUTLOOK.

The work of the Nevada Station is now being developed more definitely along the lines of agronomy, animal husbandry, and horticulture as modified by irrigation practice. Cereals are being studied as to water requirements and adaptation to local conditions, including dry-farming practice. The irrigation investigations are in cooperation with this Office. Alfalfa is being tested as a pasture for pigs, and breeding experiments with cattle, sheep, and swine have been

[a] On leave.

undertaken. Eight acres have been set aside for botanical and horticultural experiments, which will include tests of fruit trees from nurseries in different parts of the country to secure stock best suited to Nevada conditions, experiments with cover crops for orchards to conserve irrigation water, and adaptation tests of ornamental trees and shrubs. Nearly 1,000 shrubs have been received from the Arnold Arboretum. Forage plant problems and range studies with winter range for sheep are continued, grass and forage plant gardens have been started, and small forest plantings have been made. Studies of anthracnose, contagious pleuro-pneumonia, and life history and means for repression of grasshoppers have been made.

The last legislature appropriated $10,000 for the equipment and support for two years of a substation in southern Nevada where horticultural and agricultural problems are to be studied. The station library has been put in better condition for use. Farmers' institutes have been conducted as heretofore by station men, and farmers are making large demands for station publications.

A reorganization of the station staff and duties has been planned that will relieve the officers from considerable teaching, to the advantage of the station work. If this is carried out as contemplated it should make more funds available for station investigations. The State's contribution to the station has hitherto been very meager, the assigned reason being the relative unimportance of agriculture in comparison with mining and other industries, but with the funds given for a substation in the southern part of the State a beginning has been made that may lead to continued support of the station. Additional income is needed for the proper equipment of the station that its work can be placed on a broader and more efficient basis.

LINES OF WORK.

The principal lines of work conducted at the Nevada Station during the past year were as follows: Chemistry; botany—studies of range problems; soils; field experiments—tests of varieties of wheat, grasses, alfalfa, and other forage plants; horticulture; forestry; animal breeding; animal diseases—anthrax and pleuro-pneumonia; entomology, and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	698.42
Balance from previous year	505.29
Total	16,203.71

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 58 on ground squirrels and other rodent pests in Nevada, and the Annual Report for 1904.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham.*

Department of New Hampshire College of Agriculture and Mechanic Arts.

W. D. GIBBS, M. S., *Director.*

GENERAL OUTLOOK.

Horticultural investigations continue to occupy an important position in the work of the New Hampshire Station. The horticulturist has completed his studies on the squash, the beet, and the cabbage, with reference to varieties, classification, history, etc., and has done a large amount of work in crossing squashes, cucumbers, tomatoes, melons, peppers, and carnations. He has also grown varieties of vegetables in cooperation with the Bureau of Plant Industry of this Department. In agriculture pig-feeding experiments making a comparison of raw *v.* cooked potatoes, and a number of other feeds have been closed; also the fertilizer experiments with grass. Nurse crops for new seeding and a number of forage crops are being tried and corn is being selected for earliness. A series of dynamometer tests on farm implements has recently been undertaken, and cooperative experiments with farmers in raising alfalfa and clovers have been arranged. The entomologist has been studying the brown-tail moth and the codling moth, and has taken up a study of the relation between temperature and the hibernation of insects. The chemist is devoting his time largely to a systematic study of the availability of potash in heavy clay soil.

The station is doing considerable work of direct practical application and is planning more. The past year has been one of preparation in several departments. The outlook is now good and the support of the station from its constituents is encouraging. Special stress is to be laid on bringing the station's results and improved methods of agriculture home to the farmers of the State.

LINES OF WORK.

The principal lines of work conducted at the New Hampshire Station during the past year were as follows: Chemistry—study of soils and analysis of fertilizers and feeding stuffs; field experiments—cultural experiments and variety tests of oats, corn, and forage crops; horticulture—tests of varieties of potatoes, strawberries, tomatoes, and other fruits and vegetables, experiments in breeding and forcing vegetables, and renovation of old orchards; forestry; feeding experiments; entomology—suppression of insect pests, and a study of the life zones and hibernation of the principal insects of the State; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	1,702.83
Total	16,702.83

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 112–119, and the Annual Report for 1904. The bulletins are on the following subjects: Experiments in destroying black flies; corn meal, middlings, and separator skim milk for fattening pigs; the Babcock test for New Hampshire farmers; the inspection of feeding stuffs in 1904; inspection of fertilizers in 1904; tile drainage, and forestry experiments.

NEW JERSEY.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

E. B. Voorhees, D. Sc., *Director.*

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

E. B. Voorhees, D. Sc., *Director.*

GENERAL OUTLOOK.

The investigations of the New Jersey stations in dairy husbandry have been continued along the lines already in operation to determine the possibilities of alfalfa as a substitute for various high-priced

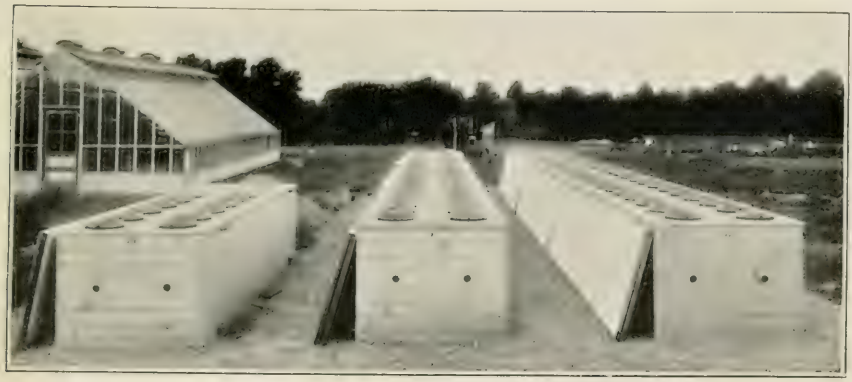

FIG. 1.—IN FAIR WEATHER THE POTS ARE UNCOVERED.

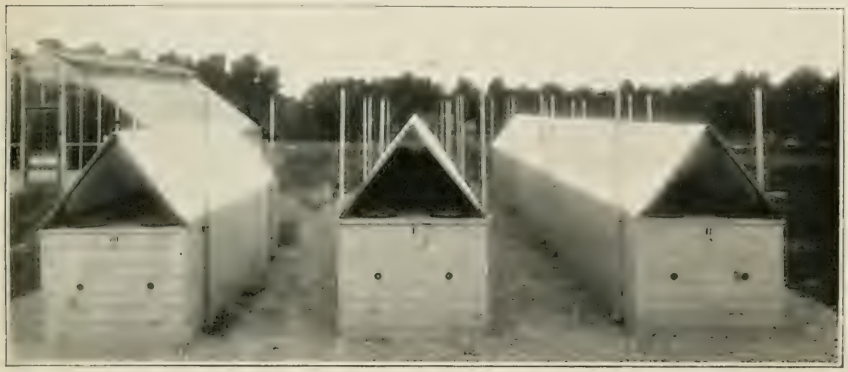

FIG. 2.—PORTABLE CLOTH COVERS FOR PROTECTION OF POTS IN INCLEMENT WEATHER.

FIG. 3.—BALANCE FOR WEIGHING POTS WITHOUT REMOVING THEM FROM THE FRAME.

POT EXPERIMENT PLANT OF NEW JERSEY STATIONS.

nitrogenous feeds in rations for dairy cows. The results thus far obtained from different feeding experiments point to the practicability and economy of thus using alfalfa, and the experiments in cooperation with farmers throughout the State have shown the adaptability of the soils of New Jersey for the growth of this leguminous crop, successful fields having now been established in nearly every county in the State. The station is also cooperating with this Department in testing seed of alfalfa grown in different parts of this country and of other countries. The other cooperative work with farmers in the State includes a study of the light brown soils of southern New Jersey with reference to their improvement by means of green manures and chemicals, and their adaptability to the growth of various forage crops.

An elaborate pot experiment on the general subject of nitrogen assimilation and the fertility and needs of different soils has recently been undertaken in which chemical, physical, and bacteriological studies are made. One hundred and sixteen glass pots have been set in a wooden frame, constructed with double walls to prevent heating (Pl. V, fig. 1), and provided with portable cloth shelters (Pl. V, fig. 2). A peculiar and simple device has been made by which the pots can be readily lifted and weighed (Pl. V, fig. 3). Among other lines of work recently inaugurated is the chemical investigation of the composition of carbohydrates in different feeding stuffs.

The entomologist is continuing his work with the San José scale and other insects, but is devoting special attention to developing means for eradicating the mosquito pest. As a result of his work under a special State appropriation of $10,000, the State legislature has appropriated $2,500 for 1905 and $3,500 for 1906 for a continuation of investigations, and $4,000 for 1905 and $6,000 for 1906 to enable the station to give State aid (not exceeding 25 per cent of the total cost) to municipalities and other communities engaged in eradicating mosquitoes under the direction of the station officers. The work of the New Jersey stations has steadily progressed during the past year and continues to combine to an unusual degree scientific accuracy with practical efficiency. The influence of these stations on the agriculture of the State is more widely and effectively felt than ever before.

LINES OF WORK.

The principal lines of work conducted at the New Jersey stations during the past year were as follows: Chemistry—study of carbohydrates in feeding stuffs, chemical composition and relative value of the various kinds of lime used in the State, methods of examining insecticides, studies of the losses of nitrogen in barnyard manures and of the assimilation of nitrogen in soils; biology—oyster cul-

ture; botany—breeding of corn, beans, and tomatoes, analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments—forage crops, soiling crops, experiments with fertilizers and garden crops, experiments with barnyard manures, study of nitrogen assimilation; horticulture—cultural experiments with orchard and small fruits, ornamentals, and vegetables, cross fertilization of egg-plants, sweet corn, cucumbers, and tomatoes; diseases affecting beans, potatoes, sweet potatoes, and other garden vegetables; diseases of animals; entomology—study of mosquitoes and methods of eradicating them, study of the rose scale, orchard insects, and the use of insecticides; dairy husbandry—breeding up a dairy herd; study of domestic pasteurizing methods and the care of milk in the home; feeding dairy cows, including the investigation of legumes as substitutes for purchased feeds; bacteria of soils, and irrigation.

INCOME.

The income of the stations during the past fiscal year was as follows:

State Station: State appropriation (fiscal year ended October 31, 1905)	$27,000.00
College Station: United States appropriation	15,000.00
Total	42,000.00

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of these stations received during the past fiscal year were Bulletins 172–185 and the Annual Report for 1903. The bulletins include the following subjects: The use of fertilizers, a review of the results of experiments with nitrate of soda; experiments with manures and fertilizers on different varieties of asparagus and raspberries; alfalfa hay, cowpea hay, and soy-bean silage as substitutes for purchased feeds, cotton-seed meal *v.* wheat bran and dried brewers' grains; concentrated feeding stuffs; analyses and valuations of commercial fertilizers; analyses of fertilizers; insecticide experiments for 1904; free distribution of experiment-station seed; experiments on the accumulation and utilization of atmospheric nitrogen in the soil; insects injurious to shade trees and ornamental plants; a popular review of the work of the experiment station; the analyses of stone lime, prepared lime, oyster-shell lime, wood ashes, and marl; and condimental feeds and condition powders.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, *Agricultural College.*[a]

Department of New Mexico College of Agriculture and Mechanic Arts.

LUTHER FOSTER, M. S. A., *Director.*

GENERAL OUTLOOK.

The investigation of problems in irrigation and closely related work has claimed the greatest attention at the New Mexico Station during the past year. Among the specific investigations are those on the cost of pumping for different crops, the relative efficiency of different pumps, soil moisture in relation to irrigation and to underground drainage, the rise and fall of underground water (in cooperation with the Reclamation Service of the U. S. Geological Survey), and the effect of well water on different crops. The irrigation investigations are in cooperation with this Office. The station is also investigating forage problems on the ranges and is cooperating with the Bureau of Plant Industry in a study of cacti as forage and in a study of cactus fruits as food for man or beast. The indications are that some varieties of this fruit will be found excellent for food. In both the fresh and dry state it is already a staple article of diet among the natives in some localities. Some varieties have excellent flavor and contain a large percentage of sugar. A good quality of jelly and marmalade has been made from certain varieties by the domestic science department of the college, and even the fruits which have an insipid taste in the fresh condition make good jelly, which can be rendered quite firm by the addition of a small amount of apple juice. The large amount of sugar, in some cases amounting to as much as 10 or 12 per cent, renders it unnecessary to add more than about half the usual quantity used in the preparation of fruit products generally.

The horticultural work includes numerous experiments with vegetables, studies of plant diseases and disease-resistant plants. The purchase of 23 acres of land for horticultural purposes makes it possible to extend the work along these lines considerably. The college has also purchased a farm of 250 acres, 100 acres of which is capable of irrigation. This will make it possible to place the irrigation investigations on a larger and more reliable scale, and will also furnish pasturage for cattle when they are not under experiment.

The station, in making special features of its irrigation and forage crop investigations, will undoubtedly be of great service in developing practices adapted to the local conditions. The possession of

[a] Telegraph address, *Las Cruces;* express and freight address, *Mesilla Park.*

additional land better adapted to agricultural and horticultural operations will make it possible to develop those lines of investigation to an extent hitherto impossible.

LINES OF WORK.

The principal lines of work conducted at the New Mexico Station during the past year were as follows: Chemistry—chemical survey of the waters of the Territory, analytical work, and study of native forage plants (cacti); field experiments—alfalfa, grasses for lawns and pastures, cereals, soil renovators, and forage crops; soils; feeding experiments with dairy cows, steers, and sheep to test the value of various grains and forage crops for soiling and for dry feed; horticulture—culture, pruning, spraying, and irrigation of orchard, vineyard, and small fruits, vegetable culture, tests of shrubs, flowers, and forest trees; botany—range problems; entomology; and irrigation—duty of water, pumps and pumping, irrigation waters.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	2,038.43
Miscellaneous	600.00
Total	17,638.43

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publication of this station received during the past fiscal year were Bulletins 51–53 on native ornamental plants of New Mexico, onion culture, and pumping for irrigation.

NEW YORK.

New York Agricultural Experiment Station, *Geneva.*

W. H. JORDAN, D. Sc., *Director.*

GENERAL OUTLOOK.

Among the publications of the New York State Station during the past fiscal year mention should be made of bulletins on specific gravity as a factor in seed selection, the composition of commercial spraying

soaps, the chemistry of cider vinegar, the proportion of animal food in the ration for ducklings, relations of casein and paracasein to bases and acids and their application to Cheddar cheese, sulphur washes for orchard treatment, proteids of butter in relation to mottled butter, winter injury to fruit trees, and the quality of commercial cultures for legumes. The station has also prepared as a part of its annual report The Apples of New York, in 2 volumes, which will contain more than 300 plates, half of which will be colored. Of work practically completed, or on which definite progress has been made but not yet published, mention should be made of the successful eradication of tuberculosis from the station herd and replacing diseased animals by healthy calves raised from both diseased and healthy mothers, experiments relating to the use of coarse fodders for poultry, and to the sources of protein for poultry, a study of galactase in cheese ripening, studies on the influence of fertilizers on the quality of fruits, studies on potato blight, fall spraying with sulphur washes, and fertilizer experiments in orchards with wood ashes, and with different fertilizers.

But little strictly new work has been undertaken, but crops have been grown preparatory to a comparative feeding of steers on a maximum of home-grown and minimum of purchased feeds, and on rations with larger proportion of feed from purchased materials. The chemist's work on koumys is also new, as is also a study of mites by the entomologist. The station continues to cooperate with the Bureau of Plant Industry of this Department on experiments with trucking crops, the storage of apples, and the breeding of sugar-beet seed. The bacteriologist has been making bacteriological examinations of nitrocultures in conjunction with the station bacteriologists in New Jersey, Delaware, and Michigan.

The cooperative and demonstration work with farmers has included treatment of asparagus rust in 1 locality, treatment of raspberry cane blight in 1, potato spraying experiments in 15, experiments with grape stocks in 2, the economy of dwarf orchards in 3, systems of orchard management in 2, growth of foreign varieties of chestnuts in 1, experiments with forage crops in 3, a test of sulphur washes in 15, and the control of the codling moth in 3.

A new $3,000 building for the storage of grain and machinery has been completed, making much more convenient the handling and maintenance in proper condition of the extensive outfit of farm and garden implements, and the storage of crops. New separators and a combined churn and butterworker also add to the convenience of the dairyman, while an 18-horsepower gas engine as a source of power for many purposes and a mill outfit greatly facilitate the preparation of feeds. Many changes in the staff have occurred. For the first time in many years the head of a department has resigned, the horti-

culturist going to the Iowa college and station and being succeeded by U. P. Hedrick, of Michigan. Other changes have occurred through the resignation of assistants to accept better paid or more attractive positions elsewhere, and one death has occurred, that of W. H. Andrews, for more than 10 years assistant chemist of the station.

The New York State Station continues to be maintained on a high plane of scientific thoroughness combined with practical efficiency. With a strong organization and relatively large resources it is accumulating results of increasing importance to the State and the nation. Its operations are being extended with a view of meeting more definitely the needs of different agricultural regions of the State, and it is planning to further increase enterprises having for their principal aim the demonstration of the practical benefits of the results of its researches and the adapting of these results to the actual requirements of agricultural practice in different regions.

LINES OF WORK.

The principal lines of work conducted at the New York Station during the past year were as follows: Chemistry—study of problems in cheese ripening, of changes in milk, and of fertilizers and feeding stuffs; bacteriology—study of problems in cheese ripening, tests of methods for the repression of rusty spot in cheese, and study of nitrocultures; meteorology; fertilizers—study of the proportions and forms of fertilizing ingredients best suited to the staple crops of the State; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments—tests of commercial fertilizers and stable manure on crops in rotation, study of crops grown on soils treated with crude chemicals, and cooperative tests of forage and soil-renovating crops, variety tests of cowpeas and wheat, growth of mother beets to test the possibility of raising sugar-beet seed; horticulture—study of the cause and effect of self-sterility among grapes, effect of fertilizers on the quality of strawberries and bush fruits, tests of various stocks for native grapes and for dwarf apples, comparison of American and Japanese chestnuts, use of screens for shading strawberries, experiments with apples in cold storage, breeding of grapes, raspberries, currants, gooseberries, and strawberries, test of lettuce fertilizers in the greenhouse, systems of management in apple orchards, collection of data to determine the significance of correlation of parts as a factor in plant breeding; diseases of plants—investigations and experiments in the treatment of raspberry and blackberry diseases, especially cane blight, study of diseases of apples, ten-year test of the efficiency of spraying potatoes to prevent disease and to increase yield, test of repressive measures for black rot of cabbage and cauliflower, with

investigation of soft rot of the same plants, study of Rhizoctonia as a cause of plant diseases; feeding experiments; poultry experiments—study of the effect and value of different classes of nutrients in poultry feeding and of inbreeding and selection as affecting egg production; entomology—biological study of the San José scale and the development of a successful and convenient method for controlling this insect, study of mites, currant fruit-worm, blackberry insects, and poplar weevil; dairying, and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$1,500.00
State appropriation (fiscal year ended October 1, 1905)	93,753.97
Total	95,253.97

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 248, 251, and 253–267, and the Annual Report for 1903. The subjects treated in these bulletins are as follows: New York apples in storage (with popular edition); vitality of the cabbage black-rot germ on cabbage seed; report of analyses of commercial fertilizers for the spring of 1904; fall spraying with sulphur washes (with popular edition); inspection of feeding stuffs; seed selection according to specific gravity; the composition of commercial soaps in relation to spraying (with popular edition); a study of the chemistry of homemade cider vinegar (with popular edition); the proportion of animal food in the ration for ducklings (with popular edition); director's report for 1904; some of the relations of casein and paracasein to bases and acids, and their application to Cheddar cheese; sulphur washes for orchard treatment (with popular edition); the proteids of butter in relation to mottled butter (with popular edition); potato spraying experiments in 1904 (with popular edition); plant-food constituents used by bearing fruit trees, tabulated analyses showing amounts of plant-food constituents in fruits, vegetables, etc.; report of analyses of samples of fertilizers collected by the commissioner of agriculture during the summer and fall of 1904; effect of certain arsenites on potato foliage (with popular edition).

Cornell University Agricultural Experiment Station, *Ithaca.*

Department of Cornell University.

L. H. BAILEY, M. S., *Director.*

GENERAL OUTLOOK.

The development of the Cornell Station under the new administration has progressed satisfactorily, except that the lack of funds has exerted a retarding influence. In the department of agronomy the work outlined in the last report of this Office has been continued, selection and breeding work being a prominent feature of nearly all the field-crop experiments. There has also been some work in farm mechanics on the draft of implements. In animal husbandry the work has consisted of experiments in meat production with cattle, sheep, and swine, and breeding experiments with dairy cattle.

In the horticultural department a wide range of investigations is being carried on, but special emphasis is being placed on studies of a spot disease found on Refuge wax beans, in which it has been found that picking off the diseased pods as they appear is quite effective; of the black rot of grapes, and of varieties of peonies with special reference to establishing a standard nomenclature. About 1,600 varieties of peonies are now being grown at the station, and some 400 more will be added. This work is being done in cooperation with the American Peony Association. Tests are also being made of methods of propagating from tuberous cuttings, and of storing cut flowers. The horticulturist is also studying about 400 varieties of beans in cooperation with the Bureau of Plant Industry of this Department. The station has been working on this subject for four or five years in cooperation with a large grower in the State in an effort to straighten out the nomenclature of varieties. Experiments in both warm and cool greenhouses on the effects of acetylene light on plant growth have given some striking results. Easter lilies, for example, produced larger plants and earlier blooms, and radishes were 10 days earlier. These experiments were made with numerous flowering plants and vegetables, and an effort is now being made to reduce the work to a commercial basis. Some work with mushrooms has been done in cooperation with the botanist, who is continuing his studies of fungi with special reference to working out the life histories of economic species of mushrooms and other fungi. A bulletin on mushroom growing for amateurs has been issued. The chemist has continued to cooperate with the Bureau of Chemistry of this Department in studying the effect of environment on the chemical composition of sugar beets, and has taken up, in cooperation with the agronomist of the station and a canning factory, studies on the effect of selection on the sugar content of sweet corn. The entomologist has continued his

studies on the troublesome insects of the State, especially those affecting grapes. He has found a remedy for the berry moth and for two comparatively new shade-tree pests. The poultry experiments on housing, ventilation, and feeding are being continued. Alfalfa pasturage for chickens is being tested, and a study of the rôle of grit in the diet is being made.

All of the agricultural work at Cornell University—instruction, investigation, and extension—has been greatly strengthened. There were about 400 students in the agricultural courses last year, including a considerable number of graduate students, and students of twenty different nationalities. The investigations are being developed as fast as funds will permit, and the extension work is being pushed. The farmers' reading course now has 26,000 readers. In the nature-study work there are 486 clubs, with a membership of over 14,000 children, who sent in over 33,000 letters on such subjects as alfalfa, soils, pumpkins, horses, dogs, cows, birds, and poultry. Two-thirds of the letters dealt with agricultural subjects, this being twice as many as ever before, showing a decided growth of interest in agricultural matters. With the completion of the new agricultural building both the college and the station will have greatly improved laboratory facilities, and be in a position to greatly extend their usefulness, provided they can secure adequate maintenance funds. There are abundant reasons why the State of New York should amply endow the agricultural department of this univeristy on a scale commensurate with the agricultural interests of the State, and no doubt this will be done.

LINES OF WORK.

The principal lines of work conducted at the Cornell Station during the past year were as follows: Chemistry—study of soils, sugar content of beets and sweet corn, feeding stuffs, dairy products, insecticides, and fertilizers; field experiments—tests of rotations, legumes, and fertilizers, tillage and fertilizer experiments with potatoes, beans, buckwheat, etc., plat experiments with grasses, and selection and breeding of field crops; horticulture—forcing strawberries, tree fruits, and mushrooms, studies of peonies, Japanese plums, and methods of spraying, investigation of plant growth under artificial light; diseases of plants—fungus diseases of forest and shade trees, study of the rôle of fungi in rendering available the plant food in dead wood, study of edible fungi and of numerous fungus and bacterial diseases of vegetables; feeding experiments—dairy cows, sheep, and swine; diseases of animals; poultry experiments—crossing of breeds, experiments in the cost of egg production, and on the effect of early molting on laying in the early fall and winter; entomology—study of the life history of several economic insects, and spraying experiments, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$13,500.00
State appropriation [a]	10,000.00
Farm products	210.95
Total	23,710.95

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 219–225, 227, and 228, and the Annual Report for 1904. The subjects of the bulletins are diseases of ginseng, skimmed milk for pigs, alfalfa in New York, record of an attempt to increase the fat in milk by means of liberal feeding, the grape berry moth, two grape pests, bovine tuberculosis, mushroom growing for amateurs, and potato growing in New York.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts.

B. W. Kilgore, M. S., *Director.*

GENERAL OUTLOOK.

The work of the North Carolina Station continues to be developed mainly along the lines of plant production for improved varieties and soil renovation, plant diseases, and dairying. About 40 acres is now devoted to plat experiments and 60 acres to rotation experiments, conducted on a self-supporting basis. The dairy work is mainly on problems of feeding and milk production, and is also largely self-supporting. There is some poultry work, including feeding, incubator and brooder work, and experiments with egg preservatives. The biologist is working on watermelon wilt in cooperation with the Bureau of Plant Industry of this Department, and on tobacco wilt, trying different methods of treatment and testing different varieties for resistance. He is also making some studies of the diseases of the apple and tomato.

The new agricultural building of the college, which is described on page 329 of this report, provides special research laboratories and

[a] Estimated amount of State appropriation spent for experimental purposes.

other improved facilities for such college officers as are connected with the station. The college had an enrollment of about 140 agricultural students during the year, and is doing much toward introducing elementary agriculture into the public schools of the State.

The State department of agriculture is continuing its work in the inspection of foods and fertilizers and the management of experimental farms. During the past few years about $65,000 has been spent for the land and equipment of four farms of about 200 acres each. Besides the farms established at Kingsboro and Statesville, one has recently been laid out at Willard for truck crops, and one at Blantyre, in the mountain section, for orchard fruits, potatoes, cabbage, celery, and other truck crops. These farms are devoted largely to demonstrations of results determined elsewhere, but there will also be some experimental work. As far as they are devoted to field crops, the experiments will be largely parallel to those carried on on the station farm at Raleigh.

The North Carolina Station is making progress in the differentiation of its research work, and its influence is being more widely felt in the State through its work in different localities. If its present policy is steadily maintained, the accumulation of results along the practical lines on which most of its operations are being conducted will undoubtedly be of increasing benefit to the State.

LINES OF WORK.

The principal lines of work conducted at the North Carolina Station during the past year were as follows: Chemistry—rate of nitrification of different nitrogenous substances in different soils, methods of analysis; soils; field experiments—variety, cultural, and fertilizer tests with cotton, corn, and cowpeas, experiments with grasses and forage plants; horticulture; plant diseases—wilt of tobacco and melons; animal husbandry—beef production, feeding work horses; diseases of animals; poultry experiments; dairying, and tests of farm machinery.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	[a]14,000.00
Farm products	771.35
Total	29,771.35

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

[a] Estimated amount of State appropriation spent for experimental purposes during the fiscal year ended December 1, 1905.

PUBLICATIONS.

The Annual Report for 1903, which includes brief accounts of the operations of the different departments of the station during the year, a statement of receipts and disbursements, reprints of the regular bulletins (Nos. 182–185) and press bulletins issued during the year, and special papers on the following subjects: Nitrification of different fertilizers, studies in nitrification, nitrifying power of typical North Carolina soils, the assimilation of free nitrogen by bacteria, and determination of sulphates in plants.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College.*[a]

Department of North Dakota Agricultural College.

J. H. Worst, LL. D., *Director.*

GENERAL OUTLOOK.

The North Dakota Station continues to give prominence to the origination and introduction of cereals, forage and fiber plants, fruits, and forest plants suited to North Dakota conditions and resistant to prevailing diseases; acclimatization tests of plants; studies of rotations and methods of culture in their relation to the maintenance of yields and of soil fertility; the conservation of moisture; the destruction of weeds; study of diseases of plants and their treatment, especially flax wilt; the care and use of manure; the breeding of improved strains of cattle, sheep, and swine, and the working out of better methods of feeding farm live stock; studies of dips and of practical methods of dipping for the eradication of live-stock pests, and chemical studies of wheat and of soil fertility. Among the new crop productions now ready for distribution are a variety of flax, a six-rowed barley, a two-rowed barley, and a variety of corn.

New studies of the different cereals for immunity from rust, and a study of the life history of rusts have been instituted this season. Another new piece of work is the study of the amount of soil water to determine the efficiency of tile drains as compared with open ditches. The employment of machinery in harvesting grain on wet land has been made possible by using a gasoline engine for power and mounting the machine on special trucks. The station cooperates with the Bureau of Plant Industry of this Department in investigations with cereals, forage plants, and other crops, and in studies of

[a] Freight and express address, *Fargo.*

varieties of flax, and of clover seed from different sources. Cooperation with the Forest Service of this Department in tests of trees adapted to the region has also been arranged.

A chemical building to cost $45,000 is in process of construction. This building will contain offices and laboratories for station work, as well as for college purposes. A library building is being constructed with $15,000 donated by Mr. Andrew Carnegie. This is one of the few land-grant institutions to which gifts for this purpose have been made by Mr. Carnegie, the others being the University of Maine and State College of Pennsylvania. The food-inspection work of the chemist has been so favorably received that additional laws providing for the inspection of formaldehyde, Paris green, and paints, and for tests of the milling qualities of different grades of wheat have been enacted, and the food-inspection law has been amended. The appropriation for this work is $9,000 for the biennial period. The last legislature also provided $10,000 for the establishment of a second substation at Dickinson, in the western and drier portion of the State, and continued the appropriation of $5,000 per annum for the substation at Edgeley. The college is taking part in a movement to introduce agricultural instruction in the public schools and to train teachers in nature study and school-garden work.

The past year at the station has been marked by decided progress in strengthening of force, developing of the work, and differentiation of college and station work. It is to be hoped that the State will recognize the substantial benefits it derives from the station work and provide sufficient funds to put it on a firmer financial basis.

LINES OF WORK.

The principal lines of work conducted at the North Dakota Station during the past year were as follows: Chemistry—investigation with soils and fertilizers, study of gluten content of selected wheats and of plant food in soils; botany—studies of grasses and forage plants and noxious and poisonous weeds, and seed control; field experiments—rotations, methods of culture, tests of hardy varieties of cereals and forage plants, selection of seed, selection and improvement of potatoes, sugar beets, corn, clover, alfalfa, and other farm crops; plant breeding—cereals; horticulture—variety tests of native plums and other fruits and of vegetables, experiments with forest trees; analysis of foods and spraying materials; diseases of plants—flax wilt, rusts, smuts, etc.; animal husbandry—feeding experiments with horses, mules, sheep, and pigs, and tests of the comparative feeding value of brome grass and timothy; diseases of animals; dairying; and tests of farm machinery.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation for substations	5,000.00
Farm products	1,213.70
Miscellaneous, including balance from previous year	4,266.16
Total	25,479.86

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 62–64, and Part II of the Annual Report for 1904. The subjects of the bulletins were weed studies, adulterated food products and food studies, and root systems of field crops. Part II of the Annual Report gives the results of the inspection and analysis of food products in North Dakota under the direction of the food commissioner for the year 1904.

OHIO.

Ohio Agricultural Experiment Station, *Wooster.*

C. E. THORNE, M. S. A., *Director.*

GENERAL OUTLOOK.

The work of the Ohio Station in the study of the problems relating to maintenance of soil fertility is being continued along the lines originally projected. It now covers more than 1,300 permanently located plats of land situated in four widely separated sections of the State and on soils typical of large areas. Of several hundred of these plats, located in part at the main station at Wooster and in part at the substation at Strongsville, the station has a definite history covering ten years or more, a fact which makes them especially valuable for certain lines of investigation, and they are being utilized in cooperative investigations by the Bureaus of Chemistry and Soils of this Department. At the Germantown substation special attention is being given to fertilizer and cultural experiments with tobacco to supplement the work of the Bureau of Soils on curing. At the Carpenter substation emphasis is placed on apple growing and forestry. Forest plantings are also being made in different parts of the State. There is a special demand for woods suitable for posts, and

with the increase in price of lumber farmers are much more interested in forestry. The horticultural department is also giving attention to fruit and vegetable growing, the latter in cooperation with the Bureau of Plant Industry, which is also cooperating with the botanist in conducting a plant-disease survey of the State. The other work of the botanist is mainly on the crossing of varieties of corn, wheat, and tobacco.

The station's investigations on the treatment of barnyard manure and on the importance of lime to clover and alfalfa are attracting much attention and are influencing the practice of many of the leading farmers of the State. Many carloads of powdered phosphate rock and of lime are being used over the State as the result of this work. The entomologist has continued spraying experiments for the San José scale and the codling moth. In the case of the codling moth the July spraying has been shown to be important. Observations have been made on different varieties of wheat with reference to relative immunity from the Hessian fly and midge. There seems to be little difference as regards immunity from the Hessian fly, but for the midge, bearded varieties are less affected than smooth and late varieties than early. Examinations have been made to determine the time of egg laying of the Hessian fly and whether other plants feed the fly. The agronomic work of the station is being extended to include not only a continuation of varietal and cultural tests of cereals and forage crops, but also a line of investigations on the improvement of the quality of the cereal grains through seed breeding and selection. A study of leguminous forage crops and corn is being conducted in cooperation with the Bureau of Plant Industry.

The experiments in cooperation with farmers, conducted under the supervision of the station experimentalist, are giving promise of great usefulness. A leading object of these experiments is to discover, through their agency, a number of farmers in different sections of the State who, by conducting scientifically planned experiments on their own farms under the station's guidance, may become demonstrators of improved methods in their respective neighborhoods.

The Ohio Station is actively endeavoring to meet the growing demand for demonstration work in different localities, which here as in other States is tending to broaden materially the scope of the operations of the station. At the same time the officers of the station keenly realize the necessity for increasing the scientific thoroughness and accuracy of their original investigations, and are seeking to strengthen their work in this direction. This is a wise policy, and the State will do well to support the station liberally in carrying it out on a consistent and efficient plan.

LINES OF WORK.

The principal lines of work conducted at the Ohio Station during the past year were as follows: Soils; field experiments—fertilizer and rotation experiments with corn, oats, wheat, potatoes, tobacco, and leguminous crops, variety tests of cereals, and experiments with cover crops; horticulture—growing vegetables under cheese cloth, forcing tomatoes, lettuce, cucumbers, and muskmelons, variety tests of vegetables and fruits, orchard management, and forestry; plant breeding and selection—corn and wheat; diseases of plants—rhizoctonia in potatoes, onion smut, grape rot, diseases of ginseng and tobacco, plant disease survey; feeding experiments with cattle, and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation, including balance from previous year	52,470.16
Fees	131.75
Farm products	5,127.52
Miscellaneous, including balance from previous year	5,375.24
Total	78,104.67

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 148, 150, 151, 154, 156–161. The subjects of the bulletins were as follows: Peach diseases; Ohio soil studies; proceedings of the second annual reunion of the Ohio State Board of Agriculture, the College of Agriculture of the Ohio State University, the farmers' institute lecturers of Ohio, and the Ohio Agricultural Experiment Station; varieties of strawberries; tobacco diseases and tobacco breeding; winterkilling of peach trees; forestry investigations; the maintenance of fertility, liming the soil; the codling moth; and experiments with fertilizers on tobacco.

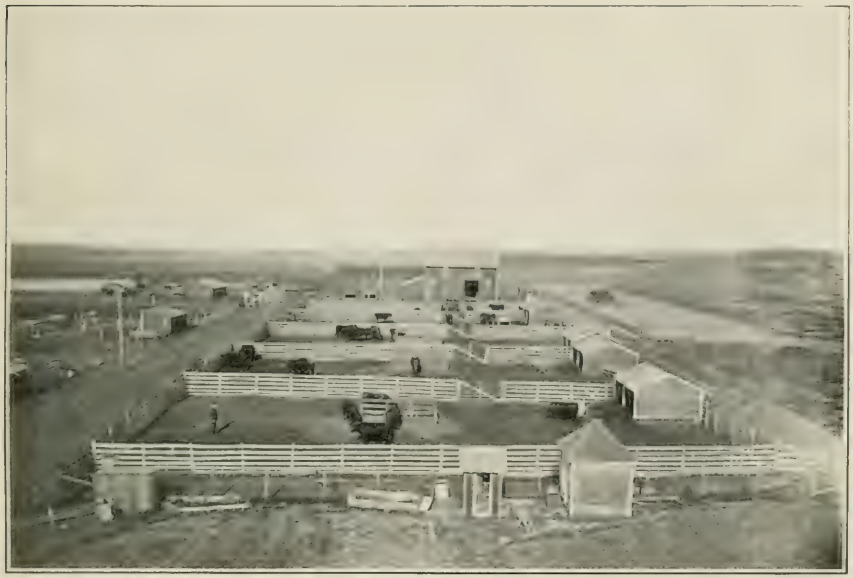

FIG. 1.—OKLAHOMA STATION LOTS FOR STEER-FEEDING EXPERIMENTS.

FIG. 2.—BLACK-HULLED WHITE KAFIR CORN. CONTINUOUS CULTURE—MANURED AND UNMANURED.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, *Stillwater.*

Department of Oklahoma Agricultural and Mechanical College.

JOHN FIELDS, B. S., *Director.*

GENERAL OUTLOOK.

The different departments of the Oklahoma Station have made substantial progress during the year. The bacteriologist and veterinarian has completed his bacteriological studies of drinking water for both man and beast, making a comparison of well water and that from ponds and windmill tanks. He has also been studying the artificial impregnation of mares, and the biology of the organisms of root tubercles on soy beans, alfalfa, and crimson clover. The agriculturist is breeding up a small herd of native dairy cows, and conducting feeding experiments with steers (Pl. VI, fig. 1), using Kafir corn heads with cotton seed, and comparing ground with unground Kafir corn in connection with whole cotton seed. He is also continuing the field experiments with alfalfa and wheat for pasture, fertilizer experiments with Kafir corn (Pl. VI, fig. 2), rotations, etc. The horticulturist has continued the work outlined last year, and undertaken breeding experiments with currants to secure a strain that will endure the dry winds of Oklahoma.

The chemist has been making a chemical study of Kafir corn, and has also carried out analytical work in connection with the feeding experiments and with the bacteriologist on the nitrogen-gathering bacteria.

A fertilizer and feeding-stuff law was passed during the winter, providing that the analytical work should be done by the station at a stipulated amount for each sample, the execution of the law to be under the State board of agriculture. The latter also has charge of the nursery-inspection law which was recently passed, and will pay the station men for any services they may render.

The Oklahoma Station and College have partaken of the prosperity of the Territory and been dealt with generously. The appropriation for the college last year was unusually large, including $75,000 for a building for the departments of agriculture and horticulture, and for administration; $15,000 for additional shops and recitation rooms for engineering; $2,500 for a gymnasium; $8,000 for acquiring the rights of lessees on the section granted to the college by Congress, and an increase of $5,500 per annum in the maintenance fund. The popularity of the station is said to be responsible for a large share of this increase.

The station is devoting itself to the leading agricultural problems and the development of new lines of farming. It is being wisely and

economically administered, and its outlook is very encouraging. It is making a strong impression on the farmers and now has their cordial support and confidence.

LINES OF WORK.

The principal lines of work conducted at the Oklahoma Station during the past year were as follows: Chemistry; field experiments—cereals, pasture and forage crops, continuous cropping, rotation experiments, potatoes, improvement of Kafir corn, castor bean, and cotton; horticulture—orchard and small fruits and vegetables, and breeding currants; forestry; diseases of plants; botany; bacteriology; animal husbandry—feeding experiments, breeding up dairy herd; diseases of animals—blackleg, parasites, dips, and loco diseases; and entomology—Hessian fly, cotton boll-weevil, and melon louse.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,421.65
Miscellaneous, including balance from previous year	2,837.98
Total	19,259.63

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 64, on destroying insects and fungus diseases, and the Annual Report for 1904, which is a summary statement by the director of the work and expenditures of the station during the year, to which are added reprints of some of the press bulletins issued during the year.

OREGON.

Oregon Experiment Station, *Corvallis.*

Department of Oregon State Agricultural College.

JAMES WITHYCOMBE, M. Agr., *Director.*

GENERAL OUTLOOK.

The Oregon Station has published the results of experiments with poultry under confinement, and of studies of the digestibility of vetch hay and corn silage. The other work of the station has been con-

tinued with some additions. The investigations concerning the feasibility of soiling dairy cows have been in progress three years and have shown conclusively that soiling is economical of land. As an average for the three years, 3.6 acres in alfalfa, vetch, rye, and winter oats (different relative areas in different years) yielded nearly 95,000 pounds of green forage, sufficient to maintain ten cows four months. A similar area in pasture would hardly maintain four cows four months. For several years an effort has been made to find a good pasture grass, and out of about 100 varieties tested during the past ten years *Festuca arundinacea* promises to be one of the best cattle pasture grasses for that section. Other efforts are being made to solve forage problems in Oregon, including cooperation between the agriculturist and the botanist in the attempt to domesticate the wild clovers and other economic wild plants. The chemist is aiding in this work by studying vetches for high protein content. This work is giving gratifying results, and from present indications it would seem that a plant carrying at least 20 per cent of total protein can be secured. He is also developing a method of drying hops, which consists of a new process of evaporation, so as to cure the product under lower temperatures, and thereby materially conserve the lupulin. This work bids fair to prove of exceptional value to a very important industry of this State.

The dairyman is studying the value of paraffin in the curing of Cheddar cheese. The entomologist, in addition to numerous studies of insect pests of the field and orchard, is giving considerable attention to plant diseases, including the watermelon wilt and onion rot, both of which are becoming troublesome in the State. The bacteriologist has undertaken some new work in the retting of flax by the use of selected culture organisms, the retting of various weeds for fiber, and a study of the micro-organisms in manure at different stages of decomposition to ascertain the value of the ptomaines as plant food. The station is cooperating with this Office in irrigation investigations and with the Bureau of Plant Industry in testing varieties of potatoes for disease resistance.

An adjustment of station funds has been effected which should make it possible to extend some of the lines of station work. The wide adoption of the station's recommendations regarding forage crops, soiling, rotation, hop culture and curing, and the other features of agricultural practice shows an appreciation of the work along these lines, and some of the results in lines of feeding, dairying, and canning vegetables and fruits are apparently of great practical importance. There seems to be a growing sentiment on the part of the people to consult with the station staff, as shown by the large correspondence and by the increased demand for station publications.

LINES OF WORK.

The principal lines of work conducted at the Oregon Station during the past year were as follows: Chemistry—analytical work, investigations with silage, waste products for fertilizers, plant food in soils, physics of soils, experiments in drying hops, study of protein in vetch hay; bacteriology—flax retting, micro-organisms of stable manure; soils; field crops—rotations, variety tests of cereals, grasses and other forage crops, hops, fertilizer tests; horticulture; diseases of plants; digestion and feeding experiments with dairy cows and swine, including soiling experiments with both; poultry experiments; entomology; dairying, including investigations on the curing of cheese; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, including balance from previous year	1,516.27
Total	16,516.27

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 81–86 and the Annual Reports for 1903 and 1904. The bulletins are on the apple in Oregon, the perpetuation of pure cultures for butter starters, poultry under confinement, digestibility of vetch hay and corn silage, and irrigation in Klamath County.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station, *State College.*

Department of the Pennsylvania State College.

H. P. Armsby, Ph. D., LL. D., *Director.*

GENERAL OUTLOOK.

The work of the Pennsylvania Station was continued along the same general lines as heretofore. The chemist has prepared a scheme for a very simple soil test with fertilizers to enable farmers to determine for themselves the approximate fertilizer needs of their land. The results of the station fertilizer tests continue to show that phos-

phoric acid is the controlling element on the station soils. Additional investigations have been carried on as to the practicability of raising alfalfa on the limestone soils of central Pennsylvania, the results being quite encouraging. It is believed that Pennsylvania farmers are warranted in attempting to grow alfalfa wherever deep, porous, well-drained soils are available for this purpose.

The important and fundamental investigations in animal nutrition with the use of the respiration calorimeter have been continued in cooperation with the Bureau of Animal Industry. One of these experiments, in which the availability of coarse fodders and corn meal was compared, has given interesting results. In general, it may be said that they show that the current method of comparing feeding stuffs on the basis of the total amount of digestible matter contained in them is seriously in error, and that the method of comparison by means of so-called "fuel values" is also inaccurate. Thus, it was found that for purposes of maintenance the digestible matter of corn meal was worth 21 per cent more than the same amount of digestible matter from timothy hay, while for productive purposes the corresponding difference was 56 per cent.

For the first time in its history the Pennsylvania Station has State funds for maintenance, the last legislature having appropriated $10,000 for two years, together with $2,500 for the erection of an implement shed and poultry houses. The other appropriations made for the agricultural department of the college were $75,000 for the agricultural building, and $30,000 for the maintenance of agricultural courses. These appropriations are especially important as indicating the changed attitude of the Commonwealth toward agricultural education and research. They were secured largely through the united efforts of the allied agricultural organizations of the State, and help to demonstrate that the agricultural forces of the State are united in their support of the movement for the proper equipment and maintenance of the agricultural work of the college.

There is evidently a great opportunity for the enlargement and strengthening of the agricultural work of the college and station to meet more adequately the needs of the agricultural people of this great State. With the awakening of interest in this matter recently evidenced, there should be little difficulty in greatly expanding the work of this college and station in the near future. Delay in formulating definite plans and perfecting organization for their execution would be unfortunate.

LINES OF WORK.

The principal lines of work conducted at the Pennsylvania Station during the past year were as follows: Chemistry—cooperation with other departments in the study of foods, feeding stuffs, excreta, ferti-

lizers, and agricultural products, miscellaneous analytical work, experiments with tobacco, referee work for the Association of Official Agricultural Chemists of the United States; meteorology; horticulture—variety tests of small fruits, experiments with crown gall of fruit trees, growing ginseng; field experiments—rotation experiments with fertilizers, rotation of legumes for soiling purposes, tobacco culture, variety tests of farm crops; feeding experiments—investigations in animal nutrition in the respiration calorimeter, feeding steers, and correlated chemical studies on the relative losses from the manure of fattening cattle under different conditions of feeding; dairying—building up a herd from common stock, feeding and care of dairy cows.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation, including balance from previous year	1,141.68
Fees	13,284.65
Farm products	4,453.43
Miscellaneous	250.13
Total	34,129.89

A report of the receipts and expenditures of the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were: Bulletins 67–70, and the Annual Reports for 1903 and 1904. The bulletins are on the following subjects: Variety tests of wheat, methods of steer feeding, the annual report of the director, and condimental, tonic, and other stock foods.

PORTO RICO.

Porto Rico Agricultural Experiment Station, *Mayaguez.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

D. W. May, M. Agr., *Special Agent in Charge.*

GENERAL OUTLOOK.

The Porto Rico Station has continued its former investigations and taken up field operations with rice and other crops, paying special attention to methods of culture and the use of fertilizers. Lowland

rice has not been formerly grown in Porto Rico, and it is believed possible to grow a large proportion of the supply of this cereal, practically all of which is now imported. The station has purchased a saddle-bred stallion and will undertake some breeding experiments. In addition, the station has acquired some pigs and will soon buy a few chickens for experimental purposes. An attempt is also being made to interest planters and others in improved breeds of cattle.

The experimental work in horticulture continues to occupy first rank in the station's operations. The plantings of citrus fruits, cacao, and rubber will be continued and extended. An experiment will be begun in planting an orchard of citrus trees in a small valley already covered with native forest trees. It is believed that the conditions of moisture found under the partial shade that is to be maintained will result in a more active growth of fungus parasites of the scale insects of oranges, etc., and thus render spraying unnecessary. Comparisons will be made with an orchard on cleared ground kept well cultivated. Investigations with mangoes and pineapples will be continued. Attempts will be made to propagate the better varieties of mangoes as rapidly as possible, cooperation with the Bureau of Plant Industry of this Department being maintained to secure improved varieties of mangoes and other plants. The pineapple industry seems to be developing rapidly in Porto Rico, and experiments with varieties, methods of planting, and use of fertilizers will be continued. Attention will be given the introduction of other economic fruits that seem promising for Porto Rico. The experiments with bananas, yautias, cassava, yams, and other plants that now furnish the larger part of the food of the people of Porto Rico will be continued, particular attention being given to the subjects of adaptation, culture, and use. Continued efforts in vegetable growing have resulted in splendid success with crops that were heretofore failures, and a bulletin on vegetable growing is in course of preparation. The success is attributed to the liberal use of fertilizers and thorough tillage. A limited experiment with tobacco is being carried on at Mayaguez this season, the object being to study some of the phenomena of fermentation.

The old plantation purchased by the insular government for the use of the experiment station has undergone extensive changes. Buildings have been repaired, fences built, and the lowlands drained. About 80 acres are now under cultivation and more land will be planted as the necessity for experiments and the means justify. The pioneer work having been nearly completed, it will now be possible to devote to experimental purposes the funds formerly used for clearing, fencing, etc. The policy of continuing the services of competent labor has been justified, as the laborers have become more efficient and require less constant supervision than formerly. A tract of about 7 acres ad-

joining the station, formerly the agronomic station under Spanish rule, has been turned over to the station for its use.

The insular legislature at its last session passed a seed and plant inspection law and a fertilizer law. In the former the station is charged with the inspection, while in the latter the station acts in an advisory capacity. The seed and plant inspection law is limited to the inspection of coffee, cotton, and citrus fruit trees, but on account of the fact that many parasites occur on a large number of species of plants the law should be made to include all importations. Cane, cacao, rubber, and other economic plants should be protected as well as those mentioned in the law.

The Porto Rico Station is becoming recognized as an important factor in developing the agriculture of the island. For many crops no definite data are available and these problems will be given attention as funds permit. The work at the coffee substation has already demonstrated the possibility of improving the production of that staple crop, and the extended adoption of the method of culture recommended would revolutionize the industry in Porto Rico. The problem of familiarizing the coffee growers with these experiments is a serious one, and it is one that can hardly be left to the station alone. The popularizing of the station's work through the medium of farmers' institutes has been begun and will be continued. The recent arrangements for cooperative and directive work for the insular government shows an appreciation of the station's work by the authorities.

LINES OF WORK.

The principal lines of work of the Porto Rico Station during the past year were as follows: Collection and variety tests of tropical vegetables and fruits; cultural and fertilizer tests with northern-grown crops to determine their adaptation, time of planting, etc.; experiments with fiber plants; investigations of injurious insects, and fungus and bacterial diseases of plants; selection of coffee; rejuvenation of an old coffee plantation; tobacco investigations; soil survey, and distribution of seeds for trial by farmers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,013.62
Total	16,013.62

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 4, on propagation and marketing of oranges in Porto Rico; Bulletin 5, on tobacco investigations in Porto Rico during 1903–4, and Circular 5, on coffee planting in Porto Rico.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, *Kingston.*

Department of Rhode Island College of Agriculture and Mechanic Arts.

H. J. WHEELER, Ph. D., *Director.*

GENERAL OUTLOOK.

The lines of work of the Rhode Island Station continue to be about the same as heretofore, and there has been no important change in the equipment of the station. Especial attention is being given to questions relating to the raising of turkeys, mainly with reference to the prevention of blackhead disease. This disease has become so prevalent in New England as almost to destroy the industry of turkey raising. The station investigations have indicated that the disease is spread by the keeping of turkeys with hens, though the exact way in which the disease is transmitted has not yet been determined. To further test this matter the station has taken a piece of land in the woods a considerable distance from the station farm and isolated from surrounding farms. It is hoped that turkeys raised under this environment will be free from blackhead. Efforts are also being made to secure a breed of turkeys resistant to disease. Turkeys are being brought in from Virginia and other regions for this purpose. This work is in cooperation with the Bureau of Animal Industry of this Department.

Field experiments to determine the extent to which soda may take the place of potash as a fertilizer are being extended through cooperation with the Bureau of Soils, and a study of the paraffin wire basket method of testing soils originated by the Bureau of Soils is being made. In cooperation with the Bureau of Plant Industry the station is testing varieties of corn, cowpeas, and other crops. It is also conducting one cooperative experiment with a farmer on the treatment of grass land. This is designed to furnish suggestions as to the desirability of conducting a considerable number of similar tests on farms in a number of sections of the State. The extension work is being continued under the auspices of this college with funds given by the State.

The business of the Rhode Island Station is carefully conducted, and with its present funds there is little opportunity for extension of its work. Its investigations on soils, fertilizers, and turkey diseases are of more than local importance.

LINES OF WORK.

The principal lines of work conducted at the Rhode Island Station during the past year were as follows: Chemistry—analytical work in connection with other experimental investigations; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments—fertilizers, rotations *v.* continuous cropping, variety tests, experiments with grasses; horticulture—rejuvenation of old orchards, manurial experiments with bush fruits, selection and breeding of fruits (raspberries and blackberries) and vegetables, orchard cover crops, and lawn grasses; and poultry experiments—diseases, brooding, incubation, etc.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,028.81
Miscellaneous	2,709.64
Total	18,738.45

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 100–104 and the Annual Report for 1904. The bulletins are on the following subjects: When to spray, analyses of commercial fertilizers, experiments in grass culture, and plant peculiarities as shown by the influence of sodium salts.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College.*[a]

Department of Clemson Agricultural College.

J. N. Harper, B. S., *Director.*

GENERAL OUTLOOK.

The investigations of the South Carolina Station have not changed materially during the last fiscal year. The chemical division is investigating among other things the manufacture of starch from the sweet potato and has erected a plant for the purpose. The agricul-

[a] Telegraph and express address, *Clemson College;* freight address, *Calhoun.*

tural division is cooperating in this work and is doing considerable work with cowpeas, alfalfa, and other legumes, including wild specimens, for feed and for soil improvement. Cotton is also receiving marked attention with reference to its fertilizer and cultural requirements and the improvement of staple and disease resistance. In animal husbandry and dairying some work in feeding and breeding and in handling dairy products for southern markets is being developed. There is a continuation of the investigation of rice blast and the insects affecting the rice plant, and of cultural and varietal work with fruits and vegetables. The veterinarian is testing the oxygen treatment for milk fever, studying the stomach worm in cattle, and doing some work in cooperation with the Bureau of Animal Industry of this Department and with farmers on the eradication and treatment of Texas fever. An attempt will be made to prepare an antitoxin for Texas fever. The diversification experiments at the substation near Charleston have been continued.

The year has been one of reorganization at the South Carolina Station. There have been many changes in the staff, including the resignation of the agriculturist and vice-director, which took effect at the close of the college year, in accordance with an agreement entered into a year previously, and the appointment of J. N. Harper, formerly of Kentucky, to the position of agriculturist and director. The appointment of a separate director was made at the request of the president of the college, who has endeavored to make a very definite separation of college and station work. Dr. H. Metcalf, botanist and bacteriologist of the station, has resigned to accept a position in this Department and will be succeeded by H. D. House, of this Department.

The college is dealing very liberally with the station. It now publishes popular bulletins as a feature of extension work, and proposes also to relieve the station of all expense in connection with the farmers' institutes. With a strong staff and improved facilities for carrying on investigations, and with a director who can give his principal time and energies to the planning of the station work and to its business, it may be said that the outlook for the station is very favorable.

LINES OF WORK.

The principal lines of work conducted at the South Carolina Station during the past year were as follows: Chemistry—study of different forage plants, plant food in soils; analysis and control of fertilizers; botany—diseases of rice; field experiments—domestication of native grasses and other forage crops, tests of crops for economic pork production, rotations, tests of sorghum and Kafir corn for hay, experiments with varieties of wheat and oats; horticulture;

plant breeding—cotton, strawberries; feeding experiments—mainly with dairy cows and poultry; veterinary science—diseases of cattle; entomology—orchard inspection, methods of destroying insect pests of fruits and vegetables, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,620.83
Farm products	960.70
Miscellaneous, including balance from previous year	2,635.34
Total	20,216.87

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 88–94, 96–108, and 110–113. Bulletins 92, 94, 97–102, 104, 106, 107, 108, and 110–113 are on the analyses of commercial fertilizers. The other bulletins include the following subjects: Sorghum as a sirup plant; sanitary conditions in the home and on the farm; Texas fever, inoculation; coast experiments; grasses and forage plants; a chemical study of the tea industry in South Carolina; reports of experiments with forage crops at the coast land experiment station, 1904, and analyses of cotton-seed meals.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, ***Brookings.***

Department of South Dakota Agricultural College.

J. W. Wilson, M. S. A., *Director.*

GENERAL OUTLOOK.

This station continues to give chief attention to the breeding of fruits, ornamental plants, cereals, forage crops, and live stock suited to South Dakota conditions. As a result of the extensive experiments with fruits and ornamental plants to increase hardiness and shorten the period of maturity so as to meet the severe climatic conditions of the region a number of excellent varieties have been developed by selection, crossing, and grafting from native fruits, such as the sand cherry and plum, or from hardy varieties introduced from other

regions of the United States and from abroad. Similar results by like methods are being obtained with cereals and forage plants, the work at the central station being supplemented by tests at the substation at Highmore under drier conditions. Special attention has been given to macaroni or durum wheats in comparison with ordinary wheats, the field tests being supplemented by analyses and milling, baking, and macaroni-making tests. The work with cereals is being done in cooperation with the Bureau of Plant Industry of this Department, as is also that with varieties of vegetables and fiber plants.

The breeding experiments with cattle and swine mentioned in the last report of this Office are under way, and experiments in crossing range ewes with rams of improved breeds have been undertaken to secure a better type of sheep for range conditions. There are also numerous feeding experiments with the different animals under observation to determine the relative value of different pastures, forage crops, mill by-products, millet seed, and the staple cereals—corn, oats, and barley. The new barn furnishes good facilities for both instruction and investigation. The agriculturist resigned at the close of the year to accept a position in the Bureau of Plant Industry of this Department, and the work in agronomy has been put in the immediate charge of the director.

By wisely concentrating its efforts on a few of the more important lines of work, such as animal husbandry and plant breeding, this station has been able with very limited funds to accomplish much of great value to the agriculture of the State. The wisdom of pursuing these fundamental lines of investigation uninterruptedly through a series of years is made evident by the important results of permanent value which are now rewarding the years of patient effort to find or produce strains or varieties of forage crops, fruits, and live stock suited to the peculiar conditions of South Dakota.

LINES OF WORK.

The principal lines of work conducted at the South Dakota Station during the past year were as follows: Physics and chemistry of soils; field experiments—rotations; plant breeding—selection and adaptation, including native and introduced fruits, cereals, and forage crops; diseases of plants and animals; animal husbandry—feeding and breeding experiments with cattle, sheep, and swine; entomology; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,000.00
Miscellaneous	3,140.73
Total	19,140.73

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications received from this station during the past fiscal year were Bulletins 83–91 and the Annual Report for 1904. The following are the subjects of the bulletins: Millet for fattening swine, report of investigations at the Highmore Station for 1903, early garden peas, fattening range lambs, the western sand cherry, breeding hardy fruits, preliminary experiments with vapor treatments for the prevention of the stinking smut of wheat, tankage and other by-products for pigs and shrunken wheat for swine, and cooperative tests in 1904 of peas, beans, sweet corn, and cabbage.

TENNESSEE.

Tennessee Agricultural Experiment Station, *Knoxville.*

Department of the University of Tennessee.

H. A. Morgan, B. S. A., *Director.*

GENERAL OUTLOOK.

The president of the University of Tennessee, the director of the station, the assistant agriculturist, and the assistant for plat work all resigned September 1, 1904, to accept similar positions elsewhere, and consequently much time was spent during the year in reorganizing. The new president entered upon his duties September 1, 1904, but the office of director remained vacant until January 1, 1905. Meanwhile the president acted as director of the station. The work in agronomy has been put in charge of the chemist, who has an assistant to look after the details of the plat work. New work with field crops has been started to test varieties of corn, cereals, and other crops for this locality, and the fertilizers best adapted to them; experiments in rotation of crops, with special reference to the use of fertilizers and stable manure under different conditions; experiments with green manuring for worn uplands and with phosphates

of various kinds, both with and without green crops turned under; and experiments to test the effect of leguminous crops when grown with nonleguminous crops. The location of plats has been changed in part to a more level land on the second bottom nearer the Tennessee River. It is also planned to make more use of the first bottom land for experimental purposes, as this area is typical of much land in Tennessee which is farmed with more or less risk on account of overflows. In this way the station will have experiments on first and second bottom and upland.

The horticultural investigations include variety and fertilizer experiments with strawberries, tomatoes, grapes, potatoes, and various studies on peaches, plums, cherries, apples, pears, and grapes. The botanical department has undertaken an investigation of clover sickness, a serious malady in Tennessee. A number of fungus diseases have been found, and what appears to be the chief cause of the trouble has been found to be a new anthracnose caused by an apparently undescribed species of Colletotrichum. Investigations of a disease known as trifoliosis, occurring in horses and mules pastured exclusively on alsike clover, have been undertaken. In some instances, where animals have been left on the alsike for an extended period, the disease has proved fatal. It has been observed that as soon as the animals are removed from the alsike and put on a different ration, they begin to improve, but if they are put back on alsike they again show symptoms of the disease. Experiments with sweet potatoes are being taken up as a new enterprise on land not hitherto used by the station.

The station is cooperating with the Bureau of Plant Industry of this Department in a series of experiments to establish hardy varieties of winter cereals, and in experiments with cereals, grasses, and forage crops in various combinations with and without legumes, the crops to be utilized as feed and green manure. A new department of zoology and entomology has been established during the year, and among other lines of investigation this department will conduct investigations in apiculture. The State board of entomology was also established, and the director and entomologist of the station was appointed State entomologist and pathologist.

The changes incident to the reorganization of the station have necessarily retarded its work, but the new management is making earnest efforts to overcome difficulties and has inaugurated a number of useful enterprises. The work is now well in hand and is being vigorously pushed. This station is, however, seriously handicapped by lack of adequate funds for maintenance and equipment. It should be put in a position which will enable it to work more effectively for the various agricultural interests of the State.

LINES OF WORK.

The principal lines of work conducted at the Tennessee Station during the past year were as follows: Chemistry—pot and other experiments with soils, digestion experiments, analytical work; inspection of fertilizers; field experiments—selection of cereals and legumes, experiments with forage crops for soiling and silage, methods of cultivation, green manuring, tests of meadow grasses, grazing experiments, etc.; horticulture—cultural, fertilizer, and grafting experiments with orchard and small fruits and vegetables; seeds; weeds; diseases of plants; feeding experiments; beef and dairy cattle and hogs; entomology, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	680.00
Farm products	4,810.10
Miscellaneous	677.89
Total	21,167.99

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins Vol. XVII, No. 3, on training and pruning fruit trees and vines, and No. 4, on replacing grain with alfalfa in a ration for dairy cows.

TEXAS.

Texas Agricultural Experiment Station, *College Station.*

Department of the State Agricultural and Mechanical College of Texas.

J. A. Craig, B. S. A., *Director.*

GENERAL OUTLOOK.

During the past fiscal year the Texas Station has given special emphasis to its feeding experiments to determine the value of local feeds. An experiment has been made to test the value of rice and rice products, alone and in combination with molasses feed, and a bunch of yearlings has been fed for show purposes to demonstrate what can be done with Texas feeds and molasses. Pigs have been fed

fermented cotton-seed meal to determine the practicability of utilizing this product without deleterious effects.

Another important line of investigation to which the station has given prominence is that on cotton. The cotton specialist of the station has 20 acres in plat and field experiments, and also some pot work to study the various factors in breeding cotton. This work is in cooperation with the Bureau of Plant Industry of this Department, and includes studies of the relation of various factors to productiveness and earliness. The agronomist is doing fertilizer and variety work with corn, conducting rotation experiments, testing forage plants for Texas, and making culture experiments. He has a series of 80 plats carefully laid out, and is trying inoculation experiments for alfalfa with cultures of nitrogen-fixing bacteria and with soil inoculation applied in both fall and spring.

The veterinarian is studying blind staggers, which caused the death of 4,000 or 5,000 horses in Brazos County last year, and is also giving attention to a disease of goats and continuing his inoculation work with Texas fever. The horticultural work includes fertilizer experiments with peaches in a new orchard, variety tests of pecans and plums, fertilizer tests and spraying experiments with tomatoes, the latter to control the blossom-end rot, which is very troublesome, and fertilizer experiments with sweet potatoes. The horticulturist is also experimenting with a half-acre farmer's garden for illustrative purposes and with bunch crops, which he is putting up for market. He is studying the geotropism of grape roots with the idea of securing a deep-rooted vine which will withstand drought. The horticultural work is conducted partly on the station grounds and partly at the Troupe substation.

The last legislature passed a feeding-stuff law, placing its execution in the hands of the station and providing a tonnage tax to pay the expense. Only $3,000 a year was provided for each substation, which is inadequate considering the important bearing that these substations have had in the development of the agriculture of the State. For example, from Beeville in 1898, the year in which the station was established, 21,738 pounds of vegetables were shipped out by express and none by freight. In 1904 207,409 pounds of vegetables were shipped by express and in addition 61 freight carloads. H. H. Harrington, chemist of the college and station, has been elected president, to succeed D. F. Houston, resigned.

The station is doing more work than ever before and is arousing much more popular interest. The farmers are now looking to the station for aid in various lines, and the station's correspondence is large. It is accomplishing all that could well be expected with the funds at its disposal; but the interests of this large State are so mani-

fold and diverse that the Hatch fund is far from sufficient to meet the demands. Every department is cramped for funds, and it becomes necessary to restrict the lines of work.

LINES OF WORK.

The principal lines of work conducted at the Texas Station during the past year were as follows: Chemistry—nitrification, study of feeding stuffs, soils, seed testing and feed inspection; field experiments—forage crops, variety tests, fertilizer and cultural experiments with corn and cotton; horticulture—variety, cultural, and fertilizer experiments with truck crops, nuts, and fruits, and study of geotropism of grape roots; feeding experiments; diseases of animals, and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation for substations	6,000.00
Farm products	82.85
Miscellaneous	1,529.52
Total	22,612.37

A report of the receipts and expenditures of the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 72–75 and 77 and Circulars 5–8. The bulletins were on the following subjects: Strawberries at Troupe Station, the composition of rice by-products, insects mistaken for the Mexican cotton boll weevil, early cottons, and onions and bunch crops at Beeville. The circulars were on cutworms, two plum weevils, grasshoppers, and the cotton boll-weevil in Texas.

UTAH.

Agricultural Experiment Station, *Logan.*

Department of the Agricultural College of Utah.

P. A. Yoder, Ph. D., *Director.*

GENERAL OUTLOOK.

Irrigation continues to be the main line of investigation around which nearly all the work of the Utah Station is grouped. In the experiments relating to irrigation problems at the station two small

farms have been secured and are devoted almost entirely to the study of crops and their water requirements. One tract is carefully flumed, and it is possible to accurately measure all water applied and that which runs off, thus determining the actual amount taken by the soil and the plants. An attempt is being made to determine the maximum and minimum quantities of water required for the production of different crops; effect of the application of the water at different stages of crop growth; relation of soils and subsoils to quantity of water required to make a crop; movement of water in soils, in which the results of about 40,000 determinations of soil moisture are about ready for publication; and the relative efficiency of irrigating by the flooding method and by furrows. Other investigations are being carried on in pot experiments to determine a number of factors in soil moisture movements. Much of this work, together with some work in draining irrigated land, is being done in cooperation with this Office. Other cooperative investigations are being carried on with the Bureau of Plant Industry of this Department on cereals and sugar beets, with the Bureau of Chemistry on the chemistry of sugar beets, and with the Bureau of Soils on the reclamation of alkali soils and crops for the reclaimed lands. The dry land farming experiments have been continued and extended, and give promise of good results. It is believed that this method of farming will reclaim in the Western States an area many times greater than can ever be brought under the system of irrigation.

The horticultural work includes variety tests with onions and irrigation for vegetables at the substations in southern Utah, and orchard management and irrigation at Brigham City. The work in animal husbandry, poultry husbandry, and entomology has been continued as in former years. P. A. Yoder, associate chemist, has been elected director of the station, vice J. A. Widtsoe; William Jardine, agronomist, vice L. A. Merrill; W. W. McLaughlin, irrigation engineer; and H. J. Frederick, veterinarian. The legislature at its last session appropriated $39,000 for experimental work under the station, apportioned as follows: For experiments in arid farming, $15,000; irrigation and drainage investigations, in cooperation with this Office, $10,000; for a central experimental farm to be devoted to fruit growing, $8,000; and for the maintenance of the branch station in the southern part of the State, $6,000. The increased appropriations for the Utah Station and the action of the legislature in turning over to it the control of the State station in the southern part of the State and in providing for a central fruit experiment station, show a growing appreciation of scientific agricultural investigation on the part of the public. Through its various cooperative enterprises, demonstration farms for dry land farming, and farmers' institutes, the station is reaching the farming communities better than before.

LINES OF WORK.

The principal lines of work conducted at the Utah Station during the past year were as follows: Chemistry—soils, feeding stuffs, sugar beets; alkali soil investigations—reclamation of alkali soils; meteorology; field experiments—rotations, testing varieties of cereals, sugar beets, and garden vegetables, and arid farming; horticulture; diseases of plants; cattle and sheep breeding; feeding experiments—cattle, sheep, horses; dairying; poultry experiments; entomology; irrigation—seepage investigations and water requirements of plants and soils.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,556.27
Balance from previous year	79.16
Total	16,635.43

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 88–91 and the Annual Report for 1903. The subjects of the bulletins are as follows: The relation of smelter smoke to Utah agriculture, a new centrifugal soil elutriator, feeding beet molasses and pulp to sheep and steers, and arid farming in Utah. There were also several circulars on plans for arid farming investigations and for irrigation investigations.

VERMONT.

Vermont Agricultural Experiment Station, *Burlington.*

Department of University of Vermont and State Agricultural College.

J. L. Hills, Sc. D., *Director.*

GENERAL OUTLOOK.

Few changes of importance have been made during the past year in the work of the Vermont Station. The results of feeding trials extending over seven years have been summarized and the study of soft rots of vegetables, in cooperation with the New York State Station, have been closed. The station is making a considerable feature of studies of potato diseases. Thorough botanical and bacteriological

investigations of these diseases are being continued and extensive field experiments in the introduction of disease-resistant varieties are being carried on in cooperation with the Bureau of Plant Industry of this Department. The station is also cooperating with the Bureau of Plant Industry in studies on the effect of climate on potato seed and in drug plant investigations.

The botanical and bacteriological investigations of the Vermont Station are being vigorously and successfully conducted and are of more than local value. The inspection service is also well organized and efficiently performed. The investigations in dairy husbandry have given useful results, but have now reached a point where they should be put on a different basis in order that by more thorough and scientific work results of wide and permanent value to the dairy interests of the State may be obtained. To do this most effectively the financial resources of the station should be increased, and it is hoped that a way may be found to do this.

LINES OF WORK.

The principal lines of work conducted at the Vermont Station during the past year were as follows: Chemistry—composition of potatoes, artichokes, etc., methods of analysis; bacteriology; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; botany—grasses and other forage crops, destruction of weeds, etc.; horticulture—propagation, pollenization, and hybridization of plums; diseases of plants—soft rots of vegetables, and diseases of potatoes; feeding experiments, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,545.72
Individuals	25.80
Fees	2,824.44
Total	19,395.96

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 108 and 110–115, on the following subjects: Commercial fertilizers, commercial feeding stuffs, abstract of Seventeenth Annual Report, 1903–4, preparation and use of sprays, alfalfa in Vermont, and disease-resistant potatoes.

VIRGINIA.

Virginia Agricultural Experiment Station, *Blacksburg.*

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute.

A. M. SOULE, B. S. A., *Director.*

GENERAL OUTLOOK.

The work of the Virginia Station during the past year has been largely of a preliminary nature, owing to the almost complete reorganization of the staff a year ago. At the same time the former investigations of the station have been continued, and some of them have given valuable results. It has been demonstrated that the composition of cider may be quite easily controlled by the use of pure musts, that these can be prepared and distributed to the farmers of the State at a slight cost by the station, and that the uncertainty and grave loss due to fermentation in the ordinary process of cider making can thus be eliminated. This is a matter of great importance, because thousands of bushels of apples are annually allowed to go to waste in the State because of the belief that it would not pay to manufacture them into cider, or because of the bitter experience many have had in their attempts to manufacture cider vinegar through the infection of the cider by undesirable yeasts and ferments.

A rather important piece of investigation was brought to a close during the present year relative to spraying cattle with kerosene emulsion for the destruction of the horn fly. The apparatus used consists of a series of spraying nozzles so arranged that the animals passing through a narrow chute are thoroughly covered with the solution. Its efficiency has been tested through two seasons, and it can be recommended as a cheap and efficient means of controlling the horn fly. This information will be of unusual interest to dairymen and beef raisers in all sections of the country. The bacteriologist is giving special attention to studies related to legume cultures for soil and seed inoculation. Cultures in liquid form for the principal leguminous crops have been sent to hundreds of farmers in the State.

The more important investigations inaugurated during the present year are confined to the departments of field investigations and animal husbandry. Investigations are in progress to determine the best varieties of corn, the influence of climate and elevation on corn, and the improvement of corn through cross-fertilization and selection. Similar investigations are in progress with wheat and other winter cereals. Tests are being made of all the principal legumes to establish their relative importance in Virginia agriculture and to determine the manner in which they can be used most effectively for ani-

mal nutrition and soil improvement. There are also fertilizer tests and rotation experiments with the principal farm crops. In the department of animal husbandry experiments have been undertaken to determine as far as possible the relative feeding value of silage made from different crops when fed with various combinations of meal, the comparative value of various forms of roughage for beef and dairy cattle, and the relative merits of different classes and grades of stock for beef and dairy purposes. A systematic plan of cross-breeding experiments has been inaugurated for the purpose of studying the various fundamental laws governing breeding.

During the year several additions have been made to the equipment of the station. A cattle feeding barn, which will accommodate 100 beef cattle, has been erected at a cost of $1,500, and a barn for the department of agronomy at a cost of $2,500. The foundations for a new $100,000 agricultural building for the college and station were laid last spring, and the work of construction is now going on. The work of the station is being actively pushed, and different departments are making plans of work to cover a series of five years. Much work that will enlist the sympathy and support of the farmers in different parts of the State is being done, and the outlook for the station is in the main very promising.

With the prospect which this State has of great increase in its agricultural interests in the near future, which may be materially stimulated and augmented by the general adoption of up-to-date methods of farm practice, the agricultural college and experiment station may easily be a very important factor in building up this industry and adding to the general prosperity of the State. The college and station should therefore receive the hearty support of the people of the State, and every effort should be made to put their work on the most efficient basis. The progress recently made in this direction is very gratifying.

LINES OF WORK.

The principal lines of work conducted at the Virginia Station during the past year were as follows: Chemistry—study of soils, fertilizers, and field crops; geology; field experiments—study of forage plants, corn, and other crops, including seed selection and breeding, tillage and manurial experiments, and rotations; analysis of foods; inspection of orchards; horticulture; bacteriology—of milk and soils, critical study of nitrifying and denitrifying bacteria; animal husbandry—breeding experiments, feeding experiments with beef and dairy cattle and swine, study of silage, corn stover, wheat straw, cotton-seed hulls, etc., as substitutes for hay; dairying; veterinary science; entomology; cider and vinegar making; biology, and study of ferments.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Miscellaneous	55.47
Total	15,055.47

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 143 and 148–153, and the Annual Report for 1904. Bulletin 143 belongs to the series of orchard studies, and treats of the composition of apples. The other bulletins are on hay substitutes, cowpeas and soy beans, the composition of cider as determined by dominant fermentation with pure yeasts, apple production in Virginia, experiments with caustic soda and some patent washes against the San José scale, and the horn fly.

WASHINGTON.

Washington Agricultural Experiment Station, *Pullman.*

Department of State College of Washington.

E. A. Bryan, M. A., LL. D., *Director.*

GENERAL OUTLOOK.

The work of the Washington Station has been continued along well-established lines. Special attention has been given to animal husbandry, including feeding experiments with cattle and sheep, in which all feeds were grown on the station farm. A farm of 120 acres has been rented for this work and a cereal specialist has been appointed to have charge of it. He now has over 2,000 varieties, hybrids, and selections under observation. The rotation, seeding, and cultural experiments with wheat as the main crop have been carried on seven years and results are about ready for publication. Experiments for the control of the wild oat pest by cultural methods are under way, and a series of cooperative experiments with farmers in soil management have been inaugurated. The cereal and forage investigations are continued in cooperation with the Bureau of Plant Industry of this Department, and the irrigation work in cooperation with this Office. The department of botany and entomology published four bulletins during the year on diseases and insect pests of

fruit. Other work on plant diseases and insect pests is being carried on, including spraying experiments for the extermination of the hop louse and a study of the crown gall of hops. The veterinarian is studying the morphology of the bacterium supposed to cause the symptoms of poisoning in sheep, and has continued his studies of tuberculosis in cattle and poultry. In the department of chemistry the study of Washington forage crops has been continued, attention being given to the chemical composition as affected by time of cutting, stages of growth, methods of curing, and the application or withholding of irrigation water. Studies are in progress on the chemistry of insecticides and of ripening fruits, and on the action of enzyms on ripening fruit. A soil survey is being made and a study of the effect of environment on the chemical composition of wheat has been started.

The new horticulturist, W. S. Thornber, formerly of South Dakota, came to the station late in the year and devoted his time largely to planning his work and starting plantations of forest seedlings and ornamentals. W. A. Linklater, recently of the correspondence agricultural school at Sioux City, Iowa, has been appointed head of the animal husbandry department of the college and station. The last legislature changed the name of the Washington Agricultural College and School of Science to State College of Washington, and appropriated $165,000 for maintenance during the next biennium. No appropriation was made for the Puyallup substation, which has been closed, nor for farmers' institutes, which will be continued with college funds.

The Washington Station is gaining in appreciation among the people, is making good progress in developing and carrying on investigations of importance to the region, and is in a fairly satisfactory condition, except that the teaching work of the staff is heavy and the funds of the station are too limited to permit the appointment of assistants to relieve the situation. The president has recommended the separation of the presidency and directorship, and it is hoped that the regents will act favorably upon his recommendation.

LINES OF WORK.

The principal lines of work conducted at the Washington Station during the past year were as follows: Chemistry—methods of analysis, chemical studies of hay, forage crops, fertilizers, foods, and dairy products; botany—study of crown gall, black spot, canker, tomato blight, pear blight, grain smuts; bacteriology; soils; field experiments—tests of grasses for pasture, varieties of oats, barley, emmer, spelt, and einkorn, rotations, time of seeding, sugar beets; horticulture; plant breeding—cereals, clover, alfalfa, and vetches; diseases of

plants; feeding and breeding experiments—cattle, swine, and sheep; veterinary science—control of the squirrel pest, poisonous effect of certain plants on sheep, tuberculosis of cattle and poultry; entomology—study of the codling moth in cooperation with other northwestern stations, insects affecting cereals, fruits, and hops; dairying; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	225.10
Total	15,225.10

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 61–66, on the following subjects: A report on irrigation conditions in the Yakima Valley, Washington; the raspberry cane-maggot; the raspberry root-borer, or the blackberry crown-borer; the apple scab in western Washington; three common insect pests of western Washington; blackspot canker.

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, *Morgantown.*

Department of West Virginia University.

J. H. Stewart, M. A., *Director.*

GENERAL OUTLOOK.

No material changes in the work of the West Virginia Station have been made during the past year. The usual amount of institute work has been done and addresses have been delivered by members of the station staff at various educational and farmers' meetings throughout the State. The constantly increasing correspondence indicates a larger interest and confidence in the work of the station among citizens of the State. The chemist has discontinued temporarily the work on the preservation of fruit juices by means of pressure in order to devote all of his energies to the possibilities of pressure in the artificial fixation of atmospheric nitrogen, which investigation was begun over eight years ago and has been receiving much attention ever since.

Many of the more plausible methods proposed by others have been carefully tested, and some of them materially improved. This station's original method, which consists essentially in heating compressed air by means of an electrical current, still continues to give the best results. A larger equipment is being installed and the work will be continued.

The agricultural department has continued to give prominence to poultry investigations with special reference to egg and meat production. A five years' comparative test of stable manure and commercial fertilizers as a top dressing for meadows, with reference to the economic production of hay as well as the total yield per acre, has been concluded, and the results are now being published in bulletin form. A comparison of Ayreshires, Jerseys, and crosses between these two breeds has been inaugurated and will be carried on for some years. A test of the maximum and minimum ration of silage and grain feeds for the economic production of milk is being conducted. The station is now conducting a cooperative experiment with a number of farmers in the State for the purpose of ascertaining if it be possible to exterminate the stomach worm of sheep (*Strongylus contortus*) from the flocks and fields. The remedy used is a preparation of coal-tar creosote, and very promising results have been obtained.

The horticulturist is studying potatoes with special reference to blight resistance, and peaches with special reference to the best fertilizers to use. This work is carried on in different parts of the State. In the greenhouses at the station special attention has been given to experiments with lettuce and chrysanthemums. A study of the methods of marketing fruits is also being made with a view of impressing West Virginia farmers with the advantage of greater attention to this matter. About 50 new varieties of potatoes are being tested in cooperation with the Bureau of Plant Industry of this Department. There is also cooperation between this Bureau and the bacteriologist of the station in a study of the plant diseases of the State. The entomological work of the station includes an exhaustive study of the grape curculio and a study of the life history of the woolly aphis. The fertilizer and nursery work have been continued.

The work of the West Virginia Station has been steadily pursued during the past year. Many of its investigations are of direct practical usefulness to the agriculture of the State, and it is encouraging to find that the farmers are taking increased interest in them. The horticultural work should be further developed, and since this line of work must necessarily be conducted principally away from the station, the station horticulturist should be relieved from duties connected with the college. While the farmers' institutes are doing

much to arouse interest in better methods of farming, there is great need for the more thorough organization of agricultural education in West Virginia. The college of agriculture of the university should be put in a position to do more effective work at the university and by extension work through the State.

LINES OF WORK.

The principal lines of work conducted at the West Virginia Station during the past year were as follows: Chemistry—study of insecticides and fungicides, analytical work with feeding stuffs and waters, study of pressure as a preservative, of a process for the fixation of atmospheric nitrogen, and of the salt brines of certain poisonous plants, methods of analysis; analysis and control of fertilizers; inspection of orchards and nurseries; soils—study of fertility by use of rotations, green manures, commercial fertilizers and barnyard manure, study of acid soils, soils of orchard sections, methods of burning and distributing native lime, etc.; field experiments—variety tests of cereals and legumes, fertilizer experiments with pastures and meadows; horticulture—adaptability of mountain-glade lands for truck crops, cranberries and other fruits, forcing experiments with vegetables, experiments with insecticides and fungicides, and studies of diseases of fruits and vegetables; feeding experiments with sheep; poultry experiments—production of meat and eggs, incubation experiments to improve flavor of meat and eggs of domesticated fowls; and entomology—insects injurious to orchards, orchard products, and forest trees.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	11,682.33
Farm products	2,951.83
Miscellaneous	139.49
Total	29,773.65

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 92, 93, and 95, on commercial fertilizers, mixtures and appliances for spraying, and Special Bulletin 3, on San José scale in West Virginia.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison.*

Department of the University of Wisconsin.

W. A. Henry, D. Agr., D. Sc., *Director.*

GENERAL OUTLOOK.

Few new lines of work have been taken up by the Wisconsin Station during the past year, but old lines have been extended and developed as far as means and facilities would permit. The station has recently closed a comparative test of alfalfa, medium red clover, timothy, and brome grass, in which the weight of green forage obtained from alfalfa was approximately double that of clover, three times that of timothy, and five times that of brome grass; nearly the same proportions held for hay, while in the case of protein, alfalfa yielded three times as much as clover, nine times as much as timothy, and twelve times as much as brome grass. The total quantities of dry matter and fat were also much in favor of alfalfa. In an experiment in the production of grade lambs in winter and marketing them about the middle of March, at an average age of seventy-five days, the station realized a net profit of $6.43 on each lamb. An extensive series of tests in withholding salt from dairy cows showed that serious derangement was sure to come at some time, usually directly after parturition. The bacteriologist has had good success in locating some of the causes of difficulty in the manufacture of Swiss cheese and the pasteurization of milk in a number of commercial plants.

The disposal of dairy sewage and the manufacture of whey butter are new lines of work which are to be taken up. A small sewage plant has been constructed to take care of the dairy sewage. A septic and filter bed system is to be employed, the effluent to be used for irrigation purposes. To foster the horse breeding interests of the State a department of horse breeding has been created, and placed in charge of Dr. A. S. Alexander, veterinarian of the station. The legislature has passed an act requiring all stallions used for breeding purposes in the State to be registered and licensed by this department. Wisconsin is considered one of the best States in the Union for breeding high-quality horses, and it is believed that the efforts inaugurated will greatly stimulate this important industry. The department of agricultural engineering has made rapid growth on its educational side, and is making investigations in stable ventilation and with concrete fence posts. The work in agronomy continues to be extensive, and includes considerable new work in corn breeding and testing. The soil work continues to be largely concerned with investigations on muck soils. The new work in animal husbandry consists quite largely of

feeding experiments. The department of chemistry is investigating condimental stock feeds, studying proteids of milk, methods of estimating butter fat, and creamery sewage. The latter work is cooperation with the dairy department. The department of horticulture is closing up the old experiments on the improvement of native plums and apples, and starting systematic breeding work with these fruits. The tobacco investigations are being continued with State funds, as are also the cranberry investigations, in which this Office cooperates. The extensive cereal investigations are conducted partly in cooperation with the Bureau of Plant Industry of this Department and partly with the Wisconsin Agricultural Experiment Association, with which the station is also cooperating in a number of other lines.

A number of additions have been made to the staff of the station during the past year, including an assistant to the director, who will serve as editor of station publications and also undertake investigations in animal nutrition, and assistants in horticulture and soils.

The Wisconsin Station, while maintaining the high standard of its work in animal husbandry and dairying, with which it has been so prominently identified in past years, has in recent years developed especially along the lines of agronomy, agricultural engineering, and horse breeding in a way that keeps it fully in touch with modern progress in these important directions, and make it increasingly helpful to the agriculture of the State.

LINES OF WORK.

The principal lines of work conducted at the Wisconsin Station during the past year were as follows: Chemistry—studies of condimental feeds, proteids in milk, and organic matter of drying plants; bacteriology—studies of nodules of legumes, soil bacteria, pasteurization, and yeasts in cheese; soils—pot and field experiments with muck; field experiments—cereals, forage crops, and soil renovation; horticulture—studies of seedling apples and plums, breeding of native plums and apples, experiments with strawberries, cranberries, tomatoes, and tobacco; horse breeding; feeding experiments—horses, cattle, sheep, and swine; dairying—Swiss cheese manufacture, and creamery sewage disposal, experiments with skim milk, condensed milk, and cream; irrigation; drainage; and agricultural engineering—stable ventilation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	18,500.00
Fees	1,975.00
Total	35,475.00

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 114–126 and the Annual Report for 1904. The bulletins are on the following subjects: A lesson in bovine tuberculosis; the quality of cheese as affected by rape and other green forage plants fed to dairy cows; on the relation of food to the production of milk and butter fat by dairy cows; the relation of food to dairy production; licensed commercial feeding stuffs, 1904; a report on cranberry investigations; concentrated feeding stuffs and fertilizers licensed for sale in Wisconsin, 1905; alfalfa, or lucern; the beet-sugar industry of Wisconsin; report on tobacco investigations in Wisconsin for 1903 and 1904; silo construction; two ways of treating tuberculosis in herds.

WYOMING.

Wyoming Agricultural Experiment Station, ***Laramie.***

Department of the University of Wyoming.

B. C. Buffum, M. S., *Director.*

GENERAL OUTLOOK.

The Wyoming Station made considerable progress during the past year in concentrating and reorganizing its work more efficiently. The good results reported by the station last year in its experiments in feeding lambs peas have attracted attention and led ranchers to take up this work, one ranchman putting in 400 acres of peas. During the past year a new series of experiments in feeding lambs was carried out. The more important results of these experiments were that barley fed with alfalfa produced better results than the feeding of corn with alfalfa, though the difference between the two grains was slight; that corn combined with native hay is not a good ration; that it is possible to use ground flaxseed from which the oil has not been compressed in compounding practical feeding rations, and that it is possible to fatten lambs without grain by the use of alfalfa, turnips, and flaxseed. Spelt is also proving a fine crop for that country. It gives a large yield of excellent feed. Experiments are being made with Tamworth pigs, raising them at that altitude on home-grown feed, and comparing wheat with corn as a grain ration. Wheat gave gains nearly twice as large as those from corn, both grains being fed in equal amounts. Some experiments were con-

ducted to show the possibility of using to advantage cured alfalfa hay in the swine rations, and the results show that growing pigs of 90 pounds or upward will make satisfactory gains on a ration of approximately one-half wheat and one-half alfalfa hay. For young pigs, however, dry alfalfa was not satisfactory.

In agronomy the principal work taken up was some new experiments with barley. This is one of the most important grains raised in the State, and detailed information of varieties suitable for feeding and brewing and the best cropping systems with barley, promises to be of much value to the people. Tests are being made of sweet clover (Melilotus), which grows well at that altitude and on very alkaline and poor soils. It is thought to be a fine high-altitude plant, and experiments will be made in curing it with salt so that cattle will eat it. Considerable work is being done with turnips and ruta-bagas, as these have given such good results in the feeding experiments, and potatoes are being grown with seed from different localities to avoid Rhizoctonia. The main part of the farm is being used to grow large crops of alfalfa and peas to be used in the station's feeding experiments.

The most important investigations newly inaugurated by the station have been studies of the high altitude native and cultivated grasses and forage plants. These studies include ration experiments, experiments to determine digestibility, and studies of chemical composition. The digestion experiments carried out indicate that alfalfa raised above 7,000 feet altitude has a higher coefficient of digestibility than shown by trials in other places. A small amount of irrigation work was done in cooperation with this Office, and some varieties of flax were grown in cooperation with the Bureau of Plant Industry. The last legislature passed three bills of interest to the station, one appropriating $2,000 for farmers' institutes and short courses during the next two years under the control of the agricultural department of the university; another providing a fund of $2,000 for horticultural experiments at Lander, which will be under the control of the director of the station and two others, and a third bill establishing a State horticultural society and making the botanist and zoologist of the station an ex-officio member of that board.

The feeling toward the station in the State is good, and it is gaining a strong hold on the people. This is evidenced by the success of the short courses, which have been operated for two winters very largely through the efforts of the station, and have attracted large and enthusiastic attendance. These have been practically protracted farmers' institutes at the experiment station. The outlook for the station is unusually good. It needs to expand its work and take up some other departments, but there will be difficulty in doing this unless additional funds can be secured.

LINES OF WORK.

The principal lines of work conducted at the Wyoming Station during the past year were as follows: Botany; range improvement; meteorology; soils—rotations, continuous cropping, cultural experiments, renovators, study of soil characteristics; fertilizers; field experiments—variety tests and cultural experiments with cereals, forage crops, and garden vegetables; analysis of foods; feeding experiments—beef and dairy cattle, pigs, poultry, and range sheep and lambs; and irrigation—measurement of water on the station farm, plat experiments, and effects of irrigation on alkali.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	604.30
Total	15,604.30

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 62–64, and the Annual Report for 1904. The subjects treated in the bulletins include some food products and their adulteration, native and introduced saltbushes, and feeding experiments with lambs, 1903–4.

STATISTICS OF LAND-GRANT COLLEGES AND AGRICULTURAL EXPERIMENT STATIONS, 1905.

By Miss M. T. Spethmann.

The following statistical statements relate to the institutions established under the acts of Congress of July 2, 1862, and August 30, 1890, most of which maintain courses of instruction in agriculture, and to the agricultural experiment stations, which, with few exceptions, are organized under the act of Congress of March 2, 1887, and are conducted as departments of the institutions receiving the benefits of the land-grant act of July 2, 1862. These statistics have been compiled in part from replies to a circular of inquiry sent out from the Office of Experiment Stations, and in part from the annual reports of the presidents of these institutions made on the schedules prescribed by the Commissioner of Education. Tables showing the annual disbursements on account of the acts of Congress of March 2, 1887, and August 30, 1890, prepared in the Departments of the Treasury and the Interior, are also included. Owing to the complex organization of many of the institutions, it is impracticable to give exactly comparable statistics in all cases, and in some instances the data furnished are incomplete.

SUMMARY OF STATISTICS OF LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, are now in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. The total number of these institutions is 65, of which 63 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1905 is estimated to be as follows: Land-grant fund of 1862, $12,049,626.89; other land-grant funds, $3,295,193.51; other permanent funds, $15,968,463.07; land grant of 1862 still unsold, $4,101,749.18; farms and grounds owned by the institutions, $6,665,013.43; buildings, $28,192,385.11; apparatus, $1,957,030.42; machinery, $2,623,995.48; libraries, $2,520,350.21; live stock, $342,998.09; miscellaneous equipment, $3,544,959.03; total, $81,251,764.42. The income of these institutions in 1905, exclusive of the funds received from the United States for agricultural experiment stations ($694,163.45), was as follows: Interest on land-grant funds of 1862, $721,-

491.77; interest on other land-grant funds, $96,960.70; United States appropriation under act of 1890, $1,200,000; interest on endowment or regular appropriation, $552,004.19; State appropriation for current expenses, $3,048,422.22; State appropriations for buildings or for other special purposes, $2,313,060.53; income from endowment, other than Federal or State grants, $671,888.10; tuition fees, $881,195.30; incidental fees, $607,980.94; miscellaneous, $1,674,150.79; total, $11,767,154.54. The value of the additions to the permanent endowment and equipment of these institutions in 1905 is estimated as follows: Permanent endowment, $628,542.08; buildings, $2,133,225.41; libraries, $182,247.43; apparatus, $173,589.42; machinery, $153,025.78; live stock, $50,712.36; miscellaneous, $180,170.71; total, $3,501,513.19.

The number of persons in the faculties of the colleges of agriculture and mechanic arts was as follows: For preparatory classes, 475; for collegiate and special classes, 2,062; total, 2,672. In the other departments the faculties aggregated 1,889, making a grand total of 4,561 persons in the faculties of the land-grant institutions.

The students in 1905 in the colleges for white persons were as follows: (1) By classes—preparatory, 5,072; collegiate, 20,020; short course or special, 10,196; postgraduate, 515; other departments, 17,830; total, 53,518. (2) By courses: *Four-year*—agriculture, 2,526; horticulture, 112; household economy, 854; mechanical engineering, 4,227; civil engineering, 3,624; electrical engineering, 2,934; mining engineering, 1,022; chemical engineering, 379; architecture, 148. *Shorter than four years*—agriculture, 3,230; dairying, 617; horticulture, 38; veterinary science, 749; military tactics, 16,657.

The students in colleges and schools for colored persons were as follows: (1) By classes—preparatory, 4,781; collegiate, 709; short or special, 409; other departments, 683; total, 6,294. (2) By courses—agriculture, 1,624; industrial courses for boys, 2,494; industrial courses for girls, 3,428; military tactics, 1,566.

The graduates in 1905 were 5,061, and since the organization of these institutions, 62,081. The average age of graduates in 1905 was 22 years. The total number of volumes in the libraries was 2,141,465. The total number of acres of land granted to the States under the act of 1862 was 10,233,169, of which 844,164 are still unsold.

SUMMARY OF STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories, and under special appropriation acts in Alaska, Hawaii, and Porto Rico.

In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana, separate stations are maintained wholly or in

part by State funds. A number of substations are also maintained in different States. Excluding the substations the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the act of 1887 during 1905 was $1,515,734.47, of which $718,163.45 was received from the National Government, the remainder, $797,571.02, coming from the following sources: State governments, $540,467.31; individuals and communities, $8,925.80; fees for analyses of fertilizers, $82,428.32; sales of farm products, $93,058; miscellaneous, $72,691.59. In addition to this the Office of Experiment Stations had an appropriation of $177,500 for the past fiscal year, including $15,000 for the Alaska experiment stations, $15,000 for the Hawaii experiment station, $15,000 for the Porto Rico experiment station, $20,000 for nutrition investigations, $67,500 for irrigation investigations, and $5,000 for farmers' institutes. The value of additions to the equipment of the stations in 1905 is estimated as follows: Buildings, $68,834.28; libraries, $10,119.29; apparatus, $19,166.09; farm implements, $14,621.59; live stock, $23,862.27; miscellaneous, $19,016.20; total, $155,619.72.

The stations employ 845 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 56; assistant and vice-directors, 18; special agents in charge, 3; chemists, 166; agriculturists, 58; agronomists, 44; animal husbandmen, 56; poultrymen, 12; horticulturists, 82; farm and garden foremen, 30; dairymen, 39; botanists, 56; plant pathologists, 11; entomologists, 65; zoologists, 4; veterinarians, 36; meteorologists, 8; foresters, 4; mycologists, 4; biologists, 3; physicists, 5; geologists, 8; bacteriologists, 18; irrigation engineers, 13; in charge of substations, 27; secretaries and treasurers, 30; librarians, 12; clerks and stenographers, 46. There are also 54 persons classified under the head of "miscellaneous," including superintendents of grounds and buildings, gardeners, farm mechanics, laboratory assistants, etc. Four hundred and twenty-three station officers do more or less teaching in the colleges with which the stations are connected. During the year the stations published 403 annual reports and bulletins, which were supplied to over 731,000 addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

STATISTICS OF THE LAND-GRANT COLLEGES AND UNIVERSITIES.[a]

Unless otherwise specified, the statistics reported in the tables are for the institutions as designated in the list given below:

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study.*

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Four-year courses and degrees.	Short courses.
Alabama	Alabama Polytechnic Institute.	Auburn	C. C. Thach, M. A., LL. D.	Chem. and agr., civil engin., elect. engin., mech. engin., mining engin., phar., general, chem. and metal. (B. S.).	Agr., mech. arts, phar. (2 yrs.), phar. (3 yrs.), agr. (1 yr.), summer school for farmers (10 days).
	Agricultural and Mechanical College for Negroes.	Normal	W. H. Councill, Ph. D.	Sci. (B. S.), agr. (B. A. S.), mech. (B. M. S.)	Indus. and lit. studies (1 to 4 yrs.).
Arizona	University of Arizona	Tucson	K. C. Babcock, Ph. D.	Lit. (Ph. B.), sci., chem., mining engin., civil engin., mech. engin. (B. S.).	Mineralogy and assaying (2 yrs.), prep. (4 yrs.).
Arkansas	University of Arkansas.	Fayetteville	J. N. Tillman, B. LL.	Agr. (B. S. A.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), mining engin. (B. Mi. E.), chem. engin. (B. Ch. E.), chem. (B. S. C.), lit. and sci. (B. A. and B. S.), music (B. Mus.), normal, art.	Agr., hort., dairying, elect. engin. (2 yrs.), mech. arts (2 or 3 yrs.); prep. (2 yrs.); agr., dairying (4 weeks).
	*Branch Normal College	Pine Bluff	Isaac Fisher	Collegiate (B. A.), normal (L. I.), manual training, mech. arts.	Prep. (3 yrs.).
California	University of California	Berkeley	B. I. Wheeler, Ph. D., LL. D.	Letters (B. A.), social sci. (B. L.), natural sci., commerce, agr., mech. engin., elect. engin., mining engin., civil engin., chem. (B. S.).	Prep. med. (3 yrs.), agr., animal indus., dairying (10 weeks), nutrition (3 weeks), ent. (4 weeks), vit. (4 weeks), summer session (6 weeks).
Colorado	The State Agricultural College of Colorado.	Fort Collins	B. O. Aylesworth, A.M., LL. D., Litt. D.	Agr., mech. engin., civil and irrig. engin., general and domestic sci., hort. (B. S.).	Agr., commercial, normal course in domestic sci., prep. (2 yrs.); agr. (2 months).
Connecticut	Connecticut Agricultural College.	Storrs	R. W. Stimson, A. M., B. D.	Agr. or hort., home econ., general sci. (B. S.)	Agr. or hort., mech., home econ., nature study, coml., general sci. (2 yrs., diploma), summer school for teachers (3 weeks), farm dairying, creamery, pomol., business (winter, 12 weeks), poultry (6 weeks), 32 ten-day courses.
Delaware	Delaware College	Newark	G. A. Harter, M. A., Ph. D.	Clas., Lat. sci. (B. A.), agr., general sci., civil engin., mech. engin., elect. engin. (B. S.).	Agr. (2 yrs.); agr. (winter, 10 weeks).
	State College for Colored Students.	Dover	W. C. Jason, M. A., B. D.	Clas. (B. A.), sci. (B. S.), agr. (B. Agr.), engin. (B. E.).	Normal (3 yrs.), industrial (2 yrs.), prep. (2 yrs.).
Florida	University of Florida	Lake City	Andrew Sledd, A. M., Ph. D., LL. D.	Mech. engin., elect. engin., civil engin., agr. or hort., gen. sci. (B. S.), lit. (A. B.), normal (B. Ped.).	Normal (3 yrs.); mech. arts, agr., phar. (Ph. G.) (2 yrs.); normal (1 yr.).

	Florida State Normal and Industrial School.	Tallahassee	N. B. Young, M. A.	Normal	Prep. (2 yrs.), industrial.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White, Ph. D., D. C. L.	General sci., agr., civil engin., elect. engin. (B. S.).	Agr., hort., dairying (1 yr.), agr. (12 weeks).
	Georgia State Industrial College.	Savannah	R. R. Wright, A. M., LL. D.	Collegiate (A. B.)	Normal (3 yrs.), industrial, prep. (3 yrs.).
Idaho	University of Idaho	Moscow	J. A. MacLean, A. M., Ph. D.	Clas. (B. A.), agr. and hort., sci. (B. S.), civil engin. (B. C. E.), mining engin. (B. M. E.), elect. engin. (B. E. E.), music (B. M.).	Agr. and hort. (2 yrs.), prep. (2 yrs.), agr. and hort. (6 weeks).
Illinois	University of Illinois	Urbana	E. J. James, Ph. D., LL. D.	Lit. and arts (B. A.), archi. engin., civil engin., elect. engin., mech. engin., railway engin., municipal and sanitary engin., sci., agr., domestic sci. (B. S.), music (B. M.), libr. sci. (B. L. S.), phar. (Ph. G.), phar. chem. (Ph. C.), med. (M. D.), dentistry (D. D. S.).	Law (LL. B.), surgery (D. D. S.) (3 yrs.); summer school (9 weeks).
Indiana	Purdue University	Lafayette	W. E. Stone, Ph. D	Mech. engin. (B. S., M. E.), civil engin. (B. S., C. E.), elect. engin. (B. S., E. E.), agr. (B. S. Agr.), sci. (B. S.), phar. (B. S. Phar.).	Agr. (2 yrs.), agr., hort., animal husb., dairying (winter, 10 weeks), phar. (2 yrs., Ph. G.).
Iowa	Iowa State College of Agriculture and the Mechanic Arts.	Ames	A. B. Storms, A. M., D. D., LL. D.	Agr. (B. S. A.), vet. sci. (D. V. M.), mech. engin. (B. M. E.), civil engin. (B. C. E.), elect. engin. (B. S. in E. E.), mining engin. (B. S. in M. E.), sci., general and domestic sci. for women (B. S.), tech. (B. S.), domestic sci. (B. D. S.).	Dairying (1 yr.), dairying (16 weeks), corn judging (2 weeks), stock judging (2 weeks).
Kansas	Kansas State Agricultural College.	Manhattan	E. R. Nichols, A. M	Agr., mech. engin., general sci., elect. engin., domestic sci., archi., vet. sci. (B. S.).	Domestic sci. (2 terms, 12 weeks each), farmers' (2 winter terms, 12 weeks each), farm dairying (12 weeks), dairying (12 weeks).
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson, Ph. D., LL. D.	Clas. (A. B.), mech. engin. (B. M. E.), civil engin. (B. C. E.), mining engin. (B. E. M.), agr. (B. Agr.), sci. (B. S.), pedag. (B. Ped.).	Agr. (2 yrs.), prep. (2 yrs.), agr. (winter, 10 weeks).
	The Kentucky Normal and Industrial Institute for Colored Persons.	Frankfort	J. S. Hathaway, M. A., M. D.	Normal	Normal, agr., carpentry, cooking, music, dressmaking, printing, blacksmithing, wheelwrighting (3 yrs.), business (1 yr.).
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	T. D. Boyd, M. A., LL. D.	Agr., elect. engin., sugar chem. and manuf. (5 years), civil engin., mech. engin., general sci., premed. (B. S.), commercial, Lat. sci., lit. (B. A.).	Prep. (1 yr.), agr. (2 yrs.), agr. (10 weeks).
	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill	Clas., sci., agr., mech., normal, printing, music.	Agr., dairying, bookkeeping (2 yrs.), mech., tinsmithing (3 yrs.), typewriting.
Maine	The University of Maine.	Orono	G. E. Fellows, M. A., Ph. D., LL. D.	Clas. (B. A.), sci., agr., hort., chem., civil engin., mech. engin., elect. engin., mining engin., forestry, phar. (B. S.).	Law (3 yrs., LL. B.), agr. (2 yrs.), phar. (Ph. C.) (2 yrs.), agr., hort., and dairying (8 weeks), poultry management and hort. (3 weeks).

[a] Including also institutions receiving apportionments from the appropriation of 1890.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Four-year courses and degrees.	Short courses.
Maryland	Maryland Agricultural College.	College Park	R. W. Silvester, M. S.	Mech. engin. (B. M. E.), agr., sci. (B. S.)	Agr. (2 yrs.), prep. (1 yr.), agr. (10 weeks).
	Princess Anne Academy	Princess Anne	Frank Trigg, M. A	Academic, normal	Industrial.
Massachusetts	Massachusetts Agricultural College.	Amherst	Wm. P. Brooks,[a] Ph. D.	Agr. (B. S.)	Agr. for women (2 yrs.), dairy farming, hort. (winter, 10 weeks), bee culture (2 weeks).
	Massachusetts Institute of Technology.	Boston	H. S. Pritchett, Ph. D., LL. D.	Civil engin., mech. engin., mining engin. and metal., archi., chem., elect. engin., biol., phys., electro-chem., chem. engin., sanitary engin., geol., naval archi. elective (B. S.).	
Michigan	Michigan State Agricultural College.	Agricultural College.	J. L. Snyder, A. M., Ph. D.	Agr., mech., forestry, women's (B. S., each 4 and 5 years).	Cheesemaking (4 weeks), creamery management, live stock and general farming (8 weeks), fruit culture (8 weeks).
Minnesota	The University of Minnesota.	Minneapolis	Cyrus Northrop, LL. D.	General (B. A.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), mining, metal. (E. M., Met. E.), chem. (A. C. or C. T.), agr. (B. S., Agr.), forestry (B. S. For.), home econ. (B. S.).	Agr. (3 yrs.), home econ. (3 yrs.), agr. (8 weeks), dairying (4 weeks).
Mississippi	Mississippi Agricultural and Mechanical College.	Agricultural College.	J. C. Hardy, A. M., LL. D.	Agr., hort., dairying, vet. sci., chem., mech. engin., phys. and elect. engin., civil and rural engin., geol. and mining, textile (B. S.).	Agr., mech. arts, elect. engin., textile (2 yrs.), prep. (1 yr.), agr. (10 weeks), summer school for teachers (5 weeks).
	Alcorn Agricultural and Mechanical College.	Lorman	L. J. Rowan, B. S	Scientific (B. S.)	Business, carpentry, agr., shoemaking, blacksmithing, painting, domestic sci., millinery, etc. (3 yrs.); prep. (2 yrs.).
Missouri	University of Missouri	Columbia	R. H. Jesse, LL. D	Agr. (B. S.), civil engin. (B. S., C. E.), mech. engin., mining engin. (B. S., M. E.), elect. engin. (B. S., E. E.), sanitary engin., chem. engin., hydraulic engin., metal., archi. (B. S.).	Plant production, animal husb., dairying (8 weeks), summer school for teachers (8 weeks).
	Lincoln Institute	Jefferson City	B. F. Allen, A. M., LL. D.	Collegiate (B. A.), normal	College prep., normal prep., carpentry, blacksmithing, mach. work, sewing, cooking, laundering (3 yrs.).
Montana	The Montana State College of Agriculture and Mechanic Arts.	Bozeman	J. M. Hamilton, M. S.	General sci., domestic sci. (B. S.), agr. (B. S. A.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), art, music.	Agr., engin., business (2 yrs.), domestic sci. (1 yr.), agr. (5 months).
Nebraska	The University of Nebraska.	Lincoln	E. B. Andrews, LL. D	Clas., lit. (B. A.), general sci., agr., civil engin., elect. engin., steam engin., municipal engin., mech. engin., chem. engin., premed., tech. forestry (B. S.).	Agr. (3 yrs.), law (LL. B., 3 yrs.), mining engin. (3 yrs.), mech. arts (2 yrs.), domestic sci. (2 yrs.), dairying, agr. (9 weeks), summer session (6 weeks), judging (1 week), art, music.

Nevada	Nevada State University.	Reno	J. E. Stubbs, M. A. D. D., LL. D.	Liberal arts (B. A.), mining and metal. agr., domestic sci., mech. engin., civil engin., general sci. (B. S.).	Agr., dairying, bot., ent., bact., domestic sci., assaying (3 months).
New Hampshire	The New Hampshire College of Agriculture and the Mechanic Arts.	Durham	W. D. Gibbs, M. S.	Agr., mech. engin., elect engin., tech. chem., general (B. S.).	Agr. (2 yrs.), agr. (winter, 10 weeks), dairying (10 weeks).
New Jersey	Rutgers Scientific School, The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts.	New Brunswick	W. H. S. Demarest	Agr., civil engin. and mech., chem., elect., biol., clay working and ceramics (B. S.), Lat. sci. (B. Litt.).	Clay working and ceramics (2 yrs.).
New Mexico	New Mexico College of Agriculture and Mechanic Arts.	Agricultural College.	Luther Foster, M. S. A.	Agr., mech. engin., domestic sci., general or sci. (B. S.).	Agr. and hort. (2 yrs.), pract mech. (2 yrs.), prep. (2 yrs.), sten. (1 yr.), Engl.-Span. sten. (1 yr.), business (1 yr.).
New York	Cornell University	Ithaca	J. G. Schurman, A. M., D. Sc., LL. D.	Arts (A. B.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), archi. (B. Arch.), agr. (B. S. A.), med. (M. D.), vet. sci. (D. V. M.).	Law (LL. B., 3 yrs.), special lect. courses in gen. agr. and nature study, (1 or 2 years), agr., dairying, poultry husb., hort. home econ. (winter, 11 weeks), reading courses for farmers and farmers' wives; summer school for teachers.
Norta Carolina	The North Carolina College of Agriculture and Mechanic Arts.	Raleigh	G. T. Winston, A. M., LL. D.	Agr., (B. Agr.), mech. engin., civil engin., elect. engin., mining engin., textile sci. and art. (B. E.), indus. chem. (B. S.).	Agr., mech. arts, textile indus. (2 yrs.), agr., dairying (10 weeks).
	The Agricultural and Mechanical College for the Colored Race.	Greensboro	J. B. Dudley, A. M., LL. D.	Agr. (B. Agr.), mech. (B. S.)	Dairying (6 weeks).
North Dakota	North Dakota Agricultural College.	Agricultural College.	J. H. Worst, LL. D	Agr., general sci., mech., pharm. chem. (B. S.).	Agr. (3 yrs.), steam engin., dairying, phar., domestic econ., nature study, prep. (2 yrs.), agr. (12 weeks), stock and grain judging (10 days).
Ohio	Ohio State University	Columbus	W. O. Thompson, A. M., D. D., LL. D.	Agr. (B. S. Agr.), hort. and forestry, domestic sci., chem., indus. arts, manual training, phar. (B. S.), arts (B. A.), archi., civil engin. (C. E.), clay working and ceramics, mining engin. (E. M.), elect. engin. (M. E., E. E.), mech. engin. (M. E.).	Agr. and hort., ceramics, domestic sci., indus. arts, mining, phar. (2 yrs.), dairying (2 terms), vet. med. (3 yrs., D. V. M.), law (LL.B.) (3 yrs.).
Oklahoma	Oklahoma Agricultural and Mechanical College.	Stillwater	A. C. Scott, A. M., LL. M.	Agr., general sci., mech. engin., civil engin., elect. engin. (5 yrs., B. S.).	Agr., domestic sci. (2 yrs.), business (1 yr.), mech. (20 weeks), agr. and dairying (winter, 8 weeks), summer school for teachers (11 weeks), stock judging and seed selection (1 week).
	Agricultural and Normal University.	Langston	I. E. Page, M. A	Clas. (B. A.), sci. (B. S.), normal (B. S. D.), agr. (B. S. Agr.), elect. engin., mech. engin., civil archi. (B. M. E.).	Normal elementary (4 yrs.), college prep. (3 yrs.).
Oregon	Oregon State Agricultural College.	Corvallis	T. M. Gatch, M. A., Ph. D.	Agr., mech. engin., elect. engin., mining engin., household sci., phar., lit. commerce (B. S.).	Mining (2 yrs.), dairying (8 weeks), agr. (10 days).

[a] Acting president.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.

State or Territory.	Name of institution.	Location.	President.	Collegiate courses of study (undergraduate).	
				Four-year courses and degrees.	Short courses.
Pennsylvania	The Pennsylvania State College.	State College	G. W. Atherton, LL.D.	Clas. (B. A.), general sci., mod. lang. and lit., Lat. sci., philos., agr., biol., chem., civil engin., elect. engin., indus. chem., math., mech. engin., mines and mining, phys. (B. S.).	Chem., mech., mining (2 yrs.), agr. (1 yr.), agr., mining (12 weeks), dairying and creamery (8 weeks), summer school (2 weeks), corresp. courses in agr.
Rhode Island	Rhode Island College of Agriculture and Mechanic Arts.	Kingston	K. L. Butterfield, A.M.	Agr., mech. engin., highway engin., chem., biol., elect. engin., general sci. (B. S.).	Agr. (2 yrs.), indus. (2 yrs.), prep. (2 yrs.), farm mech. (12 weeks), poultry school (12 weeks), farm practice (6 weeks).
South Carolina	Clemson Agricultural College of South Carolina.	Clemson College.	P. H. Mell, M. E., Ph. D., LL. D.	Agr. and hort., agr. and animal husb., mech. and elect. engin., civil engin., metal. and geol., textile indus. (B. S.).	Textile indus. (2 yrs.), prep. (1 yr.), teachers' course (1 month).
	The Colored Normal, Industrial, Agricultural and Mechanical College of South Carolina.	Orangeburg	T. E. Miller, LL. D.	Regular (B. A.), mech. (B. S.), agr. (B. Agr.), normal (L. I.), prep. and normal (5 yrs.).	Model school, indus., music, art.
South Dakota	South Dakota Agricultural College.	Brookings	R. L. Slagle	Agr., domestic sci., gen. sci., mech. engin., elect. engin., civil and agr. engin., hort., phar. (B. S.).	Normal (3 yrs.), agr. (2 yrs.), phar. (2 yrs., Ph. G.), agr. (6 weeks), hort., domestic sci., butter making, cheese making, steam engin. (12 weeks), sten. and typewriting, commercial sci., steam engin. (1 yr.), art (3 yrs.), music.
Tennessee	University of Tennessee	Knoxville	Brown Ayres, Ph. D., LL. D.	Lit. (B. A.), sci., agr. sci., civil engin., mech. engin., elect. engin., mining engin., chem. engin., phar. chem. (B. S.), med. (M. D.).	Dental surgery (D. D. S.), agr., phar. chem. (Ph. C., 2 yrs.), law (B. LL.), prelim. med. (2 yrs.), agr. (10 weeks), cereal judging, pract. stock feeding, stock judging and dairying, farm poultry (winter, 1 and 2 weeks), summer school for teachers (6 weeks).
Texas	Agricultural and Mechanical College of Texas.	College Station	H. H. Harrington, M. S.	Agr., textile engin., elect. engin., mech. engin., civil engin., archi. engin. (B. S.).	Stock farming, dairying, hort. (10 weeks).
	Prairie View State Normal and Industrial College.	Prairie View	E. L. Blackshear	Clas. and sci. (6 yrs., B. A.), normal, industrial.	Mech. arts, agr. and hort., and dairying.
Utah	Agricultural College of Utah.	Logan	W. J. Kerr, D. Sc.	Agr., domestic sci., commerce, civil engin., mech. engin., general sci. (B. S.), mech. arts, manual training in domestic arts.	Agr., domestic sci., commerce (3 yrs.), prep. (2 yrs.), agr. (4 weeks), agr., domestic arts, mech. arts, commerce (12 weeks), summer school (5 weeks).
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham, D.D., LL. D.	Clas. (B. A.), lit. sci. (Ph. B.), civil and sanitary engin., elect. engin. mech. engin., chem., agr., commerce and econ. (B. S.), med. (M. D.).	Agr. (1 or 2 yrs.).

Virginia	The Virginia Agricultural and Mechanical College and Polytechnic Institute.	Blacksburg	J. M. McBryde, Ph.D., LL. D.	Agr., hort., applied chem., general sci., civil engin., mech. engin., elect. engin., applied geol., prep. med. and vet. sci. (B. S.).	Agr., mech. (2 yrs.), summer school (6 weeks).
	Hampton Normal and Agricultural Institute	Hampton	H. B. Frissell, D. D., LL. D.	Academic (4 yrs.)	Trade (3 yrs.). Post-graduate: Agr., trades (3 yrs.), normal (2 yrs.), business (1 yr.).
Washington	The State College of Washington.	Pullman	E. A. Bryan, M. A., LL. D.	Math. and civil engin., domestic econ., phar., chem., bot. and zool., agr., hort., econ. sci. and hist., elect. engin., mech. engin., mining engin. (B. S., B. A.), geol., Engl. lang. and lit., modern lang. (B. A.).	Supplementary courses in phys., geol. and mineralogy, Lat., phar. (2 yrs), agr., vet. sci. (D. V. S.), prep. (3 yrs.), business (1 and 2 yrs.), artisans (1 yr.), dairying (8 weeks), hort. (4 weeks), music (3 yrs.).
West Virginia	West Virginia University.	Morgantown	D. B. Purinton, Ph.D., LL. D.	General culture (B. A., B. S.), mech. and elect. engin. (B. S., M. E.), civil engin. (B. S., C. E.), agr. (B. S. Agr.), law (LL. B.), music.	Agr., mech. and elect., law, commercial (2 yrs.), agr. (1 yr.), prep. (1 yr.), agr., hort., vet. sci., stock breeding and feeding, dairying, poultry culture (12 weeks), nature study (6 weeks).
	The West Virginia Colored Institute.	Institute	J. McH. Jones, A. M.	Academic, normal, agr.	Sewing (2 yrs.), dressmaking (2 yrs.), commercial (2 yrs.), mech. (3 yrs.), printing (3 yrs.).
Wisconsin	University of Wisconsin	Madison	C. R. Van Hise, Ph. D.	Sci. (B. A.), normal (B. Ph.), law (LL. B.), agr. (B. S. Agr.), civil engin., sanitary engin., mech. engin., elect. engin., general engin., applied electro-chem., phar. (B. S.).	Phar. (Ph. G., 2 yrs.), music, agr. (2 winter courses, 14 weeks each), dairy school (12 weeks), creamery (summer), farmers' course (2 weeks).
Wyoming	University of Wyoming.	Laramie	F. M. Tisdel, Ph. D.	Clas., lit. sci. (B. A.), normal (B. Ped.), agr., mech. engin., mining engin., irrig. engin. (B. S.), music.	Prep. (3 yrs.), music (3 yrs.), prep. med., prep. law (2 yrs.), commercial (2 yrs.), agr. (1 to 2 yrs.), normal (1 yr.), school of mines (6 weeks), animal husb. (winter), domestic sci., irrig., live stock management and judgment (2 weeks).

TABLE 2.—*General statistics*

State or Territory.	Date of establishment of institution.	Date of establishment of agricultural course.	Faculty.				Experiment station officers.
			College of agriculture and mechanic arts.			Other departments.	
			Preparatory classes.	Collegiate and special classes.	Total.		
Alabama (Auburn)	1872	1872	2	37	39	.....	13
Alabama (Normal)	1875	1882	8	10	18	8	.....
Arizona	1891	1891	9	17	26	.....	7
Arkansas (Fayetteville)	1872	1872	7	14	21	21	10
Arkansas (Pine Bluff)	1875	.....	.....	8	8	.....	.....
California	1868	1868	.....	65	65	179	35
Colorado	1877	1878	14	36	[a] 45	.....	19
Connecticut	1881	1881	.....	24	24	.....	15
Delaware (Newark)	1870	1870	.....	20	20	.....	6
Delaware (Dover)	1892	1892	5	6	[a] 9	.....	.....
Florida (Lake City)	1884	1884	7	19	[a] 23	2	14
Florida (Tallahassee)	1887	1890	18	19	[a] 23	.....	.....
Georgia (Athens)	1872	1872	.....	22	22	.....	7
Georgia (Savannah)	1890	1890	10	4	14	.....	.....
Idaho	1892	1892	5	17	[a] 21	4	9
Illinois	1867	1868	9	96	105	219	32
Indiana	1874	1874	.....	108	108	10	21
Iowa	1869	1869	.....	.....	105	.....	26
Kansas	1863	1874	5	63	68	10	19
Kentucky (Lexington)	1865	1880	5	25	30	13	14
Kentucky (Frankfort)	1887	1892	3	9	12	1	.....
Louisiana (Baton Rouge)	1877	1887	5	27	[a] 28	.....	28
Louisiana (New Orleans)	1880	1890	9	8	17	.....	.....
Maine	1865	1868	5	50	50	12	13
Maryland (College Park)	1859	1859	2	22	[a] 22	.....	16
Maryland (Princess Anne)	.....	.....	10	.....	10	.....	.....
Massachusetts (Amherst)	1867	1867	.....	28	28	.....	22
Massachusetts (Boston)	1865	.....	.....	188	188	.....	.....
Michigan	1855	1855	.....	.....	75	.....	11
Minnesota	1869	1869	37	44	[a] 72	310	19
Mississippi (Agricultural College)	1880	1880	5	26	31	10	12
Mississippi (Lorman)	1871	1878	13	6	19	.....	.....
Missouri (Columbia)	1870	1870	.....	32	32	116	26
Missouri (Jefferson City)	1866	1866	8	.....	8	9	.....
Montana	1893	1893	15	28	[a] 31	.....	11
Nebraska	1869	1869	.....	43	43	156	19
Nevada	1873	1888	6	19	25	11	10
New Hampshire	1866	1866	.....	20	20	.....	14
New Jersey	1864	1865	11	30	[a] 40	3	22
New Mexico	1889	1890	4	26	30	.....	12
New York	1865	1865	.....	86	86	444	20
North Carolina (Raleigh)	1889	1889	.....	36	36	.....	10
North Carolina (Greensboro)	1891	1891	.....	10	10	.....	.....
North Dakota	1890	1890	27	25	[a] 33	.....	17
Ohio	1870	1873	.....	112	112	28	.....
Oklahoma (Stillwater)	1891	1892	.....	29	29	.....	12
Oklahoma (Langston)	1897	1899	7	5	12	.....	.....
Oregon	1868	1888	.....	33	33	.....	10
Pennsylvania	1855	1859	7	61	[a] 61	.....	20
Rhode Island	1888	1890	11	25	[a] 26	.....	11
South Carolina (Clemson College)	1889	1893	2	42	44	.....	19
South Carolina (Orangeburg)	1896	1896	12	6	18	8	.....
South Dakota	1881	1884	3	32	35	.....	13
Tennessee	1794	1869	.....	43	43	45	12
Texas (College Station)	1871	1871	.....	44	44	.....	16
Texas (Prairie View)	.....	.....	6	1	7	12	.....
Utah	1888	1889	.....	.....	58	.....	18
Vermont	1865	1885	.....	36	36	33	11
Virginia (Blacksburg)	1872	1872	.....	57	57	.....	21
Virginia (Hampton)	1868	1890	125	.....	125	.....	.....
Washington	1892	1892	17	38	55	.....	14
West Virginia (Morgantown)	1867	1867	7	38	45	19	16
West Virginia (Institute)	1891	1892	8	15	[a] 20	3	.....
Wisconsin	1848	1866	.....	58	58	199	29
Wyoming	1887	1891	6	14	14	4	9
Total	.....	.....	475	2,062	2,672	1,889	760

[a] Total counting none twice.

of land-grant colleges, 1905.

Graduates.								
In 1904-5.			Total number since organization.	Number of volumes in libraries.	Number of acres allotted to State under act of 1862.	Number of acres of land grant of 1862 still unsold.	Number of acres in farm and grounds.	Rate of interest on land-grant fund of 1862.
Number.	Average.							
	Y.	M.						Per cent.
51	.....		830	21,077	240,000	.....	325	8
127	20		999	2,448	.....	.....	182	.....
1	26		41	23,000	.....	.....	465	.....
34	23		390	12,000	150,000	.....	155	8
7	19		174	4,400	.....	.....	20	.....
345	23		[b] 4,029	133,779	150,000	1,402	411	6
4	22		259	24,139	90,000	44,000	600	6
14	20	10	234	11,266	180,000	.....	300	5
25	22		366	23,250	90,000	.....	16	6
5	23		29	1,300	.....	.....	97	.....
7	21		98	60,299	90,000	.....	354	6
27	24		87	582	.....	.....	200	.....
9	21	8	408	40,600	270,000	.....	150	7
13	22		158	850	.....	.....	86	.....
14	24	10	126	8,949	90,000	90,000	156	.....
256	23	6	[b] 4,250	110,839	480,000	40	665	5
228	.....		2,209	17,400	390,000	.....	189	5
166	.....		.....	21,824	204,000	336	1,031	6, 7, 8
103	23	5	1,120	29,958	82,313	.....	430	5, 5½, 6, 7
64	21		474	18,979	330,000	.....	258	6
12	18		136	2,760	.....	.....	310	.....
38	22	1	380	24,000	210,000	.....	583	4, 5
28	18	8	325	3,993	.....	.....	104	.....
83	23	6	976	35,500	210,000	.....	373	5
13	20	6	.....	8,500	118,000	.....	286	5, 6
10	20		27	.....	.....	.....	116	.....
30	22	8	662	26,503	360,000	.....	404	5
244	23		3,148	86,919	.....	.....	16	.....
75	.....		1,101	30,220	240,000	52,066	683	7
491	.....		[b] 5,458	110,900	94,000	40	300	3, 4, 5
35	19	7	392	24,978	207,920	.....	2,000	6
9	25		157	2,500	.....	.....	300	5
216	24	2	2,584	69,910	277,016	47,107	722	5
34	20		358	5,000	.....	.....	45	.....
.....	.....		43	17,000	90,000	88,932	220	.....
208	22		[b] 2,409	66,000	90,000	10,344	332	4½, 6
32	.....		270	11,052	90,000	2,200	85	4
19	23		285	18,328	150,000	.....	343	6
39	22	6	572	54,320	210,000	.....	105	5
6	.....		53	20,000	.....	.....	270	.....
610	.....		[b] 8,094	359,897	989,920	.....	498	5
40	23		251	6,494	270,000	.....	674	6
8	24		49	1,123	.....	.....	125	.....
5	.....		44	9,875	130,000	88,000	640	.....
209	22		1,941	67,022	630,000	.....	345	6
30	22	3	126	30,149	.....	.....	360	.....
.....	.....		6	1,175	.....	.....	160	.....
50	22		551	4,000	90,000	.....	204	6
94	23	7	819	22,179	780,000	.....	400	6
4	23		108	17,550	120,000	.....	178	3
40	19		336	17,605	180,000	.....	1,136	6
45	20		329	1,390	.....	.....	130	.....
26	23		279	19,850	160,000	160,000	400	.....
27	22	4	.....	33,000	300,000	.....	272	6
39	21		534	11,000	180,000	.....	2,416	6, 7
30	23		382	1,350	.....	.....	1,500	.....
19	21		131	26,500	200,000	80,385	116	.....
43	22		3,819	103,110	150,000	.....	120	6
77	20	11	583	8,500	200,000	.....	410	6
36	22	10	1,333	18,195	100,000	.....	798	.....
15	22		201	13,000	90,000	89,000	250	.....
50	24		982	21,000	150,000	.....	130	6
16	19		130	3,300	.....	.....	70	.....
409	23		[b] 5,303	130,356	240,000	312	495	4
17	22		133	28,523	90,000	90,000	416	.....
5,061	22		62,081	2,141,465	10,233,169	844,164	25,930	.....

[b] Including all departments of the university.

TABLE 3.—*Students by classes and*

PART 1.—WHITE STUDENTS.

State or Territory.	By classes.					
	Preparatory.	Collegiate.	Short or special.	Post-graduate.	Other departments.	Total.
Alabama	63	384	55	13	.....	515
Arizona	155	33	.....	6	.....	194
Arkansas	403	400	15	7	460	1,285
California	.....	926	[a] 955	53	2,316	4,250
Colorado	197	179	130	4	.....	[c] 496
Connecticut	.....	72	51	.....	.....	123
Delaware	.....	118	2	1	.....	121
Florida	80	84	58	3	.....	225
Georgia	.....	151	32	1	.....	184
Idaho	156	173	3	1	.....	333
Illinois	271	1,101	[a] 132	107	2,118	3,729
Indiana	.....	1,419	85	30	.....	1,534
Iowa	291	883	617	13	176	1,980
Kansas	500	726	253	26	.....	[c] 1,462
Kentucky	99	369	[a] 114	20	86	688
Louisiana	132	307	15	4	.....	458
Maine	9	417	13	13	105	557
Maryland	60	172	15	5	.....	[c] 237
Massachusetts (Amherst)	.....	184	48	8	.....	[c] 230
Massachusetts (Boston)	.....	1,529	32	.....	.....	1,561
Michigan	178	666	162	8	.....	[c] 1,009
Minnesota	530	431	230	.....	2,599	[c] 3,790
Mississippi	295	387	40	9	.....	731
Missouri	.....	429	80	31	1,352	1,892
Montana	63	75	78	4	119	339
Nebraska	.....	473	379	.....	1,876	2,728
Nevada	69	134	.....	3	51	257
New Hampshire	.....	118	41	.....	.....	159
New Jersey	165	162	7	2	54	390
New Mexico	126	45	63	3	.....	237
New York	.....	1,146	[a] 1,046	40	2,029	[c] 4,261
North Carolina	.....	315	151	6	.....	472
North Dakota	247	79	390	5	.....	721
Ohio	.....	827	180	6	822	1,835
Oklahoma	.....	183	339	.....	33	555
Oregon	75	486	108	11	.....	680
Pennsylvania	49	637	[f] 2,562	1	.....	3,249
Rhode Island	72	58	19	.....	.....	[c] 147
South Carolina	145	528	.....	.....	.....	673
South Dakota	184	164	131	9	.....	488
Tennessee	.....	353	45	8	324	730
Texas	.....	382	31	1	.....	414
Utah	37	143	[a] 551	2	.....	733
Vermont	.....	320	27	1	193	541
Virginia	.....	668	40	23	.....	731
Washington	377	273	137	6	.....	793
West Virginia	.....	78	70	1	956	1,105
Wisconsin	.....	783	530	17	2,083	3,413
Wyoming	44	50	134	3	78	[c] 283
Total	5,072	20,020	10,196	515	17,830	53,518

[a] Including summer session.
[b] Including electrical engineering.
[c] Total, counting none twice.

courses at land-grant colleges in 1905.

PART I.—WHITE STUDENTS.

By courses.													
Four-year.									Shorter.				
Agriculture.	Horticulture.	Household economy.	Mechanical engineering.	Civil engineering.	Electrical engineering.	Mining engineering.	Chemical engineering.	Architecture.	Agriculture.	Dairying.	Horticulture.	Veterinary science.	Military tactics.
15	.....	.....	65	32	75	17	36	.....	10	.....	4	30	477
.....	.....	.....	.....	2	.....	11	.....	.....	.....	.....	.....	.....	62
5	4	.....	15	76	36	2	7	.....	4	9	6	.....	407
64	.....	.....	[b] 232	178	.....	247	55	8	42	.....	.....	.....	1,009
18	1	5	14	34	17	.....	.....	5	130	.....	.....	15	295
54	4	4	2	1	.....	.....	.....	.....	16	3	1	4	81
5	.....	.....	9	38	32	.....	.....	.....	2	.....	.....	.....	103
5	.....	.....	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	220
15	15	.....	.....	13	3	.....	.....	.....	[d] 32	.....	.....	.....	180
2	2	61	.....	11	[e] 28	41	.....	.....	.....	.....	.....	.....	192
123	.....	42	199	291	201	.....	26	.....	.....	.....	.....	170	1,051
76	.....	.....	378	358	429	.....	.....	.....	85	.....	.....	.....	637
329	18	17	155	263	249	39	.....	.....	552	12	.....	62	38
162	.....	232	50	.....	151	.....	.....	11	99	24	.....	.....	320
17	.....	.....	157	75	.....	5	.....	.....	4	.....	.....	.....	417
40	.....	.....	31	57	25	.....	39	.....	7	.....	.....	18	328
15	.....	.....	38	134	96	1	.....	.....	13	.....	.....	.....	141
20	20	.....	66	24	.....	.....	47	.....	[d] 15	.....	.....	8	150
184	.....	.....	.....	.....	.....	.....	.....	.....	7	41	.....	.....	184
.....	.....	.....	158	140	98	77	32	41	.....	.....	.....	.....	316
152	.....	112	285	.....	.....	.....	.....	.....	80	71	7	.....	600
29	.....	3	98	120	179	107	36	.....	121	109	.....	.....	504
147	.....	.....	70	13	70	.....	.....	.....	15	3	11	9	668
76	.....	.....	53	188	146	180	22	.....	59	66	.....	45	174
4	.....	2	.....	5	8	.....	.....	.....	17	.....	.....	.....	135
11	.....	.....	35	78	102	4	4	.....	332	.....	.....	.....	315
1	2	.....	26	7	.....	44	.....	.....	.....	.....	.....	.....	132
15	.....	.....	6	.....	8	.....	9	.....	27	10	1	.....	121
12	.....	.....	.....	70	34	.....	.....	.....	.....	.....	.....	.....	167
10	.....	5	18	.....	.....	.....	.....	.....	2	.....	.....	.....	125
98	.....	.....	1,060	385	.....	.....	.....	68	199	.....	.....	110	500
59	.....	.....	66	88	60	4	29	.....	43	29	.....	.....	400
16	.....	10	23	.....	.....	.....	.....	.....	198	33	.....	104	265
99	20	33	84	117	104	26	13	15	64	25	.....	89	857
19	.....	.....	[b] 32	.....	.....	.....	.....	.....	[d] 265	.....	.....	.....	.....
67	.....	83	125	.....	21	45	.....	.....	46	.....	.....	.....	476
14	.....	.....	113	154	188	80	.....	.....	31	29	.....	.....	475
1	.....	.....	1	.....	6	.....	.....	.....	18	.....	.....	.....	90
189	.....	.....	[b] 112	50	.....	1	.....	.....	.....	.....	.....	.....	668
10	5	7	18	2	35	.....	.....	.....	18	6	2	5	107
21	.....	33	9	15	27	3	.....	.....	[d] 19	.....	.....	10	139
98	.....	.....	76	129	71	.....	.....	.....	.....	.....	.....	.....	414
14	.....	118	.....	[e] 36	.....	.....	.....	.....	101	.....	.....	.....	268
44	.....	.....	14	47	44	.....	.....	.....	2	.....	.....	10	163
58	18	.....	157	179	206	.....	.....	.....	2	.....	.....	16	708
21	3	4	26	38	23	21	.....	.....	114	12	.....	14	375
4	.....	.....	35	40	.....	.....	.....	.....	53	.....	.....	1	225
80	.....	83	104	136	162	35	24	.....	304	135	6	29	542
8	.....	.....	3	.....	.....	12	.....	.....	82	.....	.....	.....	88
2,526	112	854	4,227	3,624	2,934	1,022	379	148	3,230	617	38	749	16,657

[d] Including horticulture and dairying.
[e] Including mechanical engineering.
[f] Including correspondence courses.

TABLE 3.—*Students by classes and*

PART 2.—NEGRO STUDENTS.

State or Territory.	By classes.					By courses.		
	Preparatory.	Collegiate.	Short or special.	Other departments.	Total.	Agriculture.	Carpentry.	Machine-shop work.
Alabama (Normal)	137	9	21	220	387	127	30	30
Arkansas (Pine Bluff)	.....	125	.....	.....	125	.....	50	28
Delaware (Dover)	60	53	4	.....	117	25	40	10
Florida (Tallahassee)	131	143	.....	.....	274	87	12	.....
Georgia (Savannah)	400	18	.....	.....	418	50	25	.....
Kentucky (Frankfort)	101	65	.....	.....	166	19	10	4
Louisiana (New Orleans)	398	11	285	.....	[a] 409	47	53	53
Maryland (Princess Anne)	165	.....	.....	.....	165	12	17	.....
Mississippi (Lorman)	530	79	.....	.....	609	92	150	.....
Missouri (Jefferson City)	89	.....	79	283	451	10	60	30
North Carolina (Greensboro)	.....	135	3	.....	[a] 135	35	43	6
Oklahoma (Langston)	300	16	.....	47	363	50	26	15
South Carolina (Orangeburg)	760	55	.....	.....	815	20	37	42
Texas (Prairie View)	379	.....	.....	.....	379	20	45	.....
Virginia (Hampton)	1,281	.....	.....	.....	1,281	1,018	69	16
West Virginia (Institute)	50	.....	17	133	200	12	22	.....
Total	4,781	709	409	683	6,294	1,624	689	234

[a] Total, counting none twice.

courses at land-grant colleges in 1905.

NEGRO STUDENTS.

By courses—Continued.															
Blacksmithing.	Shoemaking.	Broom making.	Wheelwrighting.	Bricklaying.	Painting.	Printing.	Harness making.	Tailoring.	Plastering.	Sewing.	Cooking.	Laundering.	Nursing.	Millinery.	Military drill.
35	34	.....	30	.....	10	40	.....	.....	.....	80	32	15	36	20	178
40	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	4	.....	1	.....	.....	2	25	6	8	.....	.....	50
11	5	.....	3	.....	5	5	.....	16	.....	119	102	102	11	10	103
30	20	.....	5	65	15	.....	10	35	20	58	.....	.....	.....	.....	253
.....	.....	.....	.....	.....	.....	18	.....	.....	.....	60	10	75	.....	.....	65
.....	.....	.....	.....	.....	.....	14	.....	.....	.....	148	.....	.....	.....	.....	.....
9	.....	.....	3	.....	2	7	.....	.....	.....	74	51	51	.....	4	.....
160	40	.....	.....	10	40	.....	.....	.....	.....	50	35	.....	7	25	.....
40	20	.....	.....	.....	.....	8	.....	.....	.....	80	80	100	.....	80	.....
24	.....	10	5	28	5	.....	.....	.....	28	.....	.....	.....	.....	.....	30
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	125	.....	.....	.....	4	.....
43	12	.....	43	101	6	.....	15	12	101	381	.....	.....	17	.....	339
32	3	5	2	.....	.....	.....	.....	2	.....	130	125	13	.....	22	.....
30	7	.....	21	23	11	9	10	43	23	522	260	101	1	.....	448
21	.....	.....	10	15	9	11	.....	.....	15	96	68	.....	.....	9	100
497	141	15	122	246	105	113	35	108	189	1,948	769	465	72	174	1,566

TABLE 4.—*Value of permanent funds and*

State or Territory.	Land-grant fund of 1862.	Other land-grant funds.	Other permanent funds.	Land grant of 1862 still unsold.	Farm and grounds owned by the institution.
Alabama (Auburn)	$253,500.00				$4,500.00
Alabama (Normal)					10,593.20
Arizona					25,640.00
Arkansas (Fayetteville)	130,000.00				10,000.00
Arkansas (Pine Bluff)					60,000.00
California	731,325.54	$154,712.27	$2,682,797.61	$5,807.60	
Colorado	97,091.36			125,000.00	100,000.00
Connecticut	135,000.00				15,000.00
Delaware (Newark)	83,000.00				10,000.00
Delaware (Dover)					6,000.00
Florida (Lake City)	153,800.00				18,800.00
Florida (Tallahassee)					10,000.00
Georgia (Athens)	242,202.17				200,000.00
Georgia (Savannah)					10,000.00
Idaho	703.00	212,871.03		900,000.00	18,000.00
Illinois	623,709.53			400.00	175,000.00
Indiana	340,000.00				100,000.00
Iowa	683,708.52			1,744.08	101,723.00
Kansas	492,331.36				50,200.00
Kentucky (Lexington)	165,000.00				429,907.00
Kentucky (Frankfort)					25,100.00
Louisiana (Baton Rouge)	182,313.00	136,000.00			35,000.00
Louisiana (New Orleans)					22,500.00
Maine	118,300.00		100,000.00		25,000.00
Maryland (College Park)	118,000.00				30,000.00
Maryland (Princess Anne)					3,200.00
Massachusetts (Amherst)	219,000.00		142,000.00		44,350.00
Massachusetts (Boston)			2,703,190.53		689,446.35
Michigan	966,253.76			78,000.00	46,970.00
Minnesota	570,747.59	796,891.38		240.00	550,000.00
Mississippi (Agricultural College).	98,575.00	141,212.55			43,500.00
Mississippi (Lorman)	113,575.00	96,296.00			6,000.00
Missouri (Columbia)	349,881.19	220,000.00	668,958.23	60,000.00	265,206.00
Missouri (Jefferson City)					6,000.00
Montana	12,879.70	10,190.68		149,541.00	25,000.00
Nebraska	331,326.00	126,145.00			325,000.00
Nevada	99,351.54	47,541.52			40,000.00
New Hampshire	80,000.00		70,000.00		20,500.00
New Jersey	116,000.00		500,000.00		130,000.00
New Mexico					12,000.00
New York	688,576.12		6,989,670.23		369,077.98
North Carolina (Raleigh)	125,000.00				48,000.00
North Carolina (Greensboro).					25,000.00
North Dakota	473,114.00			880,000.00	32,000.00
Ohio	524,176.58	61,004.42	110,657.19		1,500,000.00
Oklahoma (Stillwater)					15,000.00
Oklahoma (Langston)					7,000.00
Oregon	193,778.00				31,000.00
Pennsylvania	427,290.50				40,000.00
Rhode Island	50,000.00				14,855.00
South Carolina (Clemson College).	95,900.00		58,539.39		42,470.00
South Carolina (Orangeburg).	95,900.00				40,000.00
South Dakota				800,000.00	40,000.00
Tennessee	396,000.00		29,000.00		285,475.00
Texas (College Station)	209,000.00				50,000.00
Texas (Prairie View)					15,000.00
Utah	166,320.25			120,577.50	12,800.00
Vermont	135,500.00		522,049.89		12,000.00
Virginia (Blacksburg)	344,312.00				31,000.00
Virginia (Hampton)	176,156.00		1,330,000.00		57,000.00
Washington	2,000.00	1,000,000.00		890,000.00	20,000.00
West Virginia (Morgantown).	114,169.00		1,600.00		
West Virginia (Institute)					11,500.00
Wisconsin	303,359.61	288,263.95	60,000.00	340.00	220,700.00
Wyoming	21,450.57	4,064.71		90,000.00	35,000.00
Total	12,049,626.89	3,295,193.51	15,968,463.07	4,101,749.18	6,655,013.43

[a] Including farm and grounds. [b] Including all other equipment. [c] Including apparatus.

equipment of land-grant colleges, 1905.

Buildings.	Apparatus	Machinery.	Libraries.	Live stock.	Miscellaneous equipment.	Total.
$153,700.00	$18,051.00	$23,488.00	$37,598.00	$2,500.00	$17,300.00	$510,637.00
52,975.00	6,900.03	4,000.00	1,500.00	376.75	.....	76,404.98
146,928.89	24,440.99	17,056.87	18,914.69	1,000.00	.....	233,941.44
300,000.00	65,000.00	35,000.00	15,000.00	2,500.00	.....	557,500.00
28,000.00	600.00	15,000.00	2,500.00	.....	1,800.00	107,900.00
[a] 3,807,607.51	.....	.....	.....	.....	.....	7,382,250.53
180,849.00	52,000.00	22,000.00	27,798.00	11,063.00	21,000.00	636,801.36
123,400.00	10,000.00	5,400.00	21,000.00	9,100.00	23,000.00	342,500.00
130,000.00	51,000.00	21,500.00	22,000.00	200.00	3,000.00	320,700.00
21,000.00	1,000.00	800.00	600.00	1,000.00	500.00	30,900.00
134,675.00	.....	.....	.....	.....	[b] 55,000.00	362,275.00
23,000.00	2,389.97	4,942.61	800.00	1,197.00	3,009.26	45,918.24
275,000.00	25,000.00	.....	20,000.00	1,800.00	10,000.00	774,602.17
32,433.04	3,144.00	.....	100.00	415.00	.....	46,092.04
214,750.40	23,072.15	9,546.32	13,715.86	4,453.11	15,201.94	1,412,313.81
1,400,000.00	290,000.00	100,000.00	135,000.00	30,000.00	130,000.00	2,794,109.53
625,900.00	.....	[c] 180,000.00	20,000.00	5,000.00	20,000.00	1,290,900.00
841,575.00	.....	[c] 202,759.55	55,000.00	27,969.00	75,238.05	2,039,517.20
363,448.55	44,278.46	23,726.90	48,534.50	20,435.60	137,100.31	1,210,105.08
262,081.00	50,650.00	25,839.00	12,843.00	2,829.00	421,990.00	1,371,128.00
30,000.00	250.00	2,675.00	1,810.00	2,000.00	1,300.00	72,135.00
302,000.00	24,143.55	23,456.80	28,536.40	.....	26,552.64	757,972.39
47,700.82	3,644.31	4,415.10	3,980.00	1,100.00	7,551.10	90,951.33
275,000.00	28,000.00	17,000.00	30,000.00	4,700.00	13,000.00	611,000.00
170,000.00	.....	[c] 50,000.00	6,000.00	.....	.....	374,000.00
12,800.00	.....	.....	.....	1,000.00	[d] 1,500.00	18,500.00
246,775.00	70,763.06	.....	25,973.00	9,682.00	61,125.00	819,668.06
886,300.75	.....	[c] 360,000.00	140,726.88	.....	.....	4,779,754.41
402,220.00	36,437.33	36,701.76	.....	12,365.50	291,082.64	1,870,129.99
1,140,000.00	120,000.00	83,000.00	95,000.00	.....	20,000.00	3,375,878.97
336,031.00	28,706.91	99,879.91	19,696.63	22,021.00	79,671.12	869,284.12
160,000.00	10,000.00	.....	3,500.00	2,500.00	2,000.00	393,871.00
498,600.00	120,000.00	19,000.00	118,710.00	7,200.00	58,000.00	2,884,955.42
125,000.00	500.00	5,000.00	2,500.00	350.00	100.00	139,450.00
120,000.00	30,000.00	33,000.00	16,500.00	.....	18,000.00	415,111.38
585,000.00	[e] 110,000.00	.....	145,000.00	15,000.00	120,000.00	1,757,471.00
170,059.47	20,158.13	13,040.66	19,774.09	1,737.95	40,689.50	452,352.86
207,000.00	24,000.00	6,500.00	14,000.00	3,800.00	15,500.00	441,300.00
400,000.00	.....	.....	49,000.00	.....	75,000.00	1,270,000.00
53,000.00	19,000.00	20,500.00	15,750.00	1,600.00	7,500.00	129,350.00
2,801,007.83	.....	.....	621,482.00	.....	941,791.89	12,411,606.05
265,050.00	15,400.00	38,000.00	7,155.97	6,000.00	15,000.00	519,605.97
50,000.00	9,000.00	7,000.00	1,530.85	3,000.00	.....	95,530.85
216,757.37	15,303.41	11,272.54	18,202.06	6,556.92	1,912.96	1,655,119.26
1,200,000.00	300,000.00	100,000.00	185,000.00	8,000.00	17,000.00	4,005,838.19
105,574.75	39,249.01	25,067.82	20,997.59	15,154.00	.....	221,043.17
38,100.35	1,850.00	9,969.25	2,000.00	685.00	3,000.00	62,604.60
160,000.00	4,500.00	23,000.00	.....	.....	.....	412,278.00
1,272,500.00	.....	.....	.....	.....	60,000.00	1,799,790.50
151,367.50	39,480.52	.....	16,968.69	1,470.56	56,913.77	331,056.04
395,159.00	20,650.00	103,070.00	16,057.00	9,514.00	71,456.00	812,815.39
85,000.00	3,600.00	7,150.00	1,700.00	2,200.00	2,000.00	237,550.00
195,000.00	14,000.00	12,000.00	5,500.00	8,500.00	5,000.00	1,080,000.00
207,855.83	52,759.64	50,933.50	13,665.56	4,113.50	15,158.68	1,054,961.80
500,000.00	16,500.00	52,000.00	13,242.00	11,000.00	30,000.00	881,742.00
92,000.00	1,000.00	3,000.00	1,100.00	2,500.00	.....	114,600.00
276,263.53	52,014.12	20,000.00	10,962.00	4,500.00	.....	663,437.40
810,000.00	42,500.00	21,000.00	101,000.00	3,620.00	165,500.00	1,813,169.89
330,702.00	.....	.....	4,927.41	.....	[d] 154,164.17	865,105.58
640,000.00	.....	.....	7,500.00	16,500.00	166,000.00	2,393,156.00
260,000.00	26,500.00	45,500.00	22,500.00	6,000.00	17,500.00	2,290,000.00
460,000.00	12,000.00	20,000.00	40,000.00	1,500.00	40,000.00	680,269.00
92,500.00	2,725.00	12,800.00	3,500.00	1,675.00	.....	124,700.00
1,528,806.52	.....	[c] 563,832.21	188,141.13	20,285.00	.....	3,173,728.42
185,000.00	64,239.83	33,222.19	27,856.90	3,329.80	9,850.00	474,014.00
28,192,385.11	1,957,030.42	2,623,995.48	2,520,350.21	342,998.09	3,544,959.03	81,251,764.42

[d] Including apparatus and machinery. [e] Including machinery.

TABLE 5.—*Revenue of land-grant*

State or Territory.	Federal aid.			State aid.
	Interest on land grant of 1862.	Interest on other land grants.	Appropriation act of 1890.	Interest on endowment or regular appropriation.
Alabama (Auburn)	$20,280.00		$14,075.00	
Alabama (Normal)			10,925.00	
Arizona			25,000.00	
Arkansas (Fayetteville)	3,900.00		18,181.82	
Arkansas (Pine Bluff)			6,818.18	
California	42,416.88	$8,973.31	25,000.00	$43,500.00
Colorado	6,161.61		25,000.00	
Connecticut	7,049.63		25,000.00	
Delaware (Newark)	4,980.00		20,000.00	
Delaware (Dover)			5,000.00	
Florida (Lake City)	7,710.00		12,500.00	
Florida (Tallahassee)			12,500.00	
Georgia (Athens)	16,954.14		16,666.67	
Georgia (Savannah)			8,333.33	8,000.00
Idaho			25,000.00	
Illinois	33,000.26		25,000.00	
Indiana	17,000.00		25,000.00	
Iowa	35,265.03		25,000.00	
Kansas	25,647.89		25,000.00	
Kentucky (Lexington)	8,644.50		21,375.00	37,626.54
Kentucky (Frankfort)	1,255.50		3,625.00	
Louisiana (Baton Rouge)	9,115.69	5,440.00	13,158.62	
Louisiana (New Orleans)			11,841.38	
Maine	5,915.00		25,000.00	
Maryland (College Park)	5,817.18		20,000.00	
Maryland (Princess Anne)			5,000.00	
Massachusetts (Amherst)	10,410.21		16,666.66	4,407.27
Massachusetts (Boston)	6,293.06		8,333.34	
Michigan	69,722.95		25,000.00	100,000.00
Minnesota	22,600.40		25,000.00	31,500.05
Mississippi (Agricultural College)	5,914.50	8,472.75	12,339.20	
Mississippi (Lorman)	6,814.50	5,777.77	12,660.80	
Missouri (Columbia)	17,494.06	12,320.00	23,437.50	33,397.90
Missouri (Jefferson City)			1,562.50	
Montana	9,420.00		25,000.00	
Nebraska	35,000.00	20,000.00	25,000.00	150,000.00
Nevada	4,100.00	1,930.87	25,000.00	
New Hampshire	4,800.00		25,000.00	
New Jersey	5,800.00		25,000.00	
New Mexico			25,000.00	
New York	34,428.80		25,000.00	
North Carolina (Raleigh)	7,500.00		16,750.00	
North Carolina (Greensboro)			8,250.00	
North Dakota	10,845.66		25,000.00	
Ohio	31,450.59	5,318.42	25,000.00	
Oklahoma (Stillwater)		9,164.00	22,500.00	
Oklahoma (Langston)			2,500.00	
Oregon	10,305.11		25,000.00	
Pennsylvania	25,637.43		25,000.00	5,382.57
Rhode Island	2,500.00		25,000.00	
South Carolina (Clemson College)	5,754.00		12,500.00	118,820.12
South Carolina (Orangeburg)	5,754.00		12,500.00	
South Dakota	11,158.67		25,000.00	
Tennessee	23,960.00	250.00	25,000.00	
Texas (College Station)	14,280.00		18,750.00	
Texas (Prairie View)			6,250.00	
Utah	7,394.70		25,000.00	
Vermont	8,130.00		25,000.00	5,000.00
Virginia (Blacksburg)	20,658.00		16,666.67	
Virginia (Hampton)	10,329.36		8,333.33	
Washington	5,000.00		25,000.00	
West Virginia (Morgantown)	6,637.16		20,000.00	
West Virginia (Institute)			5,000.00	
Wisconsin	25,877.63	19,313.58	25,000.00	
Wyoming	4,407.67		25,000.00	14,369.74
Total	721,491.77	96,960.70	1,200,000.00	552,004.19

colleges for year ended June 30, 1905.

State aid—Continued.		Income from endowment other than Federal or State grants.	Fees and all other sources.			Total.	United States appropriation for experiment stations (act of 1887).
Appropriation for current expenses.	Appropriations for buildings or for other special purposes.		Tuition fees.	Incidental fees.	Miscellaneous.		
$25,445.11			$900.00		[a] $7,339.08	$68,039.19	$15,000.00
4,000.00					500.00	15,425.00	
25,197.55			160.00	$3,112.88	1,480.43	54,950.86	15,000.00
73,769.21	$49,467.87			4,070.00		149,388.90	13,163.45
10,750.00			400.00			17,968.18	
331,366.36	193,707.13	$106,249.37	3,230.00	41,923.45	321,453.58	1,117,850.08	15,000.00
64,042.54				1,122.00	9,722.14	106,048.29	15,000.00
20,000.00				16.00	30,507.56	82,573.19	7,500.00
	7,500.00		1,200.00	3,000.00	3,699.10	40,379.10	15,000.00
	2,000.00				5,468.00	12,468.00	
12,237.88					[b] 11,192.93	43,640.81	15,000.00
1,000.00						13,500.00	
					657.61	34,278.42	15,000.00
						16,333.33	
21,500.00	30,928.15				867.15	78,295.30	15,000.00
250,000.00	276,200.00			[c] 205,995.57	60,854.21	851,050.04	15,000.00
149,628.18	71,542.34		8,364.00	40,283.20	17,972.31	329,790.03	15,000.00
110,000.00	241,500.00		1,084.00	27,497.47	5,865.10	446,211.60	15,000.00
50,000.00	41,380.00		9,806.00			151,833.89	15,000.00
			5,541.82	41.15	987.40	74,216.41	15,000.00
8,000.00				165.00	4,789.40	17,834.90	
15,000.00	23,700.00		1,170.00	2,215.00	26,924.90	96,724.21	15,000.00
10,000.00					368.50	22,209.88	
26,000.00		4,000.00	15,000.00	15,639.00		91,554.00	15,000.00
9,000.00	57,000.00			[c] 22,635.75	12,567.48	127,020.41	15,000.00
			401.25		1,683.26	7,084.51	
43,650.00	3,500.00		294.00	1,182.28	2,305.96	82,416.38	15,000.00
25,000.00		69,894.38	297,344.25	11,925.99	27,264.49	446,055.51	
			970.00	5,687.50	43,484.79	244,865.24	15,000.00
234,442.71	224,654.64		126,071.80	18,388.35	14,050.57	696,708.52	15,000.00
65,946.36	18,388.55		450.00	3,017.50	35,364.90	149,893.76	15,000.00
8,000.00	6,500.00		90.00		1,900.00	41,743.07	
116,598.25	135,752.16	100.00		13,509.00	45,992.23	398,601.10	15,000.00
27,200.00	25,000.00					53,762.50	
17,500.00	6,000.00		2,999.50		4,924.79	65,844.29	15,000.00
40,000.00	147,250.00		11,000.00	8,000.00	20,368.00	456,618.00	15,000.00
25,000.00	24,675.00		1,800.00		698.42	83,204.29	15,000.00
10,500.00		3,480.48	1,785.00	1,702.83	31,259.10	78,527.41	15,000.00
2,473.12		19,269.91		[c] 6,030.00	116.60	58,689.63	15,000.00
12,403.41			1,291.00		2,988.73	41,683.14	15,000.00
25,000.00	40,000.00	386,347.71	270,258.74	72,400.55	374,978.23	1,228,414.03	13,500.00
25,000.00			11,254.47	7,514.49	7,446.31	75,465.27	15,000.00
7,500.00	3,750.00		24.50	152.91		19,677.41	
31,397.95	95,400.00			4,307.50	4,696.08	171,647.19	15,000.00
293,582.04	41,832.36		43,034.44		37,392.86	477,610.71	
16,082.10	1,743.61			1,149.50	8,466.05	59,105.26	15,000.00
19,164.00						21,664.00	
	25,000.00			1,512.25	2,124.30	63,941.66	15,000.00
52,000.25	73,402.52		810.00	19,053.82	48,542.65	249,829.24	15,000.00
15,000.00	31,500.00				4,000.00	78,000.00	15,000.00
		3,512.36	3,070.00		35,462.02	179,118.50	15,000.00
	7,500.00					25,754.00	
31,500.00			2,558.00	3,078.00	9,274.67	82,569.34	15,000.00
		2,263.00	[a] 13,521.92		8,086.54	73,081.46	15,000.00
60,000.00	50,000.00			2,065.00		145,095.00	15,000.00
20,500.00					12,000.00	38,750.00	
31,315.20	12,998.70		3,507.50	1,520.25	10,312.54	92,048.89	15,000.00
6,000.00	60,000.00	21,904.77	[a] 18,166.11		3,627.15	147,828.03	15,000.00
40,000.00	82,500.00				[b] 27,010.00	186,834.67	15,000.00
		51,254.24			140,927.84	210,844.77	
55,000.00	12,500.00		195.00	3,012.15	16,402.57	117,109.72	15,000.00
93,900.00	31,587.50				20,976.59	173,101.25	15,000.00
1,800.00	29,200.00			200.00	7,802.60	44,002.60	
378,000.00	127,500.00	3,611.88	22,818.50	54,820.00	138,960.32	795,901.91	15,000.00
			623.50	34.60	42.75	44,478.26	15,000.00
3,048,422.22	2,313,060.53	671,888.10	881,195.30	607,980.94	1,674,150.79	11,767,154.54	694,163.45

[a] Including incidental fees. [b] Including tuition and incidental fees. [c] Including tuition fees.

TABLE 6.—*Additions to equipment of land-grant colleges, 1905.*

State or Territory.	Permanent endowment.	Buildings.	Libraries.	Apparatus.	Machinery.	Live stock.	Miscellaneous.	Total.
Alabama (Auburn)		$6,300.00	$1,698.00	$2,851.16	$1,488.00	$235.00		$12,572.16
Alabama (Normal)		12,000.00					$1,000.00	13,000.00
Arizona			2,400.00	2,408.98	1,704.70			6,513.68
Arkansas (Fayetteville)				3,000.00	2,500.00	1,500.00	1,000.00	8,000.00
Arkansas (Pine Bluff)								
California		348,576.06	16,694.12	24,604.59				389,874.77
Colorado		2,000.00	6,193.25	3,000.00	5,000.00	2,638.00	3,000.00	21,831.25
Connecticut		1,738.55	280.09	590.67	95.95	187.55	414.48	3,307.29
Delaware (Newark)			850.00	800.00	700.00		1,000.00	3,350.00
Delaware (Dover)		2,100.00	300.00					2,400.00
Florida (Lake City)		12,500.00	261.88	446.02	173.10	811.04	2,405.19	16,597.23
Florida (Tallahassee)								
Georgia (Athens)		45,000.00	5,000.00	5,000.00		250.00	4,000.00	59,250.00
Georgia (Savannah)								
Idaho	$82,563.92	25,918.90	752.70	647.14	2,631.98	40.00	1,251.94	113,806.58
Illinois	5,489.00	100,000.00	15,000.00	25,000.00	25,000.00	10,000.00	10,000.00	190,489.00
Indiana		70,000.00	3,000.00	15,000.00	2,500.00	1,200.00	2,000.00	93,700.00
Iowa		220,000.00	2,000.00		[a] 6,500.00	3,300.47		231,800.47
Kansas		8,200.00	1,500.00	2,500.00	2,175.00	4,000.00	700.00	19,075.00
Kentucky (Lexington)		17,029.59	596.15	2,013.69	243.03	75.00	1,683.62	21,641.08
Kentucky (Frankfort)			15.00		40.00	175.00		230.00
Louisiana (Baton Rouge)			841.00	3,674.24	4,356.37		552.64	9,424.25
Louisiana (New Orleans)								
Maine								
Maryland (College Park)		30,000.00	750.00	[b] 12,500.00				43,250.00
Maryland (Princess Anne)								
Massachusetts (Amherst)	424.65		1,000.00	2,272.71			5,000.00	8,697.36
Massachusetts (Boston)								
Michigan		77,943.25						77,943.25
Minnesota	25,000.00	41,000.00	5,000.00			1,100.00		72,100.00
Mississippi (Agricultural College)		72,175.00	1,816.26	6,284.84	8,223.39	7,218.00	13,676.12	109,393.61
Mississippi (Lorman)		5,000.00	80.00				1,500.00	6,580.00
Missouri (Columbia)								
Missouri (Jefferson City)			1,000.00	100.00				1,100.00
Montana	2,610.30		1,500.00	3,000.00	3,000.00	345.00		10,455.30
Nebraska		135,000.00	10,000.00	5,000.00			7,000.00	157,000.00
Nevada		3,536.03	1,611.78	607.32	1,094.04	490.00	658.13	7,997.30
New Hampshire			1,024.00	2,023.12	385.03	155.50		3,587.65
New Jersey	10,994.00	2,755.00	2,089.83	1,130.96	246.37		1,589.68	18,814.84
New Mexico			1,250.00	1,000.00	200.00	250.00	200.00	2,900.00
New York	29,393.74	20,000.00	55,579.00				[c] 63,247.36	168,220.10
North Carolina (Raleigh)		60,000.00	655.97	400.00	1,000.00	1,000.00		63,055.97
North Carolina (Greensboro)		4,550.00	35.00	168.60	690.00	380.00	140.00	5,963.60
North Dakota		61,757.37	1,168.21	1,383.76	469.01	2,628.85	1,062.96	68,470.16
Ohio	118,587.47	200,000.00	2,500.00					321,087.47

Oklahoma (Stillwater)		7,074.75	918.12	4,750.00	1,559.70	3,645.00	1,200.00	19,147.57
Oklahoma (Langston)		3,100.00	200.00	150.00	400.00	135.00	250.00	4,235.00
Oregon			477.33	553.15	3,489.97	378.50	1,398.26	6,297.21
Pennsylvania	175,000.00	100,000.00	1,000.00					276,000.00
Rhode Island			600.00	550.00				1,150.00
South Carolina (Clemson College)		900.00	1,000.00	2,265.53	2,937.94			7,103.47
South Carolina (Orangeburg)				225.00	50.00			275.00
South Dakota			400.00	1,100.00	500.00			2,000.00
Tennessee		768.91	1,018.62	1,803.37	3,264 24	82.50	943.15	7,880.79
Texas (College Station)		50,000.00	1,162.00	28,500.00	25,000.00	705.00	1,000.00	106,367.00
Texas (Prairie View)			250.00	1,000.00		100.00	200.00	1,550.00
Utah			429.54		6,000.00		5,510.00	11,939.54
Vermont	38,479.00	100,000.00	6,020.00					144,499.00
Virginia (Blacksburg)		73,302.00	1,727.41				[d] 27,688.30	102,717.71
Virginia (Hampton)	140,000.00	40,000.00	500.00			2,500.00	7,000.00	190,000.00
Washington			342.10	2,486.94	762.27	192.00	355.57	4,138.88
West Virginia (Morgantown)		10,000 00	3,500.00	1,500.00	12,000.00			27,000.00
West Virginia (Institute)		13,000.00	200.00	398.70	1,275.00	560 00	260.00	15,693.70
Wisconsin		150,000.00	16,206.06		[a] 22,237.13	3,156.52	11,114.60	202,714.31
Wyoming			1,854.01	889.93	3,133.56	1,278.43	168.71	7,324.64
Total	628,542.08	2,133,225.41	182,247.43	173,589.42	153,025.78	50,712.36	180,170.71	3,501,513.19

[a] Including apparatus.
[b] Including machinery.
[c] Including apparatus, machinery, and live stock.
[d] Including apparatus and machinery.

TABLE 7.—*Disbursements from the United States Treasury to the States and Territories of the appropriations in aid of colleges of agriculture and the mechanic arts under the act of Congress approved August 30, 1890.*(a)

State or Territory.	Year ending June 30—										
	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	b 1900.
Alabama	$15,000	$16,000	$17,000	$18,000	$19,000	$20,000	$21,000	$22,000	$23,000	$24,000	$25,000
Arizona	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Arkansas	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
California	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Colorado	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Connecticut	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Delaware	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Florida	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Georgia	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Idaho	.....	.....	.....	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Illinois	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Indiana	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Iowa	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Kansas	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Kentucky	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Louisiana	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Maine	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Maryland	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Massachusetts	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Michigan	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Minnesota	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Mississippi	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Missouri	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Montana	.....	.....	.....	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Nebraska	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Nevada	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New Hampshire	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New Jersey	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New Mexico	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
New York	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
North Carolina	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
North Dakota	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Ohio	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Oklahoma	.....	.....	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Oregon	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Pennsylvania	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Rhode Island	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
South Carolina	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
South Dakota	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Tennessee	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Texas	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000

Utah	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Vermont	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Virginia	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Washington	.....	.....	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
West Virginia	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Wisconsin	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Wyoming	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
Total	660,000	704,000	782,000	864,000	912,000	960,000	1,008,000	1,056,000	1,104,000	1,152,000	1,200,000

[a] From the annual statement of Commissioner of Education to the Secretary of the Interior, 1905.

[b] For each of the years ended June 30, 1901, 1902, 1903, 1904, 1905, and 1906 the sum of $25,000 was paid to each of the 48 States and Territories included in this tabular statement, the total amount disbursed for each of said years being $1,200,000.

STATISTICS OF THE AGRICULTURAL

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Alabama (College)	Auburn	J. F. Duggar, M. S	Feb. —, 1883	Feb. 24, 1888
Alabama (Canebrake)	Uniontown	J. M. Richeson, M. S.[a]	Jan. 1, 1886	Apr. 1, 1888
Alabama (Tuskegee)	Tuskegee Institute	G. W. Carver, M. A	Feb. 15, 1897	.....
Arizona	Tucson	R. H. Forbes, M. S	.....	1889
Arkansas	Fayetteville	W. G. Vincenheller	.....	1887
California	Berkeley	E. W. Hilgard, Ph. D., LL. D.	1875	Mar. —, 1888
Colorado	Fort Collins	L. G. Carpenter, M. S.	1879	Feb. —, 1888
Connecticut (State)	New Haven	E. H. Jenkins, Ph. D	Oct. 1, 1875	May 18, 1887
Connecticut (Storrs)	Storrs	L. A. Clinton, M. S	.....	do
Delaware	Newark	A. T. Neale, A. M., Ph. D.	.....	Feb. 21, 1888
Florida	Lake City	P. H. Rolfs, M. S	.....	1888
Georgia	Experiment	R. J. Redding	Feb. 18, 1888	July 1, 1889
Idaho	Moscow	H. T. French, M. S	.....	Feb. 26, 1892
Illinois	Urbana	Eugene Davenport, M. Agr.	.....	Mar. 21, 1888
Indiana	Lafayette	Arthur Goss, M. S., A. C.	1885	Jan. —, 1888
Iowa	Ames	C. F. Curtiss, M. S. A.	.....	Feb. 17, 1888
Kansas	Manhattan	J. T. Willard, M. S	.....	Feb. 8, 1888
Kentucky	Lexington	M. A. Scovell, M. S	Sept. —, 1885	Apr. —, 1888
Louisiana (Sugar)	New Orleans	W. R. Dodson, A. B., B. S.	Sept. —, 1885	.....
Louisiana (State)	Baton Rouge	do	Apr. —, 1886	
Louisiana (North)	Calhoun	do	May —, 1887	
Maine	Orono	C. D. Woods, Sc. D	Mar. —, 1885	Oct. 1, 1887

[a] Assistant director in charge.

EXPERIMENT STATIONS.

statistics, 1905.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1904-5.		Number of addresses on mailing list.	Principal lines of work.
			Number.	Pages.		
13	11	8	5	206	13,000	Chemistry; botany; soils; analyses of fertilizers and food materials; field and pot experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; dairying.
3	.....	7	1	32	1,500	Soil improvement; field experiments; horticulture; floriculture; diseases of plants and animals.
9	8	8	1	10	1,500	Field experiments; horticulture; diseases of plants; animal industry; poultry investigations; dairying.
7	1	3	4	111	7,500	Chemistry; botany; field experiments; improvement of ranges; horticulture, including date-palm culture; plant breeding; feeding experiments; dairying; irrigation.
10	5	4	4	106	10,000	Chemistry; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology; dairying.
35	19	18	10	509	9,200	Chemistry; soils; bacteriology; fertilizer control; field crops; horticulture, including date culture, viticulture and zymology; botany; meteorology; animal husbandry; entomology; dairying; poultry culture; drainage and irrigation; sylviculture; reclamation of alkali lands; animal and plant pathology; nutrition investigations.
19	10	9	11	296	8,000	Chemistry; meteorology; field experiments; horticulture; forestry; plant breeding; diseases of plants; animal husbandry; entomology; irrigation.
19	.....	5	7	609	12,000	Chemistry; analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; diseases of plants; plant breeding; forestry; field experiments; entomology.
15	10	6	8	382	9,000	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; horticulture; poultry experiments; dairying.
6	5	4	5	164	6,888	Chemistry; bacteriology; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology; dairying.
14	8	.....	9	284	4,017	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; veterinary science; entomology.
7	1	4	5	134	14,000	Field experiments; horticulture; plant breeding; entomology; feeding experiments; dairying.
9	6	6	6	123	5,500	Chemistry; physics; botany; field experiments; horticulture; plant breeding and diseases; entomology; feeding experiments.
32	20	22	8	334	28,000	Chemistry; bacteriology; pot and field experiments; horticulture; forestry; plant breeding; animal husbandry; diseases of plants and animals; dairying.
21	8	8	8	332	11,500	Chemistry; soils; pot and field experiments; horticulture; plant breeding; breeding and feeding experiments; diseases of plants and animals; entomology; dairying.
26	15	20	6	196	15,000	Chemistry; botany; soils; field experiments; horticulture; plant breeding; forestry; diseases of plants; animal husbandry; entomology; dairying; rural engineering; good roads investigations.
19	7	7	7	434	21,456	Chemistry; soils; horticulture; plant breeding; field experiments; feeding and digestion experiments; poultry experiments; diseases of animals; entomology; dairying; extermination of prairie dogs and gophers; irrigation.
14	1	3	7	241	9,500	Chemistry; soils; analysis of fertilizers, foods and feeding stuffs; inspection of orchards and nurseries; field experiments; horticulture; plant breeding; animal husbandry; diseases of plants; entomology; apiculture; dairying.
28	2	9	6	384	11,000	Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation. Geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments; horticulture; animal husbandry; diseases of animals; entomology.
13	4	2	13	444	9,000	Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; dairying. Chemistry; botany; analysis and inspection of foods, fertilizers, concentrated commercial feeding stuffs, and agricultural seeds; inspection of creamery glassware; horticulture; plant breeding; diseases of plants and animals; food and nutrition of man and animals; poultry raising; entomology.

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Maryland	College Park	H. J. Patterson, B. S.	1888	Apr. —, 1888
Massachusetts	Amherst	W. P. Brooks, Ph. D.	[a] 1882	Mar. 2, 1888
Michigan	Agricultural College	C. D. Smith, M. S		Feb. 26, 1888
Minnesota	St. Anthony Park	W. M. Liggett	Mar. 7, 1885	1888
Mississippi	Agricultural College	W. L. Hutchinson, M. S.		Jan. 27, 1888
Missouri (College)	Columbia	H. J. Waters, B. S. A.		Jan. —, 1888
Missouri (Fruit)	Mountain Grove	Paul Evans	Feb. 1, 1900	
Montana	Bozeman	F. B. Linfield, B. S. A.		July 1, 1893
Nebraska	Lincoln	E. A. Burnett, B. S	Dec. 16, 1884	June 13, 1887
Nevada	Reno	J. E. Stubbs, M. A., D. D., LL. D.		Dec. —, 1887
New Hampshire	Durham	W. D. Gibbs, M. S	1886	Aug. 4, 1887
New Jersey (State)	New Brunswick	E. B. Voorhees, D. Sc	Mar. 10, 1880	
New Jersey (College)	do	do		Apr. 26, 1888
New Mexico	Agricultural College	Luther Foster, M. S. A		Dec. 14, 1889
New York (State)	Geneva	W. H. Jordan, D. Sc	Mar. —, 1882	
New York (Cornell)	Ithaca	L. H. Bailey, M. S	1879	Apr. —, 1888
North Carolina	Raleigh	B. W. Kilgore, M. S	Mar. 12, 1877	Mar. 7, 1887
North Dakota	Agricultural College	J. H. Worst, LL. D		Mar. —, 1890
Ohio	Wooster	C. E. Thorne, M. S. A.	Apr. 25, 1882	Apr. 2, 1888
Oklahoma	Stillwater	John Fields, B. S		Dec. 25, 1890
Oregon	Corvallis	James Withycombe, M. Agr.		July —, 1888
Pennsylvania	State College	H. P. Armsby, Ph. D., LL. D.		June 30, 1887

[a] In 1882 the State organized a station here and maintained it until June 18, 1895, when it was combined with the Hatch Station at the same place.

statistics, 1905—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1904-5.		Number of addresses on mailing list.	Principal lines of work.
			Number.	Pages.		
16	7	6	11	251	17,000	Chemistry; fertilizers; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; animal breeding; entomology; dairying.
22	8	5	20	424	32,250	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments; horticulture; diseases of plants and animals; digestion and feeding experiments; entomology; dairying; effect of electricity on plant growth.
11	8	13	15	602	38,273	Chemistry; analysis and control of fertilizers and feeding stuffs; bacteriology; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology; stable hygiene.
19	8	.....	5	258	13,716	Chemistry; fertilizers; field experiments; horticulture; forestry; diseases of plants and animals; food and nutrition of man; plant and animal breeding; feeding experiments; entomology; dairying; farm management; farm statistics.
12	7	8	2	88	20,000	Soils; fertilizers; field experiments; horticulture; plant breeding; animal husbandry; diseases of animals; poultry culture; entomology; dairying.
26	17	17	7	193	8,000	Chemistry; soil survey; botany; field experiments; horticulture; diseases of plants and animals; feeding experiments; animal and plant breeding; entomology; dairying.
5	.....	.....	3	37	4,500	Horticulture; entomology; inspection of orchards and nurseries.
11	10	7	5	275	3,996	Chemistry; meteorology; botany; field experiments; dry farming; horticulture; feeding experiments; poultry experiments; entomology; dairying; irrigation.
19	12	10	7	138	36,000	Chemistry; botany; meteorology; soils; field experiments; horticulture; plant breeding; diseases of plants and animals; forestry; feeding and breeding experiments; extermination of prairie dogs; entomology; dairying; irrigation.
10	6	6	3	120	3,100	Chemistry; botany; soils; field experiments; horticulture; forestry; animal breeding; animal diseases; entomology; irrigation.
14	8	8	7	116	12,000	Chemistry; field experiments; horticulture; plant breeding; forestry; feeding experiments; entomology; dairying.
14 8	2 4	5 3	7 5	621 343	5,500 5,500	Chemistry; oyster culture; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments; horticulture; plant breeding; diseases of plants and animals; entomology; dairy husbandry; soil bacteriology; irrigation.
12	9	8	5	188	13,500	Chemistry; botany; soils; field experiments; horticulture; feeding experiments; entomology; irrigation.
25	.....	12	24	1,077	40,751	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of feeding stuffs; Paris green, and creamery glassware; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
20	17	15	11	443	14,128	Chemistry; fertilizers; field experiments; horticulture, plant breeding; diseases of plants and animals; feeding experiments; poultry experiments; entomology; dairying.
10	7	7	4	204	30,000	Chemistry; soils; field experiments; horticulture; diseases of plants and animals; animal husbandry; poultry experiments; dairying; tests of farm machinery.
17	10	4	5	527	10,800	Chemistry; botany; field experiments; plant breeding; horticulture; forestry; diseases of plants and animals; analysis of foods and spraying materials; feeding experiments; dairying; tests of farm machinery.
24	.....	10	9	245	45,000	Soils; field experiments; horticulture; plant breeding; forestry; diseases of plants; feeding experiments; entomology.
12	9	5	5	104	21,943	Chemistry; field experiments; horticulture; plant breeding; forestry; botany; bacteriology; diseases of plants and animals; animal husbandry; entomology.
10	7	4	6	132	5,500	Chemistry; bacteriology; soils; fertilizers; field crops; horticulture; plant selection; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
20	7	2	5	339	16,140	Chemistry; meteorology; fertilizers; horticulture; field experiments; feeding experiments; dairying.

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Rhode Island	Kingston	H. J. Wheeler, Ph. D		July 30, 1888
South Carolina	Clemson College	J. N. Harper, B. S		Jan. —, 1888
South Dakota	Brookings	J. W. Wilson, M. S. A		Mar. 13, 1887
Tennessee	Knoxville	H. A. Morgan, B. S. A	June 8, 1882	Aug. 4, 1887
Texas	College Station	J. A. Craig, B. S. A		Apr. 3, 1889
Utah	Logan	P. A. Yoder, Ph. D		1890
Vermont	Burlington	J. L. Hills, Sc. D	Nov. 24, 1886	Feb. 28, 1888
Virginia	Blacksburg	A. M. Soule, B. S. A	1888	1891
Washington	Pullman	E. A. Bryan, M. A., LL. D.		1891
West Virginia	Morgantown	J. H. Stewart, M. A		June 11, 1888
Wisconsin	Madison	W. A. Henry, D. Agr., D. Sc.	1883	1887
Wyoming	Laramie	B. C. Buffum, M. S	1887	Mar. 1, 1891
Total				

statistics, 1905—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1904-5.		Number of addresses on mailing list.	Principal lines of work.
			Number.	Pages.		
11	4	4	8	326	9,000	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; plant breeding; poultry experiments.
19	11	10	26	318	11,200	Chemistry; analysis and control of fertilizers; botany; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; veterinary science; entomology; dairying.
13	8	4	6	205	9,500	Chemistry; botany; horticulture; field experiments; plant breeding; diseases of plants and animals; animal husbandry; entomology.
12	8	6	4	70	6,800	Chemistry; inspection of fertilizers; field experiments; horticulture; plant breeding; seeds; weeds; diseases of plants; feeding experiments; entomology; dairying.
16	10	14	5	90	25,000	Chemistry; seed testing and feed inspection; soils; field experiments; horticulture; feeding experiments; diseases of animals; irrigation.
18	11	9	2	310	7,600	Chemistry of soils and feeding stuffs; alkali soil investigations; field experiments; horticulture; diseases of plants; breeding and feeding experiments; dairying; poultry experiments; entomology; irrigation; arid farming.
11	5	4	9	468	11,000	Chemistry; botany; bacteriology; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; dairying.
21	15	6	7	164	10,000	Chemistry; geology; biology; field experiments; horticulture; plant breeding; bacteriology; analysis of foods and soils; inspection of orchards; breeding and feeding experiments; veterinary science; entomology; cider and vinegar making; ferments.
14	12	13	9	193	5,450	Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; veterinary science; entomology; dairying; irrigation.
16	7	7	5	202	10,000	Chemistry; analysis and control of fertilizers; soils; field experiments; horticulture; diseases of plants; inspection of orchards and nurseries; feeding experiments; poultry experiments; entomology.
29	22	5	15	966	17,500	Chemistry; bacteriology; soils; field experiments; horticulture; plant breeding; breeding and feeding experiments; dairying; irrigation and drainage; agricultural engineering.
9	6	3	5	220	3,200	Botany; meteorology; soils; range improvement; fertilizers; field experiments; plant selection; food analysis; breeding and feeding experiments; irrigation.
845	423	393	403	15,588	731,408	

TABLE 9.—*Revenues and values of additions to*

Station	Hatch fund.	State.	Individuals and communities.	Fees.	Farm products.
Alabama (College)	$15,000.00			$6,073.24	$382.67
Alabama (Canebrake)		$2,500.00			610.39
Alabama (Tuskegee)		1,500.00			
Arizona	15,000.00	13,698.86		127.00	807.56
Arkansas	13,163.45				1,567.33
California	15,000.00				
Colorado	15,000.00				
Connecticut (State)	7,500.00	[a] 15,950.00	$8,500.00	[a] 3,610.31	
Connecticut (Storrs)	7,500.00	1,800.00			
Delaware	15,000.00				
Florida	15,000.00				2,183.14
Georgia	15,000.00	637.87			1,735.26
Idaho	15,000.00				[a] 1,450.92
Illinois	15,000.00	85,000.00		522.50	682.04
Indiana	15,000.00				
Iowa	15,000.00	28,125.00	400.00		6,723.34
Kansas	15,000.00	[c] 7,650.00			[a] 4,266.05
Kentucky	15,000.00	[a] 14,286.00		18,040.30	5,282.55
Louisiana	15,000.00	15,000.00		6,030.00	2,233.12
Maine	15,000.00	1,500.00		3,755.00	1,760.52
Maryland	15,000.00	5,000.00			4,582.57
Massachusetts	15,000.00	13,625.00		4,365.00	1,512.95
Michigan	15,000.00	[c] 3,500.00		2,480.00	1,718.51
Minnesota	15,000.00	[d] 38,749.90			[d] 8,138.50
Mississippi	15,000.00	[e] 20,000.00			2,061.18
Missouri (College)	15,000.00	3,000.00		4,948.87	5,073.14
Missouri (Fruit)		14,050.00			
Montana	15,000.00	6,440.67			4,581.86
Nebraska	15,000.00	[c] 15,000.00			7,679.47
Nevada	15,000.00				698.42
New Hampshire	15,000.00			1,702.83	
New Jersey (State)		[f] 27,000.00			
New Jersey (College)	15,000.00				
New Mexico	15,000.00				2,038.43
New York (State)	1,500.00	[g] 93,753.97			
New York (Cornell)	13,500.00	[h] 10,000.00			210.95
North Carolina	15,000.00	[i] 14,000.00			771.35
North Dakota	15,000.00	[c] 5,000.00			1,213.70
Ohio	15,000.00	[a] 52,470.16		131.75	5,127.52
Oklahoma	15,000.00	1,421.65			
Oregon	15,000.00				[a] 1,516.27
Pennsylvania	15,000.00	[a] 1,141.68		13,284.65	4,453.43
Rhode Island	15,000.00				1,028.81
South Carolina	15,000.00	1,620.83			960.70
South Dakota	15,000.00	1,000.00			
Tennessee	15,000.00			680.00	4,810.10
Texas	15,000.00	[c] 6,000.00			82.85
Utah	15,000.00				1,556.27
Vermont	15,000.00	1,545.72	25.80	2,824.44	
Virginia	15,000.00				
Washington	15,000.00			225.10	
West Virginia	15,000.00			11,682.33	2,951.83
Wisconsin	15,000.00	18,500.00		1,975.00	
Wyoming	15,000.00				604.30
Total	718,163.45	540,467.31	8,925.80	82,428.32	93,058.00

[a] Including balance from previous year.
[b] Balance from previous year.
[c] For substations.
[d] Including substations.
[e] For substations, including $14,000 for McNeill substation for biennial period 1903–1905.

equipment of the agricultural experiment stations, 1905.

Miscellaneous.	Total.	Additions to equipment in 1905.						
		Buildings.	Libraries.	Apparatus.	Farm implements.	Live stock.	Miscellaneous.	Total.
$2,080.08	$23,535.99	$950.00	$450.00	$685.00	$545.00	.....	$320.00	$2,950.00
.....	3,110.39	5,000.00	250.00	50.00	100.00	$200.00	50.00	5,650.00
.....	1,500.00	.....	.....	90.00	25.00	.....	.....	115.00
105.85	29,739.27	3,237.01	20.76	157.80	188.75	300.00	177.78	4,082.10
.....	14,730.78	227.50	64.63	3.44	150.00	631.50	624.04	1,701.11
.....	15,000.00	71.10	42.91	191.81	139.53	.....	43.93	489.28
[a] 967.75	15,967.75	.....	42.69	300.27	16.60	428.06	.....	787.62
30.71	35,591.02	.....	462.12	221.44	39.48	.....	530.04	1,253.08
684.31	9,984.31	242.68	65.22	80.26	29.74	294.50	.....	712.40
.....	15,000.00	725.04	463.29	233.88	30.01	5.40	281.08	1,738.70
.....	17,183.14	55.00	99.67	92.93	230.09	811.04	137.88	1,426.61
[b] 2,857.62	20,230.75	.....	.....	15.00	170.00	.....	.....	185.00
.....	16,450.92	204.38	155.23	149.39	520.88	40.00	46.62	1,116.50
[b] 1,003.56	102,208.10	12,500.00	125.58	2,633.05	2,094.64	2,700.00	3,861.20	23,914.47
[a] 11,880.78	26,880.78	176.08	234.47	103.53	353.15	8.00	242.00	1,117.23
1,323.48	51,571.82	217.65	.....	401.03	20.70	1,280.35	.....	1,919.73
.....	26,916.05	279.19	89.90	517.31	200.00	.....	865.00	1,951.40
32.22	52,641.07	16,274.59	370.20	332.70	87.66	75.00	1,350.92	18,491.07
[a] 13,359.42	51,592.54	1,575.43	329.73	122.83	317.54	1,460.50	.....	3,806.03
[b] 54.07	22,069.59	1,260.78	329.85	178.64	184.67	.....	.....	1,953.94
[b] 1,016.69	25,599.26	1,301.51	383.24	167.20	423.46	485.00	.....	2,760.41
3,463.70	37,966.65	700.00	170.44	1,322.05	110.00	54.70	336.37	2,693.56
[a] 5,021.98	27,720.49	133.89	355.53	1,060.28	364.42	1,198.84	209.89	3,322.85
.....	61,888.40	.....	.....	241.64	763.77	1,110.00	.....	2,115.41
[a] 3,240.49	40,301.67	1,410.00	100.00	.....	200.00	500.00	900.00	3,110.00
[b] 110.86	28,132.87	.....	97.71	91.45	11.80	971.50	.....	1,172.46
.....	14,050.00	.....	.....	.....	.....	.....	.....	.....
.....	26,022.53	.....	100.00	428.00	50.00	470.00	.....	1,048.00
[b] 655.98	38,335.45	.....	.....	267.19	235.99	397.60	455.25	1,356.03
[b] 505.29	16,203.71	516.78	347.85	341.17	306.65	530.10	402.65	2,445.20
.....	16,702.83	.....	259.50	453.87	247.47	73.50	317.08	1,351.42
.....	27,000.00	852.94	128.64	978.95	.....	.....	83.05	2,043.58
.....	15,000.00	316.43	509.07	287.51	187.87	.....	162.56	1,463.44
600.00	17,638.43	.....	500.00	250.00	1,000.00	250.00	500.00	2,500.00
.....	95,253.97	4,500.00	732.38	.....	.....	500.00	.....	5,732.38
.....	23,710.95	587.74	57.31	389.82	111.85	9.00	440.05	1,595.77
.....	29,771.35	126.22	32.12	62.53	299.39	186.35	.....	706.61
[a] 4,266.16	25,479.86	2,778.73	111.22	247.44	158.89	29.20	3,984.18	7,309.66
[a] 5,375.24	78,104.67	2,890.29	264.98	542.10	682.59	2,507.16	142.87	7,029.99
[a] 2,837.98	19,259.63	.....	66.36	136.29	359.70	643.69	.....	1,206.04
.....	16,516.27	.....	140.13	178.00	144.97	378.50	17.50	859.10
250.13	34,129.89	.....	9.67	169.81	.....	122.00	173.31	474.79
2,709.64	18,738.46	653.38	362.33	95.92	36.63	432.50	199.64	1,780.40
[a] 2,635.34	20,216.87	.....	59.12	483.12	64.32	38.09	25.41	670.06
3,140.73	19,140.73	490.00	73.29	215.49	110.00	226.00	.....	1,114.78
677.89	21,167.99	493.91	149.43	834.84	248.78	82.50	110.13	1,919.59
1,529.52	22,612.37	489.12	28.85	25.00	69.25	345.35	101.36	1,058.93
[b] 79.16	16,635.43	213.12	175.00	350.00	350.00	100.00	300.00	1,488.12
.....	19,395.96	646.72	90.22	501.21	451.56	1,107.70	596.05	3,393.46
55.47	15,055.47	2,000.00	11.92	271.37	693.61	.....	.....	2,976.90
.....	15,225.10	.....	.....	325.00	.....	17.00	150.00	492.00
139.49	29,773.65	3,232.62	312.20	389.42	421.32	840.36	94.18	5,290.10
.....	35,475.00	1,504.45	644.53	1,111.11	659.86	743.28	684.18	5,347.41
.....	15,604.30	.....	250.00	388.00	414.00	1,278.00	100.00	2,430.00
72,691.59	1,515,734.47	68,834.28	10,119.29	19,166.09	14,621.59	23,862.27	19,016.20	155,619.72

[f] For the fiscal year ended October 31, 1905.
[g] For the fiscal year ended October 1, 1905.
[h] Estimated amount of State appropriation spent for experimental purposes.
[i] For the fiscal year ended December 1, 1905.

TABLE 10.—*Expenditures from United States appropriation for the*

Station.	Amount of appropriation.	Classified expenditures.						
		Salaries.	Labor.	Publications.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.
Alabama	$15,000.00	$7,395.53	$1,227.74	$1,367.81	$121.05	$468.81	$301.84	$753.22
Arizona	15,000.00	6,431.84	4,504.82	49.09	350.68	294.31	51.03	354.51
Arkansas	13,163.45	7,988.79	2,071.90	407.08	109.32	221.04	75.05	152.64
California	15,000.00	5,602.38	5,594.31	400.00	664.04	121.19	446.13	366.16
Colorado	15,000.00	10,863.30	211.61	1,780.93	356.02	7.30	.....	.....
Connecticut (State)	7,500.00	7,500.00	.....	.....	.....	.....	.....	.....
Connecticut (Storrs)	7,500.00	3,544.14	1,528.73	192.10	164.03	68.87	84.96	177.65
Delaware	15,000.00	9,640.06	1,116.79	717.82	120.19	102.80	400.87	45.71
Florida	15,000.00	8,298.21	1,840.36	1,104.37	82.11	194.65	468.70	93.88
Georgia	15,000.00	7,280.00	2,514.08	1,501.94	229.64	235.26	256.65	.....
Idaho	15,000.00	8,244.95	2,206.83	1,006.09	235.45	229.67	316.53	180.03
Illinois	15,000.00	6,814.72	2,681.15	1,788.32	827.55	457.54	120.00	.....
Indiana	15,000.00	7,901.62	1,525.15	2,616.05	420.25	74.93	32.00	883.78
Iowa	15,000.00	9,215.13	.....	2,253.31	365.26	502.46	.....	477.46
Kansas	15,000.00	7,828.33	4,038.30	329.55	37.97	331.18	32.80	136.36
Kentucky	15,000.00	11,650.00	242.16	1,224.81	216.70	49.71	400.13	184.52
Lousiana	15,000.00	13,670.98	.....	1,329.02	.....	.....	.....	.....
Maine	15,000.00	8,300.00	1,789.56	259.36	356.07	211.46	535.03	247.55
Maryland	15,000.00	8,252.57	2,830.58	183.72	322.07	310.87	367.47	207.91
Massachusetts	15,000.00	6,992.42	1,788.14	782.84	367.35	221.78	544.60	106.39
Michigan	15,000.00	6,283.78	3,429.77	191.50	583.38	201.44	96.24	190.90
Minnesota	15,000.00	10,129.03	2,284.62	75.28	317.21	27.63	777.35	.....
Mississippi	15,000.00	6,865.67	2,042.62	912.23	238.96	210.66	110.10	.....
Missouri	15,000.00	5,983.13	2,622.50	431.57	125.90	274.94	40.05	86.11
Montana	15,000.00	10,701.68	1,483.99	734.06	430.81	397.11	29.90	115.70
Nebraska	15,000.00	8,800.71	1,695.53	1,508.82	602.97	97.20	.....	134.09
Nevada	15,000.00	9,599.75	2,419.02	201.20	170.20	201.45	443.63	129.39
New Hampshire	15,000.00	8,884.40	1,982.52	1,040.36	86.68	138.99	105.89	74.87
New Jersey	15,000.00	9,730.00	1,062.32	790.16	502.98	116.69	417.45	163.40
New Mexico	15,000.00	8,179.30	1,740.53	599.96	243.98	599.57	318.53	37.78
New York (State)	1,500.00	1,485.29	.....	.....	14.71	.....	.....	.....
New York (Cornell)	13,500.00	9,916.41	956.25	786.61	183.04	49.93	20.04	129.87
North Carolina	15,000.00	9,685.32	1,770.97	545.75	380.91	109.76	43.51	100.45
North Dakota	15,000.00	7,339.05	2,964.38	1,102.74	300.10	.25	396.13	111.96
Ohio	15,000.00	13,588.94	1,337.55	.....	.....	.....	.....	.....
Oklahoma	15,000.00	6,559.13	3,011.47	1,583.57	275.07	154.64	240.03	79.76
Oregon	15,000.00	10,160.00	2,226.64	369.54	40.00	120.36	.....	160.40
Pennsylvania	15,000.00	11,216.88	.....	502.78	374.97	.....	323.78	402.80
Rhode Island	15,000.00	9,377.76	1,854.43	45.67	144.76	109.40	373.36	53.66
South Carolina	15,000.00	9,878.92	1,423.58	1,560.02	105.28	75.99	122.75	483.12
South Dakota	15,000.00	7,381.68	4,038.34	1,361.97	165.81	188.71	.....	323.19
Tennessee	15,000.00	7,943.36	3,197.48	443.74	270.63	49.51	339.35	171.00
Texas	15,000.00	7,949.64	2,359.34	1,133.13	273.16	210.39	34.15	146.65
Utah	15,000.00	7,394.05	3,537.27	133.39	431.90	47.02	.....	527.95
Vermont	15,000.00	7,169.27	3,170.89	669.02	469.31	35.88	501.53	145.09
Virginia	15,000.00	8,816.25	1,251.97	1,214.97	251.30	241.84	188.83	031.65
Washington	15,000.00	10,083.01	2,052.43	505.96	115.00	147.78	922.18	58.41
West Virginia	15,000.00	12,305.72	18.00	.....	261.49	206.90	514.44	348.39
Wisconsin	15,000.00	8,235.00	1,332.91	276.45	49.50	59.29	100.00	383.78
Wyoming	15,000.00	7,306.85	1,246.63	811.42	227.20	107.28	752.60	317.86
Total	718,163.45	422,364.95	96,226.16	38,826.11	12,982.96	8,284.44	11,645.61	9,876.00

[a] The expenditures under the different heads are affected

agricultural experiment stations for year ended June 30, 1905. [a]

Classified expenditures.—Continued.											
Seeds, plants, and sundry supplies.	Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Buildings and repairs.	Balance.
$1,315.98	$292.53	.....	$486.42	$238.49	.....	$244.13	.....	.....	$36.98	$749.47	.....
245.64	457.23	$251.79	20.76	624.24	$198.11	157.80	$31.25	$669.44	20.40	287.06	.....
624.04	85.75	150.55	64.63	.....	47.00	4.66	631.50	204.00	98.00	227.50	.....
127.43	48.00	305.75	42.91	139.53	43.93	191.81	.....	820.33	15.00	71.10	.....
344.11	30.20	.....	42.69	16.60	46.40	265.27	428.06	586.51	21.00	.....	.....
452.49	.....	314.24	65.22	29.74	82.00	21.76	59.50	456.89	15.00	242.68	.....
271.36	5.20	85.02	463.29	30.01	280.89	233.88	5.40	606.28	149.29	725.14	.....
279.02	432.29	402.20	91.61	203.49	126.00	69.68	811.04	379.31	15.00	108.08	.....
486.15	408.27	1,005.19	14.91	203.22	.....	.....	.....	54.53	73.85	736.31	.....
365.23	.....	555.34	155.23	520.88	46.62	149.39	40.00	460.75	82.63	204.38	.....
584.20	143.37	.....	41.43	694.29	14.00	91.35	.....	685.25	28.00	28.83	.....
386.89	.....	.....	230.47	192.45	242.00	100.28	.....	203.05	15.00	176.08	.....
251.65	.....	.....	.....	20.70	.....	401.03	1,280.35	.....	15.00	217.65	.....
355.89	.....	553.15	20.06	212.95	73.88	485.74	270.25	80.87	35.00	177.72	.....
127.46	.....	.....	370.20	24.60	85.50	25.60	.....	75.73	116.35	206.50	.....
420.54	120.29	743.29	329.85	190.27	142.46	178.64	70.65	489.41	29.40	586.17	.....
135.09	195.42	560.65	383.24	74.13	2.80	167.20	285.00	517.13	15.00	189.15	.....
410.48	738.11	379.78	78.36	398.37	162.26	586.31	127.05	158.46	25.00	750.00	$382.30
584.09	.....	332.22	303.48	201.11	209.89	958.79	1,198.84	211.82	.....	22.75	.....
254.91	40.00	703.78	.....	54.25	5.75	.....	185.00	12.15	.....	133.04	.....
641.48	67.95	1,717.53	8.00	828.11	50.30	.....	259.50	283.93	15.00	747.96	.....
534.33	1.90	3,544.77	97.71	11.80	.....	91.45	971.50	167.34	15.00	.....	.....
338.77	.....	.....	69.83	76.85	96.02	510.28	.....	.....	15.00	.....	.....
455.25	.....	633.92	.....	235.99	92.15	267.19	397.60	30.63	15.00	32.95	.....
306.65	.....	.....	47.85	48.25	73.63	138.15	80.10	593.95	30.00	516.78	.....
501.40	331.74	160.96	259.50	247.47	317.08	453.87	73.50	96.87	157.09	86.81	.....
190.08	70.05	.....	509.07	187.87	162.56	287.51	.....	260.43	233.00	316.43	.....
469.24	31.56	1,419.99	2.50	665.33	25.08	59.96	240.25	276.50	90.00	.....	.....
178.62	.....	.....	99.31	1.25	209.45	65.57	.....	193.92	100.21	609.52	.....
374.43	334.87	485.88	22.62	381.31	31.13	62.53	174.35	295.25	96.92	104.04	.....
670.14	.....	320.26	111.22	104.45	10.60	247.44	515.00	128.04	24.00	654.24	.....
.....	.....	.....	.....	.....	.....	.....	.....	58.51	15.00	.....	.....
320.65	24.85	651.89	66.36	468.90	27.47	136.29	293.54	364.85	15.00	726.53	.....
493.39	40.50	809.22	140.13	144.97	.....	178.00	1.00	98.35	17.50	.....	.....
58.49	142.28	119.00	353.22	35.25	4.10	74.84	840.20	217.41	17.93	316.07	.....
287.72	169.03	645.80	362.33	192.50	25.86	.....	432.50	268.39	15.00	641.83	.....
261.65	490.90	.....	59.12	64.32	21.86	3.55	38.09	379.65	31.20	.....	.....
349.30	.....	336.00	73.29	111.49	.....	169.21	.....	134.65	15.00	351.36	.....
306.61	27.00	306.51	249.75	.....	43.57	743.97	.....	284.89	42.50	580.13	.....
168.58	.....	1,288.39	28.85	69.25	101.36	25.00	345.44	354.35	23.20	489.12	.....
537.36	105.00	1,032.02	21.51	101.22	92.85	264.63	46.55	494.21	19.95	213.12	.....
109.95	140.39	1,312.95	87.92	130.27	512.92	131.33	.....	295.31	16.90	101.07	.....
1,176.89	.....	.....	11.92	693.61	.....	271.37	.....	102.80	55.00	91.60	.....
830.80	.....	66.63	.....	.....	.....	.....	17.00	185.80	15.00	.....	.....
78.76	.....	222.40	261.42	3.64	91.18	335.37	.....	272.64	.....	79.65	.....
1,226.34	61.45	483.62	554.69	51.60	205.60	734.12	202.50	296.64	15.00	731.51	.....
343.78	30.00	919.70	227.40	415.93	60.85	88.13	1,278.43	364.07	15.00	486.87	.....
19,233.31	5,066.07	22,820.39	6,930.28	9,340.95	4,065.11	9,673.08	11,630.94	13,171.29	1,926.30	13,717.20	382.30

by the total revenue of the station, as shown in Table 9.

TABLE 11.—*Disbursements from the United States Treasury to the States and Territories for agricultural experiment stations under the act of Congress approved March 2, 1887.*[a]

State or Territory.	1888–1902.	1903.	1904.	1905.
Alabama	$224,999.34	$15,000.00	$15,000.00	$15,000.00
Arizona	189,803.15	15,000.00	15,000.00	15,000.00
Arkansas	225,000.00	15,000.00	14,999.67	13,163.45
California	225,000.00	15,000.00	15,000.00	15,000.00
Colorado	224,963.24	15,000.00	15,000.00	15,000.00
Connecticut	225,000.00	15,000.00	15,000.00	15,000.00
Dakota (Territory)	56,250.00	.....	.....	.....
Delaware	224,438.84	15,000.00	15,000.00	15,000.00
Florida	224,966.11	15,000.00	15,000.00	15,000.00
Georgia	224,983.55	15,000.00	15,000.00	15,000.00
Idaho	150,000.00	15,000.00	15,000.00	15,000.00
Illinois	225,000.00	15,000.00	15,000.00	15,000.00
Indiana	224,901.19	15,000.00	15,000.00	15,000.00
Iowa	225,000.00	15,000.00	15,000.00	15,000.00
Kansas	225,000.00	15,000.00	15,000.00	15,000.00
Kentucky	224,996.57	15,000.00	15,000.00	15,000.00
Louisiana	225,000.00	15,000.00	15,000.00	15,000.00
Maine	224,999.62	15,000.00	15,000.00	15,000.00
Maryland	224,967.40	15,000.00	15,000.00	15,000.00
Massachusetts	225,000.00	15,000.00	15,000.00	15,000.00
Michigan	225,000.00	15,000.00	15,000.00	15,000.00
Minnesota	225,000.00	15,000.00	15,000.00	15,000.00
Mississippi	225,000.00	15,000.00	15,000.00	15,000.00
Missouri	220,097.24	15,000.00	15,000.00	15,000.00
Montana	135,000.00	15,000.00	15,000.00	15,000.00
Nebraska	224,932.16	15,000.00	15,000.00	15,000.00
Nevada	224,939.32	15,000.00	15,000.00	15,000.00
New Hampshire	225,000.00	15,000.00	15,000.00	15,000.00
New Jersey	224,961.97	15,000.00	15,000.00	15,000.00
New Mexico	189,998.90	15,000.00	15,000.00	15,000.00
New York	224,945.27	15,000.00	15,000.00	15,000.00
North Carolina	225,000.00	15,000.00	15,000.00	15,000.00
North Dakota	182,330.62	15,000.00	15,000.00	15,000.00
Ohio	225,000.00	15,000.00	15,000.00	15,000.00
Oklahoma	164,270.80	15,000.00	15,000.00	15,000.00
Oregon	211,631.82	15,000.00	15,000.00	15,000.00
Pennsylvania	224,967.95	15,000.00	15,000.00	15,000.00
Rhode Island	225,000.00	15,000.00	15,000.00	15,000.00
South Carolina	224,542.15	15,000.00	15,000.00	15,000.00
South Dakota	168,250.00	15,000.00	15,000.00	15,000.00
Tennessee	225,000.00	15,000.00	15,000.00	15,000.00
Texas	225,000.00	15,000.00	15,000.00	15,000.00
Utah	190,000.00	15,000.00	15,000.00	15,000.00
Vermont	225,000.00	15,000.00	15,000.00	15,000.00
Virginia	224,992.57	15,000.00	15,000.00	15,000.00
Washington	165,000.00	15,000.00	15,000.00	15,000.00
West Virginia	224,969.72	14,999.50	15,000.00	15,000.00
Wisconsin	225,000.00	15,000.00	15,000.00	15,000.00
Wyoming	210,000.00	15,000.00	15,000.00	15,000.00
Total	10,331,099.50	719,999.50	719,999.67	718,163.45

[a] This table was prepared in the Treasury for the use of this Department by the courtesy of the honorable Secretary of the Treasury.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

OFFICERS.

President.

M. H. Buckham, of Vermont.

Vice-Presidents.

C. C. Thach, of Alabama.
E. H. Jenkins, of Connecticut.
J. H. Worst, of North Dakota.
B. I. Wheeler, of California.
Luther Foster, of New Mexico.

Secretary-Treasurer.

J. L. Hills, of Vermont.

Bibliographer.

A. C. True, of Washington, D. C.

Executive Committee.

H. C. White, of Georgia.
J. L. Snyder, of Michigan.
W. H. Jordan, of New York.
C. F. Curtiss, of Iowa.
L. H. Bailey, of New York.

Sections.

Section on College Work and Administration: C. R. Van Hise, of Wisconsin, chairman; H. C. Price, of Ohio, secretary.

Section on Experiment Station Work: B. C. Buffum, of Wyoming, chairman; M. A. Scovell, of Kentucky, secretary.

NINETEENTH ANNUAL CONVENTION.

GENERAL SESSIONS.

The nineteenth annual convention of this association was held at the Shoreham Hotel, Washington, D. C., November 14–16, 1905. The meeting was one of unusual interest and success, and the attendance was larger than on any previous occasion. Over 250 persons registered, and the delegation which paid its respects to the President on the afternoon of the first day of the convention included a considerably larger number.

The association was addressed at the opening session by Hon. James Wilson, Secretary of Agriculture, and a former member of the association. He declared his deep interest in the work of the association and his belief in the purposes of the institutions represented. His intention upon first coming to the Department had been to make it helpful to the experiment stations, but he found that it was first necessary to strengthen the Department itself. This he had done by building up the staff of workers and securing increased appropriations from Congress; and the stage had been reached where more attention could be given to aiding the stations. Secretary Wilson declared the greatest need of the stations to be more money, and he stated that in his forthcoming report to Congress he had strongly recommended that larger appropriations be made for the use of the stations. He held that this would be an economy measure, since there is no economy so far-reaching as the strengthening of the American farmer.

The annual presidential address was delivered by Dr. E. B. Voorhees, of New Jersey, on the evening of the first day of the convention. This related in the main to some of the duties and responsibilities of the agricultural colleges and experiment stations. Doctor Voorhees held these colleges primarily responsible for the kind and amount of work done by the stations, because the working staff is the first determining factor in station work, and it is to the colleges that we must look for the fundamental training for this work. He urged the need of more research work on the part of the stations, and declared that the present limitations were largely due to the inadequate supply of broadly trained men capable of planning highly scientific investigations. The speaker called specific attention to lines in which agriculture is in need of investigation, to prevent losses of stock and products, and to bring districts now largely wastes into more profitable cultivation. These illustrations were presented to show that "it is the manifest duty of this association, as representing both the colleges and the stations, to see to it that provision is made for the specific training of investigators; for, all things considered, our progress has been measured and its limits fixed by the available men, rather than by material equipment."

The report of the executive committee, presented by Dr. H. C. White, chairman, briefly reviewed the activities of the committee during the year, notably in securing modification of the orders of the War Department with reference to military instruction in the land-grant colleges, and its efforts in behalf of the bills before Congress for the increase of the experiment station appropriation and for the establishment of mining schools. The committee believed that the association should concentrate its efforts on a single bill, rather than attempt the support of several measures. This suggestion led to considerable discussion later in the meeting, which brought out the quite

general feeling that preference should be given to the Adams bill; but to avoid embarrassing the executive committee by too rigid restrictions it was instructed to concentrate its efforts upon the bill apparently in the most favorable condition for passage, provided the mining bill be so modified as to recognize the land-grant colleges as the beneficiaries.

The executive committee suggested a reorganization of the standing committees of the association, and made recommendations in this regard, which were referred to a special committee, whose report, presented later, provided for four standing committees, viz. (1) instruction in agriculture, (2) graduate study, (3) extension work, and (4) experiment station organization and policy. These committees are to consist of six members each, to be appointed by the retiring president, and provision is made for a gradual rotation in the membership so that the terms of only two members will expire each year. Vacancies occurring during the year are to be filled by the committees themselves. The appointments upon these committees, with the terms of office, are as follows: *Instruction in agriculture*—A. C. True and T. F. Hunt, three years; H. T. French and H. C. White, two years; J. F. Duggar and W. E. Stone, one year. *Graduate study*—L. H. Bailey and H. P. Armsby, three years; M. H. Buckham and R. H. Jesse, two years; W. O. Thompson and Brown Ayres, one year. *Extension work*—K. L. Butterfield and C. R. Van Hise, three years; B. W. Kilgore and C. F. Curtiss, two years; A. M. Soule and W. M. Hays, one year. *Experiment station organization and policy*—E. Davenport and C. D. Woods, three years; W. A. Henry and H. J. Waters, two years; M. A. Scovell and C. E. Thorne, one year.

In the course of its report the executive committee referred to the death during the year of President H. H. Goodell, who had been an active worker in the association since its organization, a member of its executive committee for fourteen years, and chairman of that committee for eight years. The committee had made special provision for a memorial address upon the life and services of President Goodell, which was presented by President W. E. Stone. In this the speaker paid an eloquent tribute to President Goodell, his work and achievements, his indomitable energy and perseverance in what he undertook, and especially those sterling qualities of heart and mind which commanded the esteem and affection of all who came to know him.

Resolutions of respect and esteem were adopted by the association, and the address was ordered printed separate from the proceedings for more general distribution.

The report of the committee on uniform fertilizer and feeding-stuff laws, by Dr. H. J. Wheeler, chairman, showed that there had been several new laws passed or modifications of old laws during the

year, which had in general followed the recommendations of the committee, and that in several other States there was dissatisfaction with the present laws which might lead to changes. The opinion was expressed that in general the movement is gradually in favor of the general provisions for fertilizer legislation recommended by the association.

Dr. A. C. True presented the report of the bibliographer of the association, noting nearly a hundred bibliographies which had appeared during the year upon subjects of interest to agricultural investigators and that of the committee on methods of teaching agriculture. It was stated that the committee desired in future to work along two main lines, viz: (1) To study courses of agriculture to be taught in secondary agricultural schools and other high schools generally, and (2) to make a more detailed study of college courses in animal husbandry and develop some special topic of this subject from a pedagogical standpoint. Doctor True then explained the work of this Office in relation to agricultural education, pointing out the recognition it has received as a leading agency for the promotion of this branch of education, and the action of the Secretary of Agriculture in requesting from Congress an increased appropriation of $5,000 for the development of work along this line.

The committee on graduate study reported, through Prof. L. H. Bailey, chairman, that arrangements have been made for holding a second session of the school of graduate study at the University of Illinois during the coming summer. A canvass of the agricultural colleges for subscriptions of $25 a year toward the maintenance of the graduate school, as provided for by the association last year, showed 27 colleges favorable to making such subscription, 15 unfavorable, and 4 doubtful. The committee emphasized the importance of the graduate school, which it thought should be a regular and continuous work of the association. It held that the school should be an institution of the association, and that it should assume responsibility for its policy and management. The college where the school was held would then be the agent of the association. The sources of income for the graduate school would be (1) fees from the students, which it thought should be fixed at $10, (2) the contributions from the association, derived from the colleges subscribing, and (3) the contributions of the institution at which the course was given. The report of the committee, with its recommendations, was adopted.

The committee on pure-food legislation reported, through Prof. W. A. Withers, chairman, that progress had been made in extending and strengthening the State laws relating to foods, and also in the better execution of pure-food laws. It referred to the satisfactory workings of the inspection of imported foods as indicating the advantages of a national pure-food law.

The report of the committee on the collective college and station exhibit at St. Louis was presented by Dr. W. H. Jordan, chairman, and was received and the committee discharged. It was shown that of the $100,000 appropriated for this exhibit, only about $90,000 had been expended. By a vote of the association the report was placed on file in the Office of Experiment Stations for future reference.

The report of the committee on indexing agricultural literature, presented by Dr. A. C. True, chairman, described the progress which has been made in the library of the Department of Agriculture in indexing scientific periodicals relating to agricultural investigations and the preparation of cards which are printed by the Library of Congress. Thus far about 7,000 cards have been issued. At present there are only 10 subscribers for the complete sets and 11 for partial sets, and the question has arisen whether it is worth while to continue this work. It was pointed out that at least 35 subscribers for the complete index would be required to warrant its continuation. The undertaking was originally authorized by the association, and the members were therefore urged to investigate the character of the index to determine whether or not it should receive their future support.

The committee on rural engineering reported through Dr. W. E. Stone, chairman, that progress had been made in strengthening the courses in this subject at several institutions, but that sufficient importance had not been attached to this subject to give it a coordinate place with such subjects as horticulture, animal husbandry, agronomy, etc. It was believed that the best work could not be accomplished until this is done. The work of this Office in testing pumps, windmills, etc., was thought to be of material benefit to professors of rural engineering, as was also the work in irrigation and drainage.

Resolutions were passed indorsing the work of this Office along the lines of agricultural education, and also of irrigation and rural engineering.

Assistant Secretary W. M. Hays, for the committee on animal and plant breeding, reported the growth of the American Breeders' Association to an organization of about six hundred members, and the successful annual meeting held at Champaign, Ill., in February last. This committee was discharged, as it had accomplished the purpose for which it was organized.

The establishment of institutions for teaching and research work in forestry in connection with the land-grant institutions was discussed by Prof. S. B. Green, who introduced a resolution looking to national aid, and by Gifford Pinchot, of the Forest Service. As the association had decided to confine its efforts toward legislation as previously indicated, the resolution was laid upon the table.

President K. L. Butterfield offered a resolution instructing the executive committee to take steps to secure, if possible, the establishment of a department of rural agricultural education in the National Educational Association. The resolution was adopted. Hon. W. T. Harris, Commissioner of Education, made a brief address in which he expressed the view that agricultural education should be considered each year in one of the special departments of the National Educational Association.

A vote of confidence and thanks was ordered sent to Representatives Adams and Mondell for their efforts in behalf of the bills in their charge for the further endowment of the experiment stations and the establishment of mining schools. The association also voted to lend its aid in support of national appropriation for the control of the gypsy moth. It went on record as indorsing the continuance of the collection and publication of data by the United States Department of Agriculture relative to the condition and yields of farm crops, for the use of farmers and for students in rural economics.

SECTION ON COLLEGE WORK AND ADMINISTRATION.

The general theme for discussion in this section was The Field and Functions of the Land-Grant Colleges, which was considered under the three heads—curriculum, discipline, and environment.

In a paper on A Minimum General Culture Requirement, President A. B. Storms held that the students which the land-grant colleges attract are not prepared for severely technical courses, and hence provision should be made for general culture studies during the first two years of the course, with opportunity for election in the last two years. The students should not be occupied in acquiring mere manual dexterity, which can be more cheaply learned in the workshop.

President J. M. Hamilton discussed the relative Amounts of Pure and Applied Science. He held that the land-grant colleges should give a good foundation in pure science, not for intellectual training alone, but as a preparation for the work in applied science. He would, therefore, have a large amount of pure science work in the early part of the land-grant college course, and make the later science work thoroughly industrial.

Prof. F. W. Rane presented a paper on Courses in Agriculture, Horticulture, and Allied Subjects, in which he confined his remarks mainly to horticulture. In his scheme for utilizing the 150 hours assigned to horticultural courses, 20 hours were given to the study of propagation, 50 to pomology, 50 to olericulture, and 30 to floriculture.

Dr. H. W. Tyler discussed what constitutes a "liberal and practical education" for an engineer, making suggestions as to the allotment of time between general science and professional work; and Dr. W. E. Stone and President J. L. Snyder considered the desirability of degree courses in home economics. The former held that since the

manual operations of this country are performed by the uneducated people, there is no place for manual training in the degree courses, but that skill in manual operations should be acquired in the lower schools. President Snyder maintained that manual development might to a certain extent be considered one of the legitimate aims of a college course, which ought to be in the broadest sense a preparation for life; and he outlined a tentative degree course in home economics.

In discussing these papers Prof. L. H. Bailey pointed out a tendency to react from the exclusively or severely technical undergraduate courses, and to hold somewhat closely to some of the traditions of education. He noted further a growing disposition to occupy the first two years of the college course with the fundamental or pure science subjects, a drift of opinion toward humanizing the conduct graduate courses, and to hold somewhat closely to some of the tradi-sympathy with the work-a-day life," a desire to introduce other subjects which have to do with the every-day life of the people, and a general indication that the courses, particularly on the agricultural side, are not regarded as severely technical. Particularly was he impressed with the emphasis placed upon the ideals of education rather than practical utility.

Student Control was the topic of a paper presented by President W. O. Thompson, who favored administrative control, which places the matter of discipline entirely in the hands of the president of the college and does away with the necessity for elaborate rules and regulations.

In discussing the relation of the land-grant colleges to the State universities, President W. J. Kerr stated that the logical division of work in the States having separate institutions would be for the universities to offer courses in liberal arts and the professions, while the land-grant colleges would offer all of the technical courses in agriculture and the mechanic arts.

In a paper on The Normal Schools, President K. C. Babcock brought out the fact that comparatively little is now being done to train teachers for small towns, villages, and rural communities. He urged that the land-grant colleges should help the normal schools by offering short courses for teachers, holding institutes, and sending out their officers to give courses and lectures in normal schools. The same general conception of the duty of the land-grant colleges in the movement for the improvement of public schools was held by Dr. A. C. True, who read a paper on The Public Schools. He said that the colleges should study the programmes of the public schools, come into close touch with their school officers and teachers, provide courses of study which will be attractive to school officers and teachers, and by summer schools or otherwise seek to bring such persons into direct contact with the system of education represented in these colleges.

Elementary and secondary courses in agriculture and mechanic arts in the public schools are required to direct students to the land-grant colleges and to prepare them to enter their courses.

Prof. John Hamilton discussed the relation of the land-grant colleges to the farmers, and pointed out three great fields in which these institutions should work, viz. (1) the college class room—four-year courses, short courses, and post-graduate courses; (2) college extension work, including correspondence courses, farmers' institutes, movable schools of agriculture, and practice farms, and (3) normal schools of agriculture for training capable farmers to take part in the extension work of the colleges.

SECTION ON EXPERIMENT STATION WORK.

The two subjects arranged by the programme committee for consideration in this section were (1) soil investigations and (2) how much demonstration work and what kind should the experiment station undertake?

Under the first subject Dr. C. G. Hopkins presented a paper on Soil Fertility in Relation to Permanent Agriculture, in which he called attention to the widespread decline of the fertility of farm lands in the United States, due to exhaustive systems of cropping and export of fertility from the farm. The extension of animal husbandry, involving the feeding of a large proportion of the crops grown to animals on the farm, and thus insuring the return of the fertility to the soil, would act as a partial check to this exhaustion; but it was pointed out that about 80 per cent of the farmers of the United States are giving attention almost exclusively to crop production, and that a large proportion of them will probably never take up animal production to an extent that will result in an increase of fertility of their farms in this way. It is therefore necessary for such farmers to adopt systems of cropping, supplemented by the use of fertilizers, which will enable them to maintain the balance of fertility or turn it in their favor.

The experiments of the Illinois Station on representative Illinois soil type usually agreed in showing that in these soils phosphoric acid is the principal requirement, and the only one which needs to be applied in commercial form. The cheapest and most efficient means of supplying the phosphoric acid has been found to be by the use of fine-ground rock phosphate in connection with green manures or other materials supplying abundance of decaying organic matter.

In the discussion following this paper, Director C. E. Thorne pointed out the fact that virgin soils and those long under cultivation behave very differently toward the same systems of cropping and manuring; Dr. H. J. Wheeler called attention to the unsuitability of untreated phosphates to exhausted soils and to market-garden crops; and Prof. W. P. Brooks stated that a large proportion of the

soils of New England are in special need of potash, and that it is impossible to determine the fertilizer requirement of a soil apart from the peculiar needs of the particular crop to be grown, a fact which was strongly emphasized by other speakers.

A paper by Mr. A. M. Peter on Some Results of an Old Method for Determining Available Plant Food in Soils was read by the secretary of the section.

Director C. E. Thorne presented a paper on Soil Investigation, in which he pointed out the necessity of supplementing chemical analysis and pot experiments with carefully conducted field experiments, and also of giving more attention to the biological processes in the soil. The results of a 7-year rotation with corn, oats, and wheat, and of a 3-year experiment with clover, at the Ohio Station, using lime and various fertilizer combinations, were reviewed, showing that phosphoric acid is apparently the first requirement of cereals on the soils experimented with, and lime the first requirement of clover, potash being second in importance for this crop. The beneficial effect of the lime, particularly on the clover crop, was apparently due to the acid condition of the soil, the character of the growth of the clover being a reliable index of the acidity and the need of lime. Such acid soils were shown to be widely distributed in Ohio.

Discussing this paper, Dr. J. G. Lipman urged the importance of more careful study of the relation of acidity to bacterial activity on the one hand and to the physiological processes of the plant on the other, and Dr. H. J. Wheeler made some suggestions regarding profitable lines of research in connection with soils.

In the discussion of the subject of demonstration work, Director Thorne explained the Ohio system of (1) test farms on which experimental work is carried on in different parts of the State; (2) cooperative experiments with farmers, taking up simpler phases of station work, and intended primarily to develop farm experimenters in each locality, and (3) special arrangement for particular pieces of work. The importance in cooperative work of relieving the farmer from pecuniary responsibility and of maintaining strict supervision of the work through station officers was pointed out. The speaker urged the need of extension of demonstration work.

Doctor Hopkins explained the system of combined experimental and demonstration work followed in Illinois on the farms controlled by long-time lease or purchase on the various typical soil areas of that State. Prof. L. C. Corbett drew a sharp distinction between experimental work and demonstration work, holding that the latter should have as its prime object the teaching of remunerative methods of farming, as illustrated in the work of the Department demonstration farms in the cotton belt. Similar views were expressed by Director C. D. Smith, who cited various illustrations of ways in which the

station had been instrumental in introducing more profitable farm practices in Michigan by means of demonstration experiments. Directors Jordan, Hills, and Wheeler held that demonstration work is not the province of the stations under the Hatch Act, the latter contending that it is an educational function and belongs properly to the extension departments of the colleges. Prof. T. F. Hunt urged that more attention should be given to the study of agricultural economics, so that there will be a better basis for advice as to business methods and management on the farm.

Prof. W. J. Spillman maintained that the purpose of demonstration farms should be to teach profitable methods of farming, based upon scientific investigations and the experience of successful farmers. Demonstration work is a necessary supplement of the present system of investigation and dissemination. He briefly explained some features of the work of the Department in farm management. Dr. H. P. Armsby warned against encouraging exaggerated expectations on the part of farmers from experiment station work. The farmer should be encouraged as far as possible to work out the problem of farm management for himself, a view which was concurred in by others.

A report on the federation of agricultural organizations in different States of the Union was submitted by Dr. H. J. Wheeler. This paper showed that in 12 States federation has already been secured and that other States are contemplating federation. The report was accepted and the committee continued.

A preliminary report on the unification of terms for reporting analytical results was submitted by Dr. C. G. Hopkins, chairman of the committee, on this subject. The report contained unanimous recommendations with regard to terms to be used in reporting analyses of feeding stuffs, foods, sugars, and insecticides, but the committee was unable to agree as to terms to be used in soil and fertilizer analysis, the disagreement being with regard to the use, proposed by Doctor Hopkins, of the "element" system of nomenclature.

Prof. H. Snyder presented the report of the committee on testing cereals, which noted the limited character of the literature relating to the testing of wheat and flour for industrial purposes, and discussed briefly some of the factors which have been shown to control flour yield and bread-making quality. Flour yields have been shown to be directly proportional to weight per bushel, but bread-making quality does not follow the same rule. Color and hardness are controlling factors in determining commercial value of wheat for milling purposes. There are many unsettled points in connection with the relation of the amount and character of the protein to bread-making quality. The committee proposes to take up first methods of preparing flour for test. The report was accepted and the committee continued.

DRAINAGE INVESTIGATIONS.

By C. G. Elliott,
Engineer in Charge of Drainage Investigations.

The work in drainage engaging the attention of this Office is related directly to agriculture and has to do with investigations of both practical and scientific character pertaining to the drainage of fertile lands which are now unused because of their swampy or saturated conditions, the improvement of lands already under cultivation but which fail to produce crops of maximum quantity and quality because of adverse moisture conditions, and all other improvement of land which will result from the adequate control of water on the surface and in the soil.

The studies and experiments included in these investigations may be classified as follows:

(1) Work connected with improving small natural streams and providing sufficient and adequate artificial outlets for the drainage of large areas of fertile land hitherto deficient in natural drainage which is projected and executed under the provisions of State drainage laws.

(2) The protection of overflowed lands bordering alluvial streams, and their interior drainage after protection works have been constructed.

(3) The solution of problems connected with the underdrainage of soils of widely different character and subject to diverse climatic conditions.

(4) The protection and subsequent management of tidal lands, which when thus improved may be valuable for agriculture.

(5) The drainage of lands in the arid region which under irrigation have become saturated and in consequence unproductive, and the prevention and removal of alkali occasioned by such saturation.

There are only certain phases of these problems which may be properly considered by the Office. Drainage works have been constructed and land has been reclaimed and improved under a great variety of conditions and by numerous methods in various parts of the country, so that the value of such improvements considered as a general proposition is recognized. Only those features of the work which are perplexing, by reason of peculiar conditions and surroundings or the inability of landowners to successfully plan and carry

out necessary work, either through lack of knowledge or inability to cooperate with neighbors, or any other good and sufficient reason why lands are not improved and agricultural methods advanced, need be investigated. Serious obstacles are frequently encountered in establishing large drainage works under the provisions of the State laws. These projects cover from 5,000 to 50,000 acres of land, the arterial or main drainage of which is constructed under certain provisions of law and in all cases necessitates concerted action of the owners of land interested. Engineering problems of some magnitude must be considered, and the general plan presented to administrative boards must take into account the subsequent drainage of individual farms for which the general system provides an outlet. These projects sometimes involve expenditures of $20,000 to $200,000, necessitating issuing and negotiating bonds to procure funds for construction, and on the whole raise many questions of engineering and agricultural economics which must be efficiently handled by engineers and the authorities empowered to administer the law if unwise litigation be avoided.

This Office has done much to assist engineers in perfecting plans, and to unite the people in carrying them out. The combined acreage of drainage districts in which such assistance has been rendered during the last three years aggregates approximately 300,000 acres. It is greatly to the interest, especially of new sections where drainage engineering is imperfectly understood, that assistance of this kind may be obtained from this Office upon request. Such service has been greatly appreciated, and there is reason to believe it has been instrumental in securing to various districts better plans and more harmony in their execution. County engineers are often greatly benefited by assistance of this kind not only in conducting the specific work at hand but in other similar projects which come to them in the course of their growing practice, so that the work of this Office reaches much farther than the particular district upon which advice is furnished.

The Office has gone further than this in several instances and made preliminary drainage surveys and general plans for the drainage of land in cooperation with owners or counties where there was not sufficient understanding of the matter to either make the surveys or develop a plan of work. This was the case in Clay County, S. Dak., where plans for the main drainage of about 70,000 acres of bottom land were made and recommendations given which resulted in needed amendments to the State law and later in the organization under its provisions of the territory to be drained. The same has been done, but in a more extended and complete manner, in four of the counties of North Dakota during the season of 1905. An agreement was made with the several counties to provide for the payment of half of the estimated cost of the drainage survey and a party of ten

men was occupied during the summer season in that field. This work developed the fact that this Office is able to make drainage surveys at a less cost than is usually paid for work prosecuted by private enterprise. Two thousand five hundred and fifty-eight miles of levels were run besides work done on stream examinations covering an area of 2,035 square miles, at a cost of $2.27 per square mile. This included the fitting out and organization of the party and disbanding it at the close of the season. From the notes and field maps obtained we are making plans and estimates for the main drainage of the more level portion of those counties. Such work, preliminary to the construction of an adequate and comprehensive system of drainage in a more complete and extended manner than counties or individuals are usually able to do, is sometimes of great advantage in starting an enterprise in such a way that it will be carried to a successful completion. Since drainage lines do not follow land lines or boundaries of individual properties, it is desirable that regard should be had to topographical rather than artificial boundaries.

The leveeing of streams for the protection of farming land is a problem of similar magnitude yet characterized by somewhat different conditions. This work is comparatively new to the farmers and where done by them has been followed by many failures, which have had a discouraging effect upon owners desiring to improve bottom-lands. This Office has made careful investigation of this phase of drainage both as regards the construction of levees and the interior ditching and drainage of the protected land, and has given in the report of 1904 valuable information as to the cause of failures and recommendations upon levee construction under different stream and soil conditions. The Office has been called upon to lay out farm levees in the Neosho Valley, in Kansas, for the protection of lands which have been repeatedly overflowed and crops destroyed. These lands are extremely fertile and their adequate protection along that stream would be of great value to the owners and to the State. It is creditably estimated there are one-half million acres of fertile bottom lands in this valley which should be protected by levees, and this Office has been requested to prepare a plan of works which will adequately control the waters of the Neosho River, in Kansas, for a distance of at least 300 miles. Concerted action on the part of the landowners benefited will be required in carrying out a project of this character.

It has been ascertained that levees constructed along streams in the Middle West by private enterprise or under the provisions of drainage laws have usually been inadequate and failed, resulting in great loss of crops besides the destruction of the works themselves. It is an accepted fact that the improvement of a country by

changing the nature of its production by cultivation and by the various improvements incident to a more complete utilization of fields has modified the flow of streams, augmenting the flood conditions in some instances and on the whole materially interfering with the former uniform discharge of streams. Levees which have been sufficient during a cycle of years become overtopped and destroyed by the unusual and spasmodic rainfall during a cycle which follows, so that the problem is to construct levees which shall meet the changed conditions and be permanent. To do this requires a close study of the changes in flow which have taken place in streams during the past and the various causes of levee failures. The expense of this kind of reclamation is consequently increased. Yet the value of the land for production purposes is so much greater than in former times that the same or a greater margin exists between the cost of the work and returns that may be expected. It has been ascertained that the complete leveeing and draining of a levee district of ordinary size, 4,000 to 10,000 acres, along the Illinois River will cost from $20 to $24 per acre for the land protected and benefited, and yet with this formidable expense in sight landowners are now arranging to carry out protection works for the complete and permanent reclamation of some of those valuable lands.

The levee problem is also important in the coast and tidal river lands of Georgia and the Carolinas, where the freshets in recent years have destroyed the banks which protected valuable rice lands, leading in many cases to their entire abandonment. The Office is securing data and making surveys for the purpose of furnishing plans to persons interested in the protection of those lands and in ascertaining the probable cost of their execution. If the returns from the land protected will be commensurate with the cost of such work it will be recommended and an attempt made to induce owners to repair and rebuild their banks and again take up the cultivation of these lands.

The banks and levees in the South were constructed years ago by hand labor, and have been repaired from time to time in the endeavor to make them secure against the changing flood conditions. It would appear upon a cursory examination that with the scarcity of labor and the necessity for more permanent works, machinery such as is employed in other places should be introduced in the southeast coast lands. If this should be done some cooperative organization or method of letting work by contract and provision for payment should be adopted in order to obviate the labor and financial contingencies which now beset the owners of these lands.

The same conditions to some extent exist along the Santee River, where levees have been washed away, and lands, formerly protected

and profitable, are now abandoned. These have great natural fertility, and being contiguous to valuable markets, merit special attention and preparation of careful estimates and plans looking to the permanent protection and improvement of these abandoned alluvial tracts.

In the more intensive cultivation of land which follows the improvement of natural channels and the construction of artificial ones where these are inadequate, underdrainage is invariably found useful and often necessary if farming operations are to be carried on at a profit. While much of this work has been done successfully in various parts of the country, and its value is fully understood as far as the theory is concerned, many problems arise where the efficiency of proposed drains is questioned and where the best method of construction is not understood. The continual improvement of farms in the Middle West and the South, looking to the utilization of every foot of fertile soil, is directing the attention of owners to this method of increasing the production of land. The difficulties encountered call not only for some skill in agricultural engineering, but for knowledge, and in some cases experimentation, pertaining to the drainage properties of soils.

As examples of such difficulties may be mentioned the fertile alluvial lands in the Red River Valley of Minnesota and the Dakotas, where it is now conceded that more complete drainage than that offered by surface drainage is desirable, and the question is raised regarding the probable efficiency of tile underdrains in that soil and in a climate where the ground freezes to a depth of 6 feet. Nothing settles a disputed point in farming so effectually as an experiment, and it is proposed to make such an experiment on the State farm at Crookston, Minn., where this Office will make the plans for a system of underdrainage for not less than 160 acres and direct a series of observations from which the effect of drains placed at different depths and distances apart may be learned and the results made public for the benefit of owners of similar lands. The same will be done on the State experiment station farm at Fargo, N. Dak., at which place some trials of tile by farmers have been attended by little benefit, and the sentiment has gone forth that for that soil and climate tile underdrainage is of doubtful value. Like questions have been raised by owners of lands in the Neosho Valley of Kansas, where the river bottom lands are supposed to be too close, waxy, and impervious to water to be benefited by the underdrains. Experimental field drains have been laid out by direction of this Office near Oswego, Kans., a part of which were constructed in the fall of 1905, and they are already reported as operating in such a way as to greatly benefit and facilitate the cultivation of the land.

This Office was called upon to advise regarding the probable effect of tile upon lands in the river-bottom country in Madison County,

Ill., and to suggest a plan of drainage adapted to their peculiar nature. It may be said that these lands include an area of 10,000 acres within 12 miles of St. Louis, are exceedingly fertile, but have been used so far mainly for the production of wheat. The rotation of crops, now a recognized necessity, has been prevented because of the heavy condition of the land resulting from its lack of drainage and the imperviousness of the soil to the passage of water. The owner of one of these farms proposes to drain 200 acres with tile to ascertain by actual field test whether the land may not be so drained as to be suitable for the planting and production of all field crops.

Similar questions arise concerning the cotton lands of the Yazoo Delta in Mississippi. This Office has made careful surveys and plans for the drainage of a cotton plantation of 2,000 acres, and will in cooperation with the owners put in experimental drains for testing their value in that kind of soil. Drainage has been practiced in the sugar-cane fields of Louisiana for a hundred years under great difficulties.

The requirements there are quite distinct from many other localities, the rainfall being 50 or more inches and not well distributed, so that provision must be made for carrying large volumes of water from the lands. The present plan for doing this is deep open ditches, which are placed at frequent intervals through the fields. Tile drainage has been tested to some extent, but has not been satisfactory for what seemed to be very good and sufficient reasons. It is believed that underdrains may be used in supplementing the present drains in such a way that the number of expensive and inconvenient open ditches may be greatly reduced. We are securing all available data in order to become fully conversant with the existing conditions and requirements, as well as with the defects found in drains of all kinds, and hope to secure some cooperation of the planters for securing the better conditions before mentioned.

In reviewing the agricultural water problems affecting southern lands mention should be made of the erosion of the hill lands, which is a constant menace to the stability of the farms and a continual source of depletion of their fertility. The experiment made by this Office in Jackson County, Ga., three years ago, for preventing this washing by the use of underdrains placed across the slope in such a way as to pass through points where seepage from upper portions of the soil cropped out, has so far been successful, and the land which was previously abandoned and filled with gullies and washes is now cultivated, without terrace or ditch, and has produced three crops of grain, which have much more than paid the expense of the improvement. Other methods of protection, particularly the various forms of terracing used, have been investigated closely, and the adaptation of the various forms in use to different slopes and condi-

tion of soil studied with a view of putting this knowledge in a form available to owners of cultivated hill lands everywhere.

This condition is not peculiar to the southern hill lands, but is found in all land where the slopes are steep, and especially where clean culture in farming operations is practiced. All questions pertaining to the control and conservation of water, distinctive characteristics of soil, and surface conditions should be carefully studied, not neglecting the kind of crops and climate, which are frequently controlling factors in the determination of the best methods that should be used.

The drainage of irrigated lands in the far West has engaged a fair share of our attention, and is a matter which until recently has been neglected in this country. The irrigated section in the West extends from the northern to the southern boundary of our country, and includes wide differences in climate and variety of soil, as well as surface slope and natural drainage facilities. The investigations of this Office show that irrigated lands furnish one of the most intricate and perplexing problems connected with the improvement of land by drainage. Some surprising facts have been ascertained, the complete study of which is essential to successfully meet difficulties of this kind which now confront the farmers in most sections of irrigated land.

Preliminary investigations have been made in various localities for the purpose of ascertaining the source and behavior of the water which works injury, its effect upon the land by reason of the saturated and swampy condition produced, and the accumulation of alkali upon the surface which usually follows and is frequently a source of serious and permanent injury. Efforts to find a method adequate to the cure of this evil have been made upon injured land in cooperation with owners of farms, who, in several instances, have constructed drainage works according to the plans, under the direction, and in some cases with the financial assistance of this Office.

Mention of a few of these experiments will be sufficient to indicate the line of work, the results of which have so far been encouraging. In 1904 some tile drains were laid by farmers near Hyde Park, Cache County, Utah, the Office of Experiment Stations furnishing the draintile and the landowners making the drains at their own expense. The water doing the injury in this locality was found to come from the higher irrigated lands, and, reaching the lower elevation and more level surface, accumulated and came to the surface, seriously injuring land which in former years had been valuable and had produced the largest crops grown in the section. The soil was found to have crevices and seams, which served to conduct the water through it, these crevices in some instances delivering streams as large as pipe stems, while in others the water percolated slowly between the grains of the soil.

The plan of the drains here installed, which by the way were intended to benefit about 30 acres of land, was outlined on the theory that a few drains properly located, passing diagonally across the slope, would intercept the water from the higher land and conduct it to a water course, thus relieving the more level land of a large volume of seep water and also cutting off the hydrostatic pressure which forces soil water to the surface in the lower and more pervious portions of the flat. The effect of these drains was marked and immediate, the owner reporting that his best crop was substantially increased and that the land, which had been constantly saturated with water during the fall, requiring irrigation soon after the drains were laid. A portion of the wet meadow was seeded to wheat in 1905 and produced 50 bushels to the acre.

The salutary effect of these few drains was such that the owners of neighboring lands, seeing their beneficial effects, at once asked our assistance in the laying out of other drains. This was done upon the request of several of the neighbors, so that now there is a series of fields in that locality, covering a mile or more in length, which are now drained upon the same general plan. Professor McLaughlin, of the State station, reports that he has in several cases, upon request, gone to surrounding fields to advise upon the best plan of draining lands in that vicinity.

Regarding the expense of such work, it should be said that at present it is difficult to measure or limit the area which may be beneficially affected by drains located upon the plan before stated. In connection with the case just mentioned it is reported that during last fall a field lying below any of those which had been drained, which had for twenty years been wet and used only for meadow, was plowed and prepared for wheat and beets for the coming season. This benefit results from the construction of drains upon other lands, and accrues to the owner without any expense or effort on his part.

It should be also stated that the mere interception of water from high lands is not sufficient in all cases to meet the difficulty. The water table of these lands has been permanently raised, and the drains do not, as a rule, lower this table below the level of the drains. The irrigation of meadows by flooding causes an accumulation of surface water in the depressions and saturates the lower lands. It is in some cases necessary to have drains in these lower places to relieve the land from the excess which comes to those points by direct irrigation, so that in planning drains both of these points should be kept in view. It should be also observed that the soil which was here drained is admirably adapted to the use of draintile, the subsoil being a pervious clay which responds quickly to the action of drains, so that for that region tile may be regarded as the most desirable and effective drain.

Another example of the beneficial results of investigations made by this Office is in the Yakima Valley, of Washington, where the soil and its alkali conditions are much different from those noted in the Hyde Park tract. A work of much greater magnitude was undertaken there by landowners at their own expense. The high price of drain-tile prohibited their use in this case, and box drains made of 2-inch planks of Oregon fir lumber were used for making the drains. The particular work designed and staked out required the use of 97,000 feet of lumber and the digging of ditches aggregating 10,350 feet in length. The water came from surrounding elevated portions quite rapidly, and in comparatively large volumes, upon the lower land by reason of the open gravel subsoil, the effect being that while during the early spring the water table in the lower tracts was 6 feet from the surface it gradually and persistently rose until in August it flowed over the surface of the ground in the lower tracts. The drains were located with the design of intercepting the water from the high lands and leading it into an established drainage water course, with the intention later of providing interior drainage for the affected land, if found necessary. These drains have been in operation two years, and the owners report that the land is dry and is now suitable for any crops they desire to plant. As further proof of this benefit, it is noted that a large hop house has been built upon land which previous to its drainage was swampy and during the latter part of the season covered with water. Owners of neighboring land followed immediately with similar drainage works and report most satisfactory results. It is further noticed as an effect of this drainage that lands which were showing the injurious effects of alkali to a greater or less extent are gradually becoming reclaimed and the hops and other crops planted upon them are reviving and becoming more productive.

As in the case before noted, the far-reaching effects of drains of this kind are somewhat surprising and contribute largely to the difficulty in assigning to the lands benefited a proper proportion of the expense of this kind of dramage. It is stated by a farmer, occupying land 1 mile distant from the tract just described, and who has been troubled for years by an excess of water in his soil during the latter part of the season, that after the installation of these drains he was obliged to deepen his wells, and that his cellar, which before had contained water, became dry. It should be noted that the efficiency of such drains depends largely upon the proper location of drains both as to alignment and depth.

During the past season this Office has cooperated with the State of Utah in the experimental drainage of some tracts in that State, the legislature having appropriated $10,000 for irrigation and drainage investigations upon the condition that this Office contribute the same amount, to be available and used during the year 1905-6. Of this

amount $1,000 was set aside, according to agreement, for drainage investigations and experiments. Experimental drains have been put in upon a tract at Huntington, Emery County, and at St. George, in Washington County, two irrigated sections which have suffered most severely from the effects of surface water and consequent injury of land from alkali. These drains were constructed during the summer, those at St. George being completed in December, 1905. The drains at both of these places were made of lumber, that being the only available material. It is too early to report definitely upon the effect of this work. It should be said that two of the farmers at Huntington are so encouraged by the success promised by this work that they are preparing to drain their land in the same manner. This experiment, however, will be closely observed, and changes or additions made as may be found necessary to meet the conditions, so that after another year it is hoped that we may give the results and outline a method of work adapted to that soil and to the conditions of the farmers.

As to the expense which should be incurred in this kind of work, a matter of vital importance in every undertaking of this kind, we have aimed to secure adequate drainage at a cost not exceeding $10 to $12 an acre. As noted in the discussion before, it is much more expensive to drain a small field in the middle of an affected tract than to take up the matter as a larger problem in which farms upon which no drains are placed will be largely benefited. It is seen that the lessening of the quantity of water flowing through the soil of any farm will have an important effect upon all lands lying farther down the slope.

The experimental work at St. George has just been completed, yet the townspeople are so confident that the work will be successful that they have at their own expense laid 2,000 feet of similar drains in the village for the better drainage of their lots, which for some time have showed injury and many of which have become unproductive by reason of the alkali resulting from the raising of the water table. The difficulties of drain construction in both of these last-mentioned places have been serious, adding much to the expense of the work and requiring considerable skill in execution.

It is to be regretted that we are obliged to use perishable material like lumber in this drainage work; but the great cost of more durable material is at present prohibitive, especially since the work is many times regarded purely experimental and its success is doubted by the people interested. While the truth of this is conceded, it is also found that, owing to the exceedingly soft and unstable condition of the soil in which drains are placed, nothing but some kind of drain which can be supported and maintained in place will serve the purpose. Experiments are usually undertaken in lands showing the most serious

conditions. However, it is to be hoped that in future work the farmers may avail themselves of the more durable draintile, or possibly of cement pipe manufactured upon the ground. When the profits from this kind of improvement are fairly determined, we may then safely incur greater expense and use more durable and costly material.

A tract of 30 acres was experimentally drained near Lexington, Nebr., at the earnest request of citizens of that town, the State having made an appropriation for irrigation and drainage investigations, a part of which was available for this purpose. These drains were constructed during the summer of 1905, and are reported to be operating satisfactorily. The occasion for work of that kind is that during the last four years the level lands along the Platte Valley, in Dawson County, have become saturated by reason of more than usual rainfall, and also because previous irrigation of land in that vicinity had filled the lower soil with water. The injury of that land by alkali is increasing, and it was desired to show that it would be benefited by thorough drainage. This experimental tract will be cultivated in 1906, and the effect of drainage carefully noted. However, the success of this experiment in that locality will not solve the great problem confronting the owners of land. A general system of open ditches which will serve as outlets for the drainage of the country and also give them good roads is the great improvement now needed. Tile drainage, however effective, can not be used in that locality until drainage ditches of proper depth are made. They in themselves will produce a marked change in the value of that land, and in many cases may be sufficient to meet all requirements.

Taking up now a description of a problem of a character differing entirely from any of those previously mentioned, it may be stated that in 1904 this Office made some preliminary investigations of the lands in the Kankakee Valley, in Indiana, and found that while large sums of money had been expended in drainage and work was still being prosecuted with remarkable vigor, there were many problems connected with the work which would eventually give serious trouble in the valley. During 1905 one of our agents has given his entire time to an examination of that country, and has collected much information bearing upon the matter and learned much concerning the fertility and value of the land cultivated and the effect of drains already constructed. The watershed of the Kankakee River is approximately 400,000 acres, but the tract known as Kankakee Marsh is about 9 miles wide and extends from the city of Momence, Ill., to South Bend, Ind. It is reported that more than $500,000 has been expended by various drainage organizations in excavating large ditches in that marsh. Mr. J. L. Clark, who has been acquainted with the Kankakee Marsh country for more than thirty years, and

has closely watched the development of its drainage, in his report to the Illinois Society of Engineers and Surveyors, at its annual meeting in 1904, says:

The drainage of this tract is a difficult problem, and engineers, as well as owners, differ greatly as to the best methods of doing it. The methods most generally advocated are, first, to widen, deepen, and straighten the river; second, to levee the river and make large drains parallel with it carried down until some unusual formation of land permits them to merge into the river; third, to levee the river and erect pumping stations. A single system, though it may not be the best, is better than a multiplicity of systems, some of which must necessarily be poorer than others, and when a failure of a part means pretty nearly a failure of the whole. More than $500,000 have been expended in digging large ditches, yet the magnitude of the marsh makes this work appear as but the bare commencement of its reclamation.

In the course of our investigations this is found true. It will be our object to continue this work until we are prepared to outline a plan which we can recommend to the various organizations and landowners controlling the marsh country, backed up by such facts as will induce them to unite and proceed with the work along lines which will secure to them efficient drainage and be equitable to all parties concerned. As yet only the upper half of this great valley has been examined. Existing drainage channels have been mapped and their effect and value to the land noted. The most difficult feature of this problem is yet before us, since it relates to a plan for taking care of the drainage water of the upper portion of the valley and delivering it safely into the Illinois River at Kankakee without injury to the lower lands.

One of the most unique and stupendous agricultural drainage problems of the country is the reclamation of the Everglades of Florida. At the last session of the legislature of that State a law was enacted creating a State board of drainage commissioners which was authorized and empowered, under certain regulations, to establish drains and canals for the reclamation of lands in that State. Steps have been taken by this board to commence the excavation of a large channel as the beginning of work for the drainage of the Everglades.

It is estimated that there is an area of 6,000,000 acres of swamp and overflowed lands now unfit for cultivation, 3,000,000 of which belong to the State. In the district established by the board of drainage commissioners a levy of 5 cents per acre has been made to defray the expenses of constructing ditches now projected. It is reported nearly the entire area of this swamp land possesses remarkable fertility, and if drained would add greatly to the prosperity of the State.

The State board has requested such assistance from this Office in engineering and the working out of plans as we may be able to render. The magnitude and importance of this work and the fact that the

present plans are in an embryo state suggest that we may with great propriety cooperate with the State board in every way possible in directing and shaping the work of this great enterprise.

The various investigations and projects which we desire to undertake during the year 1906 are as follows:

(1) The continuation of observations already started on experiments which have been installed. These include (*a*) a continuation of the measurements to determine the fluctuations of the soil water in the Fresno district of California; (*b*) weekly measurements of the water plane at Sunnyside, Wash.; (*c*) the measurement of the water plane of the tract experimentally drained at Huntington, Emery County, Utah, and at St. George, Washington County, Utah, and weir measurements of the discharge from the drains on these tracts; (*d*) observations at Hyde Park, Utah, upon the drains constructed in accordance with plans made by this Office; (*e*) similar observations upon the action of tile drains constructed last year at Lexington, Nebr.; (*f*) observations upon the action of the complete system of tile drains constructed in accordance with surveys made by this Office in the heavy lands of the Deming ranch near Oswego, Kans.; (*g*) similar observations upon the Clover Hill farm near Clarksdale, Miss., plans for the drainage of which have been made by this Office.

(2) A continuation of the investigation and surveys of the coast and tidal lands of South Carolina for the purpose of forming a plan for the improvement of these lands which may be recommended to the owners.

(3) Continuing the investigations of the drainage of the sugar cane lands of Louisiana and cooperating with some of the planters in carrying out our recommendations for improved methods of drainage.

(4) Extending our examinations of cultivated hill lands of South Carolina to other Southern States for the purpose of preparing instructions for terracing and for other methods of protection adapted to different conditions of slope and soil.

(5) To prepare plans and specifications for the drainage of 30,000 acres of river bottom and swamp lands along the Colville River in Stevens County, Wash., and for studying the source and underground flow of water in the Moxie and Yakima valleys and its relation to the drainage problems of those sections.

(6) A continuation of experimental drainage in the State of Utah which was begun last year in accordance with the terms of a bill of the State legislature providing for the same.

(7) A study of the salt conditions of the lands in the vicinity of Brownsville, Tex., with such experiments as may be necessary to fix upon a method of drainage which will overcome the difficulties there encountered by landowners and irrigators.

(8) A cooperative drainage experiment at Fresno, Cal., having for its object the improvement of vineyards by lowering the ground water during the irrigating season and the removal of alkali from portions of vineyards now seriously affected.

(9) The preliminary survey of 300 miles of the Neosho River in Kansas and the preparation of general plans to levee the river and protect the bottom lands from overflow.

(10) A continuation of examinations in the Kankakee Valley in Indiana and the making of surveys where necessary for the purpose of reporting a feasible plan for the disposal of the drainage of the entire valley.

(11) To make examinations of drainage district plans in various parts of the country when called upon and render assistance by way of advice regarding the methods of efficient and economical drainage of large areas, including the project to drain the Everglades of Florida now organized by the State drainage board of the State of Florida.

THE EVOLUTION OF FARM-IMPLEMENT INVESTIGATIONS.

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INTRODUCTION.

It has long been recognized that the success of agricultural pursuits depends primarily upon the accomplishment of the largest possible results at a minimum cost. The growing scarcity of farm labor and the constant increase in wages make labor-saving machinery on the farm of exceedingly great importance because mainly through it can the farmer reduce the cost of production. Improved agricultural implements and machinery have played a most important rôle in the agricultural development and general welfare of the United States. The success of American inventors and manufacturers in constantly improving and adding to such machinery has resulted in a steady decrease in the labor cost of agricultural production, notwithstanding a simultaneous rise in wages.

On account of the large investment in farm machinery and the variety of implements used on the farm, there is need of information on the utility and efficiency of the various kinds of implements used. This country has made rapid progress in the manufacture of farm implements, but in the testing of these implements to determine their adaptability to the work for which they are intended we have not kept pace with other countries.

IMPLEMENT TESTING IN EUROPE.

SWEDEN.

The various countries of Europe have taken the lead in the testing of farm implements. The records show that as early as 1860 there were conducted in Sweden tests with farm implements in connection with the meetings and fairs of local agricultural societies. Implement experiments were also conducted at the agricultural college of Ultuna as early as 1874. None of these trials attracted very much attention. It was only after they were conducted in connection with the national agricultural society that they created any special interest. Extensive field trials of implements were conducted in connection with this society in 1886, 1891, and 1896. The Swedish Government con-

tributed $2,680 to each of the last two exhibits and tests. It was soon found that such trials were not only of benefit to the farmers in choosing their machines, but they were of great value to implement manufacturers in that they pointed out defects in construction and weak points in the design of the machines. The chief reason for the rapid progress which has been made in Sweden in the manufacture of agricultural implements and dairy machinery is ascribed to the impetus given through these official tests. The implement manufacturers, realizing the importance of the investigations, urged upon the Swedish Government the establishment of permanent stations where such investigations could be more scientifically conducted.

A bill was introduced in the Swedish Rigsdag which provided for the establishment of two farm implement trial stations, with an annual support of $2,680. The bill, however, failed to pass for the reason given that the implement manufacturers would be the chief benefactors and they should therefore furnish the support of the stations. The following year the problem was solved by a donation from a dairy machinery company which, in 1896, presented to the Department of Agriculture, $26,800, of which $2,680 was to be spent annually in farm machinery investigations. Two experiment stations were established in connection with the agricultural colleges at Alnarp and Ultuna. To this sum was added, by private donations, $4,020 for the construction of buildings for the investigations at Alnarp, and with this sum a dairy machinery laboratory and a large implement hall were constructed. Both of the buildings were provided with instruments used in the tests, and also with numerous models used for exhibitional and instructional purposes.

The methods of conducting these investigations in Sweden are worthy of note. A committee of five was appointed, consisting of the director of the experiment station as chairman; the professor of farm machinery instruction at the college, in charge of the experiments; either the superintendent of the college farm or the professor of dairying, and two outsiders chosen by the department of agriculture for three years, "one of whom must possess technical and mechanical training, and the other one be either an agriculturist or a practical dairy expert." This committee had the right to call in other specialists in case of need, to assist in forming the conclusions. The trials were conducted in the following manner:

Invitations were extended to implement manufacturers for the test of a specific group of implements, or the tests were made at the request of manufacturers. In order to prevent the manufacture of implements especially for the trials, the committee reserved the right to take out of the manufacturer's warehouse an implement from the general stock. Not only were the implements tested for field work,

but the strength of material of the different parts was also investigated. For the testing of ordinary implements the manufacturer or his agent was required to pay the committee a fee ranging from 5 to 15 per cent of the selling price of the machine.

A number of different makes of implements of the same class were tested in the same field, and a comparison made on the following points: (1) Time required to do a certain work; (2) efficiency of work done; (3) strength of the machine; (4) construction of machine; (5) power required; and (6) cost of machine and repairs. In this way the committee could judge of the superiority and could also determine the faults of the various makes of machines. The results of the tests were published by the committee as soon after the trial as possible. When individual machines were tested at the request of the manufacturers or their agents, the result of the test might be withheld at their request, provided no machines of that kind were offered for sale to the general trade.

In case no requests were made for the test of certain implements offered for sale, and no response made by manufacturers to the invitations for trials of such implements, the committee purchased the implements in the open market and made the tests of them, publishing the results along with those of other implements tested.

DENMARK.

As early as 1869 field exhibits were conducted in Denmark, and in 1871 a committee of the Royal Danish Agricultural Society was appointed to take charge of field trials of farm implements. Since 1892 these trials have been conducted annually, and the Danish Government has contributed $1,340 a year to defray the expenses of these trials. The Danish Government also contributed medals in gold, silver, and bronze as awards for the machines which were successful in the general competitive field trials. Since 1896, however, no awards have been made. The tests are now conducted mostly on implements that are new and not well known in the country. In this way the tests prove to be of great value both to the farmers and to the implement manufacturers in the introduction of new machinery.

NORWAY.

Field trials have been conducted periodically in Norway since 1877, under the auspices of the Society for Norway's Welfare. The national government supported these investigations to the extent of granting appropriations for the purchase of dynamometers and other instruments to be used in the investigations. The results of only part of these investigations have been published.

GERMANY.

In Germany the farm-machinery investigations have been conducted mainly under the auspices of the German Agricultural Society, which was organized in 1855 and held its first farm-implement exhibit and field trial in 1887. Since then these tests have been conducted annually in different sections of Germany.

The implement trials of Germany are conducted in connection with the general implement exhibits which are part of the attractions for the annual meetings of the society. For the purpose of arranging these exhibits and conducting the field trials, the society has chosen a permanent committee consisting of eight members and a salaried secretary. This committee meets three times a year—in June, October, and February—to arrange the plans for the exhibit and field trials, and to choose the judges for the different trials. Only the secretary receives a salary for his services. The other members of the committee and the judges receive their expenses while employed.

The tests are conducted as competitive field trials, in which various implements of the same class are first placed in the general-implement exhibit, for which the manufacturers pay 20 cents a square foot for the space occupied. Those who are not members of the society are also required to pay an entrance fee of $5 for each implement exhibited, and to make a deposit equal to one-half the value of the machine exhibited in order to insure the arrival of the machines in time for the exhibit and field trial.

The society pays all expenses of the field trial, such as the expenses of the judges and the cost of the motive power for the machines, but the erection of the machines and their care during the trial is paid for by the exhibitor, who agrees, if requested, to leave the machines with the committee for further trials and closer investigation. The expenses for these investigations during the years from 1887 to 1898 were between $500 and $1,500 a year, except during the year 1904 when the trials were held in Berlin, at an expense of $3,333. These expenses did not include the cash prizes offered, which amounted to from $750 to $1,500 a year.

At the main field trials only cash prizes are offered. As an example of the distribution of prizes, mention may be made of those given at the Mannheim exhibit and field trial in 1902, which were as follows: For trials with self-binders, $400; milk pasteurizers, $200; machines for sorting potatoes, $275; and alcohol motors, $425. The German Emperor also gave a special grand prize of a porcelain vase, as well as cash prizes for the best alcohol motors.

The money to meet the expenses of the trials is paid from the treasury of the society. No government aid is given for the purpose. The society obtains its money partly from the city at which the trials

are held, and partly from the membership fees of the society, which are $5 per annum for each member, and as the society in 1902 had 13,000 members, this fee netted $65,000 for annual expenses. The results of the trials are published in the yearbook of the society.

Since 1892 the society has established a special annual exhibit for new inventions of agricultural machinery for the purpose of permitting purchasers to make comparisons and to study new inventions and innovations. Only such machines can appear in this exhibit as have been patented within the previous twenty-four months; or, in case no patent has been sought, have been in use not more than twelve months previous to the time of the exhibit. These machines must be installed at least three days before the general opening of the exhibit in order that the judges may determine whether the implements are new or of any special value. Those implements which are capable of being tested at the exhibit are tried. The others are retained to be tested later in the field, after which judgment is passed upon them. At these trials are awarded silver and bronze medals and diplomas, but these medals are not considered premiums like those given at the competitive field trials, but only as acknowledgments for new inventions, and the exhibitor must agree, in writing, to always make clear in his advertising matter the circumstances under which the medal was obtained. Misuse of this agreement is punishable by a large fine or exclusion from further exhibits until the fine is paid.

At these trials the participants must pay all expenses except those of the judges, which are paid by the society. This branch of the exhibit has become very extensive and is both interesting and useful. In 1902, at the meeting held in Mannheim, there were 74 different inventions exhibited, of which two received bronze medals and 14 diplomas, while 9 implements were retained for further trials.

Another special exhibit was inaugurated in 1902. This is a collection of all implements and machines which are intended for the same kind of agricultural work, such, for instance, as farm machinery which utilizes electricity as motive power, or machines used in the manufacture of alcohol, or dairy machinery. As these exhibits are considered splendid opportunities for advertising, the exhibitors are required to pay all expenses and to pay for space occupied, at the highest rates. A catalogue is issued each year which describes all of the exhibits and gives illustrations of all implements and machines which have been entered for the field trials.

It will thus be seen that the investigations of farm implements conducted under the auspices of the German Agricultural Society consist mainly of exhibits and field trials of such classes of implements as are selected by the society.

In many of the provinces of Germany there are, in connection with the agricultural colleges, implement-testing stations to which manu-

facturers may send their machines and have them tested for accuracy of work, strength, and durability. Such stations are located at Halle, Leipzig, Hohenheim, Bonn, Münster, Kappel, Weihenstephan, Hanover, the agricultural high school at Berlin, and other places. The tests of machines are made partly at the laboratories of the stations and partly on the farms belonging to the stations, or on large estates in the neighborhood. The trial commission consists of from 5 to 7 members who are chosen by the station director for three years. The director is usually the chairman of the commission. The professor of farm machinery is in charge of the trials, and is also the paid secretary. The other members of the commission receive expenses and $3 a day during the time they are on duty.

The manufacturers pay a certain fixed price—usually about 10 per cent of the selling price—for the testing of their implements. They also pay for the freight on the machines, and for the necessary help and power during the trial. Besides the manufacturers and inventors, individual farmers and agricultural clubs have also the privilege of sending in machines for trial purposes, and the commission itself is at liberty to arrange field trials of implements, either individually or in groups of the same class, but it is seldom that funds are available for the latter purpose.

The secretary prepares a report of the results of the different trials, which is published in the agricultural papers, but it is seldom that these results are given out in bulletin form. It is, therefore, somewhat difficult to pass judgment on the usefulness of the stations. If the test should prove that the machine is not satisfactory, the manufacturers may request that the results be withheld from publication.

The implement trial station at Halle has been organized since 1867, and has taken the lead among the German trial stations, especially during the period from 1873 to 1894, when Dr. Albert Wust had charge of the investigations.

The agricultural high school at Berlin has a well-developed and efficient department of farm machinery, with perhaps the most extensive museum of models in the world. A very complete equipment for the detailed scientific study of principles of construction and operation is now being installed.

ITALY.

The Federation of Agricultural Societies of Italy has a technical department through which the federation aims to keep itself in touch with the progressive improvements of agricultural machinery. In this department are undertaken certain investigations and comparisons of various implements to determine their efficiency for the different localities of Italy, mainly for the benefit of members of the federation who wish to purchase implements.

FRANCE.

The French Government has instituted a machinery trial station near Paris, under the direction of Max Ringelmann, which is probably the most thoroughly-equipped station for the scientific study of the principles of construction and efficiency of farm implements and machinery. Agriculture in France has been developed to such a degree that most of the country is mapped out and investigated, and the possibilities and requirements of most districts can be readily ascertained whenever there is a question of introducing improvements. Knowing exactly the requirements, the men in charge are able to report upon the suitability of any mechanism presented to them and even to offer suggestions that have proved exceedingly valuable to manufacturers. They will test new machines and inventions of any kind having reference to agricultural industry, and give an unbiased report upon their value for French agriculture.

OTHER COUNTRIES.

So good are the results which have thus been obtained that the practice is being followed in Spain, where, under the director-general of agriculture, at Madrid, there has recently been established a machinery trial station upon the same lines, and a similar department has been created by the minister of commerce and industry in the Netherlands, where agricultural engineers are given facilities for having their instruments officially tested at the agricultural academy of Wagenigen. This department gives advice to makers as to any modification or improvement that may be needed in the mechanism of an implement in order to increase its utility to Dutch users, and it also has facilities for making the machinery known to agriculturists, so that the new institution promises to be an extremely valuable intermediary between makers and users.

In Russia there have been conducted for a number of years field trials with farm implements in connection with the agricultural colleges. There is an implement trial station near Moscow, in charge of Prof. Visilij Gorjachkin. Even in far-off Siberia the writer had the privilege a few years ago to participate in a field trial of American reapers and binders at the agricultural college at Tomsk. After the trial the implements were taken to pieces, examined, and compared by the college students, and each part judged for its efficiency.

INTERNATIONAL CONGRESS OF AGRICULTURAL MECHANICS, AT LIÈGE, BELGIUM, 1905.[a]

In connection with the International Exposition at Liège, Belgium, there was held August 18–20, 1905, the first international con-

[a] From report of Mr. W. H. Beal, U. S. Department of Agriculture, delegate to the congress.

gress of agricultural mechanics. This congress was attended by 300 delegates, representing 20 countries, 8 foreign governments being officially represented.

The addresses presented cover nearly every phase of the subject of agricultural machinery and its application, but interest centered around the question of the utility of present methods of testing agricultural machinery in Europe, there being evidence of a general conviction that these methods are defective and calculated to give misleading results, and that unless they can be radically improved they had better be abolished. This criticism, however, was directed more especially against ordinary field trials and the classification of machinery based on such trials. A sharp distinction was drawn between mere field trials made with machines of the same class at different times and under different conditions and the work of machine-testing stations in which a given machine is examined with respect to its construction, the arrangement of its parts, the materials employed, and their resistance, etc., and then put to work in the field to ascertain its efficiency and the motive power required for its work. Prof. J. Pyro, of the agricultural institute of Gembloux, pointed out that field tests will not allow of a comparison being made between different machines of the same class unless they are all working at the same time, and if the trials are to give practical results the machines should be tested simultaneously upon the same land and the same crops. He advocated holding one important trial every year in connection with the trial stations, each of these trials being devoted to some special class of mechanism and carried out in the most thorough manner possible. Trials, he said, were intended to develop the improvements of machines by means of comparison, since it was only by such a course that it was possible to ascertain mechanical defects and how they could be remedied. Many of the speakers were at variance as to the value of machinery trials, but the general opinion of the congress seemed to be in favor of Professor Pyro's suggestion to organize one large trial every year for a special class of machine, in connection with the trial station.

The league of exhibitors of agricultural machinery strongly protested against the classifying of machinery in supposed order of merit on the bases of such trials. After a long discussion, the following resolution was adopted:

> The first congress of agricultural engineers considers that the methods employed in testing agricultural machinery are devoid of uniformity, and that the results of trials carried out in different countries are not comparable with each other. Consequently an international commission will be constituted to carry out arrangements to secure uniformity in the regulations for trials.

The international commission was requested to present a report upon the uniformity of trials at the next congress, which is to be held

in Vienna in 1906, and at which farm motors will be one of the special subjects for discussion.

Considerable progress has been made in Europe in establishing trial stations. However, the tests conducted heretofore have been mere demonstrations or field trials to interest and inform the farmer in a very simple and practical way. Now, however, the need of making these tests more scientific, so as to interest the manufacturer and aid and encourage him in the construction of better machines, or machines better adapted to special purposes, is realized. The tendency everywhere is away from competitive or superficial tests toward technical study of mechanical principles of construction, operation, and efficiency.

NEED OF FARM IMPLEMENT INVESTIGATIONS IN THE UNITED STATES.

In our own country conditions are somewhat different from those in any of the foreign countries mentioned. There is more need of implement exhibits and competitive field trials in Europe than in America, because manufacturers are not so far advanced and the farmers are less disposed than the American farmers to use improved machinery and implements. It is probably not advisable to conduct competitive field trials in this country between various makes of machines and to offer prizes for such trials. The method adopted in foreign countries, of publishing in their reports the names of the machines tested, is also open to criticism as far as this country is concerned, in view of the unfair advantage that might be taken of such methods of advertising. There is still a wide field of usefulness open to the agricultural experiment stations and the Federal Government, in which they might aid substantially both the farmers and implement manufacturers by means of farm-machinery investigations.

Only in recent years have the agricultural colleges recognized the importance of giving instruction to their students in the construction, care, and operation of farm implements. Notwithstanding the large amount of farm machinery manufactured in this country, there is very little reliable information available for the students and farmers who wish to become posted on the machines. It is, therefore, necessary to investigate carefully the merits of various implements and to learn by actual experiments what the farmers should expect the machines to accomplish, and what kind of machinery is best adapted to certain conditions. To be sure, all responsible implement manufacturers have their own experimental departments in which more or less care is exercised in the development of machines and the improvement of parts, but even with the best of care exercised by such departments the judgment passed upon the machines is only from the manufacturer's and not from the farmer's standpoint. If

the perfected machines were sent to some implement experiment station and there subjected to thorough scientific and impartial tests from the buyer's standpoint, and compared with similar machines of other makes, these tests would probably save the manufacturers thousands of dollars, and greater sums would be saved the farmers in that they would be able to obtain the machines suitable for their special requirements.

SOME NEEDED INVESTIGATIONS.

TILLAGE IMPLEMENTS.

Some of the lines of farm-machinery investigation which merit special attention may be mentioned. Tilling the soil is the most ancient agricultural pursuit, and the implements used for the purpose have been evolved from the crooked stick to the modern tillage implements and have revolutionized our methods of farming.

The American plows are preeminently superior in construction to plows of other countries, and they are now made in about two hundred varieties and shapes. However, no adequate or scientific investigations have ever been conducted in this country to determine which of the shapes of moldboards are best suited to the different soils; which will produce the best pulverization of soil at a minimum expenditure of power; what is the mathematically correct shape of moldboards for plows; and in what soils disk or moldboard plows can be used to the best advantage.

For pulverizing the soil after plowing, we have a great variety of harrows and cultivators, but which of these tools are best suited for soil cultivation, and what forms will produce the best tilth at a minimum cost in implements and labor, have not as yet been determined. In the semiarid regions of the West, which comprise about one-fourth of our agricultural domain, there is need of special implements for the conservation of moisture in the soil by subsurface packing and the forming of soil mulches, and special implements need to be manufactured to meet the requirements in those sections. Careful investigations need be made to determine what forms of tools are best suited to meet the needs for cultivation in the semiarid regions.

SEEDING AND PLANTING IMPLEMENTS.

Seeding and planting implements have been very much improved in this country, and yet there is a large field of usefulness for experiments and investigations to improve these implements still more. It has been determined that corn planters can be so improved in their accuracy of dropping the corn that the yield of corn may be increased about 20 per cent by the use of the perfected types of planters. The indications are that the grain drills may be improved to an equal

extent by the use of feeds which will plant the grain more uniformly. For the opening of the furrows in which to deposit the grain, there are now used single disks, double disks, shoes, and hoes, and the rows are planted 6, 7, 8, and 10 inches apart, but no reliable experiments have been conducted to determine which of these methods of planting produces the best yield of grain or requires the least power for planting.

In the semiarid regions listers are used instead of corn planters, and it has been found that better yields of corn are produced by this method of planting, as the corn roots will better withstand the drought. It seems that similar methods of planting small grain could be employed to good advantage in those regions where the rainfall is scarce during the growing season.

HARVESTING AND THRASHING MACHINERY.

The grain-harvesting machinery reached its present state of perfection about fifteen years ago, but owing to the more difficult problems to be solved in harvesting corn by machinery implements for this purpose have only come into use during the last fifteen years. A large share of the corn crop on the American farms is still being wasted annually for want of proper machinery for the care of the crop. There is need of investigations to determine what kind of corn-harvesting machinery will best meet the requirements in obtaining the largest value of the corn crop at a minimum cost. In the thrashing of small grain with our modern thrashing machines it is claimed by those who have studied the subject that the loss through improper separation, due to ignorance in the handling of the machines or to improper designs, amounts to nearly one bushel per acre on the average. This loss would amount to over 8,000,000 bushels for a single State in which wheat is the principal crop raised. Experiments ought, therefore, to be conducted to determine just what the loss is and what changes in the separators will reduce it to a minimum.

MOTIVE POWER FOR FARMS.

In using horses for propelling farm implements, no experiments have been made to determine the size or weight of animals best adapted to farm work and what should be the average number of pounds pull per day for a given sized horse. The result is that horses are often overloaded, greatly to their detriment. The traction engine is now being introduced on the large farms of the Western States to take the place of horses for plowing, cultivating, and seeding. No accurate investigations have as yet been made to determine the efficiency of this method of soil cultivation or the comparative cost of horses and other forms of motive power for the farm. It is desirable to investigate the subject so that both the farmers and

the manufacturers may know when and where traction engines can be economically employed for farm cultivation.

The windmill has been used for years for pumping purposes on the American farm, but for other power purposes it is hardly built strong enough to be of much value. There is an enormous amount of energy going to waste with the movement of the wind, which in the semiarid region of the West could be utilized in pumping water for irrigation, if suitable windmills were constructed to utilize the full power of the wind. In order to do this it will be necessary to invent some automatic arrangement which will vary the length of the stroke of the piston with the velocity of the wind. Experiments are now being conducted with several different makes of windmills in the Western States to determine what can be done with windmill irrigation.

The subject of power for the American farm is now in the transition period. Where formerly all the farm work was done by the horses and an occasional windmill for pumping water, the gasoline engine is now rapidly finding favor as a farm motor, and its usefulness can be greatly extended in doing much of the disagreeable work on the farm. The farmers need information on methods of installing their power plants so that they may use these motors economically and to the best advantage.

Numerous and conflicting statements are made as to the amount of gasoline used per horsepower hour, and not enough information, from actual tests, is available from which the users of these engines may know the cost of producing power. An investigation of this subject will be of great value both to the farmer and the manufacturers. With the introduction of the gasoline engine comes an increase in price of gasoline, which now costs the consumer almost double what it did a few years ago, and the producers claim that the demand will soon exceed the supply. It is therefore of the utmost importance to find some other fuel to take the place of gasoline in internal-combustion engines. That Germany has investigated this problem to the great advantage of her farmers is indicated by the following extract from a consular report by Frank H. Mason:

> Germany has no natural gas wells or native petroleum supply. When, some years ago, the question of adopting motor carriages for military purposes was under discussion, it was remarked by the officials of the war department that kerosene and gasoline engines could only be operated with one or the other of the products of petroleum, which is not produced in Germany, and the supply of which might, in case of war, be wholly cut off. But the broad sandy plains of northern Germany produce in ordinary years cheap and abundant crops of potatoes, from which is easily manufactured, by processes so simple as to be within the capacity of every farmer, a vast quantity of raw alcohol. German inventors and scientists have been busy with improvements in the processes of machinery and distilleries. New and highly perfected motors, lamps, and cooking and heating apparatus have been devised and put into use, until crude alcohol is becoming one of the most widely utilized products of German industry.

The German Government has encouraged this industry in every way possible, and has removed all taxes from alcohol used for technical purposes. Alcohol has been produced in Germany for 13 cents per gallon, and with very slight changes the ordinary gasoline engine can be made to use alcohol in place of gasoline.

It is hoped experiments may be conducted to determine just what changes are necessary in the present gasoline engines to adapt them to the use of alcohol as a source of motive power; also to learn at what price per gallon the alcohol can be manufactured in this country from the waste materials on the farm, such as small and unsalable potatoes, poor grades of corn and barley, and even waste cornstalks, beet pulp, and sawdust. There is no question but that alcohol can be used as a substitute for gasoline for various purposes, nor is there any doubt but that a great many of the products of the farm now wasted can be utilized for the production of alcohol.

The introduction of alcohol for technical purposes and its manufacture from the by-products of the American farms will open up new fields of labor. The farmhouses may have all the modern improvements of city homes. They may be lighted by alcohol, the farmer's wife may cook the food without much labor, and the farmer may apply this source of power to a great number of the drudgeries of the farm, and perhaps do his general farm work with alcohol motors instead of horses.

It will thus be noted that farm machinery investigations in the United States are of quite a different nature from those which so far have been conducted in Europe. The needs in this country are also quite different from those of other countries. American inventors have developed our modern farm implements, and have supplied our farmers with a great variety of machines, but for this very reason there is need of scientific and impartial investigations to determine which of these types of machines will best meet the requirements of different soil and crop conditions, and to eliminate those which prove to be unprofitable for the farmer to use. Such investigations would also form the basis for the development of new types of machines with which to meet the requirements of modern methods of agriculture, and thus to increase the yield of crops and reduce the cost of production.

SOME EXPERIMENT STATION WORK RELATING TO THE FOOD AND NUTRITION OF MAN.

By R. D. Milner,
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INTRODUCTION.

During a large part of their history the experiment stations in general have been quite actively engaged in inquiries regarding the composition of feeding stuffs and their appropriate use in the nutrition of domestic animals. In more recent years some of the stations have undertaken similar investigations on the food of man. The problem of the nutrition of man has so much in common with that of domestic animals that quite naturally the two have been studied together, though until within a few years much more experimental inquiry into the laws of nutrition was conducted with animals than with man, partly because of the greater ease and convenience of experimenting with animals and partly because of the especial activity of the experiment stations in this direction. During the past decade, however, direct investigation of the food and nutrition of man has been increasingly active, and at the present time scientific data regarding this subject and its application to the general health, comfort, and well-being of mankind are being rapidly accumulated. Very much of this is due to the cooperative nutrition investigations of this Department, the object and nature of which are explained on page 23.

These investigations are carried on very largely in cooperation with experiment stations in different sections of the country. Independent of these cooperative investigations, however, different stations have conducted researches of a like or a similar character, which, though not especially numerous in many individual cases, are of much importance and in the aggregate contribute a considerable amount of our general information regarding the food and nutrition of man. For instance, many of the stations have made chemical analyses of the food products of the regions in which they are located, and much of our present knowledge regarding the composition of food materials is derived from such sources. So much information of this kind is at present available that very little work of this character

is now done in connection with the cooperative nutrition investigations; only such in fact as is incidental to the study of special problems.

By way of illustration of the character of the investigations that are made at different stations some examples may be cited. At the Iowa,[a] Maine,[b] Michigan,[c] North Dakota,[d] Wyoming,[e] and other stations studies were made of the composition and relative economy of a large number and variety of the cereal breakfast-food products in the different markets. Investigations of the value of nuts as food were made at the Maine Station.[f] The composition and digestibility of cereal breakfast foods and of poultry were studied at the Connecticut Storrs Station,[g] and the Minnesota Station[h] has determined the digestibility of beans, cheese, and a number of other common food materials. A dietary study has been reported by the Oregon Station,[i] and at the Illinois Station[j] experiments on the cooking of meat have been made.

At the Maine Station[k] investigations were made of the chemical composition and milling and bread-making qualities of wheat flour of local production. The Oregon Station[l] made a study of the cost and chemical composition of bread. The digestibility of bread as affected by toasting was studied at the California Station.[m] At the New Jersey Station[n] an investigation was made regarding the changes in the composition of corn meal due to the action of molds. The Minnesota Station[o] studied the effect of rust upon the protein content of the wheat kernel and upon the yield of flour, and tested the composition and bread-making quality of rusted wheat. The effect of wheat smut on the bread-making qualities of flour was studied at the North Dakota Station[p]; also at the Arkansas Station[q] some interesting determinations of the digestibility of certain edible fats and oils used as human food were made with animals. The New York Cornell Station[r] made an investigation on the factors which determine quality in potatoes, with especial reference to the improvement of this crop when grown as food for man.

Very much of our present knowledge regarding the chemical constitution of different kinds of proteids of vegetable and animal

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[a] Iowa Sta. Bul. 74.
[b] Maine Sta. Buls. 55 and 84.
[c] Michigan Sta. Bul. 211.
[d] North Dakota Sta. Bul. 53.
[e] Wyoming Sta. Bul. 33.
[f] Maine Sta. Bul. 54.
[g] Connecticut Storrs. Sta. Rpts. 1903, 1904, and 1905.
[h] Minnesota Sta. Bul. 74.
[i] Oregon Sta. Bul. 62.
[j] Illinois Sta. Circ. 71.
[k] Maine Sta. Buls. 97 and 103.
[l] Oregon Sta. Bul. 62.
[m] California Sta. Rpt. 1902–3.
[n] New Jersey Stas. Rpt. 1903.
[o] Minnesota Sta. Bul. 75.
[p] North Dakota Sta. Rpt. 1900.
[q] Arkansas Sta. Bul. 78.
[r] New York Cornell Sta. Bul. 230.

origin is derived from the investigations of these bodies made at the Connecticut State Station.[a]

Some important information relating to nutrition has been obtained in connection with the experiments conducted by different stations in the study of other subjects. For example, investigations of various problems of interest to the cheese industry conducted by the New York State[b] and Wisconsin[c] stations have furnished valuable contributions to our chemical knowledge of these important food products, while facts of decided importance in the study of the processes of gastric digestion have also been accumulated. Again, in studies of the feeding of animals for the production of fat and lean meat at the Wisconsin Station[d] important knowledge has been obtained regarding the effects of rations with relatively large and relatively small protein content upon the development of the internal organs, the strength of bone, the quantity of blood, etc., of immature animals, which has a very decided bearing upon the problem of the nutrition of man.

Numerous other examples could be given of the ways in which experiment stations have taken part either directly or indirectly in the solution of this problem. Enough has been shown, however, to indicate that when the facts are brought together they form a contribution which in the aggregate is large, and that the knowledge thus obtained is of decided value.

PRODUCTION AND DISTRIBUTION OF FOOD.

A very much larger part of the work of the stations relating to the food of man, however, has to do with another side of the subject, namely, the production and distribution of food, the extent and importance of which is less generally considered. No treatment of the subject of nutrition, especially from an economic standpoint, would be sufficiently comprehensive without taking this into account. It is the purpose of the present article to consider briefly the significance of some of the experiment station work of this character. A complete summary of all lines of such work is not attempted; only a few of the more salient features are mentioned by way of illustration, but other investigations just as valuable as any here considered might also be cited. Furthermore, not all of the equally valuable results by different stations in any line of work here considered have been included in the discussion. The more prominent results to which ref-

[a] Connecticut State Sta. Rpts. for different years.

[b] New York State Sta. Buls. 214, 233, 236, and others.

[c] Wisconsin Sta. Rpt. 1903 and other years.

[d] Wisconsin Sta. Rpt. 1901.

erence is made are in some instances duplicated in the work of similar nature and importance at other stations not mentioned.

IMPROVEMENT IN YIELD AND QUALITY OF CEREALS.

The cereals are by far the most important of the vegetable foods in the diet of the American people. In several hundred dietary studies made in connection with the cooperative nutrition investigations, cereal foods of all kinds comprised, on the average, 20 to 25 per cent of the total food consumed, and supplied about 30 per cent of the total protein of the diet. Investigations having for their object the improvement of the yield and quality of the cereal crops, such as are conducted by a number of experiment stations, are therefore of inestimable value.

These investigations cover all lines of agricultural practice, including studies of the effects of soil, tillage, fertilization, moisture, etc., of methods of combating plant diseases and insect pests, and other lines, but perhaps the most significant of all are the efforts toward improvement by breeding and selection that have been undertaken within recent years. The results obtained with wheat in the work of this nature that has been carried on for several years at the Minnesota Station[a] afford an excellent illustration of the benefits that accrue from such investigations. Especial attention has there been devoted to the scientific origination of new varieties by breeding and selection, with the special purpose to secure varieties that would produce the largest yields and also have superior milling and bread-making qualities and highest nutritive values. As a result of efforts in this direction, some varieties of wheat of very superior qualities have been produced and distributed, which, if widely grown, would materially improve the yield and quality of wheat. According to fair estimates an increase of a fifth in the average production of wheat is not at all unlikely.

Of especial interest in the present discussion are the efforts of different stations to improve the quality of cereals as regards their protein content. This most important food ingredient is also the most expensive in the diet, and one problem in the nutrition of man is to reduce the cost of this nutrient. Any attempt to increase the quantity of protein in food materials used in such quantities as the cereals is therefore a step in this direction, since the more that protein can be supplied in the cereal foods the less will be the need of obtaining it from more expensive materials.

Very encouraging success has attended the efforts in this direction.

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[a] Minnesota Sta. Bul. 62.

At the Illinois Station,[a] for example, an extended investigation was made of the structure of the corn kernel and the composition of its different parts, and of the possibility of increasing the yield of any ingredient by a proper selection of seed. With careful selection and breeding, the average yield of protein by some varieties of corn was increased by one-third or more.

As before suggested, the work of the Minnesota Station[b] with wheat also included investigations of a similar nature. In the case of wheat it has been pointed out that the varieties with maximum gluten content furnish as much protein as average beef, and such wheat, provided its bread-making properties are good, is most desirable, but it makes considerable difference in what part of the wheat kernel the increase of protein is found. It should be found in the endosperm, from which the flour is made. In the investigations at the Minnesota Station, therefore, milling and bread-making tests of the different varieties of wheat are included.

At both the Illinois and Minnesota stations especial effort has been made to determine the physical characteristics of the kernels of grain that are associated with differences in composition, and it has been demonstrated that these are sufficiently pronounced to enable the differentiation to be made by mechanical examination, so that any intelligent grower may select his seed in accordance with the ingredient that he desires to produce. It is believed also that the same principles apply in the case of other cereals, as rye and oats. The possibilities of increase in the protein content of cereal food materials in general use are therefore great.

As an illustration of the result of the introduction of new varieties of cereals, the investigations with durum wheat, or macaroni wheat, as it is commonly known, are interesting. Macaroni, vermicelli, spaghetti, and noodles constitute a very important class of food materials made from wheat. Much better grades of these materials are made from durum wheat than from ordinary wheat. Several varieties of durum wheat imported and distributed by the Department have been very carefully tested under various conditions by different stations, and have proved very successful. At the South Dakota Station[c] especially, considerable attention has been given to the growth of macaroni wheat and to the study of its milling and chemical characteristics and the manufacture of macaroni. The practicability of the use of macaroni flour in bread making has also been demonstrated by the station, and considerable advantage for its use in this respect

[a] Illinois Sta. Bul. 87.

[b] Minnesota Sta. Buls. 85 and 90.

[c] South Dakota Sta. Buls. 81 and 92.

has been claimed because of the relatively large proportion of protein in durum wheat as compared with that in ordinary wheat. The results obtained at the different stations have given reasonable assurance that this country could produce all of the macaroni and similar materials which it consumes and supply a considerable portion of the macaroni wheat and flour for use abroad.

IMPROVEMENT IN CHARACTER OF DAIRY PRODUCTS.

No class of food materials has received more general attention than the dairy products, milk, cream, butter, and cheese. A large number of the stations have made investigations of the chemistry and bacteriology of these materials, and of the various problems concerned in their production and distribution. For example, the Connecticut Storrs Station[a] conducted investigations extending over many years on the bacteria of milk and on the organisms concerned in the ripening of cream for the production of the best quality of butter. The Iowa Station[b] also made similar investigations and conducted practical experiments in butter making that have been of great value to the butter producers and have resulted in a considerable improvement in their product.

A very large part of the study of dairy problems has been in the interest of the production and distribution of pure milk of a standard quality. Largely as the result of the work of the experiment stations, State legislatures have enacted laws establishing standards of composition of milk, and many of the stations are required to see that these laws are obeyed. As a result, milk supplies are being quite generally improved in this respect; but, as the stations are continually pointing out, there is still opportunity for much greater improvement in the quality and purity of milk. There is altogether too much carelessness and indifference to cleanliness in the handling of milk.

No article of diet is more dangerous than impure milk that is contaminated with disease-producing organisms. It has been shown that milk is a very favorable medium for the growth and dissemination of organisms producing tuberculosis, typhoid and scarlet fevers, cholera, and diphtheria, and serious outbreaks of such diseases have frequently been traced to milk supplies that have been infected through the ignorance and slovenly habits of persons engaged in the milk business. As commonly handled, milk may become contaminated at every stage from production to consumption.

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[a] Connecticut Storrs Sta. Rpt. 1900 and other years.

[b] Iowa Sta. Buls. 32, 35, 40, 71, and 76.

One reason why milk is especially dangerous is that it is generally consumed without cooking. To avoid the danger of infection from milk it is sometimes pasteurized or sterilized. These methods of treating milk have been extensively investigated by the experiment stations.[a] When the milk is for the feeding of infants, however, it is important that its nutritive properties be not seriously affected. Many physicians are of the opinion that sterilized milk causes serious disturbances in very young children, and prefer to run the risk of infection from the use of raw milk. The Maryland Station[b] made a thorough investigation of the effect of sterilization of milk upon its digestibility and nutritive value. It was found that the sterilized milk was slightly less completely digested by calves than the raw milk, and that it had certain deleterious effects upon the young animals to which it was fed.

For adults the effect of sterilization upon the nutritive value of milk would be less important, but no one would care for milk known to be impure, even if the danger from its use could be removed by such treatment. As the facts about milk become more generally realized, consumers are demanding that milk shall be handled in such a way that contamination with dangerous bacteria shall be avoided.

Even if no pathogenic bacteria are present, milk handled carelessly may contain large numbers of organisms that destroy its keeping qualities. This fact is perhaps more generally recognized than the danger from disease organisms in milk, and there is a constantly increasing demand for the improvement of milk in this respect. The growth of these organisms can be checked by low temperature, and methods of cooling the milk have been introduced.[c] Repeated investigations at the stations[d] have shown, however, that the number of such organisms in milk can be very greatly reduced by more attention to cleanliness in the production and distribution of milk; and as the results of these investigations become known consumers are demanding that the producers of this article of diet shall pay more attention to these matters, and the stations are showing how improvement may be brought about.

Investigations with cheese also form a large and important part of experiment station work on dairy products. Cheese is a very nutritious article of diet. Chemical analyses have shown that it is especially rich in both protein and fat, and digestion experi-

[a] New Jersey Stas. Bul. 152; Wisconsin Sta. Rpt. 1903.

[b] Maryland Sta. Bul. 77.

[c] Maryland Sta. Bul. 88.

[d] Illinois Sta. Bul. 92; Kansas Sta. Bul. 88; Maryland Sta. Bul. 88; Michigan Sta. Bul. 221; New York Cornell Sta. Buls. 197 and 203; Connecticut Storrs Sta. Buls. 25 and 26, and others.

ments with man indicate that its nutrients are quite thoroughly digested. For these reasons the price at which cheese is commonly sold makes it a very economical food material. The popularity of cheese, however, depends not so much upon its nutritive value and economy as upon its flavor, a certain flavor in cheese being very greatly relished. Incidentally this adds to its nutritive value, because it has been demonstrated that flavor has considerable physiological importance in its effect upon the secretion of digestive juices.

Unfortunately the ordinary cheeses on the market differ very decidedly in respect to both flavor and texture, varying from a tough, waxy, sour curd that is very unpalatable to a crumbling pungent substance with a strong, rank flavor. Indeed, there is such a lack of uniformity in cheese in respect to these characteristics that it is rather difficult to obtain two samples that are very much alike, and there is very much inferior cheese on the market. Chiefly for such reasons the consumption of this very nutritious food material has not increased as rapidly as it might otherwise have done, if indeed it has not actually decreased.

So much success has attended the efforts of butter makers to produce butter of a standard quality by controlling organisms that are concerned in the process that cheese makers have attempted to adapt similar methods to their industry. In this connection investigations of very decided value have been conducted by some of the experiment stations. A considerable amount of this work has been done in cooperation with this Department. At the Wisconsin [a] and New York State [b] stations extensive studies of various factors concerned in the manufacture of the common hard cheese have been made in the attempt to establish this industry on a scientific basis. Efforts to control the process of making and curing cheese so as to obtain uniformity in flavor, texture, and other qualities have been decidedly encouraging. At the Oregon Station [c] also an investigation was made of methods of controlling the flavor of cheese. The successful application of the principles established by these investigations should result in a vast improvement in the quality of hard cheese found on the market, and this would without doubt be followed by a greater consumption of this very nutritious food product, to the advantage of both producer and consumer.

The soft cheeses, such as Roquefort and Camembert, have a stronger flavor than the ordinary hard Edam cheese and are much relished. The taste for cheeses of this type is becoming more general in this country, and the demand for them is increasing rapidly. These

[a] Wisconsin Sta. Rpts. 1900 and other years.

[b] New York State Sta. Buls. 203, 207, 214, 233, 236, and others

[c] Oregon Sta. Bul. 78.

cheeses are produced abundantly in Europe, and from there the larger part of those used in this country are imported. The conditions under which the cheeses may be kept, however, are such that they can not be imported satisfactorily; hence there is considerable opportunity for a profitable industry in the production of cheeses of this type in this country, and in the effort to satisfy the demand for them attempts are being made to establish the soft cheese industry here. Some types have been very easily produced, but others with more pleasing odor and delicate taste are demanded. In order to determine to what extent scientific study of the problems concerned in the production of soft cheese would help in aiding the establishment of the industry, the Connecticut Storrs Station[a] has devoted considerable attention to the thorough investigation of the methods of producing cheeses of this type, and already has met with a considerable measure of success.

FOOD PRESERVATION AND PREPARATION.

The development of various industries for the better utilization and distribution of agricultural products has had a very material effect upon food consumption. Until comparatively recent years many of the products of the farm were available for general consumption during only a limited season, and some of them, especially the more perishable, within a rather limited area. At the present time, owing to the development of methods of preservation and distribution, all sorts of products may be obtained all the year round, and their market has been extended to all parts of the country. Furthermore, there has been a remarkable increase in the number and variety of foods into which farm products are converted, comprising canned meat and vegetables, desiccated foods, evaporated milk, package goods, including specially prepared cereals and other similar products, jams, preserves, and jellies, and many other food products which are so commonly found on our tables to-day, but almost unknown a few years ago unless of domestic manufacture. With such changes in the available food supply, very naturally the dietetic habits of the people in general have been somewhat modified.

Although the industries concerned with the preservation and distribution of food products stand in close relation to both producer and consumer, very few experiment stations have given much attention to investigations which relate to them. Rather more has been done in the interest of the consumer, to protect him against fraud, than in the interest of the producer, to help him establish his industry upon a scientific basis. Such work as has been done along both lines, however, is of considerable importance in the present discussion.

[a] Connecticut Storrs Sta. Bul. 35.

Many agricultural products are of such a nature that they can not be widely distributed without protection against deterioration. The decay of animal and vegetable food materials is due to the activity of bacteria which gain access to them from many sources, and increase rapidly under suitable conditions of moisture, temperature, and absence of substances injurious to the organisms. Methods of preservation of food depend upon the prevention of the growth of the bacteria, either by destroying them, by keeping the material dry or cold, or by adding some antiseptic. A number of experiment stations have studied methods of storing apples, potatoes, and other common vegetables and fruits for home use and for market purposes, and in connection with this work have investigated the causes of decay and similar problems.

Very many products, such as fruits and vegetables, which are perishable in the fresh state may be kept indefinitely when dried. This method of preservation has several advantages, in that it is relatively inexpensive and may be practiced in a small way as well as commercially. Furthermore, in drying, the materials decrease in bulk and weight and the cost of distribution is thereby materially reduced. Objection to the method is that the food materials are usually not preserved in their natural condition, and their flavor is sometimes lost, and in some cases preliminary soaking or cooking before use is necessary. With many products, however, the advantages are more than the disadvantages. At the South Carolina Station [a] some problems connected with the production and distribution of the sweet potato were investigated. It had been demonstrated that large crops of this vegetable could be produced, but they could not be marketed successfully because in their condition as harvested they were too perishable and would not bear rough handling and exposure to cold weather. The station devised a simple method of drying the potatoes so that they would keep indefinitely, and might be handled and distributed much more easily and cheaply. The successful introduction of such a method means a wider distribution and a more extended use of this nutritious farm product. At the Oregon Station [b] investigations were made on the methods of preventing discoloration of evaporated fruits and vegetables.

Many food materials are preserved by storing at low temperature, at which the organisms that cause decay will not thrive; but unless natural means for maintaining low temperature can be utilized this method is too expensive for general use. It is applied in a commercial way to the preservation of meats, butter, eggs, vegetables, and other food products. This has been the subject of investigation at several of the stations. The North Carolina,[c] North Dakota,[d] and

[a] South Carolina Sta. Bul. 71.

[b] Oregon Sta. Rpt. 1903.

[c] North Carolina Sta. Bul. 191.

[d] North Dakota Sta. Bul. 44.

other stations have investigated methods of preserving eggs from spring and summer, when they are abundant, to fall and winter, when fresh eggs are less plentiful. For commercial purposes cold storage proves more practicable, but the farmer and the housekeeper seldom have such facilities. Different methods that have long been used in the household for preserving eggs with more or less success were tried at some of the stations and their values determined.

Fruits and vegetables are preserved in their fresh condition by heating them at high temperature long enough to destroy the organisms present, then hermetically sealing them to prevent other organisms from gaining access to them. This is the principle on which the proper canning of food products depends. An investigation on the canning of fruits and vegetables was conducted at the Virginia Station [a] in a small factory erected for the purpose of utilizing the products of the fruit and vegetable garden and providing a cheap supply of canned goods for the dining hall of the agricultural college. In this work it was the "aim to pack first-class goods absolutely free from preservatives, other than salt and sugar, that are in use as condiments in the products as they are ordinarily eaten. We have also tried to handle our products so as to preserve their natural appearance and flavor." In this investigation a considerable variety of farm products was canned, and it was demonstrated that they could be satisfactorily preserved in this way.

At the New York State Station [b] an interesting investigation was made on the swelling of canned peas, which is the occasion of much loss to this industry. This swelling was found to be due to a certain species of bacteria, the spores of which survive the heating during the process of canning. It was shown that further heating destroyed these germs without injury to the commercial quality of the goods.

To avoid losses due to fermentation, such as those just cited, resort is sometimes made to the use of antiseptics to destroy the organisms that may survive heating during canning. Indeed, in some cases the preservation of food is accomplished chiefly by the use of such substances. This is a cheap and easy method, and the natural form and flavor of the materials are not impaired, unless an excessive amount of the preservative is used. This method of preservation is so effective and so easily followed that it has been quite universally adopted, until it is difficult to obtain preserved foods that do not contain some chemical substances that have been added to prevent deterioration.

Very decided objection to the use of such substances has been made. It has been suggested that the process of decay is so similar to that of digestion that whatever will prevent the former is likely to interfere with the latter. Considerable attention has been given to the

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[a] Virginia Sta. Bul. 146.

[b] New York State Sta. Bul. 249.

study of the effects of these preservatives upon the body, and some of them have been found to be decidedly injurious. The investigations at the Virginia and New York State stations would indicate that their use is unnecessary. In the report of the work at the latter station it was stated that "it has been maintained that the use of antiseptics is unavoidable in certain departments of canning, but the list of substances which have not been successfully canned without the use of antiseptics is small. The use of such substances in many cases is an admission either of carelessness or ignorance on the part of the canner."

FOOD ADULTERATION.

Many of the States have enacted legislation for the control of the quality of the foods in their markets, and in some of them the duty of inspecting foods has been placed with the experiment stations. Methods for the detection of adulteration have been very highly developed by some of the stations, very notable work of this character having been done at the Connecticut State Station.[a] As a result of the activities of the stations in this direction, the quality of food materials on sale in the markets of the different States is being decidedly improved. In many cases adulterated foods are not allowed to be sold; in other cases they are not prohibited from the markets, but must be so branded as to indicate exactly what they are, what adulterants, preservatives, etc., have been used in them, that the consumer may know just what he is buying.

Pure-food laws have been enacted in many of the States, Territories, and island possessions, and in some instances the carrying out of the provisions of the law is intrusted to experiment station officials. This is the case in Connecticut, Kentucky, Maine, and North Dakota.

CONCLUSION.

It is perhaps unnecessary to cite other instances in order to emphasize the fact that the experiment stations are in general quite actively interested in the solution of some of the many problems regarding the food and nutrition of man. Perhaps it might be inferred, from the nature of the institutions and the significance of the subject, that such would be the case.

It is the proper business of an agricultural experiment station to discover and establish the laws that underlie the right practice in agriculture. The scientific investigations of the stations are conducted in the interest of agricultural production. The activity in any line of investigation is in proportion to the importance of the problem. The chief agricultural product is food, which all need. As there is opportunity for improvement in the feeding of farm ani-

[a] Connecticut State Sta. Annual Reports.

mals, so there is even more demand for improvement in the food and nutrition of man. By as much as man is of more importance than the beast that serves him, by so much is it of more consequence that the relation his food bears to his comfort and productive capacity should be understood. Very naturally, then, and very rightly, the investigation of these problems enters largely into the field of experiment station activity. And this is in behalf of not only the farmer, but also people of all other occupations, since the support of the stations comes as directly from the rest of the people as from the farmers.

Although the stations have already performed in the aggregate a large amount of work along the lines referred to in the present article, and in related lines not mentioned, the indications are that similar work will be undertaken still more extensively in the future. For example, there is a growing opinion that the energies of the station should be directed toward the solution of the problems of the various industries for the utilization of farm crops as well as toward the production of the crops; that more attention should be devoted, for instance, to the study of the technology of the preparation and preservation of butter, cheese, evaporated fruits and canned goods, macaroni, and other prepared cereal products, etc. Studies on canning and preserving, the manufacture of special cereal foods, and other lines of work which have to do with the preservation and distribution of food products bear an important relation to both producer and consumer. It seems as properly a part of the work of an experiment station to conduct investigations which will help in establishing these and related industries on a scientific basis as it is to conduct investigations on the growing of both animal and vegetable food products, particularly when we remember that the experiment stations have already devoted a great deal of most useful study to the production and distribution of cheese, butter, and other dairy products. Such investigations would aid very materially in the improvement of the available food supply.

SOME RESULTS OF EXPERIMENT STATION WORK WITH INSECTICIDES.

By E. V. Wilcox, *Office of Experiment Stations.*

The organization lists of the agricultural experiment stations show that at present there are 58 entomologists connected with these institutions exclusive of those employed at the insular stations. Since the organization of the experiment stations an immense amount of entomological work has been carried on by these agencies, resulting in the publication of nearly 4,000 bulletins and reports dealing exclusively with entomology. It has been found practically impossible to present a summary account of this work within the confines of a short article. The reasons for the enormity of such a task are not far to seek. In the first place many questions of priority of discovery would immediately arise and would necessarily give the account a controversial aspect which is entirely foreign to the purpose of the present article. Moreover, the number of subjects treated in the entomological bulletins and reports is so great that the mere mention of each insect discussed and each insecticide method tested would fill a considerable number of pages. On account of the obvious impracticability of presenting a summary of all of this work at present it has been thought wise to confine this account to a discussion of some of the more important pieces of insecticide work done at the experiment stations. Even with a subject confined within these limits it has been necessary to exclude even the mention of numerous insecticides, especially those of proprietary nature, which have received less attention than some of the few standard insecticides. For practical purposes, therefore, the present article deals with the more important contributions of experiment station entomologists to the study and practical application of standard insecticides.

GENERAL INSECTICIDE METHODS.

The development of insecticides and the perfection of methods for their application are naturally associated with the outbreaks of certain injurious insects of unusual importance. Thus the San José scale is responsible to a greater extent than any other insect for the unusual efforts put forth by experiment station entomologists in devising practical contact insecticides which would eradicate not only

the San José scale but other related species which are not directly susceptible to the action of poisons. In giving an account of the experiment station work along this line it is perhaps well to begin with the lime-sulphur-salt wash.

THE LIME-SULPHUR-SALT WASH.

The lime-sulphur-salt wash, also known as California wash on account of the fact that it was first brought into prominence in that State, is now generally recommended by station entomologists as the best remedy for scale insects. At the California Station[a] experiments were carried on to determine the effect of variations in the amount of lime and other ingredients in this wash. Various amounts of lime were used, ranging from 20 to 50 pounds per 60 gallons of water. In all cases the San José scale was killed, and the amount of lime necessary to combine with the sulphur was found to be about equal parts by weight. In general the percentage of scales affected by the wash was greater where there was a scarcity of lime. This was especially true where heavy rains occurred after spraying. Similarly the amount of sulphur per 60 gallons of water was made to vary from 5 to 40 pounds. Where the smaller quantities of sulphur were used there was a falling off in the efficiency of the wash. When the amount of salt was varied little difference in the results was discernible, even where the salt was entirely omitted. The station, however, does not feel prepared to recommend the disuse of salt in the wash. The California Station also compared the cost of making a lime-sulphur wash without boiling with that of the ordinary boiled wash. It was found in this comparison that the cost of the two methods, as involved in a day's work with the power outfit, applying 2,000 gallons per day, was $35.40 for the wash boiled by fire and $45.75 for the wash made with caustic soda. The formula finally determined upon as the most satisfactory from every point of view calls for 30 pounds of lime, 12 pounds of sulphur, and 10 pounds of salt for each 60 gallons of water. This wash was found effective against all scale insects and some other related species except the brown apricot scale, for which a resin compound containing resin, caustic soda, fish oil, and water is recommended. The California Station recommends that the lime-sulphur-salt wash be applied in winter to dormant trees. In some instances the wash was applied to apricot trees in bloom without injury, but this procedure is not recommended.

The Connecticut State Experiment Station[b] carried on experiments with lime-sulphur-salt wash on 11,500 trees, chiefly peach, pear, and apple. The California wash proved to be about equally

[a] California Sta. Bul. 166.

[b] Connecticut State Sta. Buls. 144, 146; Bul. Immediate Inform. 1.

effective with the lime and potassium sulphid mixture recommended by that station. The California wash was much more satisfactory than whitewash or strong Bordeaux mixture, for the reason that it remained much longer on the trees after the occurrence of rain. The Oregon wash, in which copper sulphate was substituted for salt, soon disappeared from the trees, although in some instances it was very effective in destroying the scale. During the spring of 1903 Connecticut orchardists are reported to have tested lime-sulphur mixtures on about 40,000 trees with very satisfactory results. In the experiments at this station lime and sulphur mixtures remained longest on the trees when applied just before the leaves appeared. The reason for this seemed to be that the leaves protected the washes from the spring rains. In orchards where two applications were made, one in late fall and one in the spring, the San José scale was nearly eradicated. The same station followed up this line of work in the succeeding season with further experiments on 4,000 orchard trees of various kinds, using 15 different formulas of lime and sulphur combinations. In these tests it was found that where the spraying was done as soon as the leaves fall a large proportion of the young scales was killed, since they are then more susceptible than later. In comparing the 15 different formulas of boiled and unboiled mixtures of lime and sulphur it appeared that a boiled mixture containing an equal quantity, or a little more or a little less, sulphur was as effective and cheap as any of the mixtures for ordinary orchard work. The unboiled mixtures contained lime and either potassium sulphid, sodium sulphid, sulphur, or a combination of sulphur and sodium sulphid, or sulphur and caustic soda. The combination of lime, sulphur, and sodium sulphid gave excellent promise of becoming a satisfactory insecticide. Caustic soda seemed to possess certain disadvantages, particularly the unpleasantness of handling it. During the season of these direct experiments by the station about 100,000 fruit trees were sprayed with these mixtures in Connecticut with generally satisfactory results.

During the spring of 1905 the Connecticut Storrs Station[a] continued its experiments with sulphur compound in combating San José scale. As a result of all the investigations at this station it is concluded that it is not possible to kill all of the scales on infested trees for the reason that the spray does not come in contact with all of the insects. In tests of lime and sulphur mixtures, however, from 91 to 95 per cent of the scales were killed. The presence of salt in the mixture did not add anything to the adhesive qualities of the insecticide nor to its effects upon the scale. Of all the various proportions of lime and sulphur used the most effective was one in which the

[a] Connecticut Storrs Sta. Bul. 30.

formula called for 20 pounds of lime, 10 pounds of sulphur, 10 pounds of sodium sulphid, and 40 gallons of water. The least expensive mixture, however, was one containing 20 pounds of lime, 14 pounds of sulphur, and 40 gallons of water boiled for 45 minutes. This mixture prepared ready for use cost 54 cents per 40 gallons.

In experiments at the Connecticut Storrs Station excellent results were obtained from the lime-sulphur wash, containing 25 pounds of lime, 20 pounds of sulphur, and 15 pounds of salt per 50 gallons of water. At this station it appeared that when an excess of lime was used the whitewash thus produced by solution in water was of no special advantage, and when an excess of sulphur was used some of the sulphur remained undissolved. It is recommended, therefore, that slightly more lime than sulphur should be used in order to make sure that the sulphur is all dissolved. In testing the changes which take place in the mixture during boiling it was found that sulphur was all dissolved when the mixture was boiled from 30 to 45 minutes, and that no beneficial effects were produced by boiling the mixture for a longer period. Some economy was learned in placing the lime and sulphur together and pouring hot water upon the lime to slake it. The heat developed by the lime in slaking is thus utilized. The addition of 4 pounds of copper sulphate to the formula used by this station produced one form of the Oregon wash, which gave results equally as satisfactory as those obtained from the California wash. The results obtained at the Storrs Station indicate that the California wash may be applied at any time when the leaves are off the trees, from November to April. The wash may be applied to all kinds of orchard trees, mountain ash, rose bushes, grapevines, other small fruits, and ornamental trees and shrubs liable to infestation with San José scale. It was found that the omission of salt from the formula lowered the cost of the mixture considerably.

In Delaware[a] lime-sulphur washes were tested either after boiling by fire or self-boiled by means of caustic soda. The caustic-soda mixture gave quite favorable results, but on the whole was considered as inferior to the boiled California wash. As a result of the experiments at this station it is recommended that the sulphur should be added to the slaking lime, and that the ingredients of the wash should be boiled in as large an amount of water as can be conveniently used. By observing these precautions it is possible to get nearly all of the sulphur in solution within 15 minutes. It is therefore recommended that boiling for 15 to 30 minutes is as satisfactory as a longer period. The wash should be applied as soon as possible after preparation, but in case it can not be applied before the crystals form they may be strained out, redissolved in hot water, after which the solution may be added to the original wash.

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[a] Delaware Sta. Bul. 64.

In Illinois the California and Oregon washes, prepared according to various formulas, have been subjected to thorough tests in combating San José scale and related insects.[a] On account of the fact that the California wash was generally supposed to be ineffective in the East by reason of the frequent rains, the Illinois Station undertook experiments to test the effects of rain on both the California and Oregon washes. During these experiments it was found that frequent short rains did not visibly diminish or delay the action of the Oregon wash, even when such rains occur within five days after the application of the insecticide. The California wash in the earlier experiments of the Illinois Station, prepared according to the formula 15–15–15–50, appeared to be somewhat less effective than the Oregon wash and more susceptible to the action of rains during the first few days after its application. The conclusion was therefore reached from the first experiments of this station that the California and Oregon washes are no less effective in the East than on the Pacific coast, and are very satisfactory insecticides in the hands of ordinary orchardists. These washes were noted as possessing the great advantage of harmlessness to the tree and of being cheaper than the applications of kerosene. In a further test of sulphur mixtures by the same station fumigation with whale-oil soap and kerosene emulsion were compared with the California wash. All proved to be effective destroyers of San José scale under favorable conditions, but fumigation was found to be restricted to small trees and to mild, quiet weather. The California wash as well as fumigation was found to be perfectly safe to all trees and shrubs if applied after the leaves had formed, but whale-oil soap and kerosene emulsion were sometimes harmful. Fumigation was the most expensive of the four methods, while the California wash and kerosene emulsion cost least. In point of convenience kerosene emulsion and California wash were given preference. On the whole the California wash was considered the best insecticide for common use against the San José scale during the winter. The latest recommendations of the Illinois Station are to the effect that the owners of infested trees and shrubs should spray promptly, using the Oregon wash with a formula calling for 15 pounds lime, 15 pounds sulphur, and 1½ pounds copper sulphate per 50 gallons water or with the California wash made in the same manner after substituting 15 pounds of salt for the blue vitriol. These washes are never to be applied while the tree is in leaf, but rather late in winter or early spring before the buds open. When used in this manner they have proved harmless to trees and shrubs of all kinds in Illinois.

[a] Illinois Sta. Buls. 71, 80; Circ. 85.

The Maryland Station has likewise devoted considerable attention to an investigation of the sulphur washes.[a] In the first experiments with sulphur washes at this station it was recommended that they be applied late in November or in December, especially if another application could be given in early spring. The best time for applying the wash, however, was found to be in spring just before the buds begin to swell. No difference was noted in the effectiveness of the wash whether salt was added or not, whether all of the materials were boiled together or part boiled and the others added later. In subsequent experiments a comparison was made of the effectiveness of various formulas of lime-sulphur-salt washes. Good results were obtained from all the formulas used, but it appeared to be desirable to use at least 20 pounds of lime and 15 pounds of sulphur to each 50 gallons of water. The solutions boiled by fire gave better results than the self-boiled mixtures. The omission of salt seemed in some cases to be without effect, while in others it appeared that the effectiveness of the wash was thereby diminished. The results obtained from these experiments indicated that the California wash may be applied in the late fall or early winter with as good results as at other seasons and the formula recommended was 20–15–10–50. Recently the various practical questions connected with the preparation and application of California washes have been reconsidered at the Maryland Station, and it is still recommended that the California wash is the most satisfactory insecticide for the San José scale. Recent experiments have demonstrated more clearly the superiority of this wash over other insecticides. While the lime-sulphur mixture is considered as a treatment for dormant trees, it appears that where only one application is possible the treatment should be postponed as late in the spring as possible before the buds have begun to open.

The California wash prepared according to the formula 20–15–10–45 was applied to peach trees in February by the Mississippi Station.[b] The mixture was boiled for forty-five minutes and was applied promptly. It is recommended, however, that the lime and sulphur be boiled forty-five minutes, after which the salt is to be added and the mixture boiled for fifteen minutes longer. December is regarded as the best month for the application of the California wash in Mississippi. February might be a better time if it were not for the liability of persistent rains during that month. In summer the wash, made according to the same formula, is recommended for application to the trunks and large branches of the trees by means of brushes. It appears that San José scale may be exterminated by two applications of California wash after peach trees have been severely pruned back.

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[a] Maryland Sta. Buls. 90, 99, 107.

[b] Mississippi Sta. Bul. 90.

Some of the most extensive and thorough tests of the lime-sulphur washes have been made by the New Jersey stations.[a] The formula first recommended in New Jersey was 50–50–50–150, the mixture to be boiled for at least an hour and a quarter. As a result of the early experiments at the New Jersey stations, it was concluded that the time of application should be late winter or early spring before vegetation has started. The practice of spraying twice annually, that is, in the fall and the spring, was discouraged on account of the possible injury to peach trees. While it is generally recommended that the California mixture should be applied hot, good results were obtained from this wash after it had become cold. The New Jersey stations recommend the California wash especially for peach trees, but argue that crude petroleum or some soluble form of oil is more reliable on other trees, especially if they are badly infested with the scale. The same formula of the California wash was tested in subsequent years at the New Jersey stations with satisfactory results. Where it was inconvenient to boil the mixture a formula was recommended calling for 33 pounds of lime, 17 pounds of sulphur, and 4½ pounds of caustic soda per 50 gallons of water. The New Jersey stations recommend that the lime be slaked with just enough water to allow the process to take place, after which it is boiled with no more water than enough to prevent burning, the sulphur having been added during the process of slaking. The boiling is to be continued until the mixture takes on a deep amber color, after which the salt previously dissolved in water is added slowly to the boiling mass. The boiling period recommended by these stations is one hour. The most recent formula suggested for the caustic soda mixture is 30–15–6–50. During the winter and spring of 1903–4, numerous failures were reported to the New Jersey stations in the use of lime-sulphur washes. In fact the majority of orchardists who tried these mixtures reported almost complete lack of success. The failures observed were chiefly in apple and pear orchards, while success was had when the insecticide was applied to peaches and plums. The cause of these unfortunate experiences on the part of orchardists was not fully determined by the investigation undertaken by the stations, but as a result of these quite general failures the stations were led to recommend more emphatically the use of petroleum mixtures or more soluble oils for all orchard trees except the less hardy kinds, such as the peach.

Very careful experiments under the most severe scientific precautions have been carried on for several years at the New York State Station.[b] The first experiments at this station indicated clearly that the lime-sulphur-salt wash is a safe and reliable remedy for use

[a] New Jersey Stas. Buls. 162, 169, 178; Rpt. 1904, p. 629.

[b] New York State Sta. Buls. 228, 247, 254, 262.

against the San José scale. It appears from the investigations of this station that the wash exercises a destructive effect upon the scale insects in two ways: (1) Directly through its soluble compounds acting soon after its application as a contact poison, and (2) through its more slowly soluble compounds which form a crust, and thus prevent the development of the young scales. When the wash was applied with sulphur in the proportion of one part to ten parts of lime, Japan plum trees were not injured even in the summer. Encouraging results were early obtained from the use of the self-boiling mixture prepared with caustic soda as a substitute for the boiled mixture. It was found that the California wash is not only a very effective insecticide, but also exercises considerable fungicidal effect. Its value as a fungicide was somewhat increased when it was combined with a solution of copper sulphate forming a combined insecticide and Bordeaux mixture. The time recommended for its application was just before the opening of the buds or the time usually set for the application of Bordeaux mixture. No injury was observed from the winter application of California wash to apple, peach, pear, or plum trees. The only effect observed upon the tree was a slight delay in the appearance of the leaves. The same station carried on quite extensive experiments to determine the value of the lime-sulphur-caustic soda wash when used in the place of Bordeaux-arsenical mixtures for a general orchard treatment. It was found that this wash was a safe and reliable remedy for scale insects and that it exercises, to a considerable extent, an action against the development of apple scab, pear psylla, and peach and pear mites. The self-boiled mixture, however, did not give as uniformly satisfactory results as the California wash prepared by external heat. One application of the wash during the dormant season was sufficient to reduce greatly the injuries from early spring leaf-eating caterpillars, such as the bud moth, and also to reduce the injuries from codling moth. As used against the last-named insect, however, it was inferior to Bordeaux-arsenical mixtures. The station continued its experiments with the California wash with particular reference to a determination of the effects of fall applications upon fruit and leaf buds, as well as upon San José scale. The orchards in which these tests were made consisted of standard varieties of various fruits. In one orchard which was not infested with San José scale, the application of sulphur washes caused a slight diminution in the amount of bloom and foliage of peach and plum trees. This effect was less marked after the use of lime-sulphur wash than when other contact insecticides were used. It was also observed that with the advance of summer there was a decided increase in the amount of new growth and foliage upon the treated trees. The fruit yield was greater on treated than

on untreated plum trees. Otherwise there was very little difference between the two sets of trees.

In another orchard which was infested with scale the plums lost from 10 to 50 per cent of their flowers after treatment and showed slight injuries to the leaf buds, especially upon the lower branches. Cherries suffered a loss of 5 per cent of the blossoms, apples and pears being similarly affected. In the third orchard, likewise infested with the scale, no apparent reduction in the number of blossoms or leaves was observed as a result of treatment with lime-sulphur sprays. The California wash with or without salt and self-boiled or boiled with heat was in all cases effective in destroying the scale. The addition of salt did not increase the effectiveness of the wash. In recent experiments by the New York State Station it appears that one application of the sulphur wash was sufficient to reduce the amount of apple scab 22 per cent. A combined treatment consisting of one application of a sulphur wash before blossoming and two applications of the Bordeaux-arsenical mixture after blossoming reduces the injury from apple scab and codling moth to the same extent as is observed after the usual three applications of Bordeaux-arsenical mixture for these pests. The pear-leaf blister-mite was effectively controlled by one application of the sulphur wash before blossoming. These results, combined with those obtained in New York and elsewhere, showing considerable fungicidal value of the sulphur washes, indicate the wide usefulness of this preparation.

In Ohio[a] a test was made to determine the value of California and Oregon washes when applied in the fall and also in the spring. The California wash was completely effective in destroying the San José scale when applied in the fall, and was not injurious in any way to peaches or plums. The wash appeared to prevent to a considerable extent the development of leaf curl, but had little effect on brown rot or shot-hole fungus. The formula used for the California wash in these experiments was 15–15–15–50, and the whole mixture was boiled for one hour. The applications were made from November 26 to December 15. The Oregon wash, prepared according to the same formula with the substitution of 1½ pounds copper sulphate for the salt, was sprayed on peach and plum trees at the same time. This test demonstrated that the Oregon wash is a perfectly safe and reliable remedy for San José scale, but shows no practical advantage over the California wash. When caustic soda was substituted for part of the lime in making a self-boiled mixture the resulting insecticide was much less effective.

In Tennessee[b] cherry, peach, plum, pear, and apple trees were sprayed about the middle of March with California wash according

[a] Ohio Sta. Bul. 144.

[b] Tennessee Sta. Bul., Vol. XVI, No. 2.

to the formula 30–30–30–100. This treatment did not manifest its effects so quickly as did crude petroleum compared with it, but ultimately the California wash proved equally effective with the crude petroleum and did much less damage to the trees. The self-boiled mixture containing caustic soda appeared to be about as effective and safe as the ordinary California wash.

Elaborate chemical studies were made in the Virginia Station[a] on the compounds produced in the preparation of the California wash when different proportions of the ingredients are used. Judging from the behavior of various preparations, it appeared that when 50 pounds of lime and 40 pounds of sulphur were used per 100 gallons of water the addition of salt improved the mixture somewhat. It was found that when different quantities of the various ingredients were used variations in the specific gravity of the mixture resulted. The greater the amount of lime and sulphur used the higher the specific gravity. In tests to determine the length of time during which the mixture should be boiled different samples were boiled for from thirty minutes to two hours. The density of the solution varied somewhat in mixtures which were boiled less than twenty minutes, but after this time the density remained almost constant even when the preparation was boiled for two and one-half hours. Repeated experiments along this line indicated that the mixture remained approximately the same whether boiled thirty minutes or two and one-half hours. As a result of the various tests at the Virginia Station, the formula 30–30–10–100 is recommended. This preparation, when properly boiled and diluted, should test about 1.053 on the hydrometer or about 7° on the Beaumé acid spindle. The California wash has been tested extensively as a winter application in Virginia with almost uniformly good results. In cases of bad infestation it is also recommended as a summer treatment to the trunks and main branches of apple trees. The chief value of salt and copper sulphate in sulphur washes is believed to be found in their tendency to cause the wash to adhere better to the trees. One application either in the fall or spring is usually effective. The Oregon wash made according to the formula 80–80–7–360 was tested on 50,000 peach and apple trees. The treatment was very effective, although the insecticide was imperfectly applied, so that some of the scales escaped being touched with the spray.

As a result of numerous experiments with the California wash in Washington[b] various modifications have been made, but the formula recommended at present is 1 pound of sulphur and 1 pound of lime per 4 gallons of water. The salt is considered unnecessary and probably a useless ingredient in this wash. The lime-sulphur wash

[a] Virginia Sta. Bul. 141.

[b] Washington Sta. Bul. 56.

proved just as effective in Washington when applied cold as when sprayed hot. The mixture is more difficult to spray when cold than when hot. Pear and peach trees sprayed with lime-sulphur mixture when in leaf were quite seriously injured, while apple and plum trees sprayed under the same conditions were very slightly affected. The application of lime-sulphur wash after May 9 in Washington appeared to be much less effective than at earlier dates. A chemical study was made of the changes which take place in the lime-sulphur-salt wash after it is applied to the trees. It was found that the water evaporates, leaving the dissolved solids upon the surface of the sprayed trees. These solids when exposed to the action of the air undergo chemical changes, the sulphids and sulphites taking up water and being converted into calcium sulphate. The calcium hydrate resulting from the excess of lime ultimately changed into calcium carbonate. These changes take place more rapidly in a moist than in a dry atmosphere, and certain portions of the deposits are constantly leached out by the solvent action of the moisture in the air. It was found that some sulphids were still present in the material on the bark after one week, but had nearly all disappeared by the end of twelve days. The results of these studies indicate, therefore, that the sulphur compounds gradually disappear, leaving carbonate of lime as a whitewash upon the bark.

It is apparent from this summary of work done at various experiment stations with lime-sulphur washes that these washes are warmly recommended by entomologists as exceedingly effective in the destruction of scale insects and certain other insect pests, as well as in the control of peach-leaf curl, apple scab, and some other fungus diseases. The California wash has also the great advantage of being practically harmless to all kinds of trees and shrubs in a dormant condition. Its use is rapidly extending from year to year among horticulturists in all States, but perhaps most rapidly in the peach-growing districts of the South, where it is considered the only remedy which can be safely recommended for scale insects.

PETROLEUM INSECTICIDES.

Kerosene has been in use as an insecticide considerably longer than lime-sulphur washes. It was first used in the form of an emulsion with soap, sour milk, and various other substances, and later in mechanical mixtures with water. Petroleum oils have also been used extensively in the place of kerosene in a pure form, in emulsions, and in mechanical mixtures with water. Considerable attention has been given to the chemical and physical properties of different grades of crude oil obtained from different parts of the country. The crude oils from Pennsylvania, West Virginia, Texas, and California have

been found to vary considerably in composition, specific gravity, and effects upon plants when used in the form of a spray.

Kerosene emulsions have been studied so thoroughly and used so extensively that every entomologist understands their application. Entomologists, farmers, and gardeners have found kerosene emulsion to be very effective in the destruction of scale insects and plant lice, and when properly prepared this insecticide is practically without danger to any crop. Considerable difficulty has been met with, however, in the use of kerosene and crude petroleum in mechanical mixtures with water. The difficulty seems to lie largely in the fact that the mixtures are only of a temporary nature and not at all stable. Moreover, the various spraying machines which have been constructed for the specific purpose of making mechanical mixtures of oil and water have never been quite satisfactory. It appears to be impossible to obtain a mixture of water and oil containing a constant proportion of the oil. In fact, the variation in this respect has been found to be so great that at times the machine would throw a mixture containing so little oil as to be of no insecticidal value, while at other times, without changing the regulating apparatus, the percentage of oil in the mixture was so great as to burn the foliage and otherwise endanger the plants upon which the mixture was sprayed. Recently, therefore, attention has been directed toward the correction of this defect by means of a treatment which renders the oils readily miscible with water.

In California [a] it was noted that oranges were frequently spotted as a result of the application of crude oil or distillation products. In this State extensive experiments have been carried on with so-called distillates, a term which is used to refer to oils derived from crude oil by a process of distillation. A considerable series of distillates are obtained during the process of refining, and some of them are heavier than others. In general, it was found at the California Station that the more volatile oils were more effective, since their vapors showed a more penetrating power than the oils in the liquid form. Insects, however, may be destroyed by a clogging of the breathing pores if heavy and slowly drying oils are used for spraying. The chief injury to vegetable tissue from oils was caused by a penetration of oils into the interior of the plants. It was found that plants in a turgid condition are less likely to absorb oil than those which are partly wilted. The upper surfaces of the leaves are able to withstand without harm amounts of oil which prove fatal when applied to the lower surfaces. In some instances it was found that the same amount of oil sprayed over both surfaces of the leaf may cause more damage

[a] California Sta. Bul. 153.

than when placed on one surface only, but when the oil was sprayed on the underside of the leaves the effect was about as harmful as when both surfaces were covered. At the California Station the injuries resulting from distillates were apparently not due to impurities in the oils, but to the use of too heavy oils. A high-grade eastern kerosene gave good results, while cheap western kerosenes were unsatisfactory. It was also found possible to reduce the danger from heavy oils by mixing them with kerosene. The burning effect in small spots observed on oranges and leaves after spraying from oils was apparently due to the fact that the oil when mixed with water does not spray evenly over the surface of the leaf, but collects in drops of greater or less size, from which the injury results. If the humidity of the air is very high at the time of spraying, the stomata of the leaves are open and may lead to considerable penetration of the oil. It is not advisable, however, to spray when the leaves are in a condition of extreme dryness. The best time for the use of oils appears to be in weather during which the air is moist. Distillate oils appear to have less injurious effects when the temperature is relatively high. In order to avoid as far as possible the injury from distillates the California Station recommends that the oils be sprayed as nearly as possible straight downward, in order not to cover the under surfaces of the leaves.

At the Connecticut State Station [a] it was found that spraying trees just before the leaves appeared in the spring with crude oil or with a mechanical mixture of kerosene and water containing 20 per cent of kerosene gave the best results in the control of the San José scale on large orchard trees. The kerosene used at this station was claimed to have a fire test of 150°, and the crude oil showed a specific gravity of 43° Baumé. No harm was produced by the use of crude oil or kerosene and water containing 15 to 20 per cent of oil when applied to dormant trees in early spring. Mechanical mixtures of refined or crude oils containing 10 to 30 per cent of the oil were used on peach trees in foliage. It was found that the San José scale could be kept in check by this method, and no harm was done to the peach trees as long as the quantity of oil was not above 15 per cent.

In Idaho [b] crude petroleum obtained from San Francisco was used in experiments in the destruction of San José scale. The crude petroleum was used in emulsions containing from 5 to 50 per cent. No harm was done to pear trees from spraying with undiluted petroleum, while an apple tree was killed. A 50 per cent emulsion of crude petroleum did no damage to either pear or apple trees. An emulsion containing 33 per cent of crude oil was applied to apple

[a] Connecticut State Sta. Buls. 135, 136.

[b] Idaho Sta. Bul. 26.

trees infested with aphis. The application was made in March. No injury was done to the trees, and the aphis eggs were destroyed by the application.

In New Jersey[a] very extensive experiments have been carried out with kerosene and crude oils of all forms. The entomologist in these stations is one of the most enthusiastic advocates of the use of petroleum oil in some form as a general contact insecticide. In this State crude oil has been used on the peach, pear, apple, plum, and cherry without causing any harm to the trees. When, however, the fruit buds of young peach and pear trees were soaked with crude oil a considerable percentage of the buds was killed. Undiluted crude oil, undiluted kerosene, and mechanical mixtures of these oils have been used extensively by fruit raisers throughout the State under the direction of the entomologist and generally with satisfactory results. As a result of other experiments at the New Jersey stations, it was recommended that crude petroleum be applied undiluted with a Vermorel nozzle, using a small opening so as to obtain an extremely fine mist. It was also recommended that just enough of the oil be used to moisten the surface of the leaves but not enough to produce streams of oil which might collect in various places and burn the bark or buds. The trunk and larger branches may receive a much larger quantity of the oil since the bark of these parts is naturally more resistant. It is recommended that crude petroleum be used with a specific gravity of 43° or more and that it be kept at a temperature of about 60° F. It is warmly recommended as a winter application, but considerable precaution must always be taken in using it during the summer and for that reason it can not be recommended indiscriminately as a summer spray in the hands of orchardists. Recently the New Jersey stations have carried on investigations to determine the best methods of treating crude oil so as to get a stable mixture with water. These experiments, in which certain insecticide manufacturers cooperated, have led to the production of so-called soluble petroleum in a number of forms. This condition was brought about by treating a vegetable or mineral oil with sulphuric acid and adding the mixture to crude petroleum. The effect of this process is to render the crude oil readily miscible with water. In fact it emulsifies almost without mechanical agitation and the emulsion is so stable that the oil does not separate from the water even after being allowed to stand for several weeks, or in some cases even for months. The importance of securing such an emulsion is apparent from the fact that with it a definite percentage of oil can be obtained and sprayed upon trees with the assurance that the percentage of oil will remain constant. The New Jersey stations recommend that in that State a soluble petroleum insecticide

[a] New Jersey Stas. Buls. 146, 186.

be sprayed on infested trees as soon as possible after October 15. It is not considered necessary to wait until the leaves have all fallen. It is apparently safe to apply the insecticide as soon as the young shoots are mature in the fall. In cases of bad infestation it is recommended that the application be repeated about two weeks later.

The New York State Experiment Station[a] has thoroughly tested the use of oils as a spray for the destruction of scale insects. In one series of winter experiments it was found that kerosene with a fire test of 150° killed peach trees when one application was made of a 20 per cent mechanical mixture with water, and seriously injured plum trees when applied in a 40 per cent mixture. At the same time pear and apple trees were not injured except when treated with pure kerosene and even then the harm was slight. In the early experiments at this station a 20 per cent mechanical mixture of kerosene had no effect upon the scales. Summer applications of refined kerosene were found to be dangerous, since the leaves were badly burned whenever the kerosene was used at a percentage high enough to kill the scale insects. Subsequently the station carried out experiments with crude petroleum as a winter insecticide. In these tests it was found that emulsions containing 25 per cent or more of crude petroleum seriously injured or killed peach trees, while plum and apple trees were not injured except when a 40 per cent or higher emulsion was used. During the same tests cherry and pear trees were not injured even by undiluted petroleum. Spring applications caused serious injury to plum trees when the petroleum was used undiluted, slight injury when used in a 60 per cent solution, while the application was harmless when a 40 per cent solution was used. Comparative tests undertaken to determine the percentage of petroleum required to kill hibernating San José scales showed that the insects are not killed by a 25 per cent mixture, while 40 per cent and higher percentages destroy the scales, whether applied in winter or spring. It was found unsafe, however, to use a 40 per cent emulsion after the buds had swollen. In general, the station concludes that vigorous trees are less liable to be injured by crude petroleum than sickly ones. Peach and plum trees appear to be more sensitive than apple and cherry trees. Moreover, there seems to be less danger of injury if trees are sprayed in early spring rather than during the fall or winter.

The final results of experiments with oils at the New York State Station indicate that spraying with kerosene or crude petroleum is safe and effective when done under the proper conditions. If kerosene is to be used only the best grades should be purchased, since lower grades are more or less dangerous. Mechanical mixtures ranging from 15 to 20 per cent of oil may be applied to apple and pear

[a] New York State Sta. Buls. 194, 202, 213.

trees in full leaf without much injury, but mixtures even of lower percentage are liable to damage stone fruits under the same conditions. Such dilute mixtures, however, appear to be of no insecticidal value except against unprotected scale insects. A good quality of kerosene may be applied to large healthy pear and apple trees while they are dormant without injury, but such is not the case after growth begins in the spring. Stone fruits, on the contrary, behave quite differently, since dormant trees are injured in dilute mixtures, while kerosene may be applied even undiluted to peach trees while the buds are swelling. It is recommended as a safe procedure to spray peach and plum trees with a 25 per cent mechanical mixture of crude petroleum after the buds begin to swell, but the same treatment applied to dormant trees will injure or kill them. The New York State Station considers it unsafe to treat pear or apple trees with crude petroleum after the buds have begun to swell.

In a test of a proprietary soluble petroleum compound at the Virginia Station [a] it was found that a 10 per cent solution applied while the trees were in leaf destroyed all the foliage on young apple trees and from 40 to 50 per cent on old trees, but had no effect on San José scale. The foliage was injured quite seriously when a 5 per cent solution was used. No damage was caused, however, from the application of a 20 per cent solution on dormant trees, and at this strength the insecticide proved effective in destroying the San José scale.

It is therefore quite apparent that the results of experiments obtained from the use of kerosene and crude oil diluted and mixed with other substances are much more at variance than those obtained from the application of lime-sulphur wash. In fact, treatments with these oils which have been reported by some entomologists as perfectly harmless have been found exceedingly injurious when used by other entomologists under apparently the same conditions. The confusing and more or less contradictory results reported have led most of the experiment stations to recommend that crude oils and kerosene pure or in mixtures with water be applied with great precaution until after considerable experience has been had in their use.

FUMIGATION WITH HYDROCYANIC-ACID GAS.

The great prevalence of San José scale has also led to extensive experiments with fumigation by means of hydrocyanic-acid gas. This remedy in numerous tests at almost all of the experiment stations which have been called upon to deal with the San José scale has been uniformly effective in destroying this pest and practically

[a] Virginia Sta. Bul. 152.

harmless when carried out under conditions which have been determined by experiments as necessary in the use of this remedy. The only objection against the remedy for use in orchard work is that of expense.

The California Station[a] has carried on elaborate tests with this method and fumigation has been generally adopted in orchard work throughout that State in the treatment of citrus trees for scale insects. In citrus orchards the lime-sulphur wash and oil compounds have certain obvious disadvantages which do not attach to fumigation. In a recent study carried on by the California Station measurements were obtained of over 2,000 trees fumigated by 30 different men of extensive experience in this work. The amount of the materials used in fumigation were obtained for each tree. A study of the data thus obtained indicated that practical experience of orchardists has not resulted in a satisfactory solution of the amount of materials to be used. A great variation in this respect was noticed in the practice of different fumigators and this variation demonstrated clearly that the process of fumigation allows a wide margin in the amount of materials between effectiveness against scale insects and danger to the plant. In the estimation of the cubic contents of tents placed over orchard trees a considerable degree of skill must be exercised, since otherwise the estimated cubic contents may vary greatly from the facts of the case. Moreover, it must be remembered that fumigation tents are never gas tight. The odor of the gas is always evident outside of the tent, even when the heaviest canvas is used. The station carried on a number of chemical experiments to determine the rate of the leakage of gas from the tents and found that the loss in this way was rapid and of great importance. In fact, it was so great that it is considered desirable in making up the doses of chemicals to be used to allow for the leakage as well as for quantities sufficient to produce the requisite density of the gas within the tent. The effect of moisture was also studied. It was found that the gas was so readily absorbed by wet tents as to disappear from the air within the tent much more rapidly and completely than when the tent was dry. This point was also considered of sufficient importance to enter into the estimate of the amount of materials required.

In Maryland[b] some of the pioneer work of fumigation in the Eastern States was done. The use of both sheet and box tents was shown to be practicable in orchards, and fumigation of nursery stock in specially prepared houses was successfully done. The best results were obtained from the use of 0.2 gram potassium cyanid per cubic foot of inclosed space.

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[a] California Sta. Bul. 152.

[b] Maryland Sta. Bul. 51.

The effect of fumigation on nursery stock has been carefully studied at the Maryland Station.[a] During the experiments at this station 3,000 nursery trees were fumigated, one-half of them in October and the other half in April, all of the trees being planted within two weeks after fumigation. The trees employed in these experiments were standard varieties of peach and apple. The time of exposure varied from thirty minutes to one hour, and the amount of cyanid of potash used varied from less than the ordinary amount to six times that quantity. In some cases the trees were apparently injured by the gas, but when these cases are compared with others in which a larger amount of cyanid was used without injury it is apparent that some other agencies, probably unfavorable weather conditions or unsatisfactory methods of planting, are responsible for part of the injury. The actual amounts of cyanid used per cubic foot were 0.2, 0.3, 0.4, 0.5, 0.75, 1, and 1.5 grams for different lots. In these experiments it was noted that peach trees are apparently more resistant to the effect of hydrocyanic-acid gas than apple trees. This must be due to the naturally greater tolerance of peach trees for this gas, since apple trees fumigated at the same time were even more completely matured than the peach trees. This fact has also been observed in experiments in New Jersey. Certain varieties of apple appear to be more resistant to the gas than others. Thus, Yellow Transparent was uninjured while Ben Davis, Maiden Blush, York Imperial, and Winesap were somewhat affected. In the spring experiments no injury from fumigation was observed even when excessive amounts of cyanid were used and the period of exposure prolonged to one hour. The 3,000 trees used in these experiments were free from San José scale, but other infested trees treated at the same time for comparison showed no living scale after fumigation.

The New York State Station[b] recognized the effectiveness of the fumigation method in destroying scale insects in orchards and has devoted considerable attention to this problem, particularly to the construction of inexpensive and practical fumigation boxes for orchard trees. During these experiments it was found possible to construct tight and satisfactory boxes which could readily be manipulated by two men and which possessed the considerable advantage over tents for the fumigation of orchard trees in that the cubic contents of the box could readily be determined. It was possible, therefore, to use the same amount of chemicals for each tree covered with the box, thus avoiding the necessity of changing the amount for each tree and weighing the cyanid of potash in the field after a calculation of the cubic contents of the tent. It is believed that the slight cost of the

[a] Maryland Sta. Bul 105.

[b] New York Sta. Buls. 181, 194, 202.

chemicals that might be saved on trees which are not large enough to fill the fumigator is not worth much consideration. Moreover, the box fumigator does not rest upon the tree and is therefore not likely to cause injury to the buds of the tree or to break off the limbs. The dimensions of the box fumigator used in the experiments of the station were 6 by 6 by 10 feet and the light framework was covered by canvas such as is ordinarily used for that purpose. In orchard work in New York the station believes that orchard fumigation is practicable only on comparatively small trees which can be pruned back to 12 feet in height and 8 feet in diameter before adjusting the canvas box. For fumigating orchard trees in winter the station recommends the use of 0.3 gram of cyanid of potash for each cubic foot of space.

Considerable attention has been given to the study of the effects of hydrocyanic-acid gas upon buds and scions fumigated in gas-tight houses. These experiments have been undertaken partly in response to complaints by certain nurserymen and orchardists that buds had been injured by fumigation. It was evidently necessary that this matter be determined since the present nursery laws of most States require the fumigation of nursery stock, including buds and scions. At the New York State Station it was found that fumigation with hydrocyanic-acid gas, using from 0.18 to 0.3 gram of cyanid of potash per cubic foot of space in the fumigating house, resulted in no appreciable injury to apple, cherry, pear, or plum buds. Peach buds were uninjured when 0.22 gram was used, but showed slight indications of damage when fumigated at the rate of 0.3 gram per cubic foot. During the same experiments it was found that in winter the San José scale was not killed when the gas was used at lower strengths than 0.3 gram, while in June the scales were destroyed with a strength of 0.18 gram.

ARSENICAL INSECTICIDES.

The experiment stations, as already indicated, have tested a great variety of other insecticides which can not be discussed in this connection. Brief mention, however, may be made of some of the work of the stations on arsenicals and one or two special insecticide methods. Paris green is one of the best known arsenical poisons, but its use has been tested at all of the experiment stations and it is commonly applied by farmers and gardeners for the destruction of leaf-eating insects. Considerable attention has been given by the stations to a study of its chemical composition for the purpose of determining whether the market samples comply with the laws of various States regarding the maximum quantity of free arsenic present and the maximum quantity of total arsenic.

In California,[a] where numerous experiments were made for this purpose, it was found that the samples of Paris green offered for sale in the markets of that State are improving in quality during recent years and that a large percentage of samples contain less than 4 per cent of white arsenic. The number of samples which did not conform to the law, however, indicate that there is considerable room for improvement as compared with Paris green analyses by various eastern stations where nearly all of the samples were found to be satisfactory. Adulteration of Paris green is apparently not accomplished in California by the addition of make-weight materials such as marble dust, gypsum, or barium carbonate. Analyses of various commercial substitutes of Paris green in California showed that most of these materials were highly objectionable on account of water-soluble arsenic compounds in them. On this account they were not recommended since, even if safe, they possess little advantage over Paris green. Wherever the quality of available Paris green is not completely satisfactory it is recommended that arsenate or arsenite of lead and arsenite of calcium be used in place of Paris green. These materials are comparatively inexpensive and safe to use and may be made at home.

The majority of experiments carried on by the experiment stations with Paris green have been concerned with the extermination of some specific insect, as, for example, the codling moth. Some of these experiments will be discussed under the head of the insect concerned.

At the New York State Station[b] experiments were made to determine the effect of certain arsenical sprays upon the foliage of potatoes. Paris green was applied to potatoes four times during the season by three different methods in common use, namely, with water, lime-water, and Bordeaux mixture. For the purpose of comparison other rows of potatoes were treated at the same time with Bordeaux mixture alone, while still other rows were left untreated. Paris green even when applied at the rate of 4½ pounds per acre produced no injury on the foliage of potatoes at any time during the experiment. The rows which were treated with Paris green in water or in lime-water showed a much more perfect foliage during the season than did the check rows. This difference is apparently due in part to the prevention of late blight of potatoes. Paris green was found to possess considerable value as a fungicide, it being estimated from these experiments that it is one-third as effective as Bordeaux mixture for this purpose. Potatoes treated with Paris green yielded 46 bushels per acre more than the check rows. The potatoes receiving Paris

[a] California Sta. Bul. 151.

[b] New York State Sta. Bul. 267.

green in limewater yielded 12 bushels less than those treated with Paris green in water, but it is not certain that the addition of lime caused this difference. The treatment with Paris green in Bordeaux mixture gave slightly larger yields than treatment with Bordeaux mixture alone. At the same time arsenite of soda stock solution prepared by the Kedzie formula was applied with limewater and also with the Bordeaux mixture. In limewater this arsenite injured potato leaves severely, although 2 pounds of lime were used for each pound of the stock solution. There was no apparent injury, however, when the same amount of arsenite of soda was used in the Bordeaux mixture. It is maintained therefore that the combination with Bordeaux mixture renders arsenite of soda comparatively safe. Nevertheless, potatoes treated with Bordeaux mixture alone yielded 34 bushels per acre more than those treated with arsenite of soda in Bordeaux mixture. From these experiments it appears that Paris green is not injurious to potato leaves if applied in ordinary quantities in limewater or Bordeaux mixture. Paris green also has some fungicidal value. Arsenite of soda, however, is dangerous for use on potatoes except when combined with Bordeaux mixture.

The use of arsenical poisons in combating insects on cabbage in Kentucky led to some misgivings regarding the possible dangers of this method to human beings.[a] Several cases of supposed poisoning from eating sprayed or dusted cabbage were reported, and an attempt was made to investigate these cases. Little satisfactory evidence could be obtained in any case. The station undertook a number of experiments for the purpose of testing this matter directly. In these experiments cabbage was sprayed from two to four times with Paris green at the rate of 1 pound to 140 gallons of water and arsenate of lead at the rate of 2 pounds per 100 gallons of water. Cabbage heads were then analyzed to determine the amount of arsenate present. From these analyses it appears that only minute particles of arsenic were present. In general, two applications of arsenicals were less effective than four. A lime-resin mixture containing resin, lye, fish oil, and Paris green was compared with the pure arsenical treatments and was found to have no particular advantage over the latter.

At the New York State Station[b] a lime-resin mixture containing 5 pounds resin, 1 pound concentrated lye, and 1 pound fish oil per 5 gallons of water was found to constitute a very satisfactory stock solution from which to prepare an insecticide for the treatment of cauliflower and cabbage. When one gallon of this stock solution was mixed with 3 gallons milk of lime, one-fourth pound Paris green, and 16 gallons of water it was found that the use of this insecticide was

[a] Kentucky Sta. Bul. 114.

[b] New York Sta. Bul. 144.

sufficient to protect late cabbage and cauliflower from an attack of the cabbage worm and cabbage looper. In addition to this insecticidal value it appeared to increase the yield of cabbage from 60 to 100 per cent. It is recommended that it should not be used on cabbage after the heads are two-thirds formed, nor on cauliflower after the flower has become exposed. The cost of two applications per acre was about $2.

Numerous experiments have been undertaken to determine the value of dust spraying. This method has been used in Missouri and elsewhere on fruit trees and is in general use in the Southern States in treating cotton.

In Delaware[a] favorable conditions were found for using the dust method for the reason that heavy dews may be expected during the season for the application of insecticides. The best results were obtained in a test of dust spraying in the use of a mixture of pulverized copper sulphate, hydrated lime, and an arsenical poison, either Paris green or arsenate of lead. It was found that about 2 pounds of the dry mixture were required to spray an amount of foliage which would be covered by 4 gallons of liquid mixture. From the experiments carried on in Delaware, however, the dust spraying under favorable conditions should not cost more than one-half as much as liquid spraying. In these tests five applications were made before the buds began to swell and others in May and June, the work being done early in the morning so as to get the benefit of the dew. The dust spray was applied to apple, pear, peach, plum, and cherry trees. Some of these trees showed the presence of fungus diseases and others not. No injury was observed on peach trees from the application of this method. As compared with liquid spraying it was found that the trees sprayed with a dust insecticide failed to hold so large a percentage of fruit. Codling moth and apple scab were satisfactorily controlled by dust spraying.

SOAP INSECTICIDES.

The New York State Station[b] undertook the study of the composition of certain commercial soaps as related to their use in spraying. It has been found that commercial whale-oil soaps in many cases failed to destroy insects and sometimes were injurious to the foliage. It appears from these experiments that the important constituents of these soaps, in so far as their insecticidal use is concerned, are water, actual soap, and free alkali. In samples of commercial whale-oil soap analyzed by the station, the amount of water varied from 11 to 55 per cent, that of soap from 15 to 60 per cent, and that of free alkali from 0 to 1.3 per cent. In one instance two lots of soap from

[a] Delaware Sta. Bul. 69. [b] New York State Sta. Bul. 257.

the same factory contained 36 and 53 per cent of water and 24 and 46 per cent of actual soap, respectively. The variation in commercial composition of whale-oil soaps appears to be so great that the orchardist can not be sure of obtaining a uniform strength of solution from a given formula, and it is observed that the lack of uniformity, therefore, seriously affects the value of these substances for spraying purposes. In order to obtain a soap of uniform composition, it is recommended that the necessary materials be purchased and combined at home. For this purpose a formula calling for 6 pounds caustic soda, 22 pounds fish oil, and 1½ gallons of water is recommended. This is sufficient to make 40 pounds of soap which, when used at the rate of 1 pound in 7 gallons of water, gave completely satisfactory results on the foliage of apple, pear, cherry, and peach trees, and currant bushes. In all cases plant lice were destroyed and no injury was observed from the soap. In further experiments to determine the effect of free alkali, soaps were made so as to contain from 1 to 50 per cent of free alkali. It was found that injury was done as soon as the amount of free alkali reached 10 per cent. In soaps containing 5 per cent or less of free alkali little damage was caused to the foliage. Homemade soap as recommended by the New York State Station can be made for about 2¾ cents per pound, and has the great advantages of uniform composition, reliability, and cheapness.

SPECIAL INSECTICIDE METHODS.

THE CODLING MOTH.

The codling moth is a serious enemy of the apple in almost all localities where that fruit is grown. The various experiment stations have, therefore, been called upon to carry on investigations on the life history, habits, and means of combating the pest. In California[a] various methods of controlling the codling moth were tested, but the only one which offered any prospect of good results was the use of arsenical sprays. For this purpose Paris green proved as effective as any other arsenical, and gave satisfactory results when used at the rate of 1 pound per 150 gallons of water. In localities where injury is observed from Paris green this may be avoided by the addition of about five to ten times as much lime as the quantity of Paris green used. Lime arsenite and lead arsenate are recommended for substitution in the place of Paris green where the latter burns the foliage. During experiments carried out in California, arsenate of lead was found to be by far the safest of all the arsenicals tested, but is less fatal to the codling moth, and must, therefore, be used in larger quantities. A mixture of Paris green, oil, and lime was also tested.

[a] California Sta. Bul. 155.

In preparing this mixture 1 pound of Paris green was stirred in 1 pint of crude oil, after which the mixture was added to 4 or 5 pounds of lime freshly slaked. The whole should then be stirred so as to cause the oil and lime to unite, and should be diluted so as to make 150 gallons. The California Station recommends that the first campaign against the codling moth be undertaken upon the trees in bloom immediately after the petals fall. The spray at this time should be directed against the ends of the blossoms from above. The second campaign should be begun about the time when the first eggs are deposited upon the trees. In some localities this period occurs much later than in others. The object of the second application is to cover uniformly all parts of the tree, and a nozzle should be used which will give a fine spray. In California it is believed that the third campaign is the most important one, and the aim of this operation is to poison the surface of the fruit so as to prevent the worms from entering the side. According to the experiments carried out in California, there is a greater danger of injuring the foliage at the third application than at previous sprayings.

During insecticide work in Delaware[a] for the control of the codling moth it is found that arsenate of lead used at the rate of 1 pound to 50 gallons of water gives from one-third to one-half more benefit in sound fruit than Paris green, green arsenoid, or arsenites of lime. The last three arsenicals proved to be about of equal value. More than 1 pound of arsenate of lead to 50 gallons of water or 1 pound of Paris green to 160 gallons is apparently unwarranted. It is believed, as a result of the experiments in Delaware, that three applications are not necessary if the first two are thoroughly made. The addition of adhesives to arsenical sprays was not found to be profitable.

In Idaho[b] one application of Paris green before the calyx had closed was found to destroy about 41 per cent of the larvæ of the first brood. This application seemed to be about six times as effective on larvæ which attempted to enter the calyx as on those which entered the side of the apple. From the use of bands an average of 215 larvæ per tree were collected. In Idaho it is recommended that in all cases the first application be made just after the petals fall and before the calyx closes. It was found impossible to control the codling moth with one or two applications, and three or four sprayings are recommended for most localities.

In Michigan[c] spraying for the codling moth has long been practiced and has been found effective. Paris green applied just after the petals fall and inside the calyx dries and remains for an indefinite period. The larvæ which attempt to enter through the calyx

[a] Delaware Sta. Bul. 59. [b] Idaho Sta. Buls. 21, 36.
[c] Michigan Sta. Bul. 222.

therefore become poisoned. In Michigan the first brood does less damage than the second, but it must be remembered that the size of the second brood depends almost entirely on the proportion of the first brood, which are allowed to reproduce. The application of an arsenical during the first week of August or about the time that the young larvæ hatch out reduces the second brood decidedly. Where three or more applications seem to be required one may be given soon after the first and another about ten days or two weeks after the first August application.

In Ohio[a] active mature larvæ of the codling moth were found in orchards from June 30 to October 13, and this indicates the length of the period during which the fruit is subject to their attacks. In unsprayed orchards about 43 per cent of the apple crop showed injury, whereas 91 per cent of the fruit was saved by spraying. According to the experiments at this station, a large number of applications of arsenicals is not necessary to control the codling moth. In some instances the first application and in others the late application appeared to be of little value. Since an early application of Bordeaux mixture is required to control apple scab and Paris green may be conveniently mixed with the Bordeaux mixture, it is recommended that such a combination be sprayed on apple trees as soon as the petals have fallen, followed at short intervals by two or three other applications, after which one or two applications of arsenate of lead may be made at intervals of two weeks. The effectiveness of the arsenate of lead was not reduced by being added to Bordeaux mixture.

The codling moth has long been a serious pest in Oregon.[b] In this State the larvæ of the codling moth appear to be very abundant late in the season, and this fact must be taken into consideration in timing the applications of insecticides. During a series of spraying experiments the average of wormy apples on unsprayed trees was 23 per cent, while on sprayed trees only 1 per cent was wormy on July 20, but at the time of picking 5 per cent appeared to be infested. The applications were made on May 13, June 11, June 25, and August 11. The results indicate that in most cases the first application is useless, the second and perhaps the third nearly so, while the fourth application was the one which brought results. These experiments, however, were carried out in a moist climate, and it is stated that in drier and warmer parts of the State the fruit is attacked earlier and an earlier application is therefore of undoubted value.

At the Utah Station extensive experiments on means of combating the codling moth have been carried on for several years.[c] In the earlier experiments at this station it was found that spraying alone

[a] Ohio Sta. Bul. 160. [b] Oregon Sta. Bul. 69.
[c] Utah Sta. Bul. 87 and other sources.

may be depended upon to furnish from 85 to 95 per cent of sound apples. It is recommended that the first application be made from above downward and from the sides inward but not upward from near the center of the tree. This application should be given immediately after the petals fall, or at least within three or four days after this occurrence. A second application is recommended within ten days to two weeks after the first. These two sprayings, as just stated, were found when carefully applied to protect from 85 to 95 per cent of the apples from infestation, while unsprayed trees compared with them showed an infestation of from 60 to 90 per cent of the fruit. While, as a result of the earlier experiments, the Utah Station did not wish to discourage late spraying, it recommended very urgently that the early spraying must be done with all possible thoroughness. Paris green at a rate of 1 pound to 150 gallons of water or arsenite of lime are the insecticides recommended.

In later experiments at the same station the relative value of early and late sprayings was directly tested, and an attempt was also made to find out how the arsenicals destroy the larvæ, and especially to determine the value of early sprays in reducing the importance of the second brood. In order to get accurate data on this subject the injury of the first brood was separated from that of the second. All apples on the experimental trees were counted during the first week in August, and each one was examined to see whether it was infested and whether the codling moth had entered at the side or in the calyx end. At this time of year all worms of the first brood are of considerable size and are easily distinguished from the small larvæ of the second brood. The windfall apples were also gathered every day, examined, and counted. After extensive data of this sort had been collected it was found that two early sprayings killed on an average on each tree 220 of the larvæ of the first brood and 356 of the larvæ of the second brood, or a total of 576 worms. Three late sprayings killed on an average 369 larvæ. It is therefore apparent that the two early applications not only destroyed more larvæ than the three late sprayings, but, by greatly reducing the first brood, exercised a still greater influence in diminishing the numbers of the second brood. The two first applications were made, one immediately after the petals fall and the other ten days later, while the late applications were made August 1, August 15, and September 1. This series of experiments was repeated in 1905, when it was found that the two early applications gave an average of 98.9 per cent sound apples at picking time. In Washington [a] it was found that about 40 per cent of the larvæ of codling moths will be found under bands if properly placed on trees, and that these larvæ reach the bands by crawling down the trees.

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[a] Washington Sta. Bul. 69.

THE PLUM CURCULIO.

The plum curculio has been shown to be an important enemy of apples by reason of the "sting" which it causes in fruit. This matter became so serious in Missouri [a] that the station felt called upon to investigate it. It was not only determined that the plum curculio was the cause of the damage, but successful remedies were worked out. There appeared to be three methods of procedure which can be followed in diminishing the injury from this insect upon apples. The trees may be sprayed with arsenate of lead before the blossoms open, after the blossoms fall, and three or four more times at intervals of ten days. Spraying with this arsenical appeared to prevent about 60 per cent of the damage. It was also found that considerable importance attaches to the careful collection and destruction of windfalls, since the larvæ remain in fallen apples for about one week. This method, if conscientiously carried out, will in itself nearly control the plum curculio. Some advantage is also found in plowing the orchard shallow and harrowing it thoroughly about the middle of July, following this treatment by further harrowing about August 1 and 15. In practice it is best to combine all these methods, and when this is done it was shown that the plum curculio could be prevented from doing serious damage to apples. In Illinois [b] the same problem was attacked and the same remedies found to be effective. Spraying with arsenicals caused a saving of from 27 to 54 per cent of the picked fruit which was liable to puncture by curculio. Under favorable conditions it was stated that from 20 to 40 per cent of fruit liable to injury may be saved by five applications, and this is considered a profitable procedure. Experiments made at the Illinois Station demonstrated conclusively that the destruction of small apples and windfalls is of great importance. The cultivation also proved beneficial. This method of attack was aimed at all three stages of the insect, but particularly the pupæ. Both larvæ and pupæ are delicate and extremely sensitive to exposure to light and air. Short exposures to sunlight are fatal to both forms of the pest, and the insect is also attacked by predaceous insects and birds. Superficial tillage for a period of thirty days or longer from July 10 is therefore recommended.

THE APPLE APHIS.

The apple aphis (*Aphis pomi*) causes more or less injury to apple trees wherever this fruit is grown. In Idaho [c] it was found that the eggs could be destroyed in winter by spraying with various contact insecticides, among which crude oil, kerosene, kerosene emulsion,

[a] Missouri Sta. Bul. 64. [b] Illinois Sta. Bul. 98.
[c] Idaho Sta. Bul. 40.

lime-sulphur wash, and other sprays were tested. The best results were obtained when the lime-sulphur wash prepared according to the formula 1–1–2 or 1–1–4 was applied in winter or early spring while the trees were still dormant. On large trees it is believed that a winter application of lime-sulphur will hardly be thorough enough under ordinary conditions to touch all of the aphis eggs. On small trees, however, the method is exceedingly effective.

In New Jersey [a] it has been shown that the apple aphis may be materially lessened at any time during the growing season by spraying with kerosene emulsion at the rate of 1 part to 12 parts of water, a 5 per cent mechanical mixture of kerosene and water, fish-oil soap at the rate of 1 pound per 6 gallons of water, or tobacco decoction of a strength equaling 1 pound tobacco per 2 gallons of water. It is recommended that particular attention be given to an application of a contact insecticide just after the eggs have hatched. In later experiments at the same station whale-oil soap at the rate of 1 pound per 4 to 6 gallons of water was found very satisfactory. If any tendency toward burning is shown, tobacco decoction may be used in its place.

THE WOOLLY APHIS.

The woolly aphis is generally distributed throughout the apple-growing regions, but it is much more injurious in certain localities than in others. At the Missouri Station [b] orchards infested with this insect were treated by removing the soil for a distance of 2 feet around the trunks of trees, and to a depth of 4 to 6 inches, after which from 2½ to 5 pounds of tobacco dust was distributed evenly about the tree, being careful to place it also close to the trunk. The tobacco dust was then covered with the soil and allowed to remain in this position. In one instance, where fifteen trees were twice treated in this way the woolly aphis appeared to be entirely destroyed, except at the roots of two of the trees. Experiments were also made with carbon bisulphid, which, when purchased at the rate of 10 cents per pound, costs about 1¼ cents for a treatment of each tree. The carbon bisulphid was injected at the rate of 3 fluid ounces per tree in three holes from 1 to 2 feet from the trunk of the tree. Some injury was done to the tree when the carbon bisulphid was injected into the soil too close to the trunk. In comparing the action of tobacco dust with that of carbon bisulphid it was found that the tobacco dust requires more labor to apply and operates much more slowly. It costs from 3 to 5 cents per tree, but it remains active much longer than the carbon bisulphid.

[a] New Jersey Stas. Buls. 143, 181. [b] Missouri Sta. Bul. 35.

THE APPLE MAGGOT.

The injury from the apple maggot, while not more serious than that of the codling moth, has been found more difficult to prevent on account of the practical impossibility of applying direct methods for the destruction of the pest. In Maine[a] elaborate experiments were carried out on various remedies in the control of this insect. As a result of these experiments it is concluded that the adult flies may quite easily be captured while resting on leaves or apples. The chief reliance, however, should be placed on the destruction of windfalls as soon as possible after they drop. The maggots do not leave the fruit until it falls to the ground. The windfalls may be collected and fed to stock in the yard or pasture, or enough sheep and hogs may be kept in the orchard to eat the apples as fast as they fall to the ground. In order to prevent still further infestation of orchards attention should be given to decayed apples and other refuse from apples stored for home consumption.

In Rhode Island[b] a thorough test was made of the effectiveness of plowing the orchard in controlling the apple maggot. These experiments were continued for a period of five years, and showed that cultivation of orchards in the spring for the purpose of burning the pupæ is practically valueless, at least in Rhode Island. There may be some advantage derived from frequent cultivation in early summer, and where practicable the ground may be sprayed with crude oil with more or less beneficial results. The only practical method of preventing the injury of apple maggots in commercial orchards, however, is found in pasturing the orchards so as to be sure that all windfall apples are eaten.

THE FRINGED-WING APPLE-BUD MOTH.

The fringed-wing apple-bud moth (*Holocera maligemmella*) has caused great injury, especially in Missouri,[c] by eating the leaf and flower buds of apple trees. Experiments at the Missouri Station showed that the best and only reliable method of combating this pest consists in thorough spraying at frequent intervals before the blossoms open. For this purpose Paris green is recommended at the rate of 1 pound in 150 gallons of water to which 3 pounds of lime has been added. The first application should be made after the buds have opened and the young leaves begin to appear. The second application may be made about five days later, and the third just before the flowers open.

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[a] Maine Sta. Rpt. 1899, pp. 190–236.

[b] Rhode Island Sta. Rpt. 1904, pp. 191–201.

[c] Missouri Sta. Bul. 42.

TENT-CATERPILLARS.

Methods for controlling the apple-tree tent-caterpillar have been studied in various States. In Connecticut [a] it was found that where early spraying is practiced no other remedy is required. Arsenate of lead or Paris green, with or without Bordeaux mixture, will kill the caterpillars when applied to the foliage. If the caterpillars begin feeding before the buds have fully opened, the colonies may be brushed from the trees and the arsenicals depended upon to kill the remainder of the caterpillars later. For spraying against the tent-caterpillar, one-half pound of Paris green or 3 pounds of arsenate of lead is recommended for each 50 gallons of water.

During some seasons the forest tent-caterpillar appears in unusual numbers and becomes a scourge of forest trees, especially maples. This pest has been studied in several States, and in New York [b] it was found that if the insect appears in orchards, the egg masses may readily be seen and may be collected and destroyed. For killing the caterpillars, it is sufficient to spray with an arsenical compound either Paris green, arsenate of lead, or green arsenite. The caterpillars may also be destroyed when they are collected in large clusters on the trunks of the trees.

RED SPIDERS.

Considerable work has been done on methods of controlling red spiders, especially at the California Station.[c] As a result of these experiments, it appears that the red spider of citrus trees while not producing the spotting of the fruit, as has sometimes been thought, does cause the fruit to drop and injures the leaves. In controlling this pest, fumigation has been found of no value. Sulphur is of far less value than for use against the red spider of deciduous fruit trees, while the value of distillate oils in combating this pest still remains somewhat uncertain. The best remedy for the red spider of citrus trees was found to be sulphate of potash prepared according to a formula calling for 32 pounds of potash, 37 pounds of finely ground sulphur, and 2 pounds of salt per 50 gallons of water. The stock solution thus made is to be diluted about 100 times before spraying. In spraying citrus trees for red spider, it appears to be necessary to use extension rods so that the spray may be applied upward and outward from the inside of the tree and also toward the center of the tree from the outside. The red spider of deciduous fruit trees may be controlled by the use of sulphur sprays. In preparing this insecticide it is recommended that 1 pound of wheat flour be mixed with 1 gal-

[a] Connecticut State Sta. Bul. 139.

[b] New York State Sta. Bul. 159.

[c] California Sta. Buls. 145, 154.

lon of water, after which the mixture is brought to a boiling point, thus forming a thin paste, which should be stirred so as to prevent the formation of lumps. In practice the paste may most conveniently be prepared in 20 or 25 gallon lots. Fifteen pounds powdered concentrated lye and 18 pounds of sulphur are then to be boiled together in 20 gallons of water. After the sulphid of potash stock solution and the flour paste have been prepared, 10 to 15 pounds of sublimed sulphur and 14 to 20 pounds ground sulphur should be placed in the spray tank with 4 gallons of the flour paste and from 1 to 2 gallons of the sulphid of potash stock solution. Water is then added to make 100 gallons. It is recommended that every effort be made to wet both the lower and upper surfaces of the leaves and to wet the twigs. For an almond tree 20 feet in diameter from 12 to 14 gallons of spray are required.

THE HESSIAN FLY.

The Hessian fly has long been one of the important enemies of wheat, and has been studied at several of the experiment stations. In Kentucky [a] it is recommended that in order to escape serious fall injury from the Hessian fly, wheat should be planted before October 6 in ordinary years, or before October 8 to 10 during very mild autumns. Wheat which has been planted late enough to escape fall injury may, however, become damaged in the spring if it is planted too near other infested wheat. Deep plowing is also found to destroy a considerable percentage of the insects. A number of insecticides were applied directly. It was found in these tests that dilute kerosene emulsion and Bordeaux mixture are of some value, the former being the most effective. Lime and Paris green in water, or dry lime alone, however, proved to be useless. As a result of later experiments, it is stated that no treatment is called for in controlling the Hessian fly provided the wheat is planted at the proper time. When, however, the adult insect invades wheat in the spring, it is sometimes necessary to apply an insecticide treatment. For this purpose kerosene emulsion is recommended, diluted at the rate of 1 part to 9 parts of water. Applications of such an emulsion were made by means of a knapsack sprayer in October, March, April, and May, at the rate of 39.6 gallons of kerosene per acre. The cost of this treatment, however, was found to be greater than the extra yield of wheat thus obtained. A similar treatment of lime and Paris green cost $3.05 per acre, and of Bordeaux about $10 per acre. All these treatments prevented to some extent the injury from Hessian fly, but their economy is still doubtful.

In Missouri [b] the use of insecticides against the Hessian fly is con-

[a] Kentucky Sta. Buls. 103, 111.

[b] Missouri Sta. Bul. 62.

sidered impracticable, and late sowing of wheat is recommended, combined with burning the stubble or plowing the field after harvesting, so as to bury the insects. The time for late sowing, so as to avoid injury from the Hessian fly, has been studied at various stations. In New York [a] it has been found that wheat sown after September 20 or 25 is usually less infested with Hessian fly than that which is sown earlier. It was also possible to gain some advantage from sowing narrow strips of decoy wheat about September 1. This may be allowed to stand not more than four weeks, and as soon as thoroughly infested may be destroyed. In Ohio [b] it appears that the two factors which are most important in determining serious outbreaks of Hessian fly are scarcity of parasites and warm weather in October. It was found that from an entomological standpoint injury from the fly may be largely prevented by late seeding. In average years, however, the risk of winter injury to wheat sown late enough to avoid the fly appears to be fully as great as the risk from the Hessian fly. It is recommended that small areas of wheat be sown from September 5 to September 18, according to the latitude, and that these plats be watched closely for the presence of the Hessian fly. If the fly is not observed by the time the plants are ten to twelve days old, the main crop may be sown, otherwise it is desirable to wait a week or so longer. In West Virginia [c] the farmers have suffered great loss from Hessian fly. It is recommended that the late date for safe sowing of wheat be determined by actual observations during a series of years. After this has been done, it should be remembered that the dates for planting will vary according to the latitude. Dates based on latitude, however, are not available unless account be taken of altitude. According to observations made in West Virginia, a difference of 200 feet in altitude is about equal to 1° of latitude. The higher the altitude and the farther north the locality, the earlier the planting.

THE CHINCH BUG.

Chinch bugs are also one of the best known enemies of wheat, corn, and various forage plants. In Maine [d] it was found that complete submersion in water even for a considerable period is not necessarily fatal to chinch bugs. Freezing, however, while they are submerged in water is almost certain to destroy them. The effect of freezing in dry and moist atmospheres was compared and the chinch bugs were most seriously affected by freezing temperatures in a dry atmosphere. In Minnesota [e] it is recommended that in the control of chinch bugs all rubbish be cleared up in the fall in order to do away with places

[a] New York Cornell Sta. Bul. 194.
[b] Ohio Sta. Bul. 136.
[c] West Virginia Sta. Bul. 67.
[d] Maine Sta. Bul. 91.
[e] Minnesota Sta. Bul. 84.

favorable for hibernation of the pest and in order to destroy, as far as possible, the hibernating adult insects. If chinch bugs are observed in great numbers on weeds in stubble after the wheat is cut, large numbers of them may be destroyed by plowing immediately after harvesting. In order to prevent the march of chinch bugs into cornfields it has been found somewhat efficacious to allow succulent weeds to grow in one or two of the outer rows of the cornfield. Better protection is secured by planting a narrow strip of millet around the cornfield at a time so that it will be from 8 to 10 inches high when the wheat is cut and when the chinch bugs are migrating to the cornfield. If, in the system of rotation adopted on a given farm, wheat is to follow corn, it is desirable that the corn stubble be plowed under and that corn shocks be removed from the field in the fall. In general wheat and corn should not be planted in close juxtaposition if chinch bugs prevail seriously. In Missouri [a] the chinch bug is said to cause the most serious trouble when it migrates from wheat to corn. If the chinch bugs migrate in large numbers, crawling in one direction, the army of bugs may be checked by plowing a belt of ground 10 feet wide around the cornfield. After plowing, the soil should be harrowed and rolled so as to be finely pulverized. Troughs may then be run likewise through this plowed belt and holes dug at intervals at the bottom of the troughs. The chinch bugs in attempting to cross the troughs will fall into the holes, where they will be covered by the kerosene or tar and will be buried. If such precautions are not taken chinch bugs may be destroyed while migrating by spraying with kerosene emulsion or some other contact insecticide.

THE GREENHOUSE WHITE FLY.

The white fly of greenhouses, or greenhouse aleurodes (*Aleurodes vaporariorum*), has long been recognized as a serious pest of greenhouse crops. In Connecticut [b] the pest has been exceedingly injurious to tomatoes and cucumbers under glass. Fumigating with tobacco was found not to be an effective remedy. Hydrocyanic-acid gas, when used at the rate of 2½ ounces potassium cyanid per each 1,000 cubic feet of space, killed the insects but also injured tomato plants. A cheap and effective remedy was found in spraying the under surfaces of the leaves with common laundry soap dissolved in water at the rate of 1 pound in 8 gallons of water. In order to prevent all injury from soap it should be washed from the leaves occasionally with water, with frequent applications of the insecticide when necessary. At the Maine Station [c] fumigation with hydrocyanic-acid gas was the most successful remedy tried. When

[a] Missouri Sta. Bul. 51. [b] Connecticut State Sta. Bul. 140.
[c] Maine Sta. Bul. 96.

fumigation was done early in the afternoon, the tomato plants were somewhat injured by the application of 1 ounce of cyanid per 1,000 cubic feet of space. The same amount of cyanid, however, caused no injury when the fumigation was done in the evening. It is recommended that no fumigation be done while the sun is shining or while the temperature is above 60° F. In Massachusetts [a] it was found possible in some instances to prevent serious injury from this pest by mere cultural measures. Spraying tomato plants in greenhouses is not recommended. Hydrocyanic-acid gas was found to be the cheapest and most effective remedy for greenhouse aleurodes. It is recommended that this be used at the rate of 0.1 gram of potassium cyanid per cubic foot of space and that the plants be exposed after sunset. This will destroy all of the insects except the eggs and a few pupæ and will not injure tomato plants. In New Hampshire [b] the greenhouse white fly was easily destroyed by spraying with a 5 per cent mechanical mixture of kerosene. For this purpose a knapsack sprayer was used. In spraying, it is recommended that the operator begin at the top of the plants and work down. The same method was used out of doors with good results. The most successful and satisfactory treatment, however, was fumigation. A greenhouse was fumigated in July at 10 o'clock in the forenoon of a clear day, the period of fumigation being fifteen minutes. At the end of this time all of the flies were dead and the plants of the greenhouse were uninjured, except the leaves of a lily. Similar treatment applied in the afternoon was also successful and without injury to the plants.

THE COLORADO POTATO BEETLE.

Several stations have been concerned in demonstrating the practical efficiency of arsenicals in the control of the potato beetle. In Maine [c] various insecticides have been compared with Paris green. It was found that there is no adequate substitute for arsenical poison in fighting this pest. These poisons may best be applied with water in the form of a fine spray and repeated as often as necessary. There appears to be no reason for using arsenoids or other proprietary arsenical insecticides unless they can be obtained more cheaply than Paris green. In the early experiments of the Maine Experiment Station arsenate of lead was found to be more satisfactory than other arsenicals, though somewhat slower in its action. In later experiments, when Paris green, bug death, and arsenate of lead were compared, no perceptible differences were observed in the color or size of the vines treated with these insecticides. Paris green was somewhat more effective than bug death. The potatoes obtained from plats

[a] Massachusetts Sta. Tech. Bul. 1. [b] New Hampshire Sta. Bul. 100.
[c] Maine Sta. Buls. 68, 87, 98.

treated with Paris green and arsenate of lead were tested for arsenic and found to be entirely free. Proprietary insecticides were found not to have any fertilizing value, as has been claimed. In Mississippi [a] arsenate of lead was applied to potatoes at the rate of 4 pounds per 50 gallons of water. The beetles were effectively checked by one application, and the arsenate of lead appeared to be more satisfactory than Paris green.

THE POTATO WORM.

The potato worm is a serious enemy of the potato in California, and methods of controlling this pest in potatoes were tested at the California Station.[b] In order to control the potato worm it is recommended that the wild nightshades be destroyed in the neighborhood of potato fields and that lantern traps be used in such fields. It is desirable to go over potato fields and cut out infested stalks as they appear. Compact hilling of the potatoes is found to prevent infestation of the tubers to a considerable extent. As soon as potato tubers are dug they should be removed from the field, in order to avoid exposure to infestation, and all rubbish should be destroyed after harvesting. If stored potatoes become infested the moth may be effectively destroyed by using carbon bisulphid at the rate of 1½ pounds per 1,000 cubic feet of space.

THE PEACH BORER.

The peach borer has been studied at so many of the stations and referred to in so many bulletins that only a few of the results obtained can be mentioned in this connection. In New York [c] a series of experiments was carried on to test various methods recommended for the control of the peach borer, especially those which were used successfully at the Missouri Station. In Missouri coal-tar applications to the trunks of the trees and the use of thin wooden wrappers were carefully tested. These methods were tried further in New York. The coal tar obtained from Missouri was not as thick as the ordinary product in New York and was quite easily applied with a brush. Wire nettings and wooden wrappers were also placed about a number of the trees. The gas tar obtained from Missouri kept out the borers quite effectively and did not injure the trees. The wire-cage protectors, however, appeared to be somewhat ineffective, while the wooden wrappers gave excellent results. In South Carolina [d] it was found important to use a good wash in connection with the ordinary worming process. Where worming was done in the fall many small borers failed to be detected, and since at this time

[a] Mississippi Sta. Bul. 81.
[b] California Sta. Bul. 135.
[c] New York Cornell Sta. Bul. 192.
[d] South Carolina Sta. Bul. 83.

of year they are usually found near the surface of the bark they may be destroyed by suitable washes. The wash recommended by the South Carolina Station is prepared according to a formula of 20 pounds of lime, 3 pounds of whale-oil soap, 4 pounds of sulphur, and one-fourth pound of Paris green in 25 gallons of water. The western peach borer has been studied at the California Station.[a] It was found that the presence of gum could not be depended upon as an indication in locating the young larvæ. Carbon bisulphid proved to be a very efficient method of killing the worms. It is somewhat dangerous to the tree, but the danger may be quite removed by observing proper precautions. The condition of the soil is considered the most important factor in determining the effect of carbon bisulphid. The soil next to the tree should be loose enough to allow the gas to come in contact with every part of the ground.

THE PEACH TWIG-BORER.

The peach twig-borer causes great damage in certain localities, and is widely distributed. In California[b] it was found that this pest could be controlled by the thorough application at the right time of lime-sulphur-salt wash prepared acording to the formula 40–20–15–60. Every part of the tree should be covered with the wash and the application should be made when the buds have begun to swell. In some cases but slight injury was observed when the wash was applied after some of the blossoms had opened.

THE GRAPE ROOT-WORM.

The grape root-worm, in recent years, has been especially injurious in the Chautauqua grape region. The New York Cornell Station has carried on extensive investigations to determine the best methods of controlling this pest.[c] It was found that a large percentage of the pupæ occur not over 6 inches below the surface of the soil and near the base of the vine. If, therefore, the soil be thoroughly cultivated between June 15 and 25 these pupæ will be injured and exposed by cultivation so as to greatly reduce the numbers of the pest. Cultivation may be repeated during July, and if thoroughly done will prevent the grape root-worm from becoming a serious pest in the vineyard thus treated. Much attention was given to the construction of suitable apparatus for capturing the beetles. Several beetle-catching devices were devised and used by grape growers. Some of these were small and simple, while others were of complicated construction and driven by horsepower. The results obtained were quite satisfactory and suggest the value of this method when combined with cultivation.

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[a] California Sta. Bul. 143. [b] California Sta. Bul. 144.
[c] New York Cornell Sta. Buls. 208, 224.

In general, however, the station had best results from spraying. The beetles usually appear about June 25, and spraying should begin at once. In the station experiments arsenate of lead was used at the rate of 4 pounds in 50 gallons of water or Bordeaux mixture. It was found that this insecticide could be applied at a cost of about $3 per acre at each application. The results obtained during a two years' test were very satisfactory. It is concluded, therefore, that the grape root-worm can be effectively controlled by this insecticide and apparently it is the cheapest and simplest method for fighting the pest. Considerable attention was given also by the same station to the control of the grape-berry moth.[a] In the case of this pest also it was shown that poisonous sprays are effective. When arsenate of lead was applied at the rate of 10 or 12 pounds per 100 gallons of water just before the blossoms opened, just after the petals fell, and when the berries were about the size of small peas, almost complete protection was secured from the insect during the rest of the season. Certain growers used arsenate of lead at the rate of 8 pounds per 90 gallons of water. This application is effective only against the spring brood of caterpillars, which attack the blossoms and recently set fruit clusters.

THE PISTOL CASE-BEARER.

The pistol case-bearer must be classed as one of the important apple pests. In New York it sometimes appears in large numbers[b] and does serious damage. It was found that the pest may be successfully controlled by a thorough application to infested trees of Paris green at the rate of 1 pound per 150 gallons of water. Enough lime should be used to give the mixture a milky appearance. In the successful experiments carried out by the New York State Station the trees were sprayed three times, the first application being made before the buds began to swell, the second after the young leaves had appeared, and a third just after the petals had fallen.

THE SQUASH BUG.

During the summer season the squash bug in badly infested localities renders it almost impossible to raise squashes. Experiments were carried out at the New Hampshire Station[c] to determine practical remedies against this pest. In cases of the worst infestation it appeared to be impracticable to raise squashes. On a commercial scale, however, more elaborate and successful methods may be adopted. In general, the use of protective nettings over young plants is recommended together with excessive seeding, good culture, and destruction

[a] New York Cornell Sta. Bul. 223. [b] New York State Sta. Bul. 122.
[c] New Hampshire Sta. Bul. 89.

of weeds. Hand picking must be relied upon by the gardener as the main remedy. The bugs may be collected from the vines, from the ground beneath them, from boards used as traps, or from squashes planted between the rows of the regular hills as traps for the squash bugs. The nymphs which appear on immature squashes in the fall may be drenched with an insecticide spray and thus the spring brood will be considerably reduced in numbers.

THE PICKLE WORM.

The pickle worm has given considerable trouble to growers of muskmelons, cucumbers, squashes, and other related plants, especially in the Southern States. In Georgia [a] careful experiments were made to determine a simple and effective remedy for this pest. It was found that the pickle worm shows a decided preference for the blossoms of the squash. This observation led to the use of the squash as trap plants. In these experiments it appeared that muskmelons could be effectively protected against pickle worms by planting squashes between the rows. The squash blossoms must be collected at frequent intervals and destroyed.

THE COTTONWOOD LEAF-BEETLE.

The cottonwood leaf-beetle, in addition to destroying the foliage of cottonwoods used for shade trees, causes serious depredations on willows. This attack acquires considerable importance in case of willows grown for the manufacture of baskets. In New York [b] it was found that the infestation of basket willows with the cottonwood leaf-beetle caused the willow whips to branch and thus rendered them useless for basket-making purposes. It was found possible to protect willows against the cottonwood leaf-beetle by three applications of green arsenite, at the rate of 1 pound to 100 gallons of water. This should preferably be used with lime as ordinarily recommended for Paris green. The spraying should begin early in the season, the first application being made before the beetles become numerous, and followed by two other applications a week or ten days apart. Newly planted fields should be sprayed by ordinary apparatus until the willows are large enough for machine sprays, after which these may be used.

THE MEDITERRANEAN FLOUR MOTH.

Mills and elevators frequently become infested with the Mediterranean flour moth, and in several States the stations have been called upon to develop satisfactory remedies for the control of this pest.

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[a] Georgia Sta. Bul. 54. [b] New York State Sta. Bul. 143.

In Minnesota[a] elaborate experiments along this line have been carried out. In this work carbon bisulphid was thoroughly tested. It was found that the insect in all its stages could be destroyed by spraying with carbon bisulphid. Apparently, however, it was not practical to kill the eggs by fumigation with carbon bisulphid, and it was, therefore, necessary to repeat the process after about ten days in order to kill the larvæ which hatch from the eggs which were not destroyed during the first fumigation. All stages of the pest except the eggs are killed by exposure for forty-two hours to carbon bisulphid at the rate of 1 part to 10,000 parts of atmosphere. A greater strength of the gas is necessary to destroy the pest in the center of tight sacks. The freezing process of destroying the Mediterranean flour moth is not practical. The insect in all its stages is destroyed by exposure for six and one-half days to a temperature of of 3 to 5° F., but in all elevators and mills there are many protected corners and cracks in which this temperature might not be reached, and where consequently a number of the insects would be left to reinfest the milling products. The use of carbon bisulphid, however, is not always effective against the Mediterranean flour moth. Recent experiments at the Minnesota Station show that hydrocyanic-acid gas may be used with more effective results. In one case a large mill was fumigated by this means, using a ton of cyanid and 1½ tons of sulphuric acid.

CORN BILLBUGS.

Throughout the corn belt the corn billbug (*Sphenophorus parvulus*) is one of the important enemies of this crop. Recently the Illinois Station[b] has developed a practical remedy for controlling this pest. It was observed that the insect was most injurious when corn was planted on ground which had previously been in timothy and had been plowed shortly before planting to corn. If such ground is plowed in the fall, the amount of injury from billbugs is very slight. It appears, therefore, that most of the injury from corn billbugs may be prevented by early fall plowing.

THE CORN ROOT-APHIS.

The corn root-aphis is another serious enemy of corn. At the Illinois Station[c] an effective and practical remedy was recently developed. It was found that the early cultivation of soil in which corn is to be planted greatly reduced the number of nests of ants which care for the corn root-aphis and consequently reduced the danger of the pest. In one instance disking three times and harrow-

[a] Minnesota Sta. Bul. 88. [b] Illinois Sta. Bul. 104, pp. 95–101.
[c] Illinois Sta. Bul. 104, pp. 102–123.

ing once reduced the number of corn root-lice to the extent of 92 per cent. A still more remarkable result was obtained in another instance, in which a single treatment with the disk harrow applied as soon as the ground was dry enough to work reduced the number of corn root-lice in the field to the extent of 89 per cent. The disk harrow is more effective for this purpose than the ordinary harrow. The method developed by the station is not only effective in destroying corn root-lice, but serves to put the soil in a better state of tillage and should therefore recommend itself to the farmer.

THE HOP APHIS.

In the hop-growing regions of the Pacific coast the hop aphis is one of the most dreaded enemies of this crop. The California Station[a] investigated this problem for the purpose of devising practical remedies. In one hop field an experiment was made in the use of kerosene emulsion and tobacco decoction combined. The tobacco decoction was made by steeping tobacco stems and refuse for two or three hours, using 1 pound of tobacco to 2 gallons of water. The kerosene emulsion was made by dissolving 7½ pounds of ordinary laundry soap in 15 gallons of hot water and adding 5 gallons of kerosene oil. The emulsion and tobacco decoction were thoroughly mixed and sprayed upon the hops. The mixture contained 3½ gallons of the kerosene emulsion for each 40 gallons of tobacco decoction. This remedy was entirely effective in controlling the hop louse. Satisfactory results were also obtained from a mixture of whale-oil soap and quassia extract. In California there seems to be no possible successful treatment in winter for the hop aphis, but by the use of the washes just mentioned the hop aphis may be kept in check, so that no winter treatment is necessary.

BLACK FLIES.

Black flies sometimes multiply to such an extent as to become a serious pest to man and cattle. In New Hampshire[b] it was found that the larvæ of this fly, which live in running water, may be destroyed by pouring a proprietary miscible oil into the water at the upper end of the colonies of larvæ. In some instances all of the larvæ in such colonies were destroyed within twenty-four hours. The oil penetrates into the water and spreads quite rapidly in all directions. Stones removed from the bottom of the stream forty-eight hours after the application still had a thin film of oil on them. In a stream 3 feet wide 1 gallon of a proprietary miscible oil killed off the larvæ for a distance of one-eighth mile from the point of application.

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[a] California Sta. Bul. 160. [b] New Hampshire Sta. Bul. 112.

THE HORN FLY.

The horn fly is recognized as a serious pest to cattle throughout the country, and methods for controlling it have been investigated at various stations. In Virginia [a] it is found that kerosene emulsion is a very successful means of controlling this pest. In applying this remedy a chute 20 feet in length or longer should be constructed in connection with the barn. At first the cattle may show some resistance to the spraying operation, but they soon become accustomed to the treatment. It was found that daily spraying for a period of two weeks reduced the number of horn flies to the point of insignificance even in cases of the most excessive infestation. Fifteen gallons of diluted emulsion prepared from ¾ pound soap and 1½ gallons of kerosene oil is sufficient to treat 100 cattle.

FLEAS.

Among the various household insect pests fleas are one of the most troublesome to eradicate. In New Hampshire [b] creolin was found to be the most satisfactory remedy for this pest. For dogs a 3 per cent solution was recommended, and for cats a 2 per cent solution. The animal should be thoroughly washed and the application will destroy the adult fleas as well as the larvæ. The application should be made as soon as any infestation of dogs and cats is observed. This method, when compared with others, was found to give by far the most satisfactory results. Commercial creolin may be purchased at any drug store and forms a milky solution when mixed with water. It may be applied to dogs and cats by washing with the hand or brush or by submerging animals in the prepared solution.

MOSQUITOES.

Within recent years an unusual interest has been developed in the destruction of mosquitoes on account of the fact that they are agents in the transmission of malaria and yellow fever, as well as great sources of annoyance to man. Methods for their extermination have been studied at several experiment stations. In Michigan [c] it was found that the usual remedies recommended for mosquito extermination, such as draining, treating pools with petroleum, and introducing fish into ponds were quite successful. When kerosene was applied to water for the destruction of mosquito larvæ, it was found that its effects lasted for about three weeks. Much of the vegetation with which the oil came in contact was destroyed. In Mississippi [d] better drainage of low-lying areas is recommended, and in grass-grown

[a] Virginia Sta. Bul. 153.
[b] New Hampshire Sta. Bul. 94.
[c] Michigan Sta. Spec. Bul. 17.
[d] Mississippi Sta. Bul. 74.

sewage ditches and other ditches in which oil could not be effectively applied by pouring on the surface it was found that good results could be obtained by spraying. When applied in that way, the oil was found to operate effectively for about two weeks. Some of the most extensive experiments with remedies for the control of mosquitoes have been carried out at the New Jersey Station.[a] At this station a great variety of insecticides were tested. Carbolic acid and cresol were found to be somewhat effective, but were too expensive. Permanganate of potash was carefully tested on account of the claims which have been set up for this chemical, but was found to be entirely ineffective. The cheapest and simplest insecticide for mosquito larvæ, however, was common kerosene of low grade. Crude petroleum in the ordinary form or in the soluble form was also tested with satisfactory results. A series of experiments was carried on with sulphate of copper either in simple solution or in the form of Bordeaux mixture. In all of these experiments it was observed that the destruction of the larvæ by copper sulphate was a gradual and irregular process. It appears that mosquito larvæ are destroyed when copper sulphate is used at the rate of 1 part to every 10,000 to 200,000 parts of water. The weakest really effective solution was 1 to 50,000, and even then was quite unreliable. No mature larvæ or pupæ were killed by any strength of the copper sulphate. The addition of salt to water in which mosquitoes were breeding produced no effect on the larvæ. Neither quicklime nor chlorid of lime appeared to possess any great value.

[a] New Jersey Sta. Rpt. on Mosquitoes, 1905.

SOME EXPERIMENT STATION WORK RELATING TO THE PRODUCTION AND SALE OF PURE MILK.

By H. W. Lawson, *Office of Experiment Stations.*

There is a rapidly deepening public interest in all matters relating to pure food, and this is especially true of milk on account of the extensive use of this product in the feeding of infants and invalids, with whom the injurious effects of unwholesome food are most marked. While the sanitary aspects of milk production have not perhaps been the most prominent feature of the dairy investigations at the agricultural experiment stations in the United States, matters relating thereto have nevertheless received much careful attention. Station dairymen everywhere have urged the observance of the conditions essential in the production and sale of pure milk, and to this end have made free use of the opportunities afforded by the press, farmers' institutes, dairy associations, agricultural college courses, and station bulletins. In addition to this educational work, the importance of which it is difficult to estimate, there has been considerable experimental work relating to the purity of milk supplies, some of which has been along comparatively new lines, but more of which has been in the nature of demonstrations serving to establish more firmly methods already known.

The purity of milk may be affected by various factors, including (1) diseases of cows; (2) feeding stuffs; (3) condition of stables and yards; (4) manner of milking; (5) methods of handling milk, such as straining and aerating; (6) presence of bacteria, and (7) the use of preservatives. To some of the more important results of experimental work at the stations, relating to the production and sale of pure milk, grouped for convenience under these headings, brief reference will be made in the following summary:

DISEASES OF COWS.

Of the diseases of cows which may be transmitted through milk, tuberculosis is of most importance. Animals placed under experimental conditions have frequently acquired the disease in this way. While authorities are still at variance as to the unity of different forms of tuberculosis, it may be considered as conclusively established that tubercle bacilli of human origin may produce typical

tubercular lesions in animals. On the other hand, experimental evidence concerning the transmissibility of bovine tuberculosis to man is necessarily wanting. The preponderance of authoritative opinion at the present time, however, supports the long-held view that bovine tuberculosis is a source of danger to human life.

That the tubercle bacillus may be present in the milk of affected cows before the disease can be recognized by physical signs has been repeatedly demonstrated. Ernst [a] found tubercle bacilli present and active in a very large proportion of cases showing no discoverable lesion of the udder. Law [b] reported the contraction of the disease by calves nursed by cows with apparently sound udders, but having general tuberculosis. Russell and Hastings [c] recorded additional experiments demonstrating by means of animal inoculations the infectiousness of the milk of tuberculous cows showing no discoverable udder lesion.

The early recognition of tuberculosis in cows therefore becomes of great importance. The most valuable means of securing this is the tuberculin tests of Koch, to the establishment of which, as a practical and reliable diagnostic agent, nearly every experiment station in this country has contributed by tests too numerous to cite.

In experiments on nontuberculous cows Law [d] found that injections of tuberculin did not impair the health of the animals nor affect the yield or the fat content of the milk. General results elsewhere have also demonstrated that the tuberculin test may be applied with perfect safety to healthy animals and their milk used without injurious results.

In the eradication of tuberculosis from dairy herds many of the stations have been actively engaged, and recently tests of von Behring's method of immunizing cattle against the disease have been undertaken. Although the milk of cows in the early stages of tuberculosis may not always be infectious, it is quite generally believed that the best interests of the public demand that no milk from tuberculous cows should be offered for sale, or at least without efficient pasteurization.

Thorough veterinary inspection of dairy animals is doubtless the best means of ascertaining any existing danger of transmitting disease from cows to milk consumers. While it is not always possible to secure such supervision with the elimination of diseased animals from dairy herds, some efforts have been made to devise means of examining milk for the purpose of detecting any abnormality which might point to the presence of disease in cows. Several methods

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[a] Massachusetts Hatch Sta. Bul. 8, p. 13.

[b] New York Cornell Sta. Bul. 65, p. 136.

[c] Wisconsin Sta. Rpt. 1904, p. 172.

[d] New York Cornell Sta. Bul. 82.

have been proposed, one of which has been studied and developed by Doane.[a]

Doane's investigations were concerned primarily with the occurrence and significance of leucocytes or pus cells in milk. Leucocytes are white blood corpuscles, and as such are, of course, a perfectly normal constituent of the blood. They are not, however, confined entirely within the blood vessels. They may be found in nearly every tissue and fluid of the body, and hence are often called wandering cells. In all acute inflammations they are present in large numbers. The solid matter in pus, which is a product of inflammation, is composed mainly of dead leucocytes. The presence of leucocytes in milk has long been known. They have often been referred to as normal and often as abnormal constituents. Doane sought to ascertain whether or not leucocytes are constantly present in the milk of healthy cows and, further, if their presence in large numbers may be accepted as proof of disease in the udder and hence a basis for the condemnation of milk.

The method employed in counting the leucocytes consisted in centrifuging for 4 minutes 10 cubic centimeters of milk in a graduated sedimentation tube at an approximate speed of 2,000 revolutions per minute, removing the layer of fat with a swab of absorbent cotton, centrifuging for 1 minute and repeating the efforts to remove all the fat, which interferes seriously with the success of the method, siphoning the milk to within one-eighth of an inch of the sediment, staining by the addition of two drops of a saturated alcoholic solution of methylene blue with sufficient shaking to secure a thorough mixing of the contents, heating two or three minutes to facilitate the action of the stain, making up to the 1 cubic centimeter mark by the addition of water, and finally putting this mixture into the blood counter and ascertaining the number of leucocytes in the entire field in the way ordinarily followed in blood work in clinical laboratories. Multiplying the number of leucocytes in the counter by 1,000 gives the number of leucocytes in 1 cubic centimeter of the milk sample.

This method was applied by Doane to the milk of the dairy herd of the Maryland Experiment Station. The leucocytes in the milk of individual cows on December 15, January 4, and March 1 numbered for cow No. 39, 37,000, 400,000, and 190,000 per cubic centimeter; cow No. 50, 180,000, 10,000, and 300,000; cow No. 56, 1,000,000, 1,600,000, and 27,000; cow No. 78, 70,000, 17,000, and 124,000; cow No. 80, 47,000, 480,000, and 52,000; cow No. 86, 200,000, 640,000, and 214,000, and cow No. 87, 320,000, 11,000, and 28,000. These figures are cited merely as illustrations. Leucocytes were invariably present, their numbers ranging from 3,000 to 1,600,000 per cubic centimeter.

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[a] Maryland Sta. Bul. 102.

A well-kept private herd of 102 cows was also examined. Here also leucocytes were invariably present in the milk, the range being from 2,000 to 4,600,000 per cubic centimeter. These and other observations, recorded in the bulletin cited, made with cows, nearly all of which at least were unquestionably in a state of perfect health, show quite conclusively that leucocytes are regularly present in cows' milk, that with most cows their numbers run into the thousands per cubic centimeter, and that variations within wide limits signify nothing.

It was observed, nevertheless, that the milk of cows affected with garget always showed a high leucocyte count, and in studying such milk Doane observed certain threads which resembled similar threads found in pus. These were best stained with Delafield's hematoxylin modified by the addition of 15 per cent of carbolic acid and counter staining with eosin. When these threads were present in any considerable quantity in milk large numbers of leucocytes were found collected in masses or clumps. In milk showing a low leucocyte count no such masses of leucocytes and fibrin threads were found. In milk showing a high leucocyte count the clumps were often present. In practice, therefore, a high leucocyte count would render a sample of milk suspicious and the presence of fibrin in addition, as indicated by clumping of the leucocytes, or as demonstrated by staining of the threads, would, in the opinion of Doane, furnish satisfactory proof of the presence of inflammation in the udder, and in such cases the milk must be considered unfit for use. Results of trials of this method in actual milk inspection are yet wanting.

Estrum, or heat, while not a disease of cows, has been studied as regards its possible effect upon the character of the milk. Doane has reported observations on this subject.[a] Determinations of the total solids, fat, protein, casein, and sugar in the milk of five cows before, during, and after periods of heat failed to show any marked variations in these constituents. It was, however, considered possible that the milk might be abnormal in other respects than that indicated by chemical analysis.

The stage of lactation exerts some influence upon the composition of the milk, and the extensive dairy herd records at the experiment stations are valuable in studying this question.

Dehorning, excitement, exposure to storms, and other influences have been reported by numerous stations as affecting temporarily the yield and composition of the milk of cows, but no mention has been made that any such factors affect the wholesomeness of the product.

The observation was made by Beach and Clark[b] that in tests of a

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[a] Maryland Sta. Bul. 95.

[b] Connecticut Storrs Sta. Bul. 32, p. 10.

proprietary preparation for applying to cows for the purpose of protecting them from flies, the milk on several occasions had a peculiar odor, which was attributed to the ointment used.

FEEDING STUFFS.

The extended investigations of the experiment stations on the feeding of cows have related mainly to economy in milk production. In connection, however, with comparative tests of numerous feeding stuffs and studies of various methods of feeding, observations have been made on the effects of different materials on the flavor and other properties of milk of more or less importance in connection with the problems involved in the improvement of milk supplies. It has long been known that certain feeds, such as young grass, produce dairy products of excellent flavor, while other materials, such as weeds, injure their quality, and observations of this kind, especially as regards the quality of butter, have been reviewed briefly by Woll.[a] While reference will be made here to some experience at the stations with several feeding stuffs to which objections have been made from time to time, it may be noted that the observations are concerned more with qualities affecting the salability of the milk than with conditions that might be injurious to health.

Milk from cows fed corn silage has been reported by King[b] and Knisely[c] and others as having a more pronounced odor than that from cows not fed silage, although the odor was not considered disagreeable. Fraser[d] has recently reported observations along the same line. The dairy herd at the Illinois Station was divided into two lots, one of which was fed 40 pounds of corn silage per cow daily, while the other lot was fed only clover hay and grain. During the course of the experiments samples from each lot were submitted to 372 persons for an opinion as to any difference in the flavor of the two samples, anything objectionable about either, and any preference. The result showed that 60 per cent preferred the milk from cows fed silage, 29 per cent the milk from cows not fed silage, and 11 per cent had no choice. Samples of each kind of milk were sent to experts in different cities, three of whom preferred silage milk, one nonsilage milk, and one had no choice. Silage milk was delivered to a hotel for a period of one month and no complaint was made as to the quality of the milk. These results indicate that most people were able to distinguish between the two kinds of milk, but found nothing objectionable about either. The observations at both the Wisconsin and Illinois stations showed that when the silage was fed after milking, the odor in the milk was less noticeable than when the silage was fed a short time before milking.

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[a] Wisconsin Sta. Bul. 116, p. 61.

[b] Wisconsin Sta. Bul. 59, p. 25.

[c] Oregon Sta. Rpt. 1903, p. 44.

[d] Illinois Sta. Bul. 101.

Woll and Humphrey[a] found that soy-bean silage imparted a very objectionable flavor to milk, butter, and cheese. They concluded that even when fed after milking time, satisfactory dairy products can not be made when this kind of silage is used. The same objections, however, did not apply to a mixed silage composed of corn and soy beans, the latter in a relatively small proportion.

In other investigations at the Wisconsin Station by Baer and Carlyle[b] rape was found to impart a strong flavor to milk, and cheese made from such milk had both offensive odors and tastes. The objectionable flavor in the cheese was more marked when young rape was fed than when the rape was mature. A stronger flavor was imparted to the milk when the rape was fed just before milking than when fed immediately afterwards. In the same series of experiments tests with clover and cabbage showed that disagreeable flavors from these materials could be carried over into the cheese.

Objections have also been made to various other feeding stuffs, such as potatoes, sugar beets, and apple pomace, especially when these materials are fed in considerable quantities. That the time of feeding in relation to the time of milking has an important bearing on the transmission of objectionable properties from feed to milk has been well established. Among the materials to which special objections have been raised by sanitarians are the residues from distilleries and breweries.

In experiments at the Massachusetts Station, reported by Lindsey,[c] cows were fed 3 or 4 pounds daily of dried distillers' grains. No objectionable flavor or odor was detected in the fresh milk, nor was the keeping quality of the milk inferior to that of other samples. Lindsey comments on the results, as follows:

> So far as the present experiment is concerned, it is believed that the healthfulness of the milk for all ordinary purposes was not impaired by the feeding of reasonable quantities of distillers' grains. It is understood that practically all of the grains now upon the market are made from distillery slop that has been dried immediately after the distillation of the alcohol. It is unquestionably true that partly decomposed feeds of any kind do impart a bad flavor and odor to milk, and quite likely are the cause of digestive disturbances, especially in case of infants, young children, and invalids. Whether fermented residues that have not undergone any putrefactive changes would produce similar effects seems questionable. It is believed that much of the bad flavor and odor found in ordinary milk is absorbed from an impure atmosphere rather than from the feed given the cow. The subject is worthy of careful study on the part of the experiment stations.

In the same series of experiments dried brewers' grains, fed in daily quantities of 4 to 5 pounds, did not apparently produce any bad

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[a] Wisconsin Sta. Rpt. 1904, p. 67. [b] Wisconsin Sta. Bul. 115.
[c] Massachusetts Hatch Sta. Bul. 94.

effects on the general condition of the animals nor on the flavor and keeping quality of the milk. With the possible objection to the use of all fermented by-products quoted above, Lindsey believes that when fed in moderate quantities fresh brewers' grains that have been dried immediately by modern methods have no bad effect on the character of the milk product. While no experiments were made with the wet brewers' grains, Lindsey comments upon their use as follows:

> It is not believed that the wet brewers' grains are an objectionable feed stuff when fed in a fresh condition and in moderate quantities. It must be remembered, however, that they are likely to spoil easily, excepting when the temperature is low, and the partly decomposed grains would not be considered suitable for producing first-class milk. When milk is intended for the use of infants, young children, or invalids, it is better not to use the wet grains.

It is well known that certain weeds eaten by cows give milk a characteristic flavor. Clark[a] found that the substance in bitterweed responsible for such a flavor was held largely or entirely by the milk serum, and could, therefore, be removed from cream by washing, which was done by mixing the cream with two or more times its volume of warm water and again separating. No methods tested were successful in removing this odor from the milk or the odor of garlic or wild onion from either milk or cream.

Similar experiments were made by Anderson[b] in getting rid of flavors in butter which seemed traceable to weeds eaten by cows. The odor was removed by washing the cream, and also by pasteurization.

In this connection may be mentioned a fishy flavor in milk, described by Harding, Rogers, and Smith.[c] The product of a particular dairy was of no commercial value on account of its rank disagreeable odor and taste. The taint was traced to the milk of one cow, which was apparently healthy, but the actual cause of the trouble was not ascertained.

STABLES AND YARDS.

While many odors in milk are unquestionably due to unsuitable feeds eaten by cows, as has been shown by the different illustrations from experiment station literature, many more are probably due to absorption from the atmosphere by the milk when it is allowed to remain in unclean stables, or where decomposing matter is present. At the Wisconsin Station[d] after milk contained in an open pail had been placed upon silage within a silo for one hour, the silage odor was detected in the milk by experienced judges in 107 out of 120 examinations. The milk, however, did not acquire the odor so readily

[a] Alabama College Sta. Bul. 121.
[b] California Sta. Rpt. 1902–3, p. 121.
[c] New York State Sta. Bul. 183.
[d] Wisconsin Sta. Bul. 59.

in this way as by feeding the silage to cows a short time before milking.

Russell[a] compared the absorption of odors by warm and cold milk. The odoriferous substances experimented with were corn silage, horse manure, urine of cows, and the volatile essential oils of cinnamon, wintergreen, and peppermint, the milk being exposed to these odors in a large box. The results, on the whole, showed that while milk absorbs odors when it is either warmer or cooler than the surrounding air, the absorption, contrary to general belief, is much more active when the milk is warm than when it is cold. The odor of peppermint oil could be detected after exposures of as short duration as ten minutes. The milk was readily tainted by the odor of fresh urine. Such data as were obtained in these experiments show conclusively that it is bad practice from the standpoint of absorption of odors alone to leave the milk for any considerable length of time in the stable after milking. It also shows the necessity, in producing faultless milk, of having the stables clean and well ventilated.

A still stronger argument for clean stables and yards is the impossibility of keeping filth out of the milk when the cleaning of the stables is neglected and cows are compelled to wade in muddy barnyards. Under such conditions a large amount of dirt is sure to get into the milk during milking, and there is then no possible way of removing the greater part of it.

Suggestions for the improvement of dairy barns were offered in a recent circular of the Illinois Station,[b] and in another circular of the same station[c] Fraser reported results of a study of the practice of allowing cows the freedom of a closed shed or covered barnyard, instead of confining them in stalls. Information obtained from 18 practical dairymen and the results of experiments at the station during two years indicated that cows kept in this way were more vigorous and healthy than when stabled; they were cleaner, the stable used for milking was in a much more sanitary condition, and consequently it was easier to produce clean milk. Fraser considered that the information at hand was not sufficient to warrant definite conclusions for all sections of the country and all conditions, but as the method had proved a marked success wherever he found that it had been tried, he considered it probable that it could be put into more extensive practice to the advantage of the dairymen and to the general improvement of the milk supply.

At the Maryland Station Doane[d] compared several materials as bedding for cows. Sawdust was found the most satisfactory, but about equally good results were obtained with shavings. These two

[a] Wisconsin Sta. Rpt. 1898, p. 104.
[b] Illinois Sta. Circ. 95.
[c] Illinois Sta. Circ. 93.
[d] Maryland Sta. Bul. 104.

materials were found to be good bedding materials in sanitary dairying. Cut corn fodder was considered better and more economical than wheat straw where both crops are grown primarily to secure bedding material.

MILKING.

The greatest contamination of milk occurs usually at the time of milking. The commonest forms are particles of dust from the air of the stable, which are especially numerous when cows are bedded or fed just before milking; filth from the udder and adjoining regions of the cow, loosened by the movements of the animal and the manipulations of milking; and impurities from the hands and clothing of the milker. Along with every particle of dirt gaining access to the milk are, of course, multitudes of bacteria.

Fraser [a] made some observations on the amount of dirt falling from udders designated as apparently "clean," "soiled," and "muddy." A glazed dish having about the same diameter as an ordinary milk pail was held under a cow's udder for four and one-half minutes, the average time which it had been found in a number of trials to be required to milk a cow. During this time the milker went through motions similar to those made in milking, but not drawing any milk. The dirt thus collected was approximately the same as would have fallen into the milk during the milking process. Seventy-five trials were made at different seasons of the year, the average results showing that 0.0152 gram of dirt fell from udders apparently clean, 0.1316 gram from udders slightly soiled, and 0.8831 gram from muddy udders. It was therefore estimated that in 32 milkings the 275 pounds of milk produced would contain 1 ounce of filth where the udders were muddy. After these tests the udders were washed and the dirt collected in the same manner as before. The amount of dirt collected before washing as compared with that after washing was 3½ times as great in the case of udders apparently clean, 18 in the case of soiled udders, and 90 where the udders were muddy.

In the same bulletin Fraser reports observations on the number of bacteria gaining access to milk under different conditions. Petri dishes having an area of 63 square centimeters were exposed under different conditions with a view to ascertaining the effect of some of the different operations commonly performed in dairying upon the bacterial content of the milk. The average number of colonies which developed in the culture medium for different exposures was as follows: Exposure made in the open field, 0.9; barnyard, 13; well-kept barn during milking, 32; poorly-kept barn during milking, 168; before feeding, 46; after feeding, 109; after brushing cows, 307;

[a] Illinois Sta. Bul. 91.

under apparently clean but unwashed udders, 578; and under washed udders, 192. As the extent of bacterial contamination is closely associated with the amount of dirt getting into milk, the figures cited indicate clearly the value of washing the udders of cows in preventing contamination of milk during milking. Fraser concludes his bulletin on Preventing Contamination of Milk by the following paragraph:

Paying special attention to cleanliness in every step of the production and care of milk will result not only in clean milk, but in a marked reduction in the number of bacteria it contains, which will greatly lengthen its keeping qualities. That the desired results may be obtained care must be constantly exercised. It is of little consequence to practice extreme cleanliness in all of the steps of milk production but one, and be filthy about that one, as this spoils the whole. Even if the majority of species of bacteria which ordinarily gain access to milk are not dangerous to health, no one cares to consume milk in which a sediment is found at the bottom if it is allowed to stand for a short time. Frequently much filth is allowed to get into milk during milking, and many milkers practice the filthy habit of keeping the teats wet with milk during the milking process; yet after it is drawn the greatest care is exercised that no dust or dirt gain access to it. As far as the final result is concerned, all painstaking care in the subsequent operations is lost because of the careless work at the beginning during the process of milking, for if filth once gains access to milk no amount of care afterwards can remedy the difficulty. It is, therefore, of the greatest importance to the advancement of better dairying that special emphasis be placed upon the operation where milk is liable to receive the most contamination. The work reported in the preceding pages shows that the greatest source of contamination in milk, as ordinarily produced, is the cow herself, and this is doubly important because it is the source which is given the least attention in actual practice.

Haecker and Melick[a] have also reported observations on the contamination of milk during milking. Petri dishes were exposed under udders which had been (1) sponged with water, (2) sponged with a 5 per cent solution of carbolic acid, (3) smeared with vaseline, and (4) merely brushed with the hand. The ordinary motions of milking were gone through with, but no milk was drawn. When the plates were exposed in the pasture the number of colonies which developed from exposure under udders treated with carbolic-acid solution was 65, with vaseline 92, with water 120, and untreated 310. When the exposures were made in the stable the corresponding numbers were 344, 346, 483, and 20,500. These figures show the value of sponging the udder as a means of reducing bacterial contamination, and also the greater danger of contamination when the milking is done in the stable.

The advantages of using a covered milk pail for excluding dirt from milk have been amply demonstrated by the work of W. A. Stocking, jr., at the Connecticut Storrs Station.[b] Two kinds of pails

[a] Nebraska Sta. Bul. 87.

[b] Connecticut Storrs Sta. Rpt. 1901, p. 105.

were used in the experiments, one the ordinary open pail and the other a pail provided with a closely-fitting cover, having on one side a funnel 4 inches in diameter, across the bottom of which was a fine wire gauze. Several layers of cheese cloth were held in place above the wire gauze by means of a second funnel fitting loosely inside the first. The whole apparatus was simple in structure and easily cleaned. Determinations were made of the amount of insoluble dirt in milk drawn into each of these pails. Fifteen tests showed on an average 0.1103 gram of dried insoluble dirt in each liter of milk drawn into the open pail, but only 0.0408 gram in each liter of milk drawn into the covered pail, showing that 63 per cent of the dirt was excluded by the cover. Straining milk removed only 46.6 per cent of the dirt. The use of a covered pail is therefore shown to be more efficient in the production of pure milk than straining milk drawn into an open pail, especially as in the latter case a considerable portion of the dirt is dissolved in the milk and can not be removed by straining.

An illustration of the value of observing aseptic precautions during milking in improving milk, especially as regards its keeping qualities, is afforded by experiments by Conn and Stocking.[a] The milk of one cow was drawn every other day in an ordinary open pail, and no extra precautions were taken to exclude dirt or bacteria. On the alternate days the milk was drawn under the following conditions: The cow's tail was tied to the leg on the farther side; the side, flank, and udder of the cow were washed with a 3 per cent solution of boric acid and wiped with a sterilized cloth; the milker washed his hands with the boric-acid solution and wiped them with a sterilized cloth; after the milking was half done, the washing of both the cow and the hands of the milker was repeated and the remaining milk was drawn through four layers of sterilized cheese cloth and a layer of absorbent cotton into a sterilized covered pail. In two series of experiments the milk obtained under the extra precautions to prevent contamination contained 267 and 242 bacteria per cubic centimeter as compared with averages of 3,888 and 3,116 respectively when no extra precautions were taken. When the two kinds of milk were kept at 70° F., the milk obtained in the ordinary manner curdled on an average in seventy-nine hours, while the cleaner milk did not curdle until the end of one hundred and thirteen hours. When the samples were kept at 50°, the times of curdling were respectively two hundred and twenty-six and four hundred hours. At this temperature the average increase of bacteria in thirty-six hours was thirty fold in ordinary milk, while in the milk obtained under aseptic precautions the increase was only tenfold. The experi-

[a] Connecticut Storrs Sta. Rpt. 1903, p. 52.

ments also showed the marked influence of a temperature of 50° in checking bacterial growth and improving the keeping quality of the milk as compared with the higher temperature employed.

HANDLING MILK.

While milk ordinarily receives the greatest amount of contamination during the process of milking, later contaminations are by no means insignificant and are often of the greatest danger, as when typhoid and other pathogenic bacteria gain access to milk through the want of cleanliness in handling.

Straining removes a certain amount of dirt, as has been noted. Conn and Stocking[a] at the Connecticut Storrs Station studied the effect of straining through two layers of sterilized cheese cloth upon the bacterial content and keeping quality of the milk. Straining apparently had no very marked effect upon the number of bacteria nor the time required for curdling. The bacterial contamination of milk by the use of unclean strainers is a matter of common comment, yet it nevertheless is of very frequent occurrence. Very little experimental work on filtering milk occurs in station literature.

The purification of milk by means of centrifugal separators has been subjected to some experimental tests at the stations. In this method the milk is run through the separator in the usual way, and the skim milk and cream are then mixed, while the solid impurities are for the most part removed as separator slime. Some attention has been paid to the effect of separation upon the bacterial content of milk. Eckles and Barnes[b] found that the reduction in the number of bacteria due to separation varied in seven experiments from 15 to 51 per cent, and that the acidity of the separated milk was slightly less at the end of twenty-four hours than that of the unseparated milk. They concluded, however, that separation improved the keeping quality of the milk little, if any. Doane[c] found that in four out of five trials the acidity of fresh samples of milk which had been separated and mixed was greater than that of the unseparated samples and concluded that the use of the separator for removing dirt from milk tends to lessen rather than improve the keeping qualities of the milk. Erf and Melick[d] obtained a reduction of one-fifth to one-fourth of the number of bacteria in running milk through a properly cleaned separator. Those results are in accord with general experience that, while centrifugal separation may remove a large proportion of the dirt in milk, it is incapable of removing bacteria

[a] Connecticut Storrs Sta. Rpt. 1903, pp. 33, 38.

[b] Iowa Sta. Bul. 59, p. 55.

[c] Maryland Sta. Bul. 88, p. 126.

[d] Kansas Sta. Bul. 131.

to the extent necessary to afford any practical protection against milk-borne diseases, neither does it apparently improve the keeping quality of the milk to any very appreciable extent.

The aeration of milk has been studied at several stations. Wing,[a] Plumb,[b] Cooke,[c] and Doane[d] have reported experiments and an exhaustive study has been made by Marshall.[e] In his experiments Marshall found that the gas content of milk contained, on an average, 81.5 per cent of carbon dioxid and 2.42 per cent of oxygen and that aeration reduced the percentage of carbon dioxid to about 35 per cent and increased the oxygen content to about 20 per cent. Among the practical results of his work the following may be noted: Odors and taints may be greatly reduced by aeration, but this should always be done in a pure atmosphere, in order to prevent in return the absorption of noxious gases by the milk. Aeration does not reduce the number of bacteria nor affect the germicidal action of milk. On account of the increased supply of oxygen, aeration is unfavorable to those fermentations in milk in which toxic substances are produced. Aeration should be conducted at body temperature immediately after milking, be carried out slowly over the most extensive surface possible, and to yield the most satisfactory results be followed rather than accompanied by cooling. Doane's recent experiments showed practically no differences at the end of twenty-four hours in the acid content and number of bacteria in aerated and unaerated samples.

The prompt and efficient cooling of milk is generally recognized to be of the utmost importance in preventing the development of bacteria, which, under ordinary conditions, are invariably present in milk as soon as drawn. Reference is here made to only two of numerous discussions of this subject in station literature. At the Kansas Station Cottrell, Burtis, and Otis[f] showed by a practical test that with care in milking and handling, cooling immediately after milking to about 60° F., and keeping in cans surrounded with well water, it was possible to keep milk in good condition for forty to fifty-two hours without the use of ice and at a very small cost. In several series of experiments at the Maryland Station[g] milk was cooled in various ways. When cooled immediately to 60° F., milk remained in a condition fit for use for fifteen hours longer than when cooled gradually by setting in running water at that temperature. A large number of such practical tests showed the value of cooling milk immediately after milking and of keeping it at a low temperature.

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[a] New York Cornell Sta. Bul. 39.
[b] Indiana Sta. Bul. 44.
[c] Vermont Sta. Rpt. 1892, p. 123.
[d] Maryland Sta. Bul. 88, p. 131.
[e] Michigan Sta. Bul. 201; Spec. Bul. 16.
[f] Kansas Sta. Bul. 88.
[g] Maryland Sta. Bul. 88, p. 139.

BACTERIA IN MILK.

Bacteria are so intimately associated with every phase of dairying that this subject has naturally received much attention in station work. The sources of bacteria in milk have been studied and the fermentations produced by various species have been investigated. Particular attention has been paid to the prevention of bacterial contamination, and methods of destroying or delaying the development of the organisms that do gain access to milk have been repeatedly tested. This subject has been treated frequently in bulletins of a more or less popular nature, among which are the following: Milk: Its Decomposition and Preservation, by R. R. Dinwiddie; [a] The Relation of Temperature to the Keeping Property of Milk, by H. W. Conn; [b] Bacteria and the Dairy, by C. E. Marshall; [c] Cleanliness in Handling Milk: Bacteriological Considerations, by H. L. Bolley; [d] Bacteriology of Milk, by L. L. Lewis.[e]

The investigations of Ward [f] showed that bacteria are regularly present in the interior of the udder, and that milk, although sterile when secreted by healthy glandular tissue, may become contaminated immediately by the bacteria normally present in the smaller milk ducts. This work furnished an acceptable explanation for the failures invariably met with in attempts at securing any considerable quantity of milk uncontaminated by bacteria. While the bacteria found by Ward in the interior of the udder did not seem to affect milk seriously and was therefore unimportant as regards the keeping quality of the milk, the results of the investigations did not, as remarked by the author, preclude the probability that forms more injurious to milk may invade the udder.

Pernot [g] endeavored to ascertain if the bacteria commonly found in stagnant water can gain access to the milk supply through the cow. Pure cultures of several of such organisms were added to the drinking water and given daily for ten-day periods. In no instance were the organisms recovered from the milk produced. Continuing these experiments with drinking water, 10 cubic centimeters of a bouillon culture of the typhoid bacillus was given to a cow daily for ten days, and 20 cubic centimeters daily for the five days following. The results failed to show that typhoid bacilli can gain access to milk in this way. It was also desired to determine if typhoid bacilli are able to enter the udder through the teat when cows wade in water containing this organism. The teats were therefore immersed in a pure culture immediately after milking and allowed to dry spontane-

[a] Arkansas Sta. Bul. 45.
[b] Connecticut Storrs Sta. Bul. 26.
[c] Michigan Sta. Bul. 146.
[d] North Dakota Sta. Bul. 21.
[e] Oklahoma Sta. Bul. 40.
[f] New York Cornell Sta. Bul. 178.
[g] Oregon Sta. Bul. 71.

ously. After twelve hours the teats were disinfected and the milk drawn and examined bacteriologically. The experiment was repeated each day for five days. Negative results were obtained in every case.

While these experiments with one cow failed to show that bacteria may pass from the drinking water to the milk or that typhoid bacilli may enter the udder through the teats, they do not necessarily assure negative results with all cows, and so should not encourage the use of polluted water. The results indicate, according to the author, that nature has provided some means of preventing germs from entering milk, which should be supplemented by providing the purest water obtainable and by fencing off stagnant water ponds.

The main bacterial contaminations of milk occur, therefore, after the milk leaves the udder, the largest amount being doubtless at the time of milking, and investigations along this line have been previously referred to. Conn and his associates at the Connecticut Storrs Station have studied the sources of bacteria in milk, described and classified numerous species found in milk, devised methods of bacteriological analysis, and reported extended studies of the growth and behavior of bacteria in milk.

Some of the results reached at this station are embodied in a recent bulletin,[a] which emphasizes not only the importance of preventing bacterial contamination by cleanliness at every stage, but the value of low temperatures in preserving milk. The following is quoted from this bulletin on account of the caution there raised against the use of old milk:

> Although the temperature of 50° F. is to be emphatically recommended to the dairyman for the purpose of keeping his milk sweet and in proper condition for market, he must especially be on his guard against the feeling that milk which is several days old is proper for market, even though it is still sweet and has not curdled. Quite the reverse is the case. Old milk is never wholesome, even though it has been kept at a temperature of 50° and still remains sweet and uncurdled. This very considerably modifies some of our previous ideas concerning milk, for it has been generally believed that so long as the milk remains sweet it is in good condition for use. Quite the contrary is the case, if it has been kept at a temperature of 50° or in this vicinity. It is not unlikely that it is this fact that leads to some of the cases of ice-cream poisoning, so common in summer. The cream is kept at a low temperature for several days until a considerable quantity has accumulated or a demand has come for ice cream, and when made into ice cream it is filled with bacteria in great numbers and of a suspicious character.

Several abnormal fermentations of milk have been reported in station publications. The presence of gas and taint-producing bacteria has been observed at the Wisconsin,[b] New York,[c] Iowa,[d] and

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[a] Connecticut Storrs Sta. Bul. 26.

[b] Wisconsin Sta. Bul. 62, 128; Rpt. 1895, pp. 127, 146.

[c] New York Cornell Sta. Bul. 158; New York State Sta. Bul. 183.

[d] Iowa Sta. Bul. 34.

other stations. An organism causing bitter milk has been studied by Conn.[a] Bacteria causing ropy milk and cream have been described by Ward[b] and Marshall.[c]

The associative action of bacteria in milk has been studied by Marshall,[d] who attaches considerable importance to this subject in practical dairying. As an illustration of the data secured by him, it may be noted that mixed cultures of a lactic-acid bacillus and a peptonizing species caused souring of milk 48 to 72 hours sooner than pure cultures of the lactic-acid organism alone.

Hunziker investigated the germicidal action of milk, concluding that the "freshly drawn milk of most cows contains varying germicidal qualities." The germicidal action was found to be greatest at 70° F., the average duration at this temperature being three to six hours and the maximum twelve hours. At lower temperatures the action was less marked, but of longer duration. Heating at 149° F. for forty minutes destroyed the germicidal agent. No practical means of utilizing this property of milk in improving milk supplies was found. "So far as investigations up to the present time have shown, the best means of improving the keeping quality of milk without the use of chemical preservatives seems to be scrupulous cleanliness and low temperatures."

The studies of Stocking[e] concerning the so-called germicidal property of milk have led to opposite conclusions. This author believes that certain of the many species of bacteria gaining access to milk as ordinarily produced find in the milk a medium unsuited for their growth and hence disappear more or less rapidly. Other species, including the lactic-acid group, find, on the contrary, conditions favorable to their development and hence multiply more or less rapidly. An increase or decrease in the bacterial content of the fresh milk depends, according to this view, upon the nature of the organisms present and the decrease often observed is, therefore, not properly to be attributed to a germicidal property, but is simply the natural dropping out of the species, finding milk an unsuitable medium in which to develop.

The value of the thorough cleansing and sterilizing of dairy utensils in lessening bacterial contamination, and hence improving the quality of milk, has been often demonstrated in experiment station work. An illustration may be cited from an article by Russell[f] on the sources of bacterial infection. A covered milk pail was

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[a] Connecticut Storrs Sta. Rpt. 1890, p. 158.

[b] New York Cornell Sta. Buls. 165, 195.

[c] Michigan Sta. Bul. 140.

[d] Michigan Sta. Spec. Buls. 23, 33.

[e] Connecticut Storrs Sta. Rpt. 1904, p. 89; Bul. 37.

[f] Wisconsin Sta. Rpt. 1894, p. 150.

cleaned in the ordinary way and another pail of the same kind was sterilized with steam for half an hour. Milk was then milked into the two pails under conditions as nearly identical as possible. The milk in the sterilized pail was found to contain 165 bacteria per cubic centimeter, while the milk in the pail cleaned in the ordinary way contained 4,265 per cubic centimeter. The milk in the sterilized pail remained sweet five and one-half hours longer than the milk in the other pail.

Data upon the value of washing powders for disinfecting dairy utensils were reported by Doane,[a] and a very recent bulletin by Erf and Melick [b] contains, in addition to practical suggestions on the care of dairy utensils, the results of a number of experiments in cleaning separators. Some of the conclusions are here quoted:

> A cream separator should be thoroughly washed every time after using. A brush should be used on every part and piece, using 5 per cent solution of borax or other good washing powder. Rinse in hot water or steam if possible. They should then be left to dry while hot. Wiping with an ordinary clean cloth contaminates utensils with innumerable bacteria.
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> The bacterial contamination in milk is increased from three to five times by running it through a separator bowl which has been used and only flushed and left standing several hours. If only flushed while using, for several days, the contamination increases several times more, and such milk would be likely to be detrimental if fed to calves.

The destruction of bacteria in milk by means of heat has been discussed in station bulletins of a more or less popular nature by Russell,[c] Smith,[d] Marshall,[e] Emery,[f] Nelson,[g] and others. In some of these bulletins new forms of pasteurizing apparatus have been described and tests of their efficiency reported. Farrington and Russell [h] and Harding and Rogers [i] have reported tests of pasteurizers under practical conditions. Aside from the effects of pasteurization in reducing the bacterial content of milk, the influence of heat upon the composition and properties of milk has received some attention by station workers, and along this line the investigations at the Wisconsin Station [j] are the most prominent. These have included studies of the effects of pasteurization upon the viscosity of milk and upon the proteids and fat globules.

The principal argument offered for the pasteurization of public milk supplies has been the destruction of pathogenic bacteria, especially the tubercle bacillus. As low a temperature as is possible to

[a] Maryland Sta. Bul. 79.
[b] Kansas Sta. Bul. 131.
[c] Wisconsin Sta. Bul. 44.
[d] Michigan Sta. Bul. 134.
[e] Michigan Sta. Buls. 147, 173.
[f] North Carolina Sta. Bul. 148.
[g] New Jersey Stas. Bul. 152.
[h] Wisconsin Sta. Bul. 69.
[i] New York State Sta. Bul. 172.
[j] Wisconsin Sta. Rpts. 1895, pp. 98, 164; 1896, p. 73; 1899, p. 129.

accomplish this is certainly desirable on account of the changes produced in milk by a high degree of heat and the probability that these changes lessen the nutritive value of the product. In this connection the investigations of Farrington, Russell, and Hastings[a] are of value. They made practical tests of pasteurization at 140° F., the temperature at which the tubercle bacillus was found by Theobald Smith to be killed when exposed for 15 to 20 minutes under conditions preventing the formation of a film upon the surface of the liquid. These conditions were secured by agitation of the milk in a closed receptacle. The character of the milk was apparently unaffected by pasteurization at 140° F., while tubercle bacilli of bovine origin were destroyed, as determined by innoculation experiments with guinea pigs. These authors, therefore, conclude, as the result of considerable experience, that by heating milk for twenty minutes 140° F. in closed pasteurizers one may be certain that the tubercle bacillus will be destroyed and the milk uninjured in any way.

PRESERVATIVES.

Some attention has been paid to the use of preservatives in market milk. Doane[b] has reviewed the literature and conducted experiments with animals on the effect of certain preservatives, and Chester and Brown[c] have made experiments to determine the effect of formaldehyde on the development of bacteria in milk. However, the experimental work at the stations seems too limited to warrant any very positive conclusions on this subject.

GENERAL ARTICLES.

Aside from the station publications reporting original work, of which some are previously noted, many bulletins have been issued which treat in a more or less popular manner of the most approved methods of producing and handling milk. Brief summaries of the contents of a few of these follow:

Alabama College Station Bulletin 97, Dairy and Milk Inspection, by C. A. Cary, treats of the necessity of milk inspection, the testing of dairy herds for tuberculosis, the feeding and watering of cows, the location and construction of dairy buildings, impurities in milk, the composition and analysis of milk, the various forms of adulteration, including preservatives, bacteria in milk, the transmission of typhoid fever and other diseases by means of milk, the disinfection of

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[a] Wisconsin Sta. Rpts. 1899, p. 129; 1900, p. 147; 1901, p. 185.

[b] Maryland Sta. Bul. 86.

[c] Delaware Sta. Bul. 71.

barns and dairy houses, and similar topics. The following is quoted from the bulletin:

Cleanliness is the great means of preventing bacterial contamination. Continuous vigilance along the line of cleanliness is the price of pure, clean, wholesome milk.

Illinois Station Bulletin 92, City Milk Supply, by W. J. Fraser, embodies the results of considerable experience in conducting a sanitary dairy and of original investigations. Suggestions are made concerning the care of yards, construction and care of barns and stables, cleanliness in milking, cooling and bottling milk, care of dairy utensils, standardizing milk and cream, and other matters requiring attention in the production of good milk. The author defines the grade of milk known as "certified" as "nothing more than milk of a known composition, as clean and free from bacteria as science and skill can make it, and produced by an inspected herd," and considers that this should be the only standard.

Even in the production of this grade of milk costly buildings are not necessary, but they should be so constructed as to be easily cleaned, and must be kept in perfect condition. The stable must be cleaned frequently, at least twice a day, when the cows are indoors, and all feeding of dry fodder, bedding, and sweeping must be completed not less than fifteen minutes before beginning to milk, thus allowing time for the dust to settle. Before milking, all udders must be washed, whether they appear soiled or not, and the milkers must wash their hands and put on clean suits of some washable material. As soon as drawn, the milk must be removed from the stable to a sanitary dairy, where it is cooled to 50° F. or below, standardized, and bottled. The bottles and all other utensils with which the milk comes in contact must be thoroughly washed and sterilized after each using.

Some of the means of improving the milk supplies which the author designates as reforms which can be secured at an insignificant expense and which should be universally insisted upon are as follows:

Keep the cows clean and do not compel or allow them to wade and live in filth. This means clean yards and clean, well-bedded stalls. Everything short of this is positively repulsive and should not be tolerated any longer in a civilized community.

Stop the filthy practice known as "wetting the teats," by which is meant the drawing of a little milk into the hands with which to wet the teats before and during milking, leaving the excess of filthy milk to drop from the hands and teats into the pail.

Wash all utensils clean by first using lukewarm water, afterwards washing in warm water, and rinsing in an abundance of boiling water, then exposing until the next using in direct sunlight, which is a good sterilizer.

Use milk pails, cans, etc., for no other purpose but to hold milk.

Keep out of these utensils all sour or tainted milk, even after they have been used for the day. Using them for this purpose at any time infects them so badly that no amount of washing is likely to clean them. Bacteria are invisible, and millions can find lodging place in the thin film of moisture that remains after dishes are apparently clean.

Brush down the cobwebs and keep the barn free from accumulations of dust and trash.

Whitewash the barn at least once a year.

Indiana Station Bulletin 89, The Source of Milk Supply for Towns and Cities, by A. W. Bitting, contains a general discussion on the production and delivery of milk in cities and descriptions of 29 dairies furnishing milk to the city of Lafayette, Ind. In the discussion such topics as the dairy herd, the stable, the food, the water, the milking, the cooling of milk, and the delivery of milk are considered.

Maryland Station Bulletin 88, Economical Methods for Improving the Keeping Qualities of Milk, by C. F. Doane, contains, in addition to the results of original investigations to which reference has already been made, much general information on the sources of bacteria in milk and practical means of controlling their growth. The following topics are considered quite fully: Purifying milk by straining, filtering, and using the separator; aerating milk; pasteurizing the milk supply, and cooling milk. Special emphasis is laid upon the importance of promptness in cooling the milk after milking.

Michigan Station Bulletin 182, by C. E. Marshall, is a popular discussion of pure milk supply, in which the importance of pure milk and measures of value in securing it are clearly set forth.

Bulletin 221 of the same station, entitled "The Care and Handling of Milk," consists of two parts. Part 1, by C. E. Marshall and W. R. Wright, deals with the significance of pure and impure milk, the transmission of diseases by means of milk, the influence of feeding upon milk production, the condition of the animal as regards health, the condition of the milk in the udder, contaminations of milk, straining, aerating and cooling milk, and stable sanitation, and concludes with the following outline for milk management:

(1) The cow should be sound—no disease should exist in the animal.

(2) The feed should be good and free from aromatic substances. If these aromatic foods are used, they should be employed according to those methods which will not cause odors or flavors to appear in the milk.

(3) The cow should be groomed and hair about the udder preferably clipped.

(4) The udder should be moistened during milking.

(5) The milker should be a neat, tidy person.

(6) The milker should be free from disease and should not come in contact with any communicable disease.

(7) The milker's hands and clothes should be clean while milking.

(8) The pail should be sterilized.

(9) The stall should be such as to reduce the amount of disturbance of dust and dirt.

(10) There should be good light, good ventilation, and good drainage in the stable.

(11) The stable should always be kept clean.

(12) Feeding and bedding, unless moist, should be done after milking.

(13) A dustless milking room is desirable.

(14) Milk should not stand in the stable.
(15) If milk is aerated, it should be done before cooling and in pure air.
(16) The sooner the milk is cooled after milking the better.
(17) Keep the milk as cold as possible when once cooled.

Part 2 of the same bulletin deals with practical conditions for the production of milk as regards dairy utensils, wash room, stable, barnyard, cow, milker, and the care of the milk after it has been drawn.

In Bulletin 228 of the Michigan Station entitled "A Discussion of the Milk Problem from the Standpoint of Production," C. E. Marshall argues for the production and sale of milk of different grades on a business basis. According to this plan such specifications as seem fair for the production of milk at 5 cents per quart, 6 cents per quart, and so on should be agreed upon by contract between producer and consumer, and it then becomes the duty of the inspector merely to see that the specifications of the contract are fulfilled. The specifications which in the opinion of the author should be embodied in any contract for the production of milk of the best grade are enumerated.

New York Cornell Station Bulletin 203, The Care and Handling of Milk, by O. F. Hunziker, deals in a popular manner with the sources of bacteria in milk, contamination during milking, straining, aerating and cooling milk, pasteurization and sterilization, and storage and transportation. The bulletin is summarized as follows:

The greater the attention paid to scrupulous cleanliness in handling milk at all stages, the shorter the time that elapses between the drawing, straining, and cooling of milk, and the lower the temperature to which it is cooled, the greater its freedom from micro-organisms, the longer it will retain its normal condition, the more profitable its production will be, and the more wholesome will it be for old and young.

Wisconsin Station Bulletin 62, Tainted or Defective Milks: Their Cause and Methods of Prevention, by H. L. Russell, treats in a popular manner of taints produced by living organisms and those due to the absorption of odors or to the derangement of the normal functions of the animal. There is also given considerable information on the source and development of bacteria in milk, including the various specific fermentations causing defects in milk, and, in conclusion, a valuable list of suggestions to milk producers in regard to the care of milk, covering the care of animals, milking, storage and transportation, and care of utensils.

In caring for milk it should be remembered that two things are necessary: (1) To prevent the absorption of any foul odors; (2) to prevent the development of living organisms in the milk that are able to form foul substances that taint the same.

The first can be accomplished by keeping taint-producing feeds from the cow and by keeping the milk in a place that is free from all undesirable odors. The second result can be attained by thorough cleanliness combined with a low temperature.

PROGRESS IN AGRICULTURAL EDUCATION, 1905.

By A. C. True,

Director of the Office of Experiment Stations.

EDUCATIONAL WORK OF THE DEPARTMENT OF AGRICULTURE.

The United States Department of Agriculture has continued to promote the advancement of agricultural education through its different bureaus. During the past year increased attention has been given to the needs of the public high and common schools, which are rapidly increasing their demands for assistance in connection with the study of nature and elementary agriculture. "At every station of importance occupied by the Weather Bureau it is the custom for the official in charge to deliver such lectures as are desired by the public schools in his immediate neighborhood, and to instruct such classes as visit the offices of the Weather Bureau. During the past year several hundred such lectures have been given."

The Chief of the Bureau of Plant Industry makes the following report regarding the school-garden work:

During the year requests for information and assistance have been received from every State and Territory in the Union save three, and also from Porto Rico. The States of New York, Ohio, and New Jersey have shown the greatest activity in school-garden work. Some 4,000 combinations of flowers, 3,000 of vegetables, and 500 ornamental collections, comprising a total of nearly 40,000 packets of seeds, were sent to New York alone; the other two States mentioned receiving about one-half this amount each. For individual school gardens there have been sent out over 15,000 collections of flower seeds, comprising 75,000 packets of five annual flowering plants; and nearly 14,000 collections, or 70,000 packets, of five sorts of vegetable seeds. A third collection of seeds, consisting of ornamental flowering plants suitable for school-ground decoration, comprising 30,000 packets, has been sent out. This makes a total of 175,000 packets of seeds supplied to schools during the year.

The work on the Department grounds in cooperation with the normal schools of Washington has been continued in charge of teachers from the local normal schools. This work consists of instruction given the normal-school students in the matter of handling soils, propagating plants, handling seeds, etc. The various school grounds of the city of Washington have been planted in accordance with plans prepared by the students. School-garden methods are also followed in the homes of the students and elsewhere, if opportunity offers. With the view of putting into practical operation the knowledge gained, a small area of land is set aside on the Department grounds for the use of the lower-grade pupils. The direction of these pupils gives practice to the normal

students, who will eventually become teachers in the public schools of the city. Plans have been made for the enlargement of this work, giving an opportunity for more extensive practice by the scholars in the minor grades, especially in the direction of planting the ordinary agricultural crops and correlating this work with the class-room studies. It is planned to give the school children opportunities to familiarize themselves not only with the methods of growing common farm and garden crops, but also to secure knowledge as to the importance and value of these crops to the country. Plat plantings are to be made, the plats themselves representing specifically the areas in acres devoted to common agricultural crops. The children will secure this information from reports and publications which are available, and will utilize it in connection with their plantings. The calculation of the amount of land to be devoted to certain crops will be correlated with work in arithmetic; studies in geography and other similar lines will also be correlated with the garden plantings. In addition, common systems of crop rotations, as practiced in various parts of the country, will be illustrated and practiced.

The total number of publications issued by the Department in 1905 was 1,072. Of these, 476 were original, comprising 20,502 pages of matter. The number of copies of publications issued during the year aggregated 12,475,157. The Department editor reports a very rapid increase in the demands for these publications from educational institutions.

EDUCATIONAL WORK OF THE OFFICE OF EXPERIMENT STATIONS.

RELATION TO AMERICAN INSTITUTIONS.

During the past year the Office of Experiment Stations has continued to follow and record the progress of agricultural education throughout the United States. In order to do this more effectively a department of agricultural education has been established in the Experiment Station Record beginning with Volume XVII, in which abstracts of important text-books, manuals, and other publications relating to this subject will be published monthly, together with notes on the agricultural colleges and schools in this and other countries. During the past year the Office has published a circular on the Teaching of Agriculture in the Rural Common Schools, and a leaflet giving a list of the educational publications of the Office, both of which have been widely distributed; it has revised and reprinted its abridged list of books and bulletins on nature study, school gardening, and elementary agriculture suitable for common schools; prepared an article on Boys' Agricultural Clubs for the Yearbook of the Department, and one on the American System of Agricultural Education for the International Congress of Agricultural Education at Liège, Belgium; published in its annual report a review of progress in agricultural education for 1904, and an article on the county schools of agriculture in Wisconsin; and gathered data for a publication describing and illustrating apparatus and illustrative material available for use in

teaching elementary agriculture. A card directory of about 1,200 teachers and investigators in agricultural subjects has been prepared for use in the Office, and about 1,000 cards of agricultural educational institutions in foreign countries have been written. Upward of 200 lantern slides, illustrating different phases of agricultural education, have been prepared and used frequently in illustrating addresses before meetings of teachers, school officers, and children. Over twenty lectures and other addresses on elementary instruction in agriculture have been given by Mr. Dick J. Crosby of the Office staff during the year, principally before bodies of teachers, and the Director has addressed several representative assemblies of teachers and farmers on the same subject.

RELATION TO FOREIGN INSTITUTIONS.

The following account of two of the international congresses at Liège, Belgium, in 1905, has been prepared by Mr. W. H. Beal, delegate to the congresses from the U. S. Department of Agriculture:

SECOND INTERNATIONAL CONGRESS OF AGRICULTURAL EDUCATION.[a]

This congress, one of the many congresses held in connection with the International Exposition of Liège, met in the Sallé des Fêtes, a large auditorium on the exposition grounds admirably adapted to the purpose. The congress extended over two days, July 28 and 29. It was conducted under the patronage of the Belgian Government and of the minister of agriculture, Baron van der Bruggen, as well as of an honorary international committee composed of the honorary committees and government delegates of various foreign countries, committees of propaganda having been formed in the different countries some time in advance of the meeting of the congress to give publicity to it and to encourage participation in its proceedings by duly accredited delegates. Such a committee was not regularly organized in the United States, but considerable propaganda work was done through the Office of Experiment Stations. The U. S. Department of Agriculture sent a delegate, and the Kansas Agricultural College and the Universities of Illinois and California were also represented at the congress.

The congress was divided into four sections:

(1) Higher agricultural education, dealing with arrangement of courses, degrees, conditions of admissions, etc., methods of instruction, and cooperation between higher education and research institutions.

[a] The first international congress was held at Paris in 1900.

(2) Secondary agricultural education, dealing with secondary schools of agriculture, courses of agriculture in general educational institutions, and practical professional courses.

(3) Popular agricultural education, including professional training for boys and girls in primary schools, movable schools of agriculture, courses in agronomy for adults, soldiers, etc.

(4) Miscellaneous methods of popularizing agriculture and disseminating agricultural information, including correspondence courses, distribution of popular publications, agricultural press, journals of agricultural education, permanent and circulating libraries, etc.

General sessions of all sections were held in the morning or afternoon as seemed convenient, and the different sections also held separate meetings. The delegate of the Department of Agriculture attended the general meetings and the sessions of the first section, of which M. Edmond Leplae, professor in the agronomic institute of the University of Louvain, was president, as well as sessions of the other sections as far as was possible. All proceedings were in French with occasional explanations in English by the president of the section.[a] About 150 delegates, representing 12 different countries, were actually in attendance at the congress (all sections), although about 500 delegates were enrolled in its membership. Four Americans were present: J. T. Willard, of Kansas; L. H. Smith, of Illinois; W. L. Jepson, of California; and the writer.

A number of papers were presented. Printed copies of these in the original language in which they were presented, with French translations, were distributed for the use of the delegates.

The papers covered a wide range of topics bearing upon agricultural education of all grades in the various countries of the world, and many of them were freely discussed by the representatives of different countries present. They were thus considered from a variety of points of view. Among the papers presented in the first section were one by C. S. Plumb on Methods of Instruction in Zootechny; and one by A. C. True and D. J. Crosby on Agricultural Education in the United States.

Professor Plumb's paper was presented in summary by the Department delegate with the help of M. de Vuyst. In this summary attention was called to the work of the committee of the Association of American Agricultural Colleges and Experiment Stations on methods of teaching agriculture, and to the fact that the course of instruction in zootechny at the Ohio State University, of which Professor Plumb has charge, and which he describes in his paper, is modeled to a con-

[a] The thanks of the writer are due M. P. De Vuyst, inspector of agriculture, for much assistance in following and understanding the proceedings of the congress.

siderable extent on the lines laid down by this committee. The essential features of the course described in the paper are (1) a four years' course leading to the degree of bachelor of science in agriculture, and (2) a two years' course which does not lead to a degree. The feature of this course which attracted most attention and occasioned the greatest discussion among delegates in the congress was the prominence given to the use of live animals as means of illustration.

The paper by A. C. True and D. J. Crosby was accepted and incorporated in the report of the proceedings of the section. The following is a summary of this paper:

Briefly stated, the facilities for instruction in agriculture in the United States include the following:

(1) The U. S. Department of Agriculture and agricultural experiment stations in every State and Territory, which afford opportunity for graduate study in agriculture and are doing much through the preparation and distribution of bulletins and reports for the dissemination of agricultural information.

(2) Agricultural colleges in every State and Territory except Alaska, Hawaii, and Porto Rico. These maintain collegiate courses in agriculture, short courses for adults, reading courses, and correspondence courses, and aid in promoting farmers' institutes and other forms of itinerant instruction, as well as elementary agricultural instruction in the public schools.

(3) Agricultural high schools, either public or private, in 30 States and Territories.

(4) Elementary agricultural instruction in at least a few of the public schools in 26 States and Territories.

(5) Farmers' institutes, which are held in 46 States and Territories and extend their influence to nearly a million of the rural population.

(6) Agricultural associations, agricultural fairs, agricultural journals, and other agencies which exert a more or less direct influence on the rural population.

Under the influence of these agencies, and of others less tangible but no less powerful, agricultural practice in the United States is rapidly getting away from the traditions and superstitions which once dominated nearly every act of the farmer. It is more and more governed by scientific principles, and farming is becoming a profession which enlists as high talent and is held in as high esteem as the so-called learned professions.

Liberal provision was made in the programme of the congress for the consideration of questions relating to popularization of agricultural education, and this was a notable feature of the congress. The deliberations of the congress brought out the fact that the need and the difficulty of interesting the practical farmer in more advanced and scientific methods are now being more clearly recognized in European countries than ever before. The European small farmer has been so long bound by traditional methods and customs and class distinctions that he lacks the initiative of the American farmer and is hard to persuade to try new methods. The present need of popular instruction in agriculture would therefore seem to be really greater in Europe than in the United States.

The courses of instruction in the higher agricultural institutions of the more advanced European countries are as a rule quite thoroughly organized; but the methods of popular instruction are still largely experimental, and their value is in large part undetermined. Among the means in use for this purpose are industrial training for boys and girls in connection with the primary schools; movable schools and itinerant lecturers; short courses in agronomy for adults, soldiers, etc., corresponding in a measure with our farmers' institutes; the publication of leaflets and simple manuals; permanent and circulating agricultural libraries; use of the agricultural press, etc. In this connection it should be noted that probably the most spirited discussion of the congress was on the proposition advanced by M. J. Graftiau, of Louvain, Belgium, to establish one authoritative agricultural journal for each country. This proposition was strongly opposed and was finally voted down by a large majority on the ground that such a paper would not be so widely read as the local papers are now, would not meet local needs and stimulate local interest, and would not be so liberal in its teaching or free in its discussion of all topics as the local papers. A sharp distinction was drawn between a centralized, subsidized medium of publication and the local *free* papers. Clerical influences opposed the centralized paper as applied to Belgium as inimical to their interests and control in local affairs. The church was the pioneer and is still to a large extent the controlling factor in the organization and management of agricultural instruction in Belgium, the prime object being to keep the rural population from migrating to the cities, where they are likely to become imbued with atheistic and socialistic ideas.

The dominant note of the congress was the need of wider diffusion of agricultural knowledge and of bringing the work of institutions for agricultural education and research more closely home to the practical farmer. Some of the means urged to this end, to which special attention was given, were more practical instruction in the higher institutions, i. e., less dependence upon text-books, lectures, models, diagrams, etc., and more work in the field, barns, and stables, with growing crops and live animals, with a view of developing initiative and power of observation on the part of students (in this feature of agricultural instruction the United States far excels the European countries); the general and more extensive use of farms for educational purposes in connection with agricultural institutions; the more extensive organization of demonstration experiments; the more careful adaptation of the instruction and research work to the local conditions and needs; the more general introduction of instruction in agriculture, horticulture, and domestic economy in primary and secondary schools; the extension of movable schools, itinerant lectures, and circulating agricultural libraries.

To give continuity and permanence to the work of the congress an international committee was appointed. The members of this committee for the United States are A. C. True and W. H. Beal, of the Office of Experiment Stations, and L. H. Smith, of the Illinois Agricultural Experiment Station.

In the intervals of attendance upon the congress opportunity was afforded for inspection of some features of the exposition in connection with which the congress was held, especially the agricultural exhibits. These were not especially notable except in case of France and Belgium. In the Belgian agricultural and horticultural building were exhibits of charts, diagrams, models, etc., illustrating in striking manner the thorough organization of agricultural education and investigation in Belgium. There were in addition many other interesting exhibits by individuals and firms. A striking and most instructive feature of the Belgian agricultural exhibit was a model farmstead and demonstration farm complete and up to date in every detail, in connection with which many household and farm operations were in progress continuously. There was thus afforded an excellent opportunity to illustrate by means of a working exhibit the Belgian system of agricultural education and research and the practical application of the results of the system.

FIRST INTERNATIONAL CONGRESS OF AGRICULTURAL MECHANICS.

This congress was held at Liège, August 18–20, 1905, in connection with the international exposition in progress there. M. A. Lonay, director of the School of Agricultural Mechanics at Mons, was the moving spirit in the organization of the congress and its secretary-general. The Department delegate to this congress submitted a paper on the Progress of Education and Investigation with Reference to Agricultural Machinery in the United States, which was accepted by the congress and printed in its proceedings. A summary of this paper is as follows:

Improved agricultural implements and machinery have played a most important rôle in the agricultural development and general welfare of the United States. The general use of labor-saving machinery and the success of American inventors and manufacturers in constantly improving and adding to such machinery have resulted in a steady decrease in the labor cost of agricultural production, notwithstanding a simultaneous rise in wages. The growing scarcity of farm labor, however, is so enlarging the demand for labor-saving devices that the need of increased facilities for instruction and investigation with reference to improved methods of construction and use of such devices is beginning to be felt in the United States. The National Department of Agriculture and the State agricultural colleges and experiment stations are therefore undertaking investigations and planning courses of instruction which are intended, on the one hand, to promote more extended and efficient use of agricultural machinery, and on the other, to assist manufacturers in the construction of

implements and machines which will best meet the special needs of the farmers. In this respect they are following the example of several of the European institutions which have done most valuable work in the systematic study and improvement of farm machinery.

The congress was well attended, there being 300 members, representing 20 countries (8 foreign governments being officially represented), and was in all respects a decided success. The congress was divided into three sections (1) dealing mainly with instruction in farm mechanics and organization of machine-testing stations; (2) means of extending the use of farm machinery; and (3) organization of associations for the cooperative purchase and use of machines, the utilization of water power for the generation of electricity, and its use in agriculture.

The papers presented were of a very varied character and covered nearly every phase of the subject of agricultural machinery and its application, but interest centered around the question of the utility of present methods of testing agricultural machinery in Europe, there being evidence of a general conviction that these methods are defective and calculated to give misleading results, and unless they can be radically improved had better be abolished. This criticism was, however, directed more especially against ordinary field trials and classification of machinery based on such trials. A sharp distinction was drawn between mere field trials made with machines of the same class at different times under different conditions, and the work of machine-testing stations in which a given machine is examined with respect to its construction, the arrangement of its parts, the materials employed, and their resistance, etc., and when all these data have been obtained the machine is put in the field to ascertain its efficiency and the motive power required for its work. Prof. J. Pyro, of the Agricultural Institute of Gembloux, pointed out that field tests will not allow of a comparison being made between different machines of the same class unless they are all working at the same time, and if the trials are to give practical results the machines should be tested simultaneously upon the same land and the same crops. He advocated holding one important trial every year in connection with the trial stations, each of these trials being devoted to some special class of mechanism and carried out in the most thorough manner possible. Trials, he said, were intended to develop the improvement of machines by means of comparison, since it was only by such a course that it was possible to ascertain mechanical defects and how they could be remedied. Many of the speakers were at variance as to the value of machinery trials, but the general opinion of the congress seemed to be in favor of Professor Pyro's suggestion to organize one large trial every year for a special class of machine in connection with the trial station.

The League of Exhibitors of Agricultural Machinery strongly protested against present methods of making field trials, and especially against the classifying of machinery in supposed order of merit on the basis of such trials. After long discussion the following resolution, offered by F. B. Löhnis, inspector-general of agriculture of Holland, was adopted:

The first Congress of Agricultural Engineering considers that the methods employed of testing agricultural machinery are devoid of uniformity, and that the results of trials carried out in different countries are not comparable with each other, and that consequently an international commission will be constituted to carry out arrangements to secure uniformity in the regulations for trials.

The commission nominated the following international commission: Austria, J. Rezek; Hungary, V. Thallmayer; Russia, B. Goriatchkine; France, M. Ringelmann; Germany, G. Fischer; Holland, S. Lako; Belgium, J. Pyro; England, Sir Ernest Clarke; the United States of America, W. H. Beal, of the Office of Experiment Stations. The international commission was requested to present a report upon uniformity of trials at the next congress, which is to be held in Vienna next year.

The congress also adopted the following recommendations:

(1) To establish trial stations in agricultural countries that do not at present possess them. (2) To institute in each country represented at the congress a commission whose duty it will be to draw up a programme of trials of agricultural machinery, in taking into account the recommendations of the congress. (3) To institute a second congress of agricultural engineers, of which the principal objects will be to discuss the programme of the commissioners and prepare a general programme upon these reports. (4) The congress decides that the agricultural industry, agricultural instruction, and agricultural engineering should be represented in equal proportions at future congresses and that the different governments should be asked to send delegates.

In many of the European countries extension of the use of agricultural machinery is retarded by the fact that much of the land is divided into such small holdings that large machinery can not be employed to advantage. A result of the discussion of this point was the passage of a resolution in favor of exercising private initiative, with a view of exchanging small holdings and grouping them together so that they can be cultivated by means of modern machinery.

The importance of educating farmers up to an appreciation of the advantage of using more labor-saving machinery and removing prejudice against such use received much attention, and methods of organizing courses of instruction in construction and use of machinery and cooperative purchase and use of labor-saving machinery were discussed. The congress passed a resolution in favor of schools being formed in all countries for the mechanical instruction of farm hands.

and of public bodies providing means for facilitating this educational propaganda.

Other subjects considered were agricultural motors, cost of thrashing grain with machines driven by different kinds of motors, hay tedders and horserakes, steam plowing, besides various phases of social economy as affected by the use of agricultural machinery. Emphasis was laid on the fact that it generally holds true that cost of production is lowest in those countries where farm machinery is most generally used and wages are highest. The introduction of machinery results in a higher class (more skilled) labor and the reduction of the labor of women and children in the fields.

The proceedings of this congress, as well as observations in Europe, confirm the view that many European countries have made much more progress in organizing machine-testing stations and courses of instruction in rural engineering than the United States, but that there is more need of such work there than in America, because the manufacture of agricultural machinery is not so advanced and the European farmer, from tradition, prejudice, or ignorance, and from the small size of his holdings, is as a rule, less disposed than the American farmer to use improved implements and machinery. For such reasons the major part of European tests of machinery have heretofore been mere demonstration or field trials to interest and inform the farmer in a very simple and practical way. Now, however, the need of making these tests more scientific, so as to interest the manufacturer and aid and encourage him in the construction of better machines, or machines better adapted to special purposes, is realized. The tendency everywhere is away from competitive or superficial tests toward technical study of mechanical principles of construction, operation, and efficiency.

It is quite evident that progress in machine testing has not kept pace with organization of courses of instruction in agricultural machinery. In fact, the organization of courses of instruction in rural engineering in general and farm machinery in particular is one of the notable features of recent development in agricultural education in Europe.

The second congress is to be held in Vienna in 1906, and farm motors is announced as one of the special subjects for discussion at that time.

RESOLUTIONS RELATING TO AGRICULTURAL EDUCATION ADOPTED AT THE INTERNATIONAL CONGRESSES OF AGRICULTURE AND AGRICULTURAL EDUCATION.

Now that the holding of international congresses of agricultural education has become a regular means for the promotion of such education and the United States is taking part in this movement, it

is well that the friends of agricultural education in this country should be informed of the general drift of opinion on the topics discussed at the congresses. This is largely crystallized in the resolutions adopted, and in order that the relation between the views of the congresses thus far held may be seen a summary of these resolutions is given herewith.

HIGHER EDUCATION.

Second International Congress of Agriculture, the Hague, 1891.—It is desirable to establish in schools of agriculture bacteriological laboratories, and to give instruction in bacteriology as applied to agriculture.

There should be established at the National Agricultural Institute of France, and in the capital cities of other countries, laboratories of zoology for the students similar to those existing in the United States for the study of injurious animals.

Third International Congress of Agriculture, Brussels, 1895.—It is indispensable for students graduating from the higher agricultural institutions to receive, for the purpose of completing their education, an especially practical course of instruction by means of an apprenticeship (stage) of one or two years, either on an up-to-date farm, in a well-conducted agricultural industry; or if they are preparing for research and laboratory work, in the laboratories directed by the highest authorities in the different lines of work.

Post-graduate students in agriculture, especially those preparing to teach, should have more intellectual than manual practice.

The congress deems it of great utility to give in the higher schools of agriculture a special course to train the pupils for lecturing.

Fifth International Congress of Agriculture, Lausanne, 1898.—That in all institutions of agricultural instruction practical experiments in feeding be carried on.

Sixth International Congress of Agriculture, Paris, 1900.—All institutions of higher agricultural instruction should be provided with farms for the purpose of demonstrating agricultural practice to the students and giving the teachers an opportunity for conducting research work; stables and yards for experimental feeding and demonstration; well-established laboratories of chemistry, botany, zoology, microbiology, agriculture, etc.; a botanical garden; collections of soils, plants, etc.; and a library.

It is necessary to supply these means of instruction and research to the institutions which are as yet without them, to develop them where they have already been introduced, and to appropriate the necessary funds for their maintenance and use.

It would be desirable to have all institutions of higher agricultural

education sufficiently equipped to enable them to enroll all the students capable of being benefited by the instruction given.

As instruction in the higher branches of agriculture is the most complex of all kinds of instruction, and as it constitutes a real encyclopedia of all the branches of agriculture, it is desirable that the pupils at a certain degree of advancement in their studies be allowed to specialize with a view to fitting themselves for the particular line of work they intend to follow. From this time on the students would no longer pursue the same courses nor the same exercises indiscriminately, and would be given an opportunity to devote themselves to the subjects of greatest interest to them. To accomplish this result it would be advisable to add a third year, known as the "year of specialization," to the course of studies in those institutions which now retain their students for only two years.

There is need of developing laboratory practice in the institutions of higher agricultural education. This is the only instruction which these institutions can give directly to their students.

The institutions of higher agricultural education ought to be located in cities, or preferably, near them. Such a location would encourage them to work up and maintain close relations with agricultural interests. All means tending to strengthen these relations, and particularly laboratories for research work, frequently visited by farmers, should be established. In connection with this plan it would be interesting to establish for farmers lectures on practical subjects, these lectures to be given at the time of large agricultural gatherings.

It is desirable that the universities direct their instruction more and more toward the application of the sciences to agriculture.

That greater importance be placed upon commercial instruction in the higher and secondary schools of agriculture.

Seventh International Congress of Agriculture, Rome, 1903.—That in the higher institutions of learning in which courses in political economy are given, the professors be requested to devote a large part of their time to questions relating to agriculture.

First International Congress of Agricultural Education, Paris, 1904.—Agricultural instruction in the higher and secondary institutions of university standing ought to be of a special character. It ought to be theoretical and should meet the professional needs of the country.

It should be based upon the fundamental principles of mathematics, physics, chemistry, and the natural sciences, and their application to animal and vegetable production.

It should include in the higher institutions special courses in applied sciences, varying in number according to needs and circumstances, and included in the following list:

Agricultural chemistry, physiological botany, bacteriology, applied

entomology, vegetable pathology, legislation and economics, and special agricultural industries (production of beer, malt, oil, sugar, etc.).

Laboratory and experiment fields for the purpose of study and research entering into the programme of the different departments.

In lycées and colleges a complete course in natural history (zoology, botany, and geology) and courses in physics, chemistry, and mathematics, in which are brought out their application to the agriculture of the country.

A course in the theory of agriculture, with lessons and demonstrations in the fields and on the farms by means of regular visits.

Such instruction, completely distinct from the professional training given in the schools of technology, would work together with the latter for the advancement of agriculture. This merits public support in so far as it is organized on the basis above indicated.

The special course in agriculture should be obligatory for all students, as is the case in mathematics, physics, chemistry, and natural sciences. As the length of the complete courses in the lycées and colleges is not changed, the time of the students not taken up by exercises in manual practice should be divided into three parts, the first being devoted to classical studies; the second to mathematics, physics, meteorology, and chemistry; and the third to the natural sciences (botany, zoology, geology, agriculture, and modern languages).

The diplomas given for completing technical courses in the higher institutions of all grades (universités, facultés, lycées et collèges) should consist uniformly of special certificates having reference to the different lines of work at each institution.

Diplomas conferring baccalaureate, licentiate, or doctorate in industry or in agriculture do not serve the purpose and may detract from the quality and solidity of the instruction and from the spirit of emulation which should exist between the different institutions.

In agricultural sections a local commission composed of practical agriculturists, professors of agriculture, presidents of the principal agricultural associations of the section, should be appointed for each institution of university rank for the purpose of giving advice regarding the programme of studies, the division of time between the different courses, and upon the management of the institution in general. In addition to this, its mission should be to point out reforms to be made and improvements to be introduced. The propositions of this commission should be submitted to the general council (conseil général) of the department for approval.

Agriculture should be given a large representation in the superior council (conseil supérieur) of public instruction.

The institutions of higher agricultural education should necessarily be provided with experiment and demonstration fields, together

with (1) experiment barns and other means for study and research work in agriculture; (2) research laboratories in chemistry, botany, zoology, physics, bacteriology, mechanics, etc.; (3) a botanical garden; (4) a museum and a library.

It is necessary to provide with these means of investigation and instruction all institutions which are not as yet thus provided, to improve and extend them in those which have already made a beginning in this line, and to make adequate appropriations for maintaining and carrying on the work.

It is advisable to draw into closer relations with each other the higher schools of agriculture and the experiment stations or research laboratories which serve to establish between the schools and the agricultural public the desired and necessary cooperation.

In the same connection it would be interesting to establish in the higher schools courses of lectures on practical subjects for farmers, these lectures to be given at the time when large agricultural meetings are held.

It is desirable that the institutions of the higher grade receive as students all the young people who are capable of being benefited by the training offered.

It would be very advantageous to establish in the agricultural institutes, at the completion of the general course, another year for postgraduate work to give the graduates an opportunity for specializing. Laboratory work and scientific practice should be developed more and more, as this is the only line of work which the higher institutions of agricultural education are capable of offering directly to their students.

It is advisable to allow candidates for admission to the schools of agriculture special credit for previous experience in farm practice.

That agricultural education in the colonies should receive more attention for the purpose of greater development.

That there be established, as complementary to higher agricultural instruction, manual training schools in which special training in irrigation, drainage, and other lines of rural engineering be given.

That the course of instruction of a certain number of practical schools of agriculture be modified in order to furnish students in these schools the necesary elementary instruction.

Second International Congress, Liège, 1905.—It is considered indispensable to give greater importance to practical instruction, under one or two permanent professors, both by means of experimental farms and farms operated normally. The natural sciences related to agriculture should be taught in the field as well as in the laboratory. The question of giving more distinctive degrees for courses in agriculture was proposed for consideration at the next congress. Instruction in colonial agriculture should receive more attention.

Instruction should be adapted to the real wants of the region, and the methods of instruction should, above all, look to a development in the student of initiative and spirit of observation. To this end frequent excursions, under the direction of the professor, to farms of the region to study both technical and economic questions, and the establishment of regional schools, are recommended, the work to be under the supervision of a permanent commission of specialists appointed by the government of each country in order to secure the necessary unity of plan and purpose.

Agricultural journals, societies, and all other agencies interested in agriculture should see to it that the people are better informed as to the agricultural institutions.

Some instruction in agriculture should be given in all secondary schools, the instruction being combined with the course in natural sciences of these schools. The instruction should as far as possible be given by graduates in agriculture.

Considering the increasing importance of the rôle which woman plays in the economic and social rural questions and in the necessity for arresting or retarding the exodus from the country toward the cities, there should be taught in all young girls' boarding schools the application of the natural sciences to agriculture and horticulture.

The teachers in the country schools should possess a scientific and serious practical knowledge of agriculture. In default of a special section in the normal schools they should take a complete agricultural course in a high school for domestic economy. A similar course should be obligatory for the teachers who are designed for special agricultural schools. The professional agricultural teaching should be organized upon a serious basis in those educational institutions which receive a certain number of young girls from the country. Considering the good results obtained in the schools of domestic economy in Belgium, in which theoretical instruction is given in the morning and practical instruction in the afternoon, it is recommended that in the interest of hygiene and the popularization of agricultural science the system be generally adopted.

ELEMENTARY EDUCATION.

International Agricultural Congress of Paris in 1889.—That the entrance examinations to the primary school be based, to a certain extent, upon the instruction given in the practical schools.

That the courses in the primary schools be modified so as to include more agricultural instruction in the country and more industrial instruction in the cities.

That the inspectors of agriculture and not the inspectors of education be given the supervision of the primary teachers in all instruction concerning agricultural matters.

That agricultural extension work be developed, and especially in the line of beekeeping, in order to disseminate the perfected methods in this branch of work.

International Agricultural Congress of The Hague in 1891.—That the establishment of practical professional schools and winter schools is of very great importance, and that the choice of their teachers from the graduates of the agricultural institutes is essential.

That agricultural instruction should not be regarded as a special branch of the programme of the primary school.

International Agricultural Congress of Brussels in 1895.—It is advisable to develop instruction in the natural sciences, physics, and chemistry, in the educational institutions of every rank, from the elementary school to and including the institutions teaching philosophy.

To make agricultural instruction more available to girls by multiplying the agricultural household schools.

To increase the number of agriculturists and professors of agriculture delivering lectures throughout the country, and to provide them with the necessary resources enabling them to develop practical instruction, and to form as close relations as possible with the tillers of the soil.

To increase the number of agricultural courses for adults to such an extent that this instruction may be given in almost every community.

Primary agricultural education should be reorganized along the following lines: (1) The instructor, at the time of his graduation from the normal school, should be given a scholarship, at the expense of the State, in one of the practical schools of agriculture; (2) a special agricultural course should be established in rural primary schools; and (3) by insisting upon the application of the resolution with reference to inspectors of agriculture and their supervision over instruction in agricultural matters, adopted at the Congress of Paris in 1889.

These recommendations are also applicable to girls' schools.

The section on popular agricultural education deems it urgent to encourage as much as possible instruction in agricultural bookkeeping, or accounting. Theoretical and, above all, practical work in this branch should be given in the normal schools for men and women, in the agricultural schools, and in the domestic science institutions. It is of equal importance that for some time to come, and beginning immediately, special courses be established for the benefit of men and women teachers who are actively engaged in teaching, and in general for all persons giving public agricultural instruction.

International Agricultural Congress of Lausanne, in 1898.—That

the method of giving agricultural instruction by means of lectures presented by traveling professors be developed more and more, together with the demonstration fields so indispensable to this line of work.

That the short technical courses for adults in certain special schools—as schools of agriculture, or schools of agricultural industries—be more generally given where this is possible.

That the agricultural societies encourage as much as possible by the means at their disposal the agricultural instruction for adults.

That agricultural instruction for adults be also given by means of periodicals treating of simple and practical subjects, and, further, by encouraging the distribution of works on agriculture sold at a reduced price.

It is desirable that instruction in elementary agriculture be given an important place among primary studies, and that one of the best ways of giving this instruction consists in lessons on subjects relating to the application of the natural sciences to agriculture.

International Congress of Agricultural Education of Paris, in 1900.—That the system of elementary instruction be supplemented by a large number of winter schools in those localities which have not as yet been provided with such institutions, and that in the regions where small farmers predominate these winter courses be given in the primary schools by instructors who have made special studies on the different subjects to be discussed.

That the government continue the development, on as large a scale as possible, of instruction in dairying, and especially in that portion of the subject which is of interest to the housewife.

That instruction in matters relating to the industries connected with the farm be given in the largest possible number of special schools.

That instruction in horticulture and viticulture, in which the results are so encouraging, be extended to the regions as yet unprovided by establishing properly located and highly efficient practical schools.

The pupils should be trained to collect and classify certain objects, such as rocks, soils, fertilizers, plants, etc., lessons in this connection to be supplemented by simple field work and by walks into the country and visits to the best farms in the neighborhood; all this outdoor work to be under the direction of the instructor.

The congress also recommends that agricultural instruction for women be given much more attention than in the past. The establishment and improvement of schools of dairying and domestic economy for girls should be encouraged. These schools should maintain the simplicity and spirit of the family. The young woman should be prepared for her life work by withdrawing her as little as possible from her environment and by increasing her love for the same.

It is also recommended that in addition to permanently established schools there be organized in localities not yet provided with them, traveling schools of dairying similar to those which are in operation in Ireland and Belgium. It is desirable that these traveling dairy schools should make use of local agricultural gatherings of different kinds in order to advertise themselves to the greatest extent.

Second International Congress, Liège, 1905.—Conformable to the opinions expressed in previous congresses, and notably in that of Lausanne, the international congress at Liège expressed the opinion that the teaching of elementary agriculture should take an important place in the programme of the rural primary schools; that the best form to give to this instruction consists of lessons in subjects which have close relation to the natural sciences in their application to agriculture.

The congress also desired to see a development in professional agricultural teaching, and one of the forms it recommended is the movable school manned by specialists and with a programme dictated by the circumstances of location and the soil.

Courses of study for farmers' wives should be multiplied, and should include, besides instruction now given, lessons by competent persons in domestic economy and maternal pedagogy.

The organization of courses of agricultural teaching for soldiers by the military authorities is favored.

Agricultural libraries can most admirably second the instruction ordinarily given, and the public authorities could not too much encourage these efforts in the beginning by the formation of semi-circulating libraries (*a*) in the agricultural societies, (*b*) in agricultural school districts.

The establishment in each country of a school teaching the theory and practice of aviculture is recommended.

The improvement of the agricultural journal by every possible means is urged.

Correspondence, conference, reading, and similar courses should receive the support and encouragement of public authorities, who should also encourage the dissemination of short treatises and leaflets on agricultural topics through the medium of agricultural societies and primary schools. The conference courses should include lessons in the experimental field, and the farmer should familiarize himself with the organization and work of the professional agricultural schools.

Stereopticon views well presented form an easy means of increasing the interest of meetings and lessons for all degrees of agricultural instruction, therefore it is desirable (1) to encourage in all sections the production of good negatives representing agricultural questions; (2) to direct the attention to the absolute necessity of preparing the

audience before presenting the views by a sufficient explanation of the question treated upon and to accompany each projection by a summarized explanation; (3) to popularize the handling and management of the apparatus for this work.

Considering that the agricultural education of young girls is one of the best means of restraining the depopulation of country localities, agricultural instruction should be more efficiently given in the primary, secondary, and normal schools for young girls; and practical schools of agriculture and domestic economy for young girls should be extended wherever their utility is recognized.

FOREIGN INSTITUTIONS.

In connection with its work for the promotion of farmers' institutes, this Office has published a bulletin on Agricultural Instruction for Adults in the British Empire (Bulletin No. 155), by Prof. John Hamilton. This bulletin describes the means adopted for reaching rural adults through itinerant teachers, traveling schools, farmers' institutes, and other forms of college and university extension. There is also some discussion of the higher institutions which are associated in the work of instruction of adult farmers. A similar bulletin has been prepared covering the countries of continental Europe.

The board of agriculture studies at Cambridge University, England, reports a steady increase both in the number of students attending the agricultural courses and in the number presenting themselves for the examinations. The syndicate appointed to consider the desirability of establishing a course leading to a diploma in forestry at this university has reported, (1) that a diploma of forestry should be established; (2) that forestry should form the principal subject of the final examination for the diploma; (3) that the diploma should be granted only to graduates of the university; (4) that candidates for the diploma should show evidence of having resided for the equivalent of one year in some recognized center of instruction in practical forestry. If these recommendations are approved by the senate, the syndicate proposes to draw up and submit to that body detailed regulations for the scope and conduct of the proposed examinations, and for the courses of lectures and practical instruction to be required of candidates for the diploma.

The total number of enrollments in the day and evening classes of the West of Scotland Agricultural College for the session 1904–1905 was 471, as compared with 376 for the previous session.

The grants made by the British Board of Agriculture and Fisheries in aid of agricultural education in the year 1903–4 amounted to $44,620. This amount was distributed among 16 different institu-

tions, including the principal agricultural colleges in England and Wales, as well as several agricultural and dairy schools. The attendance on courses of longer or shorter duration amounted to considerably over 1,000.

Buildings are being erected for a new college of agriculture for Manitoba, established by a recent session of the provincial legislature, which appropriated $200,000 for the purpose. The college is located at Winnipeg, and its principal is W. J. Black, a graduate of the Ontario Agricultural College, who will have charge of the work in animal husbandry. The principal buildings consist of a main building, 131 feet long by 67 feet wide and 3 stories in height above a high basement, and a science and dairy building, 64 by 66 feet and 2 stories in height above a high basement. The main building is of stone and white brick, and the science and dairy building of brick, with a stone foundation. The main building, in addition to providing laboratories, class rooms, a library, and an auditorium with a seating capacity of upward of 500, will afford temporary accommodations for about 60 students, the intention being to erect a dormitory building when the increase in attendance warrants. The basement and first floor of the science and dairy building will be used for butter and cheese making, milk testing, home dairying, etc., and the upper floor for laboratory and class room purposes. In addition to these two buildings a power house, principal's residence, live-stock auditorium, and horse and cattle barns are being provided. The horse and cattle barns are of modern design, and the live-stock auditorium which connects them will afford seating capacity for about 300. The college farm consists of 117 acres, and is immediately outside the city limits of Winnipeg, on the Assiniboine River. The college buildings are located on the banks of this stream, about 4 miles from the center of the city. A part of the farm will be used for experimental work in agriculture, horticulture, and forestry. The regular college course will extend over two years, and will open immediately after the fall work on Manitoba farms has been completed and close in time to allow students to reach home before the spring work begins. There will be no rigid entrance examinations, the main requirement being sufficient knowledge of the English language to benefit by the lectures and practical experience upon a farm covering at least two summers. A tuition fee of $10 per annum will be charged, and board will be furnished at actual cost. There will be special dairy courses in butter and cheese making to cover from ten to fourteen weeks. "The college in its teaching will be practical in the highest possible degree. It will train practical farmers, not educate them along lines calculated to lead young men from the farm."

The government of India has recently constituted a board of agri-

culture, the duties of which are the improvement of agricultural methods by the introduction of better quality of seed grains and roots, by the adoption of up-to-date machinery and implements, by experimenting with soils and fertilizers, and by the study of plant diseases and economic insects. "The board has also under consideration a system of agricultural tuition, with a view to a distribution throughout the country of men trained in the science of the subject." It has been decided to publish a quarterly journal on agricultural subjects, and also to issue separate scientific publications.

The following facts regarding agricultural instruction in the College of Science, Poonah, India, are furnished by Prof. J. B. Knight, a graduate of the Massachusetts Agricultural College and at present professor of agriculture in the college at Poonah. It appears that the College of Science was originally a college of engineering, but in 1879 provision was made for a class in agriculture and forestry and 72 acres of land for a college farm were bought. In 1884 an herbarium and a botanical garden were added, and in 1885 a chemical laboratory. Two years later a veterinary hospital and operating rooms were provided, and in 1890 graduates from the agricultural class were given a diploma in agriculture. A lecturer in agricultural chemistry was appointed in 1898, and the following year the standard of the agricultural work was raised and the degree changed to licentiate of agriculture. The course given at present covers three years and includes theoretical instruction in agriculture, agricultural chemistry, botany, veterinary science, etc. There are at present 77 students taking the agricultural work, by far the larger proportion being first-year men.

According to the last annual report of the Transvaal Department of Agriculture there is no agricultural school in that country, but the Transvaal Technical Institute has recently been established, and it is expected that this will form the nucleus of a future university which will include a college of agriculture. In the meantime some instruction in agriculture is provided by making arrangements to receive students or apprentices at the veterinary experiment station and the different government laboratories, experiment farms, fruit gardens, poultry yards, etc. School gardens are maintained in connection with most of the schools in the Marico and North Lichtenburg districts.

The agricultural schools conducted under the Imperial Department of Agriculture for the West Indies, which are now in operation in St. Lucia, St. Vincent, and Dominica, were established for the special purpose of affording practical training in agriculture to a selected number of boys of about 15 years of age who have passed the fourth standard in the public schools. After passing a probationary period of three months boys are formally admitted into the schools on an

agreement being signed by their parents or guardians to allow the boys to remain undisturbed at the school for a period of three or four years, during which time they not only receive free instruction but are lodged, boarded, and clothed free of expense to their parents.

There are now 31 winter schools under the control of the Rhine Province Chamber of Agriculture, 4 of which last year completed their twenty-fifth year. At that time the total attendance at the winter schools had been 11,467 pupils, 3,993 of whom had attended two winter terms. A feature of these schools is the variety of special courses, which include horticulture, the utilization of fruit, vine culture, bee culture, feeding, fertilizers, bookkeeping, and domestic economy.

A school of agriculture, with a farm attached, has been organized at Maison-Carrée, in Algeria. The number of students is limited to 25, and these will be chosen from candidates 17 years old or older who pass satisfactory examinations in mathematics, chemistry, and natural science.

The Thessalonica Agricultural and Industrial Institute has been organized at Salonica, Turkey, under the control of an undenominational board of 12 directors, incorporated under the laws of the State of New York. The school is on a 52-acre farm, 5 miles from Salonica, and has been in operation about a year and a half. Its work is similar to that of the Hampton and Tuskegee institutes.

EDUCATIONAL WORK OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

At the nineteenth annual convention of this association, held at Washington, D. C., November 14–16, 1905, questions relating to agricultural education were discussed, especially in the section on college work.

Prof. F. W. Rane, in his discussion of Courses in Agriculture, Horticulture, and Allied Subjects, confined his remarks mainly to horticulture. In his scheme for utilizing the 150 hours assigned to horticultural courses, 20 hours were given to the study of propagation, 50 to pomology, 50 to olericulture, and 30 to floriculture. Charts were also exhibited which showed a syllabus of a separate course in horticulture, and of horticulture as it is now given in several States.

In a paper on The Normal School, President K. C. Babcock brought out the fact that comparatively little is now being done to train teachers for small towns, villages, and rural communities. He urged that the land-grant colleges should help the normal schools by offering short courses for teachers, holding institutes, and sending out their officers to give courses and lectures in normal schools. The same general conception of the duty of the land-grant colleges in the move-

ment for the improvement of public schools was held by Dr. A. C. True, who read a paper on the public schools. He said that the colleges should study the programmes of the public schools, come into close touch with their school officers and teachers, provide courses of study which will be attractive to school officers and teachers, and, by summer schools or otherwise, seek to bring such persons into direct contact with the system of education represented in these colleges. Elementary and secondary courses in agriculture and mechanic arts in the public schools are required to direct students to the land-grant colleges, and to prepare them to enter their courses.

Prof. John Hamilton discussed the relation of the land-grant colleges to the farmers and pointed out three great fields in which these institutions should work, viz (1) college class room—four-year courses, short courses, and post-graduate courses; (2) college extension work, including correspondence courses, farmers' institutes, movable schools of agriculture, and practice farms, and (3) normal schools of agriculture for training capable farmers to take part in the extension work of the colleges.

One of the most important actions of this convention was the reorganization of the standing committee in accordance with the recommendation of the executive committee. The association will thus have four standing committees, viz (1) instruction in agriculture, (2) graduate study, (3) extension work, and (4) experiment station organization and policy. These committees are to consist of six members each, to be appointed by the retiring president, and provision is made for a gradual rotation in the membership, so that the terms of only two members will expire each year. Vacancies occurring during the year are to be filled by the committees themselves.

In accordance with the report of the committee on graduate study the association decided to assume responsibility for the continuance and management of the Graduate School of Agriculture. Arrangements are being made to hold the second session of this school at the University of Illinois in July, 1906.

The association instructed its executive committee to take steps to secure the establishment of a department of rural and agricultural education in the National Educational Association.

THE AGRICULTURAL COLLEGES.

The year 1905 marks the semicentennial of the founding of agricultural colleges in this country. An act for the establishment of an agricultural college was adopted by the legislature of Michigan in 1855, and approved February 12 of that year. This was in obedience to a clause of the constitution of the State of Michigan, adopted in

1850, which requires that "the legislature shall provide for the establishment of an agricultural school for agriculture and the natural sciences connected therewith." A farm was purchased near Lansing and buildings erected, but the college was not opened for students until May 13, 1857.

Pennsylvania State College celebrated the semicentennial of the granting of its charter in connection with the annual commencement June 11–14, 1905. This charter was granted by the State legislature in 1855 largely through the efforts of the Pennsylvania Agricultural Society, but the institution, then designated "The Farmers' High School of Pennsylvania," was not opened for students until 1859.

In 1905 agricultural colleges were in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. In the Southern States separate colleges are maintained for negroes, and in this way the total number of agricultural colleges in the United States is 63. The number of white students in four-year agricultural courses in 1905 was 2,638, and in shorter courses, 4,634; of negro students, 1,624 were enrolled in agricultural courses.

APPROPRIATIONS.

Among the larger State appropriations made during the past year for buildings and maintenance are the following: The University of California received an appropriation of $150,000 for the purchase and equipment of a university farm and agricultural school. The Colorado College and Station was given a special appropriation of $30,000 to extend their work. Delaware College received a State appropriation of $15,000, most of which will be expended for a drill hall and gymnasium. Connecticut Agricultural College was given $40,000 for current expenses for two years, and $60,000 for a dormitory. Kansas Agricultural College received the following appropriations for the next two years: For a horticultural building, greenhouses, and equipment, $50,000; additions to heating and power plant, $16,000; granary, $4,000, and current expenses, $90,000 for 1906 and $100,000 for 1907. Massachusetts Agricultural College was given $53,000, approximately $40,000 of which will be used for the erection and equipment of a horticultural building. The State legislature has removed the limitation to the amount which the Michigan Agricultural College may receive under the one-tenth of a mill tax. Under a former law the amount was limited to $100,000 per year, and the removal of this restriction will increase the annual revenue of the college $57,000 on the present valuation. An appropriation of $55,000 was also made to replace a dormitory destroyed by fire. The Minnesota legislature granted the following appropriations for the agricultural department of the State University: Auditorium, to

FIG. 1.—WILDER HALL MASSACHUSETTS AGRICULTURAL COLLEGE.

FIG. 2.—AGRICULTURAL HALL, UNIVERSITY OF NEBRASKA.

form part of contemplated main building, $50,000; purchase of land, $10,000; enlargement and equipment of dining hall, $10,000. The College of Agriculture of the University of Missouri was given $55,000, of which $5,000 was for a laboratory building for farm machinery. The board of regents of the University of Nebraska will erect a woman's building at the school of agriculture to cost $32,000. The New Hampshire Agricultural College received $50,500 under the following heads: Gymnasium and drill hall, $25,000; general expenses, $20,000; president's house, to supplement insurance money, $5,500. Oklahoma Agricultural College received $75,000 for a building for agriculture and horticulture, $15,000 for additional shops, $2,500 for a gymnasium, $8,000 for land, and an increase of $5,500 per annum for maintenance. Pennsylvania State College was given $150,000 for completion of agricultural building, $21,500 for extension of heat, light, and power plant, $30,000 for maintenance of agricultural courses, $2,500 for tool and poultry houses, and $139,456.33 for general maintenance. The Rhode Island Agricultural College received $20,000 for a greenhouse and poultry building, and $4,000 for a student-labor fund and for continuing the work of the agricultural demonstrator. Among the appropriations made to the South Dakota Agricultural College were the following: Salaries, $13,000 a year; maintenance, $18,200 for 1906 and $17,700 for 1907; purchase of land, $16,000.

NEW BUILDINGS.

MASSACHUSETTS.

The Massachusetts Agricultural College has completed, at a cost of $39,950, a new building to be known as Wilder Hall for the department of horticulture and landscape gardening (Pl. VII, fig. 1). The building is constructed of red brick with terra-cotta trimmings, and at all points modern fireproof construction has been used. The nonbearing partitions are of fireproof tile, the bearing partitions of brick, and the floors of hollow fireproof tile. The staircases are of Portland cement on hollow fireproof tile. Many of the floors are finished in Portland cement, and the roof is of green tile on wooden trusses. The latter is the only possible exception to the fireproof construction. The equipment will consist of the most modern furniture and apparatus. Heat will be supplied from the central heating plant of the college, and ventilation has been provided for by a very complete system.

The basement floor contains two class rooms, a storage room, and two laboratories, besides hallways and toilet rooms, a coat room, and a room for surveying instruments. The entrance to the basement is on the western front and is on grade level. It fronts toward the

college campus, and is the natural entrance for students. As the class rooms and laboratories for the larger classes are located on this floor, the movement of large bodies of students up and down stairs and through the hallways is avoided, and there is no disturbance of work which may be in progress on the other two floors of the building. Only small classes of advanced students are provided for on the upper floors.

The first or middle floor opens on the ground level on the east side of the building. This is the side on which the grounds of the department of horticulture are located, and the principal office looks directly out upon the grounds. Between the offices of the head of the department and the assistants is a small room for records, experimental files, etc. At the other end of the floor are a museum and a laboratory for senior students in horticulture, with a reading room adjoining in which horticultural periodicals and reference books will be kept. Provision is made in the center of the western side for a winter conservatory. This suite will constitute a sort of clubroom for the advanced students, and form a meeting place for seminars.

The upper floor contains a large draughting room for landscape gardening, as the work in this course is largely done on draughting tables. There is also a large class room fitted with drawing tables, photographic rooms, a private laboratory, and quarters for a janitor. This floor is well lighted, there being four large skylights in addition to the windows.

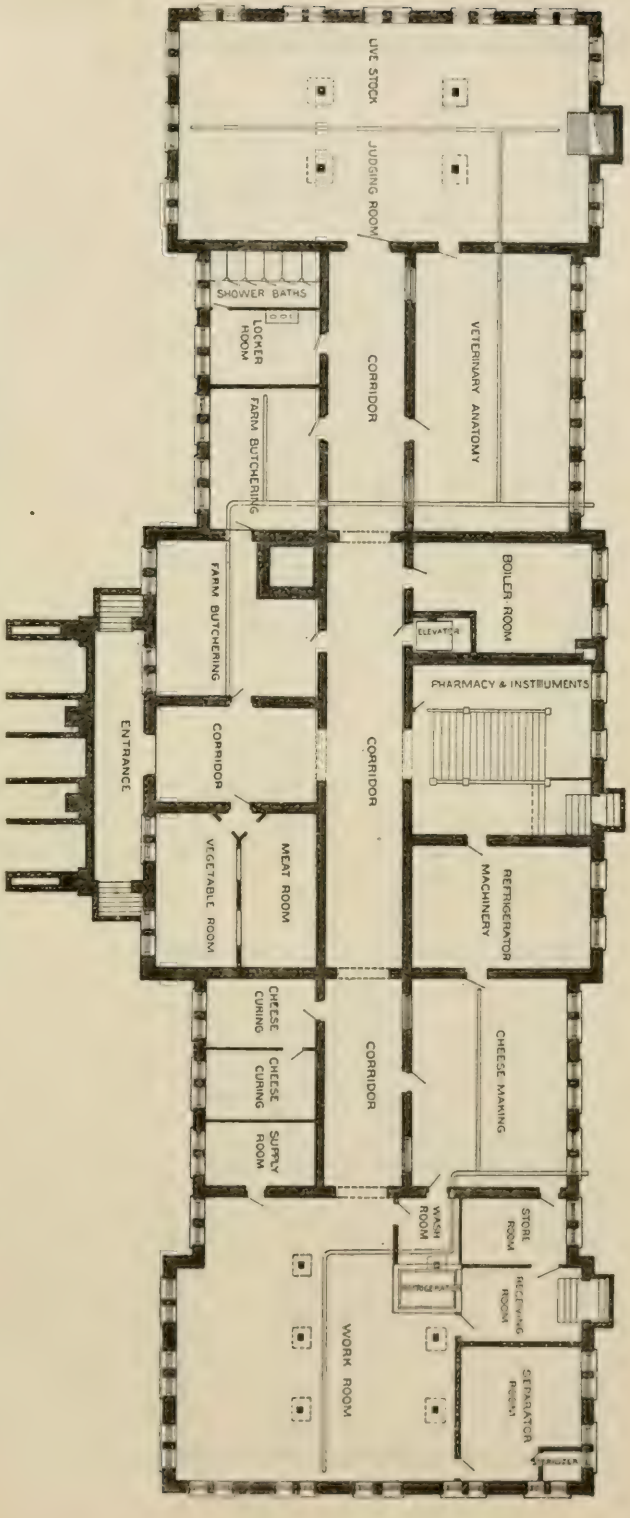
NEBRASKA.

At the University of Nebraska an agricultural hall (Pl. VII, fig. 2) was dedicated January 16, 1906. This building is of gray pressed brick, three stories high, with interior finishing of oak, and cost about $65,000. It is 140 feet long by 64 feet wide, and contains about 26,000 square feet of floor space. It contains executive offices for the experiment station and agricultural college and school, together with class rooms and laboratories for the departments of botany, animal husbandry, animal pathology, agricultural economics, mathematics, physics, and English.

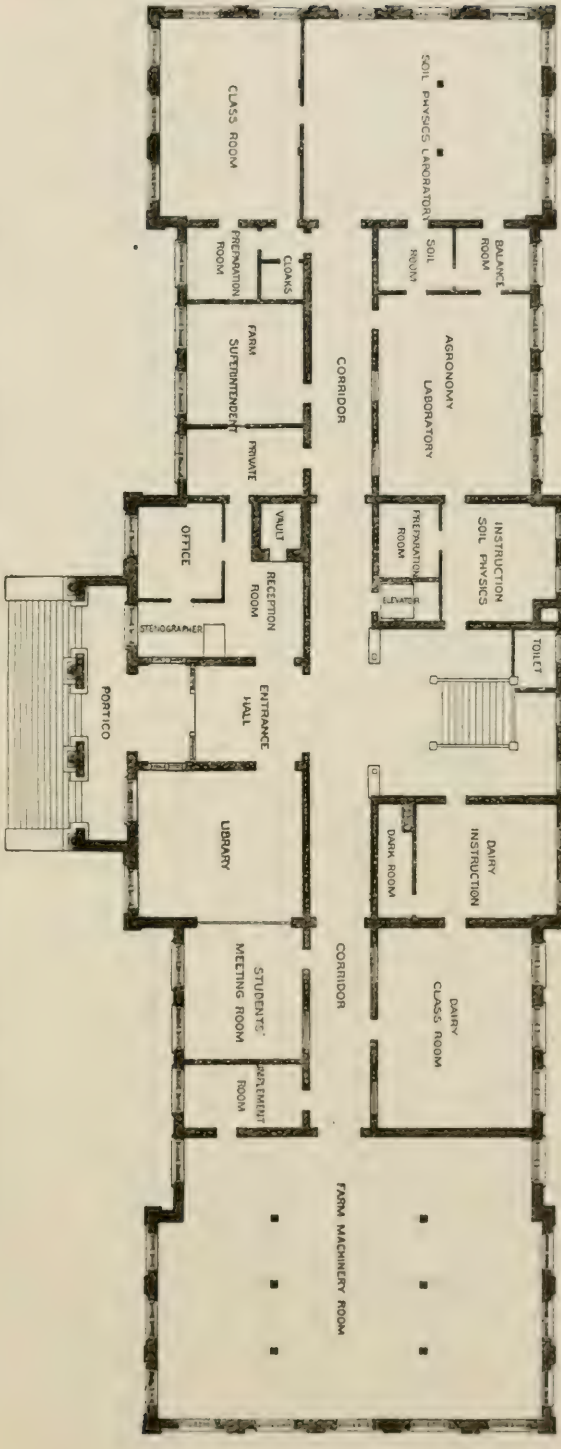
NORTH CAROLINA.

A new building, known as Agricultural Hall (Pl. VIII), has been erected at the North Carolina College of Agriculture and Mechanic Arts, which marks a noteworthy step in the development of agricultural instruction at the college. It is one of the largest and best equipped agricultural buildings in the South. It will place the agricultural department of the college on a par with any in the institution, and will add very materially to its facilities for instruction. The steady growth of interest in the agricultural courses, which has

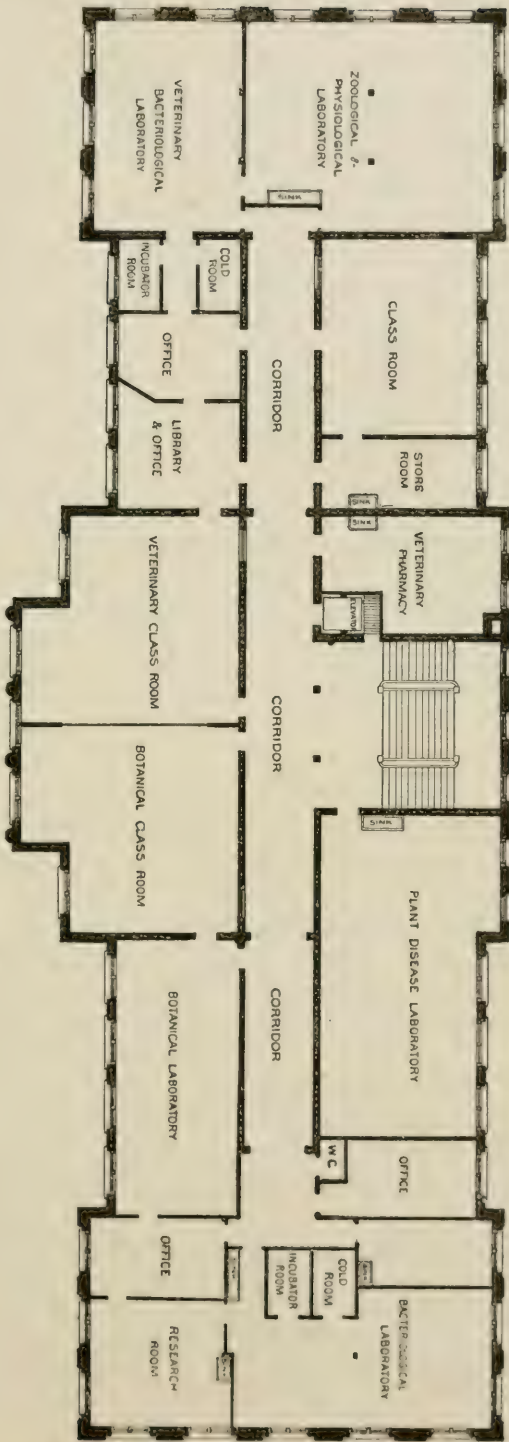
AGRICULTURAL HALL, NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.



BASEMENT PLAN, AGRICULTURAL HALL, NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.



FIRST-FLOOR PLAN, AGRICULTURAL HALL, NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.



SECOND-FLOOR PLAN, AGRICULTURAL HALL, NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

been going on within the past few years, has made these added facilities a necessity.

The new building is designed to be the central feature of a new group of buildings which are in contemplation, viz, a main stock barn, a veterinary building, a horticultural building, a building for agricultural engineering, and a dormitory for agricultural students. These will be located in accordance with a general plan which has been prepared by a landscape architect for the further development of the grounds of the institution.

The agricultural building makes provision for the administrative offices of the department of agriculture, and includes class rooms and laboratories for the departments of agronomy, animal husbandry, dairying, veterinary science, and biology in the college. It also provides improved facilities for such college officers as are connected with the experiment station, for whose station work special research laboratories and other rooms are set apart.

The building has a frontage of 208 feet by a depth of 74 feet, and is two stories high above a basement of full height, and amply lighted. In effect, therefore, it is a three-story building. The basement floor (Pl. IX) is devoted to the departments of animal husbandry and dairying, with a large live-stock judging room, rooms for farm butchering, butter and cheese rooms, etc. There will be a refrigerating plant for cooling six separate cold-storage rooms to different temperatures.

The first floor (Pl. X) contains a laboratory and class rooms for soil physics, an agronomy laboratory, a farm machinery room, and a dairy laboratory and class room. There is also a library connecting with a students' meeting room, and offices for the professor of agriculture and the farm superintendent. The second floor (Pl. XI) will be devoted mainly to botany, veterinary science, and bacteriology. There will be botanical, bacteriological, plant-disease, and physiological laboratories, class rooms for veterinary science, botany, and zoology and physiology, together with a veterinary pharmacy, incubator rooms, storerooms, and offices.

An elevator extends from the basement to the second story, and a fireproof vault is provided on the main floor. The class rooms for veterinary science and botany on the second floor are so arranged that they may be thrown together, providing a large lecture room for public gatherings.

The building is constructed of buff pressed brick and granite. It has a roof of red tile, and all outside metal work is of copper. The inside walls are of face brick, painted, and the building is of slow-burning construction throughout. Heat will be supplied from the central heating plant. The cost of the building, with equipment, will be about $100,000.

WORK OF THE COLLEGES.

The most notable feature of the progress of the work of the agricultural colleges during the past year has been the increase in the number and variety of the enterprises for extension work. The use of special railroad trains for demonstrating to farmers the value of careful selection of seed, as described in the report of this Office for 1904, has extended to a number of States. Brief courses in the judging of live stock and grain have been given at a number of colleges. Short courses and summer schools for teachers have been conducted in more States than ever before, and in general the agricultural colleges are more actively seeking to promote popular agricultural education both in the public schools and among adult farmers. At Cornell University a course of lectures on agricultural journalism has been provided in connection with the winter short courses.

The International Livestock Exposition held annually at Chicago has developed educational features of considerable importance. This exposition brings together the finished specimens of horses, cattle, sheep, and certain classes of swine, representing many types and breeds to compete for prizes offered by the exposition and the breeders' associations. Such an aggregation has not been seen anywhere else in the country, or perhaps in the world. The attendance is very large, more than 600,000 admissions being recorded at the exposition of 1905. Not only a large number of representative breeders and stockmen, but also thousands of farmers from different parts of the country go there to learn and to have their ideals of live stock developed. In 1905 17 States and the province of Ontario sent delegations of students from the agricultural colleges. There were about 100 each from Illinois, Iowa, and Nebraska, and large numbers from other colleges near by, like those of Wisconsin, Michigan, Indiana, and Ohio; 30 from Colorado, 10 from Texas, several from Kansas, Missouri, Louisiana, and 18 from Ontario. These students took part in the competitive judging tests for horses, cattle, sheep, and swine. There was also a corn-judging contest. The agricultural colleges and experiment stations contributed a large number of animals to the show, the official catalogue showing some 275 entries by them in 95 different classes.

The grand championship of the fat-stock show was won by the Iowa State College, with an Angus steer selected by Prof. C. F. Curtiss about a year ago from a carload lot at the stock yards, and fed at the college. The reserve champion was also from the college, a quite remarkable fact. This is the fourth year that the grand championship has fallen upon a college or station animal. In 1902 it went to Iowa, in 1903 to Nebraska, and in 1904 to Minnesota. The showing made by the colleges in the fat-stock classes has demonstrated their

high ability to pick out prize animals from market lots and to feed and finish them to perfection.

The champion steer among the Shorthorns was from Purdue University, and the University of Nebraska won a prize on a yearling steer. Ohio State University took a large number of prizes on its swine, including the grand championship in several classes. Numerous awards were also made to the Iowa College on its pigs, and to the University of Wisconsin on its sheep and on finished carcasses, in addition to those in the college and station specials.

The increasing prominence of the agricultural colleges and experiment stations in connection with this show is one of the striking illustrations of the change in attitude toward these institutions. Their success in open competition with the world's masters has had great influence in popularizing agricultural education. Everywhere the college and station men were greeted and referred to with respect. Farmers in the audience were pointing them out to one another, and in the judging ring they were much in evidence. These things have demonstrated the practical character of the colleges and the high degree of confidence now reposed in their specialists.

Of the list of judges at the show, nine were men connected with the agricultural colleges and experiment stations, and they judged in nearly 150 classes of horses, cattle, sheep, and swine, being in many classes the only judges. The work was repeatedly commended for the soundness and judgment displayed, and the reasons for their decisions were uniformly intelligible and freely given.

THE RURAL SCHOOLS.

The progress of the conviction among leading educators in this country that agriculture should be given a place in courses of study in rural schools was shown at the forty-fourth annual convention of the National Educational Association held at Asbury Park, N. J., in July, 1905. Elementary agricultural instruction was one of the prominent subjects of discussion at this convention, and it enjoyed the distinction of special mention in the annual address of the president of the association, delivered to thousands of teachers at the opening session. This was perhaps all the more significant as coming from the superintendent of schools of New York City, Dr. Wm. H. Maxwell. His statement was as follows:

> Again, take the teaching of agriculture. While our soil seemed inexhaustible in fertility as in extent, the need of such teaching was not felt. Now, however, we are obliged to have recourse to lands that produce only under irrigation. The rural schools have added to our difficulties by teaching their pupils only what seemed most necessary for success when they should move to the city. The farms of New England are, in large measure, deserted or are passing into alien hands. To retain the country boy on the land and to keep our soil from exhaus-

tion, it is high time that all our rural schools turned their attention, as some of them have done, to scientific agriculture. There is no study of greater importance. There is none more entertaining. If every country boy could become, according to his ability, a Burbank, increasing the yield of the fruit tree, the grain field, and the cotton plantation, producing food and clothing where before there was only waste, what riches would be added to our country, what happiness would be infused into life. To obtain one plant that will metamorphose the field or the garden, 10,000 plants must be grown and destroyed. To find one Burbank, 10,000 boys must be trained, but, unlike the plants, all the boys will have been benefited. The gain to the nation would be incalculable. Scientific agriculture, practically taught, is as necessary for the rural school as is manual training for the city school.

In the report upon educational progress of the year by Howard J. Rogers, first assistant commissioner of education of the State of New York, who had charge of the educational exhibits at the Louisiana Purchase Exposition, the teaching of agriculture was referred to among the few leading subjects of interest in the educational world at present.

Most important of all, however, was the report of the committee on industrial education in schools for rural communities. This committee was appointed at the Boston meeting of the association in 1903, to investigate and report to the association conclusions as to what should be undertaken in the field of industrial education in schools for rural communities. The members of the committee are L. D. Harvey, chairman, superintendent of schools of Menomonie, Wis.; L. H. Bailey, director of the College of Agriculture of Cornell University; Alfred Bayliss, State superintendent of public instruction in Illinois; W. T. Carrington, State superintendent of public schools in Missouri, and W. M. Hays, Assistant Secretary of Agriculture.

The report includes a summary of conclusions regarding industrial education (agriculture, domestic science, and manual training) in rural schools; an argument for such education; a discussion of what in the field of industrial education should be undertaken in rural schools of different grades, namely, one-room rural schools, consolidated schools, rural high schools, and secondary schools of agriculture and domestic economy; with suggestive outlines for courses in nature study and agriculture for elementary and secondary schools; suggestions for eliminating part of the unnecessary work now undertaken in rural schools to make room for industrial subjects and for the training of teachers to give instruction in these subjects, and an account of boys' experiment clubs, and other agencies available for cooperation in the development of industrial education.

Information regarding the organization and courses of study of the existing and proposed schools discussed by the committee is given in four appendixes, Appendix A, treating of the Dunn County (Wis-

consin) School of Agriculture and Domestic Economy; B, of the Minnesota School of Agriculture; C, of "Articulated courses in industrial subjects in the consolidated rural school; the agricultural high school, and the agricultural college, as prepared by W. M. Hays, at the request of the committee;" and D, the syllabus of an elementary course in agriculture, quoted from Circular 60, of this Office.

In general, the committee maintained that the rural schools which train nearly one-half of the school population of this country, should recognize the fact that the major portion of their pupils will continue to live upon the farm and should provide specific, definite technical training for them for the activities of farm life. It adduced strong arguments in support of this position and emphasized the educational value as well as the practical utility of courses of study framed with this end in view. The committee favored the consolidation of rural schools, in order that teachers specially fitted to this work might be secured and the instruction made more efficient. It also advocated the establishment of high schools to meet the special needs of the rural population for secondary education directly related to agricultural practice.

The general conclusions reached by the committee, as stated in the report, are as follows:

First. That in existing one-room district schools a limited amount of nature study and work in the elements of agriculture, and hand work for both boys and girls may be undertaken; that in view of the quality of the teaching force available for these schools, the immaturity of the greater number of the pupils, the crowded condition of the programme, and the lack of adequate supervision, but little can be expected in the way of industrial education in this class of schools; but where enthusiastic teachers qualified for the work, and pupils of sufficient maturity are brought together in the same school, something worth while may be accomplished, and that the effort for such accomplishment should certainly be made.

Second. That in the consolidated school having at least four teachers, one of whom is prepared to teach the elements of agriculture and manual training, and another domestic science, very much more in the field of industrial education may be attempted than in the one-room school, and with far better results. The committee believes this to be true, because in such schools teachers may be secured with far better qualifications than are possessed by most of the teachers in the one-room schools, and because in many cases pupils will remain for one or more years after completing the elementary school course, during which time the work in industrial education may be continued. In the consolidated school district, in most cases, new buildings must be erected. At small expense rooms may be provided for manual training and domestic science work, and a plat of land as a part of the school grounds set apart for illustrative and experimental work in agriculture. While the committee does not wish to enter into any argument in favor of consolidated schools for other reasons than for the facilities they may afford for industrial education, it wishes to indorse most heartily that portion of the report of the committee of twelve on rural schools concerning the advantages of the consolidated school.

Third. That in the township or other distinctively rural high school, and in the village high schools attended by a considerable number of pupils from the country, a modification of courses of study should be made which shall provide for the introduction of work, especially in the elements of agriculture and domestic science, and such further lines of industrial education as local conditions may make feasible. To make this work a success, teachers must be secured who have made special preparation for it. For such schools a text-book treating botany from an agricultural and economic standpoint is greatly needed.

Fourth. That while the agricultural or industrial high school is found in but few localities, the character of the work already done in the existing schools of this class, the interest they awaken, and the hearty support they receive from the agricultural communities maintaining them, the history of these schools in foreign countries, the value of their work both for disciplinary and practical purposes, all combine to present the strongest reasons for the organization of schools of this type in large numbers in agricultural communities. So thoroughly is the committee convinced of the importance of industrial education in rural communities, and what is essential for making this education effective, that in their opinion the establishment of secondary schools distinctively industrial in their character, and of the type mentioned, is an absolute necessity for the proper development and organization of the rural school system.

Fifth. That the agricultural colleges and experiment stations have already done much in the formulation of a body of knowledge essential in the field of industrial education, but that more yet remains to be done in putting this body of knowledge into available form for use in elementary and secondary schools, and that effort in this direction should be made a prominent feature in the work of the agricultural colleges of the country.

Sixth. That the mastery of such parts of this rapidly developing body of knowledge as is within the capabilities of elementary and secondary school pupils, furnishes a mental training unsurpassed in extent and quality by the mastery of any other body of knowledge now regarded as essential in our common school courses and requiring an equal amount of time; and that for utility value it is not equaled by any other body of knowledge at present acquired through the expenditure of the same amount of time and effort.

Seventh. That for the improvement of educational conditions in rural communities, the people in those communities must be educated to see and appreciate the possibilities and value of industrial education; that the value of this kind of education in increasing the productive capacity of those being educated is the argument which appeals most strongly to the rural population. Therefore, in the beginnings of industrial education in any community, immediate, practical results that will appeal directly to the interests of the people who support and maintain the schools must be made prominent by those concerned with its development.

Eighth. That the courses of study in rural schools should be framed with reference to meeting the needs of the children in those communities, and not with reference to preparing a small percentage of these children to enter higher schools whose courses of study are formulated, not to meet the needs of the great majority of those who attend them, but to prepare the remaining small minority to enter some still higher school.

Ninth. That it is possible and desirable so to organize the rural school system as to present an articulated series of schools from the elementary school to and including the agricultural college, in which the work at every stage shall be planned and administered with reference to the needs of the pupils at that stage without the elimination of any valuable feature in the present school system,

and without abridging in anyway the opportunities for advancement of such pupils as wish to enter other schools of secondary or higher grades.

Tenth. That in industrial education, as in every other form, the success of the work depends upon the quality of the teaching; and that therefore, since effort for industrial education in elementary and secondary schools is comparatively recent and teachers have not prepared themselves in this field, special opportunities and inducements must be offered to the teaching force to make the necessary preparation.

Eleventh. That the organization of boys' and girls' clubs for definite industrial work outside the school, of clubs of farmers and of farmers' wives for the purpose of carrying on systematic reading courses in agriculture and household affairs, should be undertaken through the cooperative effort of county and State superintendents and agricultural high schools and colleges for the purpose of arousing a general interest in rural communities in the subject of industrial education. That the Patrons of Husbandry and farmers' institutes are potent forces in creating a demand for the introduction of the industrial phase of education into the rural school system, and that their influence can be made still more effective by the establishment of working relations between their officers and workers and the school authorities.

Twelfth. That when teachers are unprepared to give instruction in the elements of agriculture and other phases of industrial effort, the work is likely to result in failure; that under existing conditions and under conditions likely to exist for a long time to come comparatively few teachers in the country schools will be prepared for this work. Therefore, any law making mandatory the teaching of the elements of agriculture, manual training, or domestic science in the entire body of rural schools within a State is unwise, in that the lack of correct information and consequent faulty teaching on the part of the great mass of country school-teachers will tend to bring the whole subject into disrepute and cause a reaction which will postpone the proper development of industrial education. But while the committee advises against making mandatory the teaching of these subjects, it advises just as strongly that every effort be made for the proper preparation of country school-teachers to begin this instruction, and that every encouragement and inducement be offered those prepared to undertake it to introduce and carry it on in the schools under their charge.

The report of this committee also contains the following suggestive courses of study for rural schools prepared by Prof. W. M. Hays:

INDUSTRIAL COURSE IN THE CONSOLIDATED RURAL SCHOOL, THE AGRICULTURAL HIGH SCHOOL, AND THE AGRICULTURAL COLLEGE ARTICULATED INTO A UNIFIED SCHEME.

The articulation of studies in agriculture and in home economics or, as it is more often called, domestic economy, through the consolidated rural school, the agricultural high school, and the agricultural college, heretofore has not been attempted. To demonstrate that this is practicable, and to frame a basic attempt from which the several school faculties may work in articulating schools of the three classes named, the outlines below are presented. These include also the studies not relating to agriculture or home economics, that some idea of proportions as well as of placement and gradation may be shown. The published course of study for the rural schools of Wisconsin, the course of study for the Minnesota Agricultural High School and the collegiate agricultural course of the University of Minnesota were used as the basis of this outline, with additions, omissions, and changes to suit. While the articulation was

kept prominently in mind, the plan was pursued of giving in each lower grade those practical things which promise to be especially valuable to the pupil who drops out. It is hoped that this outline will also be an aid to those who are responsible for the courses of study in rural schools of smaller unit and those interested in formulating courses of study in agricultural high schools smaller than the Minnesota Agricultural School, after which the high-school course of this scheme is modeled.

That these three schools designed to educate for country life can be articulated, as the city graded schools, the city high school (including the city mechanic arts high school), and general and technical courses of the State university, or other college, designed for city life are articulated, is made evident by this outline. It will be seen that this scheme will also enable pupils to transfer from country school to city school, or vice versa, up to the end of the second high-school year without great loss, thus better unifying all schools, of country and town.

It is proving no more difficult to grade the instruction in agriculture and in home economics in primary, secondary, and collegiate courses of study than it was to distribute work in English or history throughout these three classes of schools; though as yet, owing to the newness of these subjects, the process has not proceeded so far in the former as in the latter. In blocking out this scheme of nature study, agriculture, manual training, and home economics for country youth, it is understood that any given school must adopt it to its own conditions, giving such parts suited to its own grades as its surroundings, equipment, and teaching force may render practicable, arranging for articulation with other schools where possible. Thus the teacher in the one-room rural school might be able to take up a few of the nature-study courses designated for the first five grades and some of the courses in agriculture and home economics, outlined for the sixth, seventh, and eighth years. The teachers in the two or three room rural school could give still more of this work; and those pupils who are able to attend the agricultural high school would thus be better prepared there to take the advanced work provided in science, manual training, agriculture, and home economics.

The consolidated rural school provided with a teacher qualified in agriculture and a teacher trained to instruct in home economics, and two or more teachers to assist in the general instruction, could care for the entire ten grades. Even here, however, the course as outlined would necessarily need to be modified to suit local needs, equipment, and preparation of the teaching force.

Books and other helps on nature study, agriculture, and home economics for use in these variously organized rural schools and following the general scheme outlined, could be provided by makers of publications and apparatus, and could be fitted into the respective grades by any school organization using them.

The agricultural high-school course can not be at once completely reorganized in county agricultural high schools or even in large agricultural high schools in State districts of larger size. Each school will be compelled to receive pupils with various stages of preparation in the general school subjects and often with no school instruction in agricultural and home economics subjects, though usually with more or less careful home training and experience in these practical lines; and it has been found that a large percentage of those who enter with but poor preparation become strong students and continue to graduation. On the other hand, local conditions, such as the short time the pupils will remain in the agricultural high school and the limitations in the way of equipment and teaching force, will make it quite impossible to secure uniformity in

requirements for graduation. In time it may be possible to approximate the uniformity reached in this respect in city high schools, though such uniformity is by no means a matter of prime importance. The main thing sought should be to give more training to all, however early or late in the course they may drop out of school. The course below is given only as a sort of guide and a standard which all such schools may strive to reach. Where a State can organize consolidated rural schools fully developed according to the general plan given, it is believed that the agricultural high school may be given its definite portion of school work much as outlined, and that the agricultural collegiate course will develop strongly and naturally beside other collegiate and university courses. Making practical education universal in the lower schools is the real problem, and the chief function of the higher schools is to make possible some technical education in the lower schools where all pupils may receive some benefit.

The courses in agriculture, forestry, and home economics in agricultural colleges are gradually approaching a uniform standard, with requirements in amount similar to those established for entrance into the undergraduate course in universities. The desire to rank with other institutions is, however, of less importance to the State than that the college shall prepare teachers for lower schools, leaders in the industry of agriculture and in home making, and investigators and advanced teachers. Since studies in these technical branches are rapidly rising in value as means of education or culture, in addition to their technical value, agricultural college courses promise to hold a position beside the general courses, if, indeed, they shall not be ranked as broader because they both educate and prepare for definite work.

Consolidated Rural School Course.

FIRST YEAR.

Reading.	Writing.
Spelling.	Music.
Language.	Nature study.
Number work.	General exercises.

SECOND YEAR.

Reading; using in part themes from nature, the farm, and the home.	Music.
Spelling.	Hygiene.
Language.	History.
Number work.	Drawing.
Writing.	Nature study.
	General exercises.

THIRD YEAR.

Reading; nature stories forming a part.	Geography.
Spelling.	Hygiene.
Language.	History.
Arithmetic.	Nature study.
Writing.	General exercises.
Music.	

FOURTH YEAR.

Reading; country life literature included.
Spelling.
Language.
Arithmetic.
Writing.
Music.
Geography; should include the distribution of farm products.
Hygiene.
Drawing.
Nature study.
General exercises.

FIFTH YEAR.

Reading; including stories of our country and lessons in agriculture and home economics.
Spelling.
Language.
Arithmetic.
Writing.
Music.
Drawing.
Geography; including in part physical geography in respect to the work done by nature's forces in preparing soils.
History.
Physiology.
Nature study.
General exercises.
Literary society work.

SIXTH YEAR.

Reading; lessons should include animal life and adventure.
Spelling.
Language.
Arithmetic.
Writing.
Music.
Drawing.
Geography.
Physiology.
History.
Physiology; including principles of nutrition and food values.
Cooperative enterprises.
Agriculture; first half year, the affairs of agriculture; second half year, the soil,.
General exercises; for boys, woodwork; for girls, sewing.
Literary society work.

SEVENTH YEAR.

Reading and literature.
Spelling.
Grammar.
Arithmetic.
Writing.
Geography; combined with physical geography.
Music.
History.
Cooperative enterprises.
Agriculture; farming schemes and crops.
General exercises.
Literary society work.

EIGHTH YEAR.

Reading and literature.
Spelling.
Grammar.
Arithmetic; including farm problems, land surveying and farm statistics.
Music.
Geography.
History.
Agriculture; animals—practice work.
General exercises.
Literary society work.

Ninth and tenth, or first two high school years are placed in the consolidated rural school. The figures indicate the number of weekly recitations of the respective studies.

NINTH YEAR (D HIGH SCHOOL YEAR): FIRST HALF YEAR.

Agricultural botany	4
Elementary algebra	5
English	4
Drawing—farms and buildings	2
Rhetoricals	1

Boys:		Girls:	
Rural engineering	3	Sewing	2
		Agriculture	1

SECOND HALF YEAR.

Agricultural botany	4
Elementary algebra	5
English	4
Farm accounts	4
Rhetoricals	1

Boys:		Girls:	
Fences and farm conveniences	2	Cooking	2

TENTH YEAR (C HIGH SCHOOL YEAR): FIRST HALF-YEAR.

Plane geometry	5
Physiology—foods and feeds	4
Civics	4
General history	5
Rhetoricals	1

Boys:		Girls:	
Judging stock and seeds	1	Sewing	2
Carpentry	2½		

SECOND HALF-YEAR.

Plane geometry	5
English	4
Agricultural mathematics	4
General history	5
Rhetoricals	1

Boys:		Girls:	
Judging stock and seeds	1	Sewing	2
Carpentry	2½		

Agricultural High School.

ELEVENTH YEAR (B HIGH SCHOOL YEAR): FIRST HALF-YEAR.

Fruit growing	3
Higher algebra	5
Agricultural physics	4
Drawing	1
Poultry	2
Dairy husbandry	2

Boys:		Girls:	
Carpentry	2	Social culture	1
Military drill	2	Laundering	2
Gymnasium	1	Physical culture	2

SECOND HALF-YEAR.

Solid geometry	5
Elementary chemistry	5
Agricultural physics	5
Dairy husbandry	2½

Boys:		Girls:	
Drawing barns	2	Home management	1
Study of breeds	2	Drawing farmhouses	1
Military drill	2	Sewing	2
Gymnasium	1	Physical culture	2

TWELFTH YEAR (A HIGH SCHOOL YEAR): FIRST HALF YEAR.

Chemistry of plants and animals	5
Forestry	3
Entomology and zoology	5
Dairy chemistry	2

Boys:		Girls:	
Breeding animals	2	Cooking	2
Veterinary	2½	Household art	1
Blacksmithing	2½	Sewing	2
Military drill	2	Physical culture	2
Gymnasium	1		

SECOND HALF-YEAR.

Plant propagation	3
Farm management	2

Boys:		Girls:	
Breeding crops	1	Meats	1
Field crops	2	English	4
Dressing and curing meats	1	Pedagogy	4
Feeding animals	3	Cooking	3
Soils and fertilizers	5	Sewing	3
Veterinary	2½	Home economy	1
Blacksmithing	2½	Dietary studies	3
Military drill	2	Domestic hygiene	1
Gymnasium	1		

The outline below is made somewhat elective, the specific statements following show what is included in each of the subjects from among which the student may elect:

FRESHMAN YEAR.

A. Required for graduates of agricultural high schools.

First semester:		Second semester:	
Mathematics	4	Mathematics	4
Drawing	4	Chemistry	2
Botany	4	German, French, or Spanish	4
German, French, or Spanish	4	Botany	4
Military drill or gymnasium	2	Military drill or gymnasium	2
		English literature	2

NOTE.—A modern language elected must be pursued for the full two years.

B. Graduates of city high schools take in lieu of the above freshman course a full year of prescribed technical work in agriculture or home economics in an approved agricultural high school, choosing technical subjects as from the agricultural high-school course given above.

SOPHOMORE YEAR.

First semester:		Second semester:	
Rhetoric	3	Geology	3
Agricultural chemistry	4	Zoology	3
German, French, or Spanish	3	Agricultural chemistry	4
Agricultural physics	2	German, French, or Spanish	3
Military drill or gymnasium	2	Agricultural physics	2
Zoology	3	Rhetoric	1
		Military drill or gymnasium	1

JUNIOR YEAR.

First semester:		Second semester:	
English	3	Agricultural economics	3
Elective, academic	3	Elective, academic	3
Elective, academic	3	Elective, academic	3
Elective technic, major	4	Elective technic, major	4
Elective technic, minor	4	Elective technic, minor	4

SENIOR YEAR.

First semester:		Second semester:	
Elective, academic	3	Elective, academic	3
Elective, academic	3	Elective, academic	3
Elective, academic	3	Elective, academic	3
Elective technic, major	4	Elective technic, major	4
Elective technic, minor	4	Elective technic, minor	4

NOTE.—Minor agricultural subjects cover not more than two semesters' work in the junior and senior years. The major agricultural work subjects, including a graduating thesis and a year of practical work, is to be carried through the junior and senior years.

The committee also quoted the syllabus of an elementary course in agriculture prepared by the committee on teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations, which was published in an article on the Progress of Agricultural Education in the report of this Office for 1904, and also as Circular No. 60.

SECONDARY SCHOOLS.

Considerable progress has been made during the past year in the definite recognition of instruction in agriculture as a legitimate part of the public high-school system. One drawback to the introduction of agricultural subjects in these schools has been the lack of provision for giving students taking courses in agriculture credit for this work for graduation and entrance to college. The council of the State University of Missouri, desiring to promote agricultural education, has taken action to remove this obstacle by allowing a credit of one unit on the entrance requirements for a year's work in agriculture in the high school.

The regents of education of New York State, who provide uniform examinations for all the high schools of the State, thus establishing a standard for attainment and graduation for these schools, which has been a very important feature in their development, have decided to allow credits in the regular high-school courses for nature study and elementary agriculture, provided the courses in these subjects are so prepared as to show educational values comparable with those of the other subjects now recognized in the regents' examinations.

To meet this requirement the following syllabus has been prepared at the request of the New York State Education Department by representatives of the College of Agriculture of Cornell University, and it is expected that an outline of laboratory exercises to accompany the topical syllabus will be issued at an early date:

AGRICULTURE.

This outline presents an orderly arrangement of work for a three-period course for one year. It should preferably be pursued in the second year of the high school, after the pupil has completed a year's work in biology. The student must also have some knowledge of elementary chemistry; if this knowledge has not been obtained in the study of biology, one or two weeks should be devoted to it before the specific subjects of the course in agriculture are undertaken. The pupil should have an elementary knowledge of chemical combination and also of the 14 elements chiefly concerned in the composition of soil and the production of plants and animals: (1) Carbon; (2) hydrogen; (3) oxygen; (4) nitrogen; (5) sulphur; (6) phosphorus; (7) iron; (8) calcium; (9) magnesium; (10) potassium; (11) sodium; (12) chlorin; (13) silicon; and (14) aluminum.

Abundant laboratory work should be provided, at least one period out of the three, every week.

Agricultural operations are conducted for two immediate purposes—to raise plants, and to raise animals. Plants are raised either for their own value or for their use in the feeding of animals. In studying agriculture, therefore, it is well to begin with the plant, then proceed to the animal, and then consider questions of practice and management that grow out of these subjects.

PART I.—THE PLANT AND CROPS.

The study of the plant may be provided for under the general heads: (1) The plant itself; (2) the environment that influences or modifies the plant.

SECTION 1.—THE PLANT ITSELF.

Under section 1 the plant may be studied in relation to (*a*) composition; (*b*) structure; (*c*) physiology; and (*d*) heredity and plant breeding. On the assumption that the student has covered categories *a*, *b*, and *c* in his work in botany, these subjects are omitted here; therefore only part *d*, together with a classification of agricultural plants, is outlined here.

A.—Classification of economic plants.
- (1) Cereals.
- (2) Grasses.
- (3) Legumes.
- (4) Vegetables.
- (5) Fruits.
- (6) Tubers.
- (7) Roots.
- (8) Sugar plants.
- (9) Oil plants.
- (10) Fiber plants.
- (11) Stimulants.
- (12) Medicinal and aromatic plants.
- (13) Timber crops (forestry).
- (14) Flowers and ornamental plants

B.—Heredity and plant-breeding.
- (1) Principles.
- (2) Processes.
- (3) Steps in improvement of plants.
  - (*a*) Variation—environment, crossing.
  - (*b*) Selection.
  - (*c*) Testing hereditary power.
- (4) Illustrations of improvement in plants.
- (5) Methods of improvement.

SECTION 2.—ENVIRONMENT OF THE PLANT.

The subject of environment may be studied under the following heads: (*a*) light and heat; (*b*) air; (*c*) soil; (*d*) moisture; (*e*) applied plant food; and (*f*) repressive and noxious agencies.

C.—Light and heat.
- (1) Relative interdependence.
- (2) Effect.
- (3) Influence of character of light.
- (4) Influence of seasons.
- (5) Temperature for germination and growth.

C.—Light and heat—Continued.

(6) How modified: By

(*a*) Color.

(*b*) Evaporation.

(*c*) Topography.

(*d*) Character of soil.

(*e*) Cultivation.

(*f*) Rolling.

(*g*) Thickness of planting.

(*h*) Fermentation.

(*i*) Artificial means—screens, electricity, artificial heat.

D.—Air.

(1) Function above ground.

(*a*) Oxygen.

(*b*) Carbon dioxid.

(2) Function in soils.

(*c*) Oxygen.

(*d*) Nitrogen.

(*e*) Removal of carbon dioxid.

(3) Processes of soil ventilation.

(*f*) By diffusion.

(*g*) By expansion and contraction of air due to temperature.

(*h*) By expansion and compression due to barometric pressure.

(*i*) Suctional effect of gusts of wind.

(*j*) Air absorbed by rain water.

(*k*) By removal of water through drainage, evaporation, and transpiration of plants.

E.—The soil—function of the soil.

(1) As rootholds and mechanical supports of plants.

(2) As sources of plant food.

F.—The soil—origin.

(1) Disintegration and decomposition of rocks.

(2) Erosion, transportation, and deposition of sediment (by water and ice).

(3) Sorting out of sand, silt, and clay by running water and deposition of soils of different texture as a result of sorting.

(4) Movement of soils by wind.

(5) Decay of animal and vegetable materials. Humus.

G.—The soil—physical composition.

(1) Solid matter: Mineral, organic.

(2) Liquid matter: Impure water or soil solution, air.

(3) Gaseous matter: Carbonic-acid gas, water vapor.

H.—The soil—kinds of soils: Peat, muck, clay, loam, sand, gravel, stony soils.

I.—The soil—texture of soils: Relation of texture to air, retention and movement of water, drainage, temperature, weight, and solidity, roothold of plants.

J.—The soil—plant food in the soil and air (general survey).

(1) Elements essential to plant life.

(2) Elements found in minerals.

(3) Elements and compounds in air (oxygen, nitrogen, carbon dioxid, ammonia).

(4) Elements in water (hydrogen, oxygen, and dissolved oxygen).

K.—Moisture.

(1) Purpose.
(2) Importance.
(3) Quantity required.
(4) How modified: By
(*a*) Kind of soil.
(*b*) Topography.
(*c*) Fertilizers and amendments.
(*d*) Cultivators.
(*e*) Drainage and irrigation.

L.—Plant food.

(1) According to constituents.
(*a*) Nitrogenous.
(*b*) Phosphoric.
(*c*) Potassic.
(*d*) Amendments.
(2) According to form.
(*e*) Green manures. Cover crops.
(*f*) Animal manures. Farm manures.
(*g*) Commercial manures or fertilizers.

M.—Plant food (farm manures).

(1) Properties.
(2) Sources.
(3) Uses.
(4) Preparation, care, and handling.
(5) Application.
(6) Economy.

N.—Plant food (commercial fertilizers).

(1) Sources.
(2) Uses.
(3) Application.
(4) Economy.
(5) Offices of the leading elements of commercial fertilizers—nitrogen, potassium, phosphorus.

O.—Repressive agencies.

(1) Insects.
(2) Fungus diseases.
(3) Acidity of soil.
(4) Toxic agencies and untoward conditions.

P.—Farm crops.

Actual study of the leading crops of the community. The products themselves should be actually handled and studied in school, as ears of corn, beans, wheat (in head and straw if possible), potatoes, oats, fruits, and vegetables. Determine physical characteristics, as weight, size, shape, color, etc. Discuss the methods of growing the crop, its place in the farm scheme and in the rotation, methods of preparing the land and tillage, fertilizing, harvesting, marketing, insect and fungus enemies, its importance in the community, and history. At least one crop should be thus studied in detail.

PART II.—ANIMALS AND ANIMAL HUSBANDRY.

Q.—The kinds of domestic animals.

(1) Classification of common domestic animals.

Mammals: Cattle, sheep, swine, horses, asses, mules, and dogs.

Birds: Fowls, ducks, geese, pigeons, and turkeys.

Insects: Bees.

(2) Zoological relationships: Origin, history of domestication, purposes for which kept, races, breeds, and varieties of each.

R.—Nutrition of domestic animals.

(1) Relations of plant and animal life.

(2) The chemical elements of nutrients: Their number and occurrence in plants and animals.

(3) The compounds of animal nutrients.

(*a*) Water: In living plants, feeding stuffs, the animal. Its occurrence and functions.

(*b*) Mineral matters (ash) in the plant and in the animal: Amount and distribution.

(*c*) The nutrients.

S.—Nutrition (continued). The nutrients in detail.

(1) Protein.

(*a*) Nomenclature.

(*b*) Examples.

(*c*) Composition.

(*d*) Physical characteristics.

(*e*) Variability.

(*f*) Occurrence.

(*g*) Distribution.

(2) Carbohydrates.

(*a*) Examples.

(*b*) Composition.

(*c*) Physical characteristics.

(*e*) Starches.

(*d*) Nitrogen-free extract and crude fiber.

(*f*) Sugars.

(*g*) Occurrence and distribution.

(3) Fats and oils.

(*a*) Character and composition.

(*b*) Occurrence and distribution.

(4) Functions of the nutrients.

(*a*) Protein.

(*b*) Carbohydrates and fat.

(*c*) Relations to one another.

(*d*) Nutritive ratio.

(*e*) Food as a source of energy.

(*f*) Heat relations.

T.—The digestion and utilization of food.

(1) The digestive tract.

(2) Ferments.

(3) Conditions influencing digestion.

(*a*) Palatableness.

(*b*) Quantity.

(*c*) Stage of growth of plant.

(*d*) Effect of methods of preservation and storage.

T.—The digestion and utilization of food—Continued.

(3) Conditions influencing digestion—Continued.

(*e*) Grinding.

(*f*) Addition of salt.

(*g*) Frequency of feeding and watering.

(*h*) Determination of digestibility.

(4) Distribution and use of digested food; also elimination of wastes.

U.—Foods.

(1) Pasturage.

(2) Forage and fodders: Green and dried fodders, soiling, and silage.

(3) Roots and tubers.

(4) Concentrated feeding stuffs: Grains and seeds, commercial by-products.

V.—Rations.

(1) Food requirements of different animals for different purposes.

(*a*) For maintenance.

(*b*) For work.

(*c*) For growth (young animals).

(*d*) For flesh (fattening).

(*e*) For milk, eggs, wool, etc.

(2) Combination of fodders into rations.

(*f*) Amount of nutrients.

(*g*) Amount of water (succulence).

(*h*) Relative proportions of protein and nonprotein (nutritive ratio).

(*i*) Palatableness.

(*j*) Effect on product.

(*k*) Economy.

W.—Animal products.

(1) Flesh: Beef, mutton, pork, poultry; relation; composition; quality as determined by age and condition of animal; relative suitability as food for man; economy.

(2) Eggs: Composition; quality as affected by food of fowl; methods of preservation; economy.

(3) Milk.

(*a*) Source; kind of animal; physiology of secretion; methods of milking.

(*b*) Quality; chemical and physical properties; natural variations as affected by animal, by food, by environment, by adulteration.

(*c*) Determination of specific gravity, fat, organisms, impurities, adulteration.

X.—The animal. (The animal form as related to production.)

(1) Animal mechanism in relation to speed and force, types of animals for production of milk and beef, wool and mutton, eggs and flesh. Correspondence of individual to type. Standards or scales of points; methods of scoring.

(2) Selection of animal with reference to future generations; heredity; variation; evolution of modern forms from simpler types.

PART III.—FARM SCHEMES AND MANAGEMENT.

Y.—Farms schemes.

(1) Kinds of farming.

(2) Rotations, considered as to history, principles, and systems.

Y.—Farm schemes—Continued.

(3) Lay-out of farms, as to arrangement of fields, lanes, water supplies, and buildings.

Z.—Farm practice.

(1) Tillage.

(*a*) Purpose and effects.

(*b*) Methods.

(2) Drainage.

(*c*) Purpose and effects.

(*d*) Methods.

(3) Irrigation.

(*e*) Purpose and effects.

(*f*) Methods.

In Minnesota an act passed by the legislature in 1905 provides for local option in the establishment and maintenance of county schools of agriculture and domestic economy, limiting to $20,000 the amount any county may appropriate for this purpose in one year. The initiative in establishing such schools may be taken by the people or the county school commissioners, but the latter can not actually establish the school until the electors have passed on the question. Two or more counties may unite for this purpose. The schools are to be under the control of a county school board of three members, the secretary of which shall be the county superintendent of schools, and the other two members are to be elected by the county commissioners. Each school must have connected with it a tract of land suitable for experiments and demonstrations of not less than 10 acres. Tuition is to be free to residents of the county or counties contributing to its support. The State superintendent of public instruction is to have general supervision over the schools, and, with the advice of the dean of the college of agriculture of the State University, is to prescribe the courses of study.

In Kansas a law of several years' standing provides local option in the establishment of county high schools. As a result several sparsely settled counties, or counties in which there are few large towns, are supporting such schools. Among these is Norton County, which maintains a good high school in the village of Norton, a town of about 1,500 inhabitants located near the geographical center of the county.

The high school building is of brick, two stories high, over a well-lighted basement, and is located on the outskirts of the village, where land can be easily secured. The basement contains furnace and fuel rooms, lavatories, and a gymnasium. On the first floor is a physics and chemistry room, a natural history room, a music and art room, and the rooms of the business department. The second floor contains an assembly and study room and two recitation rooms. The apparatus and other equipment for the work in physics, chemistry, and natural history are exceptionally good for a small high school.

There is also a good library and reading room, with current newspapers and magazines.

The expense of running the school in 1903–4 was $9,588, including $4,430 for teachers' salaries and $5,158 for buildings, grounds, and incidentals. This was a year when considerable sums were spent for furniture, apparatus, supplies, and additional land. The running expenses for the first six months in 1905 were $3,775. Five teachers have been employed, but this year there were six.

Previous to this year the Norton County High School has offered college preparatory, normal, business, and general science courses, but no courses related in any direct way to the leading industry of the county—farming. The county superintendent of schools said that his attention had been forcibly directed to this lack in the curriculum of the high school by the experience of a young man who came to the school from one of the many large farms in the vicinity, took the four-year business course, spent one year in a local bank at $30 a month, and then concluded that he would gain in both purse and pleasure by going back to the farm. Such a young man, and there are many like him in the Norton County High School, would have welcomed an agricultural course and would have gone back to the farm much better prepared for the duties of life than he was with a business training. So the county superintendent of schools and the other members of the board of trustees decided that an agricultural course should take the place of the general science course and hired a graduate of the Kansas State Agricultural College to teach agriculture and other sciences in the high school. The Secretary of Agriculture, who was then making a trip through the "short-grass country," became interested in the enterprise and sent a representative of this Office to Norton to help work up an interest in the agricultural course and to aid in outlining the work. The president of the Kansas State Agricultural College also responded to a call for assistance and made one of a party of four that toured the county for eight days in the interests of the new course of study. As a result considerable interest was aroused in the proposed new work, a tentative agricultural course was outlined, and arrangements were made with the three farm implement dealers of the town to open their warehouses to the classes in agriculture and furnish experts to give instruction on the mechanics, care, and use of farm machinery.

The agricultural work of the course will include botany, with special reference to variation, development of species, hybridization, and the influence of light, heat, moisture, etc., on the plant; soils and tillage; plant physiology, farm crops, grain judging, and horticulture; farm accounts; farm management, including farm plans, methods of cropping, farm machinery and its care, and rural economics with special reference to the problems of a business nature that will

be met on the farm; animal production and stock judging; and dairying. The teacher of agriculture reports that the implement dealers have given further evidence of their interest in the agricultural courses by offering prizes aggregating $112 in value for a grain-judging contest, open to all young men in the county, to be held this winter, and that these prizes have been supplemented by a $15 suit of clothes from a clothing dealer. Continuing, he says: "I am well pleased with the way the boys take hold of the work. We have 9 out of 70 boys enrolled in the agricultural course, and I think most of the first-year boys will take it up when they get to it in the course. It is proving popular in the school and entirely free from the prejudice I had anticipated at the outset."

This is the nucleus of an important experiment in education. Norton is just in the edge of the great semiarid region of the Middle West. Agricultural practice in that region differs materially from that of the more humid regions on the one hand and from that of the irrigated districts on the other. The teacher of agriculture is thoroughly familiar with the agriculture of the region and has but recently graduated from an agricultural college which is devoting much study to the problems of the one hundredth meridian belt.

A high school of a different type, in which a course of agriculture has recently been introduced, is located at Waterford, Pa. Here the first high school in Erie County was established in 1800, and here in 1822 was erected a stone academy building, which is still used as the main part of the high school building. The township of Waterford has a population of 1,460, and about half of these (770) reside in the borough of Waterford. The borough has its own elementary school, but the high school is supported and controlled jointly by the borough and township.

The high school, with its three teachers and three courses of study (language, scientific, and agricultural), has an enrollment of 80 pupils, and 35 of these are in the agricultural course. This course includes agriculture, five hours a week for four years. The work of the first year is devoted to a study of plant life—germination, plant growth, plant food, reproduction, propagation, transplanting, pruning, and uses of plants; the second year to a study of field, orchard, and garden crops; the third year to domestic animals, dairying, and soil physics, and the fourth year to the chemistry of soils and of plant and animal life. Text-books are used in the class room; a small library of agricultural reference books, reports and bulletins of this Department and experiment stations, and agricultural papers contributed by the publishers is in almost constant use, and lectures on agricultural subjects are given before the class and before the whole school by the instructor in agriculture, who is an agricultural college graduate. But the feature of instruction which chiefly distinguishes

this agricultural course from the ordinary high-school course is the prominence given to the laboratory work and the outdoor practicum. For the laboratory work there is no elaborate apparatus. The pupils make much of their own apparatus, furnish their own reagent bottles, and, moreover, use them. In the plant-life course the pupils study not elaborate and carefully prepared drawings, but the plants themselves with reference to their life history and economic uses.

For the outdoor practicum the school is unfortunate in having neither land nor domestic animals or fowls, and yet it has a wealth of illustrative material all around it. Every good farm within a radius of 3 or 4 miles, nearly every barn and poultry yard in the village, the butcher shops, and the farm-implement stores furnish costly illustrative material and extend vastly the teaching force of the high school. The farmers and other owners of good live stock either bring their animals to the door of the schoolhouse to be studied by the class in agriculture or allow the class to go to their barns and fields for this purpose. It is said to be a rare thing for a good horse to come to the village and get away without being examined by the high school class in animal husbandry.

In the Sac City, Iowa, high school an agricultural course has been started, and 56 pupils are taking the course.

The Pennsylvania State legislature has recognized the National Farm School at Doylestown by granting it an appropriation of $12,000, to be used for agricultural instruction. This school now receives more applicants for admission than it can accommodate and is obliged to keep a waiting list.

In Wisconsin the Dunn County School of Agriculture and Domestic Science, at Menomonie, described in previous reports of this Office, graduated in 1905 a class of 19 boys and girls, 8 of whom completed the regular two-year course and 11 the short course. The school held a summer session to prepare teachers to meet the requirements of the State law requiring agricultural instruction in rural schools.

A recent bulletin of this school announces several lines of work which the school is prepared to do for the farmers of the country free of charge. This work includes testing of milk and seeds; inoculation of clover and other legumes; treatment of oats for smut and potatoes for scab; grafting of apple trees; planning of roads, barns, silos, poultry and milk houses, water systems, and drainage and sewerage systems; selecting of pure-bred stock, and giving information regarding feeds, stock, crops, diseases, insects, spraying, and other farm subjects.

The California Polytechnic School, at San Luis Obispo, an account of which was published in the report of this Office for 1903, has issued its first biennial report, which shows that the school has made good

progress in the erection of buildings and the acquiring of facilities for instruction along agricultural lines. The total enrollment for the first year was 20, and for the second year 52, the latter including 40 boys and 12 girls. Out of the total enrollment, 20 are in the agricultural course, 13 in the mechanics, 12 in the domestic science, and 7 unassigned. At the session beginning in the fall of 1905 the number of students has reached 100.

In Alabama the boards of control of the 9 district agricultural schools have decided to require each boy to work at least two hours a week on the school farm and each girl to do practical work in floriculture and other kindred subjects.

The Colorado State board of agriculture is making an experiment in the introduction of agriculture into the high schools of that State. Members of the agricultural college faculty are giving short courses of lectures in a number of high schools. If sufficient interest is thus aroused, an attempt will be made by the board next year to introduce agricultural instruction into the high schools generally.

In Porto Rico a farm of 100 acres has been purchased at Rio Piedras for the agricultural department of the recently established University of Porto Rico, and an agricultural school of secondary grade was begun in February, 1905, in connection with the normal school. A herd of cows has been purchased and a model dairy installed. Well-bred swine and horses will also be kept. Besides instruction a propaganda for the improvement of agricultural conditions in the island will be carried on in cooperation with the experiment station at Mayaguez under the direction of this Office. The students in this school devote the morning hours to practical work in the fields and the afternoon hours to class work.

PRIMARY SCHOOLS.

During the past year there has been widespread discussion and agitation regarding the introduction of nature study and elementary agriculture into the common schools. The number of schools in the cities and larger villages in which nature study forms a part of the course steadily increases, and this movement is spreading to the rural schools. School gardens are more generally used in connection with such instruction, and both the subjects taught and the plants grown have more direct relation to practical agriculture and horticulture. The laws of some 30 States now permit the teaching of agriculture in the common schools. Considerable work is being done by the State departments of agriculture, county school officers, agricultural colleges, and normal schools in encouraging and preparing teachers to give elementary agricultural instruction, and helps of various kinds are being published in large numbers. Publications of this character

have recently been received by this Office from the State departments of education in Georgia, Indiana, Maine, Michigan, Missouri, Nebraska, North Carolina, New Hampshire, and New York. The work done by the agricultural colleges in this direction has already been referred to (p. 330). In the programmes for courses of study for the public schools in Indiana, Missouri, and New Hampshire outlines of elementary courses in agriculture are given.

Nature Study Bulletin No. 1 of the New York State department of agriculture, entitled "Cornell Nature Study Leaflets," includes reprints of 80 leaflets originally published by the College of Agriculture of Cornell University between 1896 and 1904.

Bulletin No. 1 of the State Normal School at Chico, Cal., is a manual for teachers on school gardens for California schools, by B. M. Davis. In addition to definite instructions for the management of school gardens this bulletin contains a somewhat extended list of reference books and bulletins on garden making, agriculture, nature study, etc., for a school library.

A book entitled "Agriculture through the Laboratory and School Garden," by Miss C. R. Jackson and Mrs. L. S. Dougherty, instructors in the State normal school at Kirksville, Mo., has recently been published. This is a manual and text-book of elementary agriculture for schools, prepared to meet the need for instruction in the one-year course in agriculture for teachers at the Kirksville normal school. It comprises chapters on the nature and formation of soils, classification and physical properties of soils, soil moisture and preparation of the soil, the soil as related to plants, leguminous plants, principles of feeding, rotation of crops, milk and its care, propagation of plants, improvement of plants, pruning of plants, enemies of plants, and ornamentation of school and home grounds. Suggestions for experiments in laboratory exercises and field work are liberally interspersed throughout the book, and nearly every chapter is followed by references to literature related to the subject under consideration. There are also appended lists of general references to publications, lists of agricultural experiment stations in the United States, and of publishing houses whose books are mentioned in the reference lists, and a glossary.

The First Book of Farming, by C. L. Goodrich, formerly instructor in agriculture at the Hampton Institute, Virginia, is an elementary treatise prepared after the author had had a number of years' experience in elementary instruction in agriculture. The first part of this book is devoted to the general principles underlying plant culture, including discussions on the plant and the functions of the roots, stems, leaves, and flowers. Several chapters are given on the soil, with reference to the different kinds of soil, their moisture-holding capa-

city, and soil temperatures, together with the consideration of soil preparation, seed planting, and cultural operations. The second part of the work considers soil fertility as affected by farm practices, and is devoted to discussions on soil fertility and its maintenance, methods of controlling moisture condition of the soil, cultivation and rotation of crops, and the uses and value of farm manure and commercial fertilizers.

An interesting example of the consolidated school in which agriculture is taught is the Farragut School, located near Concord, Tenn. This school was organized by the consolidation of three school districts and was opened in September, 1904. The school is supported jointly by the Southern Education Board, which has contributed about $3,500, the State tax levy for the salaries of teachers, and local contributions. The funds thus raised, exclusive of teachers' wages, amount to $8,000, of which $6,000 was expended for a school building and equipment. The building is 54 by 80 feet, two stories high, and contains six well-lighted schoolrooms and a large assembly room. One of the abandoned schoolhouses has been moved to the site of the new building and is used for domestic science and manual training class rooms.

A small poultry house with incubator and brooder, a two-frame hotbed, and a shed for horses comprise the major portion of the farm equipment. The school has 12½ acres of land, 3 of which are used for horticulture, 6 for farm crops, and the remaining 3½ acres for campus and farmyard. It is the plan to make this a model rural school, in which agriculture, domestic science, and manual training shall be leading features. There are at present 5 teachers, including the superintendent and the teacher of agriculture, the latter a graduate of the University of Tennessee. The school is under the control of a local board of 9 members. During the first year the attendance was considerably greater than the previous joint attendance in the three small schools. This is accounted for by the fact that many boys, for one reason or another, would not attend the district schools. The field-crop work has consisted largely of forage tests and demonstration work on such subjects as seed selection, treatment for smut, and different methods of fertilization. The hotbed connected with the school not only furnishes materials for instruction, but is a source of income to the school and a convenience to the farmers of the district. A milk tester has recently been purchased, and the pupils are testing milk from cows in different dairy herds near by. The poultry work is attracting much local attention.

The industrial classes conducted under the auspices of the trustees of the John F. Slater fund in and near Norfolk, Va., in connection with the public schools for negroes, have been quite successful, and are good examples of what may be accomplished by earnest and intelli-

gent work with simple appliances and equipment. Instruction is given in woodworking, basketry, cooking, sewing, and gardening, in about 50 schools, many of which are in the vicinity of the truck-growing farms by which this region is well known. Miss Ellen Taylor is employed as superintendent, and plans the courses and visits the schools to see that the instruction is regularly and properly given.

A notable instance of school gardening on a large scale is found in the farm garden established in 1902 by Mrs. Henry Parsons, in DeWitt Clinton Park, New York City. This park is one of the public playgrounds under the supervision of the city park department. It is located in a very thickly populated section of the city, between Eleventh and Twelfth avenues and Fifty-third and Fifty-fourth streets. The tract comprises 7 acres, and includes playgrounds, a running track, a pavilion, and pergola, besides a farm garden. The pavilion is equipped with shower baths and schoolrooms for indoor gymnasium and kindergarten exercises. The upper floor is set aside as a recreation place for mothers and small children, and looks out on the Hudson River. The pergola, which is near the river, has a roof of summer-house construction. The basement of the pergola is to be used for the children and teachers in connection with the farm garden. The tract site cost $1,272,385, and the buildings have been provided at an additional expense of $203,300. Mrs. Parsons secured permission from the park commissioner to carry on the farm garden as an experiment while the track was yet incomplete. The experiment proved successful, and under the present administration the farm garden became a regular feature of the park work. The position of director of playgrounds and children's farm schools has been created under the city park department, with a salary of $2,500 per annum.

During the past year the garden area has been divided into 458 small plats. "Under the supervision of competent teachers seeds were sown, and the little farmers tended their plats from sowing time to the harvest. Several crops were harvested—there being a rotation of farmers as well as of crops—and, in all, about 2,500 children have enjoyed the advantages afforded by this odd school." The crops grown in 1905 were radishes, peas, beets, carrots, corn, lettuce, and onions. The garden comprises about 1 acre. Children from 14 schools worked in the garden, and 15 schools sent visiting classes. Adult classes also came from normal schools in New York and Brooklyn.

"In conjunction with the farm garden has been conducted a school of household industry where young girls were taught household duties, the boys being assigned to the heavier chores; and more than

500 girls have participated in the work of this school in the last three months."

Another large school garden is maintained in the vicinity of New York City at Yonkers. This comprises 1½ acres and is divided into 240 plats which are operated by as many boys, ranging from 9 to 13 years of age. This garden has been so popular that a waiting list is kept and when for any reason a boy drops out of the work there is no difficulty in filling his place. Each boy receives a ticket with his name and the number of his plat on it, together with a badge marked "School Garden." He pays 2 cents a week to the superintendent for "seed and instruction," but this of course does not begin to cover the cost of the seed alone. The principal object of this small payment is to give the boys a sense of proprietorship, and thus stimulate their interest. Each boy is required to attend to his plat at least twice a week, but the average visits have been more frequent. Each boy receives a memorandum book which has to be kept at the garden. Every time that he visits the garden he must make an entry in the book, which thus becomes a diary of his garden operations. This garden is under the auspices of the Women's Institute, the head of which is Miss Mary Marshall Butler. A practical gardener is in charge, and he is assisted by a voluntary committee of several gardeners.

The city councils of Philadelphia appropriated $3,500 in 1904 and again in 1905 for the maintenance of two public school gardens in the city. One of these was established in Weccacoe square, Catherine street below Fifth, on a vacant lot owned by the city, in the heart of a crowded foreign quarter. It contained 232 individual plats and 18 general plats. The children were selected from the seventh and eighth grades of 14 schools within walking distance of the garden. The other garden was located at Fifty-sixth street and Lansdowne avenue, in a semisuburban neighborhood, and also contained 250 plats. About 400 children were taught in each garden. During the days when there were school hours the children worked in the gardens after school. During the summer vacation they had regularly appointed hours at different times of the day. When they had been taught to hoe, thin, transplant, etc., classes were formed, which received lessons in plant life after their work for the day. Vegetables and flowers were grown and materials were furnished for nature study and drawing in the public schools. "The teachers were so deluged with requests for plats next year that they adopted the practice of appointing special hours when the children could apply. At one of these special appointments the policemen had to form the children in two lines, and two teachers were busy over two hours taking down names and addresses of would-be little farmers."

In 1905 the Weccacoe Square Garden was removed to Porter and

Fifth streets, directly opposite a public school of 1,200 pupils. In addition to the regular school garden work, classes of different grades from the kindergarten up had nature study lessons at the gardens during school hours and raised illustrative material for these lessons on class plats.

Several gardens were also maintained by the Civic Betterment Association, the Civic Club, and the Vacant Lots Cultivation Association.

In the city of Cleveland, Ohio, an advanced step in the school-garden movement has been begun by the appointment of a special officer as curator of school gardens, who will have charge of the planting and improvement of school gardens and grounds throughout the city.

THE FARMERS' INSTITUTES IN THE UNITED STATES, 1905.

By John Hamilton,
Farmers' Institute Specialist, Office of Experiment Stations.

The condition of the farmers' institutes of the country for the year ended June 30, 1905, is approximately shown by the data supplied by the farmers' institute directors of the several States and Territories. Their reports show that institutes were held in all of the States excepting Florida, Tennessee, and South Dakota, and in all of the Territories excepting Alaska, Indian Territory, and Porto Rico.

The suspension of institutes in Florida for the year ended June 30, 1905, was due to a reorganization of the educational system of the State. The superintendent reports that the institute work will be resumed this year under the control of the university, as formerly.

The director of institutes for Tennessee states that while some few institutes were held in a number of the counties none were conducted by the State. During this time, however, he has been preparing for future institutes by organizing permanent institute societies in the several counties, and during the coming year the work will be taken up and systematically and vigorously urged.

The last legislature of South Dakota made an appropriation for farmers' institutes and provided for an institute committee to take control of the work. This committee has appointed an institute director, who has already selected a corps of instructors to aid him during the coming year.

Although no institutes were held last year in the three States referred to, they all now have the requisite machinery for carrying on the work, and farmers' institutes will therefore be held in every State of the Union next year.

During the past year the attendance at the farmers' institutes of the country has increased from 841,698 to 995,192, or an increase of 153,494. The total number of institutes held was 3,271, of which 1,842 were one-day, 1,307 were two-day, and 122 were three-day institutes, the whole comprising 10,555 sessions. The money appropriated for institute purposes was $225,738.89, of which $210,660.44 was expended. The number of institute lecturers employed regularly on the State force increased from 953 to 995.

Twenty States held round-up institutes, composed of 192 sessions, with a reported attendance of 30,410. Six States reported 167 institutes for boys, one State, New York, holding 92. Four hundred and fifty-four women's institutes were held in nine States.

Among the new features in institute work reported were the organization of women's clubs, and the holding of women's institutes by four States, the equipping of railway cars with corps of lecturers and illustrative material and starting them out as specials. The expenses of these trains were borne by the railway companies over whose lines they were run, and were frequently attended by railway officials who participated in the lecture service.

In one State whenever a two-day institute was held the second day was made a field day, and was devoted to field demonstrations, as corn and stock judging, spraying and the preparation of spraying mixtures, etc. One State is conducting cooperative experiments in connection with the State agricultural experiment station. Two others are conducting dairy schools continuing from two to five days each. Two States have been holding a series of farmers' picnics in the various counties, calling them summer institutes for farmers' families. One State held a school of methods in institute teaching at which institute lecturers and college students in agriculture were present. Three other States conducted schools of instruction for their institute workers at their State agricultural colleges or experiment stations. Another has united the annual meeting of the farmers' institute lecturers with that of the State teachers' association, the programme combining two sets of subjects—technical agriculture and common school instruction. One State has taken up as a leading topic the introduction of the teaching of agriculture in the rural schools, and another has adopted the plan of completing the discussion of one subject before another is permitted to be taken up, without regard to any time limit. Another experienced director has shortened the opening talk upon each subject and lengthened the discussion, and another has magnified the question-box idea and has devoted the major part of the time to the discussion of the various subjects which the question box furnishes.

Twenty-five directors replied to the inquiry as to methods by which the Department could assist them in their work; thirteen requested the Department to furnish institute lecturers; twenty requests were for institute literature and illustrative material and for personal visits and suggestions by the institute specialist.

In order to ascertain the most pressing needs of the institutes, as viewed from the standpoint of the local managers who have the duty of arranging for the local meetings, circular letters of inquiry were sent out to over 1,500 local managers of institutes in 25 States.

Replies were received from only 19 States, embracing but 8½ per cent of the total number of persons addressed.

The majority of those who replied stated that they had "no advice to offer." Of those who did make suggestions, 35½ per cent, spoke of the need for a wider distribution of agricultural literature among farmers, and for supplying skilled specialists in agriculture as lecturers.

Almost every correspondent asked for some method by which increased attendance could be secured, particularly on the part of those who are backward in their agricultural practice and most need assistance. A number suggested corn shows as a means of improving the institutes and creating interest. Others advocated the introduction of lectures upon the teaching of agriculture in the public schools. Several were in favor of holding domestic science demonstrations. Comparatively little, however, that was new was elicited by this inquiry, showing that the movement is still in its formative stage, and that the views of the majority of the local managers as to the best methods to be pursued in its development have not yet become sufficiently well defined to warrant them in expressing decided opinions.

The need for careful study of the institute problem by experienced educators who understand the conditions that surround the agricultural people of this country is manifest, and State institute boards and directors should as speedily as possible define the lines of future progress in institute work and agree upon methods that ought to be adopted to secure the most beneficial results.

WORK OF THE INSTITUTE OFFICE.

The work of the Farmers' Institute Specialist, during the year, has been that of continuing aid to the State directors by distributing literature; by attending meetings of representative farmers; delivering addresses before farm organizations; aiding in the preparation of bulletins and circulars of information; by perfecting the organization of the work of the office, and by conducting correspondence.

During the year the States of Delaware, Iowa, Minnesota, Missouri, North Carolina, North Dakota, New York, Pennsylvania, Texas, West Virginia, and the Province of Ontario were visited and seventeen addresses were delivered.

A statistical report of the farmers' institute work of the country was prepared for the Yearbook of the Department, and an extended institute report consisting of 59 pages of printed matter was made out for the Annual Report of the Office of Experiment Stations, 1904. A bulletin on Agricultural Instruction for Adults in the British Empire, containing 96 pages, was published. Assistance was also given in editing the proceedings of the ninth annual meeting of the

American Association of Farmers' Institute Workers, a publication of the Department, consisting of 91 pages.

Six illustrative lectures prepared by expert scientists were edited under the general supervision of the institute specialist embracing the following subjects: Care of Milk, illustrated by 44 lantern slides, 12 pages; Potato Diseases and Their Treatment, illustrated by 47 lantern slides, 30 pages; Acid Soils, illustrated by 53 lantern slides, 28 pages; Profitable Cattle Feeding, illustrated by 45 lantern slides, 21 pages; Silage and Silo Construction for the South, illustrated by 50 lantern slides, 31 pages, and Essentials of Field Experimentation, illustrated by 32 lantern slides, 24 pages.

Bulletin No. 135, entitled "Legislation Relating to Farmers' Institutes in the United States and the Province of Ontario," has been revised. The names of 1,586 local institute managers have been secured and arrangements have been made for supplying these persons with farmers' institute literature.

The list of farmers' institute lecturers, known as Circular No. 51 of the Office of Experiment Stations, was revised and furnished to the State directors of institutes, and also to the directors of the experiment stations, accompanied with the request to the station directors that their official publications be sent regularly to those whose names have been thus supplied.

The exhibit room at the St. Louis Exposition assigned to the farmers' institute workers of the country was supplied during the continuance of the exposition with suitable literature and illustrative material.

The Bureau of Plant Industry of the Department of Agriculture furnished a man for about six weeks to represent it in its seed testing and investigation work in the farmers' institutes of Pennsylvania with excellent results. The chief of that Bureau has arranged for two members of his force to perform similar service during the coming institute season. If cooperation of this character could be secured generally with all of the representative interests of this Department the service would not only be appreciated by the State directors of institutes, but would do much to popularize the Department's work by placing directly in the possession of the men who need help valuable information which the Department has at hand, much of which under existing conditions is virtually inert.

Correspondence with farmers' institute workers and others has been conducted during the year, information given, and a large number of the Department's publications have been distributed.

There have been collected and compiled ready for publication histories of the farmers' institute movement in the United States, arranged by States and Territories, and there is also on hand ready for

publication a bulletin upon agricultural education for adult farmers in foreign countries.

Arrangements have been completed with a number of experts for the preparation of courses of study together with practicums suited to each, for use in movable schools of agriculture. The courses are upon the following subjects: Poultry rearing, cheese making, butter making, and fruit growing. Abstracts of these courses have been submitted and proper authorizations have been issued for their completion.

Several thousand copies of an address by the institute specialist upon normal schools of agriculture for farmers' institute workers were through the courtesy of the director of farmers' institutes of the State of Pennsylvania printed in pamphlet form and placed at the disposal of this Office. Many of these were sent out, accompanied by a letter calling attention to the publication. A large number of replies have been received, all cordially approving the project which the pamphlet advocates, and with a few exceptions indorsing the method proposed.

NEW FEATURES IN INSTITUTE WORK.

As has been stated, several new features have been developed in the farmers' institute work during the year in the direction of the improvement of the system. Two of these seem to be worthy of special mention. One is the holding of institutes devoted to a single topic, such as butter making, cheese making, poultry rearing, etc. These meetings were each continued for as much as three days and were conducted by a corps of specialists who confined their instruction to the particular topic that the institute had been called to consider.

The other new feature was the holding of a school of methods for farmers' institute workers. This school took up the work of the lecturer, the State director, the local manager, the presiding officer, and the various committees that have charge of the working up of the institute. The first of these new departures looks toward the making of the instruction in the institute more reliable and complete, and the other to the improvement of the methods in use in institute work.

Normal schools for farmers' institute workers were held in New York, Pennsylvania, West Virginia, and Illinois, with varying degrees of success. The purpose in all of these has been to endeavor to better fit the worker, particularly the lecturer, for institute service. The need for more and better teachers is the most pressing that now confronts the institute director, and it is realized that unless qualified instructors are supplied in greater numbers the work can not continue to develop. The matter, therefore, is of vital importance, and the movement in the States referred to is an effort to meet the diffi-

culty by assembling their institute teachers once each year for a week or ten days for the purpose of receiving instruction at the hands of scientific experts along the lines of their several specialties.

Now that the institute office of the Department has become established and the farmers' institute work of the country is becoming better understood, it may be well at this time to outline as definitely as possible the prospective field the farmers' institute work of the Department is likely to cover. By having such an outline at hand, those who are intrusted with the duty of providing means for meeting the requirements of this Department will be better able to determine what and how much should be first undertaken and the measures necessary for securing support sufficient to carry the purposes into effect.

STATE INSTITUTE ORGANIZATION.

In considering the obligation of the National Department of Agriculture to the several States in aid of their farmers' institute, it is necessary, first of all, to have defined as accurately and fully as possible the character and purpose of their work in this direction, and the most effective methods by which this purpose can be accomplished.

The foundation idea and purpose of the farmers' institute is educational—education along agricultural lines. As a means to this end there is the exciting of interest in agricultural affairs through meetings of agricultural people for conference, and through public addresses upon agricultural subjects by expert lecturers who call attention to the possibilities of this industry, giving instruction in the arts and sciences that underlie its successful pursuit.

The selecting of the best methods for securing this end is highly important. While it is altogether probable that no general and uniform system of farmers' institute management will ever be adopted by all of the States, there are nevertheless in every system certain essential features which each State will sooner or later be compelled to adopt if the needs of its agricultural people are to be properly met.

The first is that there must be competent central supervision—some board or individual having general direction of the institute work of the State. This is now practically undisputed. The only remaining question respecting it is the form that this central supervision or control shall assume, and its limitations.

The next essential, not however so universally accepted, is that of a permanent institute organization for each county. This is necessary in order that there may always be a body of men and women in each county who are personally interested in the institute work and that plans may be undertaken which require considerable periods of time to execute fully.

The third feature necessary to a complete system in order that the benefits of the work may be enjoyed is that of accessibility. Institute organizations should be sufficiently numerous in a county to be easily accessible to all of the citizens so that those who desire may have opportunity to become identified with the organization and enjoy its advantages. Township agricultural organizations and local farm clubs provide means for meeting this need.

A fourth necessity is that of an adequate supply of competent instructors available when needed. A properly organized system must provide for the education of its teaching force. This necessity is now recognized by most of the States.

These requirements, essential in any complete system of institutes for a State, may be scheduled under the folowing heads:

(1) A State board of institute supervision.
(2) County farmers' institute organizations.
(3) Township farmers' institute societies.
(4) Farm clubs for minor districts.
(5) Interstate normal colleges for farmers' institute workers.

AID BY THE NATIONAL DEPARTMENT OF AGRICULTURE.

The work of the National Department of Agriculture as it relates to the institutes is in the direction of assisting the States in rendering their systems most efficient for the upbuilding of their farming industry. The present law limits aid by the Department to "investigating and reporting upon the organization and progress of farmers' institutes in the several States and Territories and upon similar organizations in foreign countries, with special suggestions of plans and methods for making such organizations more effective for the dissemination of the results of the work of the Department of Agriculture and the agricultural experiment stations, and of improved methods of agricultural practice." As the law now stands the scope of the institute work of the Department is limited to "investigation, report, and suggestion of plans and methods." This restriction confines the field of institute work to limits quite below those which the Department naturally possesses.

The act of May 16, 1862, creating a Department of Agriculture declares that its "general design and duties shall be to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word." The "diffusing" of information is therefore an obligation specifically conferred and enjoined upon the Department.

Ought not the farmers' institute work of the Department, in order to be in harmony with the declared purpose of the Department and

with that of the State systems, be empowered not only to "investigate, report, and suggest," but also to disseminate information, and to do this by means of lecturers employed and sent out by the Department, and by giving practical demonstrations in class rooms, laboratories, and fields? Be authorized, in short, to cooperate with and assist the States in their various forms of institute work by actually carrying out in a practical way the plans and methods that its investigations have enabled it to recommend.

If the Department is to meet the needs of the States in the direction outlined by the schedule presented, it will be necessary for it so to enlarge its present equipment and institute organization as to provide expert assistance in all of the directions that the State institutes need help, whether in their lecture fields, their demonstration schools, the preparation of their teaching force, the distribution of literature, the gathering of institute information, the printing of charts the preparation of lectures, the giving of expert advice, or in perfecting the several State institute systems. In all of these respects the Department should be prepared to furnish aid. This means—

(1) Provision for a corps of farmers' institute lecturers to represent the Department before the agricultural people of the country. This force should be composed of experts competent to represent properly the various bureaus and divisions in their investigation work and thoroughly acquainted with the progress of similar work throughout the world.

(2) That the Department arrange to demonstrate the practicability and value of movable schools of agriculture. There are evidences that the farmers' institute work as it has hitherto been conducted has in some of the older States about reached its limit of effectiveness, and unless some advance is made upon the methods previously employed the work will retrograde and lose caste as an educational institution.

The institutes of the present time have devoted themselves chiefly to creating an interest in agriculture. They have shown to farming people that there is a large amount of scientific information in existence that is available for their use, and they have demonstrated also that it is possible to present this scientific information in an understandable way to men and women who have never had scientific training. The institutes have done this largely by means of lectures covering a great variety of agricultural topics, the lecture being in no case a complete discussion of any branch or topic, but merely a presentation of a small part of the great subject to which it refers. The equipping of movable schools, that shall give instruction to limited classes regularly organized and pledged to attendance for a

specified period opens up a field of effort and usefulness for the institute movement that is not occupied by any other institution. The method proposes to concentrate instruction upon a single agricultural operation and teach that as thoroughly as possible by means of courses of study and practicums prepared specially for rural classes. By attendance upon a school of this character farmers who are interested in self-improvement will have the advantage of instruction by an expert upon important agricultural subjects, continued for a period sufficient to enable them to become quite well informed upon at least a single branch and to be equipped for applying what they have learned to the actual operation of their farms.

Into this new field the Department of Agriculture might enter by selecting and sending out experts and supplying them with appropriate apparatus for giving instruction in one or more agricultural specialties, doing this with the consent of and in cooperation with the State officials in charge of the institute work. During the introductory stages of the movement this Department might act merely as a demonstrator, showing the methods that ought to be pursued in conducting this work and the practicabilty and usefulness of the new system. The fact that this method of instruction is new in the United States makes it necessary that demonstration schools shall be sent out to exhibit its features and prove their value. The National Department of Agriculture can very properly take the lead in the introduction of a method that promises so much for the elevation of agricultural people and the advancement of agricultural interests.

(3) The Department should also prepare outlines of courses of study for schools of the character just indicated. No such courses have yet been prepared in this country, and it is undoubtedly a legitimate part of the work of the National Department to secure the services of experts who shall make inquiry as to the methods that have been successfully pursued in foreign countries in imparting agricultural instruction by this means and adapt these methods as far as possible to the conditions that prevail in the United States.

(4) In like manner it is important that the National Department should prepare and publish sets of illustrated lectures upon agricultural subjects and also sets of agricultural charts for the use of institute lecturers. The proposition is for the Department to secure the services of experts to prepare agricultural charts in series and have them printed in colors and properly mounted for use. Work of this character is assumed by governments abroad, and advantage in some of these countries has been taken by colleges and lower schools to secure sets for use in class-room work. The originating of lectures and charts is undoubtedly a proper part of the work of the National

Department of Agriculture in its leadership of agricultural thought and progress.

There is also very much needed by institute workers a handbook containing agricultural statistics, standard tables, and other agricultural information useful for reference. If such a handbook of pocket size, printed upon a good quality of linen paper and bound with flexible cover, were prepared, it would be a great convenience to farmers' institute workers in answering questions and in preparing addresses. No complete book of this character is in existence, and its preparation, therefore, would not interfere with any existing publication, but would be along new lines and would meet a special and increasing need.

The material just outlined is of such character as to be of universal adaptability, and when once prepared can be duplicated at a slight cost and thus be made available to all of the institute workers of the country.

(5) The necessity for increasing the number of capable teachers for institute service has become urgent. The difficulties connected with the securing of such a supply is likely to prove a serious embarrassment in the prosecution of this work. The agricultural colleges and experiment stations have hitherto been depended upon in most of the States to supply expert instructors for institute service. Until recently it has been possible for the teaching force in the colleges and the men in charge of the experiment-station work to give a considerable portion of their time for institute instruction, but the great increase of students that has occurred in the past few years in the land-grant colleges and the great demand that there is for information at the hands of the experiment stations has made it practically impossible for these men to longer spare time from their regular work as teachers and investigators in the institutions to which they severally belong, to devote even a small portion of it to the farmers' institutes. This is withdrawing a most valuable part of the instruction heretofore given in the institute schools, which must be immediately replaced or the educational work of the institutes will be seriously impaired.

To supply men competent to give the instruction required will demand that some method for educating the institute lecturers shall be devised and put into effect. A plan that has been proposed is for several States to unite and form normal colleges for this purpose in connection with the agricultural colleges and experiment stations, depending upon the colleges and stations for such assistance as they may be able to contribute and upon the State boards of institute directors for additional aid in carrying on the work.

THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

The American Association of Farmers' Institute Workers held its tenth annual meeting in Washington, D. C., November 9–11, 1905. The registered attendance numbered 92, representing 29 States and 3 of the provinces of Canada.

The programme avoided technical subjects and devoted the time to the presentation and discussion of the wider questions of institute organization and influence. The method of computing the attendance at the institutes was changed by the adoption of the following resolutions:

In view of the inaccuracy and misleading character of the method now in use by this association for computing institute attendance: Therefore be it

Resolved, First. That hereafter the number in attendance at each session of each institute shall be ascertained by actual count and recorded, and the aggregate of all of the sessions shall be reported as the total attendance for the year. This aggregate, divided by the number of sessions, shall be regarded as the average attendance at each session.

Second. That attendance at the annual round-up of institute workers, out-door picnics, harvest-home meetings, and similar assemblages of farmers addressed by institute speakers shall be reported separately from the regular institutes, the total attendance for the entire meeting to be given instead of the number present at each session.

An important change in the organization of the association was effected by the appointment of standing committees on the following subjects: Rural schools, institute organization and methods, institute lecturers, cooperation with other educational agencies, movable schools, boys' and girls' institutes, women's institutes, and legislation. The committees consist of three members each, to be chosen by the executive committee. Their duties are to consider during the intervals between the annual meetings of the association the subjects severally assigned and report the results of their investigation to the annual meetings of the association, accompanied by such recommendations as they may deem proper to present.

The executive committee was authorized and advised, in fixing the dates for future meetings of the association, to select either the week immediately preceding or the week immediately following that chosen by the Association of American Agricultural Colleges and Experiment Stations.

The officers elected for the year 1906 were: President, G. C. Creelman, president of the Ontario Agricultural College, Guelph, Ontario; vice-president, W. W. Miller, secretary of agriculture, Columbus, Ohio; secretary, John Hamilton, Department of Agriculture, Washington, D. C.

THE STATE REPORTS.

The changes that have occurred during the year in the institute work of the country and its progress are noted in the brief statements which follow, given under the names of the several States and Territories, and in the tabulated statistics which form a part of this report.

The institute specialist desires to express his appreciation of the valuable assistance which he has received from the State directors in supplying him with the necessary data by which he is enabled to know what is being done in each State and Territory in institute affairs, and to present suggestions that may be of service in solving some of the difficulties that now retard the development of the institute phase of industrial education.

FARMERS' INSTITUTES IN THE SEVERAL STATES AND TERRITORIES.

ALABAMA.

The farmers' institute work in Alabama is under the direction of the board of trustees of the Alabama Polytechnic Institute and of the agricultural experiment station. There is no State law regulating or controlling the work. Last year there was appropriated by the college $600 for institute expenses. Twenty-four institutes were held, consisting of 48 sessions, with a total attendance of 3,820. Eight lecturers were employed by the State director for institute service.

The director of institutes is appointed for the period of one year by the board of trustees of the Polytechnic Institute and the agricultural experiment station. Seven members of the college and station staffs participated in the institute work. There are no permanent local institute organizations. The director arranges the programmes, attends to the advertising, and fixes the dates and places for the institutes. The sum of $600 has been appropriated for institute work for the season ending June 30, 1906.

No report of institute proceedings is printed. A six to ten day round-up or convention of institute workers is held annually at the college. At the convention last year there were 40 sessions distributed through eight days, with 245 persons in attendance. The institute meetings are not limited to any particular season, but are distributed throughout the year.

ALABAMA INSTITUTES FOR COLORED PEOPLE.

Farmers' institutes for colored people have been organized under the direction of the Tuskegee Normal and Industrial Institute. The expenses of the institutes are met by the localities in which they are

held. Meetings are advertised by circulars, personal letters, and through the agency of the various pulpits of the surrounding country. The formation of local organizations to meet once each month is encouraged. The lecture service is performed chiefly by the members of the Tuskegee Normal and Industrial Institute. Twelve one-day meetings were held last year, consisting of twelve sessions, attended by 300 persons.

ALASKA.

Farmers' institutes have not yet been organized in Alaska, but Prof. C. C. Georgeson, the special agent in charge of the experiment station at Sitka, as he visits the various districts takes advantage of the opportunity to give advice as to more advanced methods that might be employed in improving the agriculture of the several localities.

ARIZONA.

The legislative assembly of Arizona in 1903 passed an act providing for "the establishment of farmers' institutes and short courses of instruction throughout the Territory." For this purpose the sum of $2,700 was appropriated. The law places the control of the institutes in the hands of the board of regents of the university. The institute work for the past year consisted of one week of lectures at Thatcher Academy, Thatcher, Ariz. There was an average attendance of about 50 persons at each meeting.

ARKANSAS.

Arkansas has no farmers' institute legislation. An attempt was made at the session of the legislature of 1904 to secure an apropriation for institute purposes. The bill failed by a very narrow margin, but the effort to secure an appropriation will be renewed.

Thirty one-day institutes, composed of 60 sessions, however, were held under the auspices of the University of Arkansas and the Arkansas Agricultural Experiment Station. The total attendance was 7,650 and the entire cost about $400. There were four lecturers upon the State force, all of whom were contributed by the university and by the experiment station. These lecturers gave thirty-six days of time to the institute work. The dates, places, and programmes of the institutes were arranged by the director of the agricultural experiment station, in cooperation with citizens of the localities in which the institutes were held. Two hundred and fifty dollars has been appropriated for institute work for the year ended June 30, 1906. This sum is outside of any services that may be rendered by the State director.

CALIFORNIA.

The institute work in California is under the general direction of the superintendent of farmers' institutes, assisted by two conductors, one having the central and northern portions of the State, and the other having charge of the institute work in the southern section.

The legislature of 1903 authorized the board of regents of the University of California to hold farmers' institutes under such rules and regulations as they may deem proper, and at such times and places as they may direct. The law directs that the "course of instruction at such institutes shall be so arranged as to present to those in attendance the results of the most recent investigations in theoretical and practical agriculture." The legislature of 1905 appropriated $12,000 for institute work for the next two fiscal years.

During the last year institutes were held in 32 out of the 57 counties. Owing to local climatic conditions and corresponding leisure seasons in various parts of the State, institutes are held every month in the year. There were 114 institutes in all, composed of 429 sessions. The total attendance was 43,494. The cost of the institutes for the year was $8,934. The university contributed $2,934 of this amount, and $6,000 was received from the State appropriation. Six thousand copies of the proceedings were printed and distributed to persons on the regular mailing list of the agricultural experiment station. There were 25 lecturers employed by the State director, 10 of whom were members of the agricultural college and experiment station staffs. The college and station contributed one hundred days of lecture service. The arranging of dates, places, and the preparation of programmes for institutes are in the hands of the superintendent.

The superintendent provides two lecturers for each one-day institute, and three lecturers for each institute continued two days or more. There are no special or permanent local organizations in the several counties, but a local committee appointed by the last institute takes charge, under the general direction of the State superintendent, of the work of preparation for future meetings. Correspondence courses in agricultural science in its various branches have been added to the institute activities, and the superintendent reports that these courses are being well received.

COLORADO.

The farmers' institute work in Colorado has recently been placed in charge of the agricultural department of the State agricultural college, to be supervised by the dean of agriculture of that institution, aided by an assistant superintendent. In this State the only law that relates to farmers' institutes is the one in regard to the duties of the State board of agriculture, where, under the "duties of the secretary,"

the act directs that "he shall encourage the formation of agricultural societies throughout the State." The funds with which to carry on the work have hitherto been contributed by the State agricultural college. The legislature of 1905 appropriated $8,000 for farmers' institute work to be expended during the years 1905 and 1906. The new appropriation becomes available September 1, 1905. Twenty institutes were held, made up of 52 sessions, and the total attendance was 2,700. The lecture force was provided from the staffs of the agricultural college and experiment station. Twelve persons were sent out on this service, contributing in the aggregate fifty days of time. There has been no arrangement made for the publication of the proceedings.

CONNECTICUT.

Connecticut has no special law regulating the holding of farmers' institutes. The State board of agriculture, the Connecticut Dairymen's Association, and the Pomological Society are each carrying on institute work in the State. These different organizations receive money from the State for the benefit of agriculture in general—the Dairymen's Association for the dairy interests, the Pomological Society for the interests of fruit growing. The methods used by these different organizations in carrying on their work and disseminating information are entirely in their own discretion. Each has an institute committee appointed to have charge of the institute work. The board of agriculture requires that localities applying for institutes shall "furnish a suitable hall, provide local transportation for speakers and visitors, music if desired, and entertain by collation or otherwise, unless there are convenient hotel accommodations." The board pays for printing, traveling expenses, and services of speakers.

During the past year there has been cooperation between the three societies, and the institutes were held in common, instead of separately as heretofore. A general round-up or annual meeting of the institute workers is held each year, lasting from two to three days.

Fourteen institutes were held during the year, made up of 28 sessions, and attended by about 1,200 persons. There are 30 lecturers upon the institute force of the State. Six of these were furnished by the State agricultural college. No reports of the proceedings of the institutes are published. There are no specific local organizations for conducting institutes, but the superintendents depend upon the local granges and farm clubs for cooperation.

DELAWARE.

The legislature of the State of Delaware in 1903 amended the law respecting farmers' institutes, which formerly permitted a separate institute director for each of the three counties, by providing "that

the State board of agriculture may appoint a director of farmers' institutes for the State to cooperate with the farmers' institutes of the several counties." The sum of $600 is annually appropriated for institute purposes and is apportioned equally among the three counties. The salary of the superintendent is provided for outside of this amount. The law provides that the failure of any county to hold an institute in any year shall forfeit its appropriation. The objects of the institutes, as declared by the law, shall be "the discussion, orally or by written essays or papers, of agricultural and kindred questions, and for the dissemination of agricultural knowledge among the farmers of the State."

Twenty institutes were held during the past season, made up of 23 sessions, and attended by 4,199 persons. Nine lecturers were on the State force. Two of these were furnished by the agricultural college and the experiment station, contributing ten days of time to the institute work. The total expense amounted to $750. The director of institutes is also secretary of the State board of agriculture.

Local institute organizations are provided for by an act of the legislature, which requires that there shall be a president, vice-president, secretary, treasurer, and an executive committee for each county organization, and that these officers shall receive no compensation and are to hold their office for one year. Five thousand copies of the report of the State board of agriculture are printed. This report includes the proceedings of the farmers' institutes.

FLORIDA.

Authority to hold farmers' institutes is committed by the State to the board of trustees of the Florida Agricultural College and the agricultural experiment station. The superintendent is appointed by the board of trustees of the college and station, to whom, in connection with the president of the college, has been delegated the power to make rules for the holding of institute meetings and to expend the money appropriated for institute purposes.

The local organizations consist of a chairman in each county appointed by the superintendent of institutes, with authority to make all necessary local arrangements for institute meetings. The superintendent, in addition to his duties as director of farmers' institutes, is also professor of agriculture in the agricultural college of Florida. The dates and places for all institutes are arranged by the superintendent, and notices of meetings are published from three to four weeks in advance.

The legislature of 1904 failed to make an appropriation for institute support, consequently no institutes have been held this year. The following announcement by the University of Florida shows the

situation as well as the attitude of the university toward the institute movement:

The legislature having made no appropriation for this purpose for the past year, no farmers' institutes have been conducted under the regular control and direction of the university. Such work, however, has been done as has been possible with the funds at the institution's disposal; and it is believed that much good would come to the agricultural population of the State by the regular establishment and conduct of farmers' institutes in various sections. The purpose of such institutes is to present practical and timely information to the farmer, and the results hitherto obtained have been most gratifying. The director, agriculturist, horticulturist, and other members of the station staff, and many prominent specialists in agriculture have taken part in these institutes, and the university anticipates their becoming a permanent feature of its usefulness.

GEORGIA.

The legislature of Georgia in April, 1904, recognized the farmers' institute work by making an appropriation to the University of Georgia in the following terms: "To the University of Georgia for farmers' institutes, $2,500." This appropriation became available September 1, 1904, and was for one year. In addition to this the trustees of the university set aside $1,000 from the general funds of the institution for farmers' institute purposes. Forty institutes were held during the year, consisting of 108 sessions, attended by about 18,000 persons. Thirteen lecturers were upon the State force, 7 of whom were representatives of the faculty of the agricultural college and of the experiment station staff. These two institutions contributed fifty-four days of time to institute service.

No institutes had been held in Georgia for several years until 1903. Now they have been organized in each senatorial district, with local officers in each county embraced in the district. Each locality is expected to secure a suitable hall for meeting, without charge to the State superintendent, and to provide all of the local accommodations needed for successfully conducting the meeting. The State supplies from two to three lecturers to each institute, whose expenses are paid out of the agricultural college funds and the appropriation. The dates, places, and programmes for the institutes have thus far been arranged by the director. Meetings are advertised at least two weeks in advance by means of the county press. Five thousand copies of reports of the institutes were printed and distributed during the year.

IDAHO.

The legislature of 1905 appropriated $2,000 for institute work in Idaho for two years. The control of the institutes and the expenditure of the money are intrusted to the board of regents of the college of agriculture of the University of Idaho. Twenty-five institutes

were held during the year, made up of 113 sessions. Four thousand persons were in attendance. There are 14 lecturers upon the State force, 10 of whom are members of the agricultural college and experiment station staffs, who were present at all of the institutes and contributed fifty days of time. The dates, places, and programmes are all arranged by the superintendent of institutes, and announcements of the dates, places, and speakers are made from four to eight weeks in advance of the meetings. Brief reports of the discussions are prepared by the secretary, published, and sent to the regular mailing list of the experiment station and to all of the institute workers in the United States.

The form of local organization consists of an institute committee in each locality, which serves until another institute is held, and then it is either reappointed or a new one elected. The committee is organized by the election of a chairman at the institute meeting and the appointment of a secretary, together with such special committees as are needed.

ILLINOIS.

The Illinois Farmers' Institute is organized under a special act of the legislature and is a public corporation of the State. "It consists of three delegates from each county of the State, elected annually at the farmers' institutes of the county," and is managed by a board of trustees "consisting of the State superintendent of public instruction, the professor of agriculture of the University of Illinois, the president of the State board of agriculture, the president of the State Horticultural Society, the president of the State Dairymen's Association, and one member from each Congressional district of the State, to be selected by the delegates from the district present at the annual meeting." The officers of this board of directors are "a president, vice-president, secretary, treasurer, a State superintendent of farmers' institutes, and such other officers or agents as may be deemed proper for organizing and conducting the work of the organization, all of whom shall hold their office for one year, unless removed sooner by the board, and shall perform such duties as may be required of them by the rules of the board."

Article 5 of this act prescribes the duties of the State superintendent of institutes:

SECTION 1. The State superintendent of institutes shall have general supervision of institute work in the State under the direction of the board of directors and of the executive committee.

SEC. 2. He shall make recommendations as to lines of work which he believes will prove profitable for the ensuing year, together with general plans for their execution, and estimates of expenses. He shall make such other recommendations to the board of directors as he may deem for the best interest of the institute work.

SEC. 3. He shall visit the county institute and district conferences when invited to do so by the county institute officers or directors, or when in his judgment the institute work demands such visit.

SEC. 4. He shall have charge of the publication of the annual report and shall insert therein such matters as will advance the agricultural interests of the State, under the direction of the executive committee.

SEC. 5. He shall be librarian of the farmers' institute free libraries, and shall submit to the board of directors or to the executive committee, for approval, lists of books which he deems ought to be purchased for the use of the libraries when such are needed.

SEC. 6. He shall make a detailed annual report in writing to the board of directors at the last meeting of the old board of his acts and doings during the year, together with a general summary of the institute work of the State for the year. He shall also make such other reports during the year as the board of directors or executive committee may require.

One hundred institute meetings were held last year, 50 being two days and 50 being three or more days. There were 635 sessions. One hundred and fourteen speakers are listed on the lecture force, 28 of whom are members of the agricultural college and experiment station staffs. The total attendance is given by the superintendent as 69,759. An institute was held in every county in the State. The total cost amounted to $19,257.90. The local organizations in the several counties elect their own officers and formulate their own rules. They are permitted to select their own speakers and to choose such topics for discussion as they believe will be of interest to their respective localities.

Each county farmers' institute is entitled to the sum of $75 per annum on condition "that such institute shall file with the secretary of the Illinois Farmers' Institute a sworn statement which shall show that the said county farmers' institute has held one or more duly advertised sessions annually, of not less than two days each, at some easily accessible location." This statement shall also include "an itemized exhibit of the expenses of the meeting, with receipted vouchers therefor, a copy of its printed programme, and the printed proceedings showing the title and author of the papers read and by whom discussed, place or places of meeting, with average daily attendance, and such other information as may be called for by the Illinois Farmers' Institute and necessary to successfully assist this work."

The Illinois Farmers' Institute is authorized to award one free scholarship in the college of agriculture, good for two years, for each county in the State and one for each Congressional district of Chicago. The awards are made on the recommendation of the farmers' institute director for each Congressional district.

Free circulating libraries are distributed among the several county institutes. Fifty-one of these libraries have been equipped and sent out, each containing about fifty volumes. A round-up meeting of the institute workers was held during the year, lasting through nine

sessions, and having an attendance of about 8,000 persons. The superintendent reports as a new feature of their work the combination of teachers' and farmers' institutes. The teaching of agriculture in the public schools and the consolidation of rural schools have been made special features and were discussed at every institute held throughout the State.

The Scott County Farmers' Institute during the past year succeeded in inducing 19 boys to study corn judging under an expert corn judge. These boys attended all of the day sessions of the institute, acting as judges of corn brought up from the county for competition, and as a premium for the best work done in corn judging one boy had his entire expenses paid at the Corn Growers' Convention in January at the University of Illinois, where he had opportunity to earn a certificate as an expert corn judge. The expenses of sending a boy to the Corn School at Urbana is the cost of the round-trip ticket and board for two weeks, amounting from $10 to $20. Several counties are planning to introduce the corn-judging contest into their institutes this year.

The Illinois Farmers' Institute is required to make an annual report to the governor of its transactions, which report shall include papers pertaining to its work and addresses made at the annual meeting of the organization. Twenty thousand copies of this report are required to be printed each year, one-half for the use of the Illinois Farmers' Institute and the remainder for the secretary of state for distribution through the members of the general assembly.

INDIANA.

The laws of the State of Indiana require—

> the committee of experimental agriculture and horticulture of the board of trustees, together with the faculty of the school of agriculture of Purdue University, to appoint before November 1 of each year suitable persons to hold county institutes in the several counties of the State between the 1st day of November and the 1st day of April, each year, for the purpose of giving to farmers and others interested therein instruction in agriculture, horticulture, agricultural chemistry, and economic entomology.

Section 2 of the act provides that—

> such institutes shall be held at such times and places as said committee and faculty may determine, and under such rules, regulations, and methods of instruction as they may prescribe: *Provided, however*, That such institutes shall be so conducted as to give to those attending results of the latest investigations in theoretical and practical agriculture and horticulture.

Ten thousand dollars per annum has been appropriated for bearing the expenses of the lecturers and paying such items as may be necessary for the proper conduct of the work. The director of institutes is appointed by the trustees of Purdue University, the present

officer being the professor of agriculture in the university and advisory agriculturist of the experiment station.

During the year 250 institutes were held, 117 of which were two-day meetings. The total number of sessions was 883, and the attendance is given at 79,964. The cost was $10,000. The number of lecturers upon the State force was 46, 8 of whom were members of the agricultural college and experiment station staffs, who contributed twelve days of time. The schedule, including dates and programmes, is arranged by the superintendent, and the places are decided by conference with the local officers. Two State lecturers are provided for each institute, with an occasional expert speaker to discuss some special topic. Members of the college and station staffs attend institutes without charge, except for their expenses, and at times when their duties do not seriously interfere. An annual conference is held each year, as are also district institutes, comprising a number of counties, and for which special programmes are provided. A new feature of the work is a plan for competition by young people at the institutes and at the county fairs. Premiums for exhibits of corn, oats, poultry, butter, and bread, grown or made by young people between the ages of 12 and 20 who live on farms, are offered by one fair association.

The county farmers' institute or home makers' association will duplicate the premiums offered by the fair association upon the following conditions:

(1) The exhibits will be made at the several farmers' institutes to be held in the county during the season as may hereafter be designated.

(2) Each exhibitor must be present in person, submit in writing a description not exceeding 500 words of the method employed in growing the crops or poultry or in making butter or bread, and read the same at the institute.

(3) Each exhibitor must certify to the area and yield of crop or age and breed of fowls, etc., and that the article was produced by the exhibitor. This certified statement must be attested by two witnesses.

(4) Each person will be permitted to exhibit in but one class and make but a single entry.

A form of constitution for county institute organizations has been recommended, and was approved and adopted by 50 of the 92 counties of the State in 1904. The constitution provides that any resident of the county over 16 years of age may become a member by payment of the annual dues; that the officers shall consist of a president, secretary, assistant secretary, treasurer, and one vice-president for each township in the county. The president, secretary, treasurer, and the several vice-presidents constitute an executive committee, which has charge of the affairs of the association in intervals between the meetings. This committee, upon the request of the State superintendent, is required to suggest desirable dates and places for farmers' institutes, themes for speakers, and give such other information as the superintendent may desire in arranging the schedules of institutes. The

constitution also provides for "a woman's auxiliary for the purpose of holding special or separate sessions of the institute for women." A series of summer institutes designed especially for farmers' families was undertaken this year with marked success. At these summer institutes the topic discussed was some phase of domestic science. The advertising of the institute is left entirely to the local organizations, which for this purpose use postals, postal-card programmes, personal letters, and the local press. Six hundred to 1,000 copies of abstracts of the proceedings are printed and distributed each year.

INDIAN TERRITORY.

Farmers' institutes have not been organized in the Territory.

IOWA.

There is no central organization or State superintendent of farmers' institutes in Iowa, but each county is entitled to organize an institute when forty or more farmers meet and elect a president, secretary, treasurer, and an executive committee of not less than three outside of such officers, and hold an institute meeting, remaining in session not less than two days in each year. Upon presenting proof to the county auditor of such organization and such institute having been held, and an itemized statement showing the manner in which the money used has been expended, it is the duty of the county auditor to certify the statement to the auditor of the State, who upon receipt of such certification is required to remit to the treasurer of the county his warrant, not to exceed $75 in any one year. Last year 60 institutes were held in 60 out of the 99 counties in the State. The State appropriation amounted to $7,425.

The absence of any State organization or board of control has made it impossible to obtain complete data respecting the work. The secretary of the State department of agriculture has contributed the only information that it has been possible to secure. The attendance is estimated at 18,000, the number of sessions at 207, and the amount expended $3,814.60. No complete report of the institute proceedings is published, but some of the best papers read before the local institutes are published in the Yearbook of Agriculture. A State round-up meeting was held in Des Moines, consisting of two sessions, and having an attendance of 300. During the year an organization of the institute workers of the eastern counties of Iowa was effected for the purpose of cooperation in securing lecturers and arranging the dates and places for institute meetings.

KANSAS.

The legislature of Kansas of 1903 passed an act providing for the formation of county farmers' institute associations. Such associations under this act shall consist of a president, vice-president, secretary, and treasurer, and it must adopt a constitution and by-laws for its government. The county institute association is entitled to the sum of $50 from the county to bear the legitimate expenses of a two-days' institute, and the legislature has provided in addition an appropriation of $2,000 per year to the State agricultural college to be used in paying the expenses of the members of the faculty and experiment station who attend institutes. The duties of State director are performed by the chairman of a committee appointed by the president of the college on institute work. The present official in charge of the institute work is also director of the agricultural experiment station.

Fifty-five institutes were held during the year. Twenty-six were one-day, 20 were two-day, and 9 were continued for over three days. The number of sessions was 144. The total attendance was 11,455. The cost of the institutes was $1,760, not counting the salary of the director or of the college and station speakers. All of the speakers on the State force were either agricultural college or experiment station officers. Nineteen of these lecturers were engaged in institute work last year, and the total number of days in which they were employed was 320. A number of the institute force accompanied a special train in a trip throughout the State, which was fitted up for promoting the dairy industry.

The chairman of the State institute committee aranges the dates, places, and programmes for institute meetings. The proceedings are not published, except brief abstracts by local papers.

KENTUCKY.

Kentucky has no specific farmers' institute law. The work is conducted under authority given in the following extract from the general law prescribing the duties of the State bureau of agriculture:

> The efforts of the bureau shall be directed to the promotion of agriculture, horticulture, etc., and the commissioner shall promote and encourage, as far as practicable, societies and other associations in the several counties and ascertain the agricultural, horticultural, mechanical, commercial, and educational condition of every county, etc. * * * The commissioner shall put himself in communication with the different agricultural, horticultural, and labor societies, etc.

The sum of $13,000 is annually appropriated to meet the expenses of the bureau of agriculture. Of this sum the commissioner is authorized to expend such amount for institute work as he deems proper. One thousand two hundred and six dollars and sixteen cents

was appropriated during the past year for institute purposes. Seventeen institutes were held, composed of 73 sessions, and attended by 3,350 persons. The number of lecturers upon the list is 15, of whom 3 are from the agricultural college and the State experiment station. The proceedings are edited by the State director and printed in supplemental form and circulated by the leading agricultural papers of the State. The county papers also inclose these supplements, distributing them among their subscribers. About 10,000 copies of the proceedings of each institute were printed and circulated in this manner during the past year.

The arranging for institutes in the several counties is in the hands of the superintendent, who cooperates with local farm clubs in arranging the dates, places, and programmes, the State furnishing such lecturers in addition to the local teachers as may be necessary. The places and dates as well as speakers are announced as soon as the programmes have been prepared through the State agricultural papers, as well as by means of local publications. The institute director is the commissioner of agriculture, labor, and statistics for the State. Three thousand dollars has been appropriated for the institute work next year.

The State director has employed this year a man at a regular salary, who is known as the State lecturer and organizer of farmers' institutes, and whose duty it is to organize farmers' clubs in the various counties, and make preliminary arrangements for institutes and to deliver lectures throughout the State. It is now planned to organize a farmers' club in a district preliminary to the holding of an institute, as it has been found that more successful meetings can be secured where there is an organization in a community of agricultural people who are interested. After such a club has been organized it is the duty of its secretary to make a report to the commissioner of agriculture, giving the names and post-office addresses of each officer and member thereof, and he is also required to report at least four times a year the number of members admitted at subsequent meetings. Under the rules no club is organized by the bureau of agriculture with less than twenty members.

LOUISIANA.

The farmers' institute work in the State of Louisiana is conducted under a provision of the constitution of 1898, which provides that "the Louisiana State board of agriculture and immigration shall have the control and direction of all State agricultural organizations and State farmers' institutes." In accordance with this provision the State board of agriculture organized a farmers' institute committee, composed of the president of the Louisiana State University, the

director of the State experiment station, and the commissioner of agriculture and immigration. Two thousand dollars is annually appropriated for institute work. The commissioner of agriculture and immigration is the executive officer of the State committee on farmers' institutes, and has direct control of the work of organizing and conducting institutes in the several districts.

There are 33 lecturers on the State institute teaching force, 13 of whom are connected with the State college or experiment station. Last year these college and station men contributed sixty days of their time to institute work. Sixty-seven institutes were held during the year, composed of 208 sessions. The total attendance is given at 14,541. The cost of the institutes was $2,500. Three thousand five hundred copies of reports of institute proceedings were printed and distributed. Permanent institute clubs, with a president and secretary, and with one vice-president from each ward of the parish, constitute the local organization. The institute director cooperates with the local authorities in arranging the dates, places, and programmes for institute meetings. The State director of institutes is appointed by the governor for a period of four years and is also commissioner of agriculture and immigration.

MAINE.

In Maine, under the act creating the State department of agriculture and providing for the appointment of a commissioner of agriculture, the commissioner is required to "hold or cause to be held two farmers' institutes in each county annually, and as many more as the appropriation therefor will allow." An appropriation of $3,000 annually is made for carrying on the institute work and for meeting the expenses of the State dairymen's conference, provided such expense shall not exceed the sum of $500 annually. During the year 44 institutes were held, composed of 93 sessions. The total attendance was 5,731, and the amount expended was $5,000. There are 21 lecturers upon the State institute force. Abstracts of the proceedings are prepared by the commissoner and included in his annual report, of which 6,000 copies are printed.

The commissioner is appointed by the legislature and holds office for two years. The location of the county meetings is made by the county agents, and the dates and programmes are planned by the State director of institutes. The agricultural college and experiment station officers participate in the lecture work whenever desired and at times that do not conflict with their other duties. During the past year four members of the college faculty lectured before institute audiences, giving twenty-five days of their time to this service. In addition to the regular institute work the director of institutes

furnished speakers to local granges on request where they desired special farm subjects to be discussed. The expense of these speakers was paid from the institute fund.

MARYLAND.

Under the act of assembly, approved March 27, 1896, establishing farmers' institutes in the State of Maryland, it is provided that the farmers' institute director shall be appointed by the trustees of the Maryland Agricultural College, and that at least "one institute shall be held in each year in each county of the State, and an additional one in each county, if deemed necessary and desirable." The institute under this act was made a department of the Maryland Agricultural College. The total number of institutes held during the year was 26, consisting of 73 sessions. Five thousand seven hundred and forty-one persons were in attendance. Sixteen lecturers are upon the State list of institute instructors. Eight members of the agricultural college and experiment station force gave instruction in the institutes. The total cost of the institutes for the year was $3,618.70, and the appropriation for the coming year is $6,000.

The work in the several counties is conducted by a local committee or county organization, wherever such exists, or through a local correspondent appointed by the director of institutes. Reports of the institutes are furnished to the county papers, and enough of these are secured by the director to supply his mailing list. The advertising of the meetings is effected through the newspapers of the State by sending to each a programme about four weeks before the institute in the county in which the newspaper is published is held. The director each year plans a visit of representatives of the institutes in the several counties to some place of special interest outside of the State, as a farm, canning factory, city market, or educational institution, each delegate being expected to write a report of what he has observed during his visit and present this before the next institute meeting. The results of this method of verifying information have been very satisfactory.

Two cars specially fitted up for the purpose were used on two of the leading railroads of Maryland and run as seed-corn specials. The attendance in two days at these meetings was 2,107.

MASSACHUSETTS.

The farmers' institutes of Massachusetts are held under a general law establishing a board of agriculture which authorizes it to "disseminate useful information in agriculture by lectures or otherwise." By a rule of the State board the secretary of the board is required to

provide lecturers for farmers' institutes so far as the appropriation for the object will allow. The board recommends that—

Whenever any farmers' organization in the State shall desire to have a course of not more than three lectures on any farm subject they may apply to the secretary of the board of agriculture for a lecturer, and the secretary, if he thinks the subject a proper one, shall furnish a lecturer, provided he can secure a competent person to attend on the dates named, and also provided that he has not already been called on during the year to provide lecturers for more than 13 courses.

Rule 15 requires that—

Each agricultural society receiving the bounty of the Commonwealth shall hold within its limits not less than three farmers' institutes each calendar year, and the board shall render all the assistance in its power to make these institutes interesting and profitable. The secretary of the board shall provide lecturers for farmers' institutes, so far as the appropriation for the object will allow and a wise expenditure of the money warrant, but he shall not be authorized to pay more than one lecturer for each institute. The secretary of each society shall be required to certify to the holding of each institute on blanks furnished by the secretary of the board.

One hundred and fifteen institutes, composed of 167 sessions, were held this year. Twelve thousand three hundred and seventy-two persons were in attendance, and there were 71 persons upon the State force, 47 of whom were engaged in giving instruction during the year. The total cost was $1,474.24, and the appropriation for the coming year is $3,000. The local expenses of the institutes are met by the societies holding the meetings. The dates, places, and programmes for the meetings are arranged by the State director in cooperation with the local officers. The agricultural societies represented on the State board of agriculture are the local organizations under whose auspices the institutes are held. The director of institutes, in commenting upon this feature of their work, states that—

For Massachusetts we consider our present arrangement the best one, with the institutes under the local control of the incorporated agricultural societies represented on the board, who are required to hold three institutes each in every calendar year. They, with the advice and assistance of the central office, select the speakers they wish to hear from the list furnished them by the board and select the dates most convenient for their people. The board arranges with the speakers to attend these meetings and also meets their expenses, while the societies meet the expenses for hall rent and advertising and attend to the details of the same. This office maintains a general oversight of the institutes, does not employ any but worthy and instructive speakers, and further endeavors to arrange circuits of institutes with speakers of more than ordinary ability from without the State.

MICHIGAN.

The State board of agriculture is authorized by act of the legislature of 1901 to "hold institutes and to establish and maintain courses of reading and lectures for instruction in the various branches of agriculture, mechanic arts, domestic economy, and the related

sciences." The board is authorized to "formulate such rules and regulations as it shall deem proper to carry on the work contemplated in the act, and may employ such agent or agents to perform such duties in connection therewith as it shall deem best." Local farmers' institute societies are provided for in the act, and such societies are required to hold annually at least one institute of at least two days in length. To organize a local county institute society the rule of the board requires that at least—

Twenty residents of the county, without regard to sex, but of legal age, shall meet and adopt a brief constitution in harmony with the State law, elect a president and a vice-president from each township in the county, and a secretary, who shall also be treasurer. Such society shall furnish to the secretary of the board of agriculture a copy of its constitution and by-laws, and shall transmit with the same a written agreement, signed by the president and secretary of the society, stating that the society will, for purposes of farmers' institutes, conform to the rules of the board of agriculture governing such institute. Within ten days after the close of such institute the secretary shall make a report to the superintendent on blanks to be furnished by the superintendent.

The immediate management of the farmers' institutes is placed in charge of a superintendent elected by the board of agriculture. The superintendent arranges for locating and holding institutes, is authorized to approve all institute societies when properly organized, and, after consultation with members of local institute societies, determines the time and place for holding the institutes and the subjects to be discussed. He also designates the persons who are to attend as lecturers, and has authority to reject from the programme local speakers or topics that are objectionable. He has authority to call upon the faculty and instructors of the agricultural college and members of the experiment station force for such institute work as may be assigned them by the board, with the consent of the president.

During the past year 270 institutes were held, consisting of 827 sessions. Two hundred of these institutes were one-day, and 68 were two-day, and 2 were three-day institutes. The total attendance was 55,004. There were 47 speakers upon the State lecture force, 21 of whom were members of the college faculty or of the experiment station staff, and contributed ninety days' time. The appropriation for the expenses of the lecture force was $9,300, of which $1,800 was from membership fees, contributions, etc. Reports containing statistics of attendance, list of officers, etc., and a report of the annual round-up institute, together with such papers as are of special excellence, read at the county institutes, are edited by the State superintendent, and 9,000 copies were published for distribution by the institute societies. A round-up of the institute workers is held annually. The meeting for the past year was attended by 5,755 persons, and continued through 12 sessions, besides 3 conferences and 6 special sessions.

MINNESOTA.

The legislature of Minnesota, by act approved April 14, 1903, repealed all former legislation in regard to farmers' institutes in that State and provided for their future constitution, government, and support in an entirely new act composed of fifteen sections. A board of administration is created by the act, consisting of three members of the board of regents of the University of Minnesota, the president of the State Agricultural Society, the president of the State Dairy Association, and the president of the State Horticultural Society, to have charge of the execution of the act regulating the farmers' institute work throughout the State. This board of administration is authorized to appoint a State superintendent of farmers' institutes, whose term of office continues for two years. The board of administration, in conjunction with the superintendent, arranges the institute circuits and determines the times and places where institutes are to be held. The duties of the superintendent are defined as follows:

> To superintend the several institutes when located as herein provided; to engage competent instructors therefor; to receive, examine, and report upon all bills for expenses and services payable from established appropriation, and at the end of each fiscal year to make a detailed report of all farmers' institutes held under his direction, with an itemized account of all expenditures under this act during the year last past, to said board of administration.

The board of administration is directed to prepare and publish each year a farmers' institute annual. Thirty-five thousand copies of this publication were sent out last year. The law requires that—

> Each meeting shall continue for not less than one day nor more than three days, with morning, afternoon, and, when practicable, evening sessions. Each shall be free to the public, and each shall consist of practical and instructive lectures upon topics pertaining to the farm and home, and with incidents and addresses, discussions, and illustrations of such methods and practices as possess real merit and are adapted to the conditions of our agriculture, the sole object and purpose of these institutes being to disseminate practical knowledge upon questions pertaining to agriculture, horticulture, stock and dairy farming, with the least expense and inconvenience to the people of the State.

One hundred and five institutes were held during the past year, consisting of 227 sessions. All of the institutes held were one-day. The total attendance was 52,125, and the amount of money appropriated and expended was $18,000. There were 10 lecturers upon the State teaching force. The college and the experiment station were not represented upon the lecture corps. There are no local county organizations of institutes in the State, the superintendent selecting persons in each locality from year to year to assist him in organizing and conducting the local work. A few women's institutes were held during the year, and the superintendent has also started cooperative field experiments in conjunction with the State experiment station.

MISSISSIPPI.

Farmers' institute work in Mississippi is under the direction of the president of the agricultural and mechanical college. There are no laws organizing institutes in the State excepting that appropriating $3,000 to the agricultural and mechanical college for institute work. Last year 153 institutes were held, composed of 311 sessions. One hundred and fifty were one-day institutes and 2 were two-day and 1 three-day institute. The total attendance was 30,000. Institutes were held in all excepting the Delta counties. The total cost of the institutes last year was $3,000, and the appropriation for the coming year is $3,000. Twenty-four lecturers were upon the State institute force, 22 of whom were contributed by the agricultural college and the experiment station to the lecture service of the institutes. The college and station men gave to institute instruction three hundred and ninety-six days of time. No reports of the institute work were published.

The State director organizes the farmers in the several localities into clubs, and the clubs of each county into a single county club, the county club having charge of the local institute work. He also fixes the dates and places for institutes, committing the preparation of the programmes and the arrangement for speakers to the county institute club. Announcement of dates, places, and speakers is made about one month before an institute meeting is held by publishing the programme in the county papers. The State director is appointed by the board of trustees of the agricultural and mechanical college, and the appropriation made by the State is payable to this board of trustees. A round-up meeting of institute workers was held this year at the college, consisting of 6 sessions, at which 300 farmers were in attendance.

MISSOURI.

The control of farmers' institutes in Missouri is by law placed in the hands of the State board of agriculture, which is required to "hold farmers' institutes in different parts of the State for the purpose of giving instruction in agriculture." The execution of this work is placed in the hands of the secretary of the board.

The universal exposition held in St. Louis during the past year seriously interfered with the work of conducting farmers' institutes in this State. The time of the State director, who is also secretary of the State board of agriculture, was largely taken up with duties connected with the exhibit of the State at the exposition. Notwithstanding this interruption, 104 institutes were held—58 one day, 44 two days, and 2 three days, altogether composed of 256 sessions, with a total attendance of 2,560. The amount of money appropriated for

institute purposes was $5,000, of which $3,100 only was used. A technical ruling by the State auditor prevented the use of the balance of the funds, on the ground that the portion not drawn prior to January 1 was required under the act making the appropriation to be refunded to the public treasury.

The total number of lecturers reported upon the State force was 26, and the total number of days of institutes held during the year was one hundred and fifty-two. Ten thousand copies of reports of the proceedings are printed annually and distributed.

There are no permanent local organizations for institute purposes in the several counties, the director arranging each year for institutes by correspondence from the office with a local committee, which he appoints. The director fixes the dates and places and consults with the local committee respecting the programme. Meetings are advertised by publishing from two to four weeks in advance the dates, places, and names of the speakers in the local press. A traveling institute was organized three years ago, and was in successful operation during the past season. A railway car is fitted up with illustrative material and equipped with a lecture force furnished by the college of agriculture and mechanic arts of the university and by the experiment station. Numerous districts were visited in this manner and very satisfactory institutes were held, the lecturers having the advantage of the material with which the car was supplied for use in demonstration. In most places where meetings of this character are held the material used in demonstration is taken from the car to the institute hall. After the meeting has been held the people are invited to pass through the car and view the exhibits. The railroads of the State are cooperating in the movement, and the meetings are growing in interest and attendance.

A new feature in institute work was reported by the State director two years ago, having for its purpose the interesting of the children of the public schools. The method pursued is to have the conductor of an institute in a locality, after having secured the consent of the superintendent of public instruction, to interview the school directors of the district, asking permission to have one or more of his lecturers visit the public schools while they are in session and deliver one or more lectures upon some phase of agricultural life. The result has been that the children have become greatly interested in the farmers' institute, and through them the interest has extended into the homes from which they come.

MONTANA.

The board of administration of farmers' institutes in Montana is composed of the governor of the State, the director of the Montana Experiment Station, and the presidents of the Montana Registered

Cattle Breeders' Association, the Montana Wool Growers' Association, the Montana Live Stock Association, the Montana Horticultural Society, the Montana State Board of Horticulture, the Montana Agricultural Association, and the Montana Dairymen's Association. The officers of the board consist of a president and secretary, elected by the board for two years. The members of this board of administration are designated "directors of Montana farmers' institutes," and are "authorized to hold institutes for the instruction of the citizens of the State in the various branches of agriculture and prescribe such rules and regulations as they may deem best for organizing and conducting the same." At least one institute is required to be held in each county each year. The directors are authorized to designate the times and places for holding the meetings. The rules of the board require that—

> The State shall be divided into districts comprising several counties which may be reached by a party of institute workers without unnecessary expense. In one or more districts, which shall be varied each year, a corps of institute workers shall attend and hold a two or three days' session in each county. This deputation shall be accompanied by a stenographer, who shall make a full report of their meetings for the farmers' institute annual. The board shall endeavor to encourage by all means in its power the formation of local farmers' institutes, organizations, or farmers' clubs in the various counties or communities of the State. It shall lend such aid as is in its power toward maintaining these organizations and toward helping to make their work efficient and helpful to the communities in which they are organized. It shall also, as far as possible, recognize and use those local organizations in arranging for institute meetings in any locality.

It is further directed that—

> The secretary shall be superintendent of farmers' institutes and shall have immediate charge of and make all arrangements for the farmers' institute work over the State. Such plans and arrangements he shall submit for the approval of the board.

The local county organizations are required to provide suitable halls, and must furnish them with light and heat and bear all necessary advertising expenses.

Four thousand dollars was appropriated for the purpose of conducting institutes this year. Under the new act of March 6, 1903, each institute held under the authority of the board is entitled to a sum not exceeding $50 from the amount appropriated. An institute annual is authorized to be published, at a cost not to exceed $1,500 in any one year. Five thousand copies of the proceedings of the institutes of the past year were published and distributed. Forty-seven institutes were held during the year, composed of 100 sessions. Six thousand nine hundred and forty-six persons were in attendance, and 18 lecturers were upon the State force, 10 of whom were supplied by the agricultural college and experiment station. The director of

institutes is also acting director of the Montana Agricultural Experiment Station and professor of agronomy, animal husbandry, and dairying in the Montana State College of Agriculture and Mechanic Arts.

NEBRASKA.

Farmers' institutes in Nebraska are held under the general direction of the industrial college of the University of Nebraska and the agricultural experiment station. The university employs a superintendent of farmers' institutes, who is also the director of the experiment station. There is also employed an assistant superintendent of institutes, who has charge of the field work. One hundred and fifty institutes were held last year, consisting of 480 sessions. Eighty-eight institutes were one-day, 56 were two-day, and 6 were three-day. The total attendance was 67,241. Institutes were held in 68 counties. Twenty-nine lecturers were upon the institute teaching force. Eighteen of these were members of the agricultural college and experiment station staffs. Six thousand dollars was appropriated for meeting the expenses of the work. No report of the proceedings is published. The dates, places, and programmes for the institutes are arranged by the State director. The local county organizations consist of a president, secretary, and an executive committee, who are intrusted with the duties of securing meeting rooms and providing for the payment of the local expenses of the institute. The State lecturers are appointed by authority of the regents of the university, and are assigned to the several localities by the superintendent of institutes. Institutes are advertised through the local papers, by the means of posters, and by the distribution of programmes through the mail. A train with cars fitted up for the purpose, called "the seed-corn special," was equipped with materials and a lecture force by the institute director, and through the courtesy of the railroad companies was taken over the principal railroads of the State. Forty-one thousand eight hundred and eighty-six persons by this means were reached. The annual round-up of the agricultural organizations of the State was held at the university January 16 to 21, 1905. Thirty-one sessions were held, with a total attendance of 2,000.

NEVADA.

There is no law in this State providing for the organization or conduct of institutes. The work has hitherto been in charge of the State University and the agricultural experiment station, the director of institutes being president of the university and also director of the experiment station. Last year there were held 10 institutes, composed of 20 sessions, with an attendance of 665. The entire expense was $379. The State lecture force consists of 6 lecturers, 5 of whom

are members of the agricultural college faculty and experiment station staff. The local organization consists of a local executive committee, with a permanent chairman and secretary.

The arranging of dates, places, and programmes is by the staff of the experiment station, after consultation with members of the local committee. The railroad companies furnish free transportation for all workers within State limits and grant reduced rates to all who attend the institutes. The proceedings of the institute work are published in the annual report of the experiment station. Seven hundred and fifty copies were printed and distributed during the past year.

NEW HAMPSHIRE.

The public statutes of New Hampshire require the secretary of the board of agriculture "to make arrangements for, give public notice of, and, if possible, personally attend the farmers' meetings authorized by the board." Under this general authority farmers' institutes have been organized and conducted. Last season 13 institutes were held, composed of 28 sessions. Twenty-nine hundred people were in attendance, and 14 lecturers were upon the State corps of instructors, 7 of whom were members of the agricultural college faculty, and the experiment station staff, contributing fourteen days of time. The total expense was $1,500, all of which was appropriated by the State board of agriculture from the general funds received from the State for this purpose. Local arrangements for holding institutes are made by the secretary of the board with grange organizations, farm clubs, and agricultural and horticultural societies. Two thousand copies of reports of proceedings were published and distributed.

NEW JERSEY.

The farmers' institutes in New Jersey are organized and conducted under general authority granted to the State board of agriculture by the legislature. Under the act the board is authorized to "employ suitable persons to lecture before the State board of agriculture at its annual or other meetings and in the counties of the State." The executive committee of the board has delegated the management and conduct of the institutes to its secretary. Thirty institutes were held during the past year, composed of 111 sessions. Twenty-three were one-day and 7 were two-day. The total attendance was 5,538. Ten lecturers are upon the State corps of teachers, 5 of whom were members of the faculty of the agricultural college and the staff of the experiment station, who contributed forty days of time to institute service. One thousand eight hundred and thirty-eight dollars was expended for meeting the expenses of institutes, and $3,500 has been appropriated for the coming year. No report of the institute pro-

ceedings is published except that an occasional summary of the work is printed in the annual report of the State board of agriculture. There are no specific local organizations for institute work in the State. The director invites the members of county boards, granges, and farm clubs to aid him in the work of arranging for the county meetings. In most cases the dates, places, and programmes are prepared by the State director. The local communities are expected to provide proper meeting rooms and to pay all expenses for heat and light. The director attends most of the institutes, and in many instances takes part as a lecturer. An annual round-up meeting, consisting of seven sessions and attended by about 300 persons, was held in connection with the meeting of the State board of agriculture.

NEW MEXICO.

The farmers' institute work in New Mexico is under the direction of the agricultural college and experiment station. There is no specific legislation providing for the organization or control of the institute work. The expenses are met by appropriations made by the board of regents of the College of Agriculture and Mechanic Arts and of the experiment station. One institute was held at the agricultural and mechanical college, consisting of three sessions. The meeting was conducted by the professors of the college and was attended by a considerable number of farmers in the immediate locality. No report of the proceedings is published. There is no regular farmers' institute organization in the State. The cost of the institute was nominal.

The citizens in the localities where institutes are held pay all the expenses of the meeting except those incurred by the State lecturers. The advertising of the institutes is committed to the localities in which the meetings are to be held. Wherever there is an agricultural organization in a locality the institute work is conducted through this organization. If no organization exists, then a committee of citizens is appointed to arrange for the meeting. To this organization or committee is committed the preparation of the programme, the selection of local speakers, the fixing of the dates, and the securing of places of meeting.

NEW YORK.

The director of institutes in New York is appointed by the commissioner of agriculture under the authority of an act of the legislature creating the department of agriculture. The law provides for the appointment of the director of institutes and for the appropriation of funds to conduct them, leaving the manner of organization and management entirely in the hands of the State institute director.

Last year 261 institutes were held, made up of 967 sess station hundred and twenty-nine of these were one-day, 128 wer mittee. and 4 were three-day institutes. The total attendance was Sixty lecturers were upon the State corps of instructors, 20 of w were furnished by the faculty of the agricultural college and the staff of the experiment station, who contributed one hundred and ninety-five days of their time. Twenty thousand dollars was appropriated for carrying on the work, all of which was expended. As many as five separate corps of speakers are in the field at the same time. An annual meeting of the lecturers upon the State force has been held for the purpose of normal instruction. During the past year a course continuing for two weeks was provided, one week at the State experiment station at Geneva and one week at Cornell University. The corps of lecturers was well represented at both of the meetings, and much interest was manifested in the lectures and discussions. The speakers in New York are all listed under the civil service, and th director reports that there has thus far been no serious trouble from the rulings of their civil-service commission. A special effort has been made to develop institute lecturers from among their own citizens, and the large number of efficient instructors now upon the State force is evidence of the success of the director in this respect.

An annual report of institutes, numbering 25,000 copies, was printed and distributed by the State director and by members of the legislature. The local or county organization varies. Usually a local committee is selected by the State director to have charge of the arrangements for holding the county meetings. The dates, places, and programmes are arranged by the director. Each locality is required to provide a hall free of expense. The State pays the expenses for advertising and for the lighting and heating of the hall. The director frequently furnishes speakers for independent institutes that are held under the auspices of granges, farm clubs, or agricultural societies. The attendance at these independent institutes last year is reported as 31,000. The director reports having held during the season 92 institute sessions specially for farmers' boys and girls, with pronounced success. The special topics presented for discussion before all of the institutes were "Good roads" and "Rural schools."

NORTH CAROLINA.

By act of assembly it is made the duty of the commissioner of agriculture of North Carolina, by and with the consent and advice of the board of agriculture, "to hold farmers' institutes in the several counties of the State as frequently as may be deemed advisable in order to instruct the people in improved methods in farming, in the beneficial use of fertilizers and composts, and to ascertain the wants and neces-

ceeding the various farming communities; and may collect the is printed addresses made at these institutes and publish the same Ther phlet form annually for distribution among the farmers of State. He may secure such assistants as may be necessary or beneficial in holding such institutes."

Sixty-one institutes were held last year, composed of 226 sessions, and the total attendance was 11,168. Fifty-eight were one-day and three were two-day institutes. Eighteen instructors were upon the State lecture force, six of whom were members of the agricultural college faculties and the experiment station staffs. The total expense for the year was $1,971, which sum was contributed by the State board of agriculture from revenues derived from the tax on commercial fertilizers in the State. The director of institutes is also commissioner of agriculture and is elected by the people for a term of years. One thousand seven hundred dollars has been appropriated by the board for institute purposes for the coming season. Twenty-five thousand copies of an annual report of the proceedings of the institutes are printed and distributed to the regular mailing list of the department of agriculture. The local organization for the counties consists of a chairman, secretary, and committee on programmes. The director holds institutes upon request of the various localities. The local expenses are provided for by the community in which the institute is held. Announcement of the dates, places, and speakers is made by publication in the newspapers and through the distribution of posters. A round-up institute or State farmers' convention was held at the agricultural college, continuing during nine sessions, and was attended by about 500 persons.

NORTH DAKOTA.

The farmers' institute board is provided for by an act of assembly approved March 19, 1903. The board is composed of the president of the board of trustees of the North Dakota Agricultural College, the commissioner of agriculture and labor, the director of the experiment station, the professor of agriculture, and the professor of dairying of the North Dakota Agricultural College. It is made the duty of the board to—

employ a director of farmers' institutes and such other institute lecturers as may be deemed necessary; to authorize the holding of not less than 40 institutes each year, the same to be of such a nature as to instruct the farmers of the State in maintaining the fertility of the soil, the improvement of cereal crops grown in the State, principles of breeding as applied to domestic animals, the making and handling of dairy products, the destruction of noxious weeds and injurious insects, forestry and growing of fruits, feeding and management of live stock, and in general such instruction as will tend to promote the prosperity, home life, and comfort of the farming population.

This act, as amended March 15, 1905, appropriates $6,000 annually for carrying on the institute work. Sixty-one institutes were held last year, consisting of 140 sessions. Forty-seven were one-day institutes, and 13 were two-day, and 1 three-day. The attendance was 12,838. The number of speakers upon the State force was 8. Five of these were members of the State agricultural experiment station staff and contributed twenty-two days of time. The total cost of the institutes was $3,948. The appropriation for the year ending June 30, 1906, is $6,000. The institute proceedings are published in an annual, of which 10,000 copies are distributed at institute meetings and through the mail. The State lecturers are appointed by the institute board. This board also appoints the State director, whose term of office is for one year. An institute committee in each county is selected by the State institute board to look after the advertising and make such special arrangements as are necessary for the successful conduct of the meetings. The dates, places, and programmes are all arranged by the State director, and notices of meetings are advertised by means of large posters, through the publication of the programmes by local newspapers, and by postal card invitations sent out through the mail.

A round-up meeting was held at Fargo, January 17 to 20, 1905, consisting of ten sessions with an attendance of 1,310 persons. The director of institutes arranged with the Minneapolis, St. Paul and Sault Ste. Marie Railway Company to operate a special seed train March 6 to 11, inclusive. The institute board arranged for the speakers and paid all other expenses, as well as arranging for the advertising. This train covered the main line from Hankinson to Portal, and the Bismarck branch from Hankinson to Wishek, a total of 480 miles, making twenty-seven stops of 1 hour and 30 minutes each during this time. The train consisted of a large passenger coach, which was used to convey farmers to and from the stations between the regular stops and also in which to hold the meeting when the attendance would permit. The attendance ranged from 75 to over 500, making a total of 5,555 for the five days. Professors H. L. Bolley, J. H. Shepperd, Director of the Experiment Station J. H. Worst, and the superintendent of institutes composed the lecture corps. The principal subjects treated were "Grading and selecting seed grain," "Seed treatment to prevent disease in field crops," and the "Germination of seed grain." At the close of each meeting five circulars, giving a résumé of the subjects discussed, were distributed. The total expense to the institute fund was $225.

OHIO.

The farmers' institute work in Ohio is organized under the provisions of an act of assembly passed April 26, 1890, and amended April 27, 1896. Under this act whenever "twenty or more persons resident of any county in the State organize themselves into a farmers' institute society, adopt a constitution and by-laws agreeable to rules and regulations furnished by the State board of agriculture, and when such society shall have elected proper officers and performed such other acts as may be required by the rules of the State board of agriculture, such society shall be deemed a body corporate." Not more than four farmers' institute societies in any county are permitted to hold annual meetings under the auspices of the State board of agriculture. The secretary of the State board of agriculture has charge of the farmers' institute work under the general direction of the board.

Section 3 of the act provides for the maintenance of farmers' institutes through the levy of a direct tax. Ohio is the only State that has adopted this method of institute support. The section is as follows:

When a society organized under the provisions of this act shall have held an annual farmers' institute meeting in accordance with the rules of the State board of agriculture, the secretary of said board shall issue certificates, one to the president of the farmers' institute society and one to the president of the State board of agriculture, setting forth these facts, and on the presentation of these certificates to the county auditor he shall each year draw orders on the treasurer of the county as follows: Based on the last previous national census, a sum equal to 3 mills for each inhabitant of the county in favor of the president of the State board of agriculture and a sum equal to 3 mills for each inhabitant of the county in favor of the president of the farmers' institute society, where but one society is organized; but in counties where there are more than one farmers' institute society organized under the provisions of this act and holding meetings under the auspices and by the direction of the State board of agriculture, the said 3 mills for each inhabitant shall be equally apportioned among such societies, and warrants in the proper amounts issued to the respective presidents, and the treasurer of the county shall pay the same from the county fund: *Provided*, That in no county shall the total annual sum exceed two hundred and fifty dollars: *And provided further*, That the payment to any institute society shall not exceed the expense, as per detailed statement, provided in section four of this act.

The act, it will be seen, provides permanent county institute organization and secures to each a substantial fund for support. The State board of agriculture, under rules which it is authorized to prescribe, gives specific instructions for the formation of local societies and directs how reports shall be made out, and directs the details to be observed in conducting their institute meetings. The State lecturers are required to devote their time and efforts to the discussion of such subjects as are designated by the institute law, namely, "farming, stock raising, fruit culture, and all branches of business connected with the industry of agriculture."

Two hundred and eighty-nine institutes were held last year, consisting of 1,399 sessions. All of these were two-day institutes, excepting 2, which were one-day. The total attendance was 92,593. The teaching force consisted of 29 members, and the total expense incurred was $19,598. Twenty thousand copies of reports of the proceedings were printed and distributed. All of the local expenses are met by the counties from their portion of the per capita tax. The dates and places for institutes are arranged by the State director, and the programmes are submitted to him by local societies for approval. The dates, places, and speakers are announced about forty days in advance of December 1, which is the beginning of the institute season. The institutes are advertised locally by the county societies. A number of independent institutes were held during the year by local organizations. The average attendance at each of these is given at 318. A round-up meeting was held last year consisting of four sessions. About 500 farmers were in attendance.

OKLAHOMA.

A State board of agriculture, consisting of 6 elective members and the governor, who is a member ex officio, has been created by a recent act of the Territorial legislature. The 6 members of this board are elected by delegates from county institutes, which organizations are provided for in the act creating the State board of agriculture. Whenever not less than 15 farmers, residents in any one county, shall apply to the secretary of the Territory, he is required to issue a charter of incorporation, and the organization shall thereafter be known as the county farmers' institute for such county. These county institutes are required to hold an annual meeting at the county seat, at which matters pertaining to agriculture shall be discussed and one delegate be elected to attend the annual meeting of the State board of agriculture. These delegates at their annual meeting elect two members of the State board of agriculture whose terms are for three years, and the law provides that this board so elected "shall have supervision of the county farmers' institute system." The board elects its secretary and assigns his duties, one of which is the management of the farmers' institutes. The act directs that "it shall also be the duty of the secretary of the board to cooperate with the faculty of the agricultural and mechanical college and the staff of the agricultural experiment station in the preparation of programmes for institute meetings and to attend the annual meeting of each county farmers' institute." The expenses of the delegates from the county institutes to the annual meeting of the board of agriculture are paid by the Territorial treasurer upon warrants drawn by the Territorial auditor, the compensation to be at the rate of $2 per day for not more than

three days and 3 cents per mile for each mile necessarily traveled in going to and returning from such meeting.

Last year 58 institutes were held; 39 were one-day and 19 were two-day. The total number of sessions was 156 and the attendance was 5,500. There was 8 lecturers upon the State institute force, 5 of whom were members of the State agricultural college and experiment station staffs, who contributed sixty-five days of time. The dates of the institutes are fixed by the county organizations at their annual meetings, and they also assist the State director in preparing programmes. No report of the institute proceedings is published. An annual round-up meeting was held, continuing through 7 sessions, with an average attendance of 150.

OREGON.

The legislative assembly of the State of Oregon at its session of 1905 enacted the following legislation respecting the farmers' institutes:

The board of regents of the State agricultural college is hereby authorized to hold institutes for the instruction of citizens of this State in the various branches of agriculture. Such institutes shall be held at such times and at such places as said board may direct, and said board shall make such rules and regulations as it may deem proper for organizing and conducting such institutes, and shall employ an agent or agents to perform such work in connection therewith as they may deem best. The course of instruction at such institutes shall be so arranged as to present to those in attendance results of the most recent investigations in theoretical and practical agriculture.

For the purpose mentioned in the preceding section the State board may issue such sum as it may deem proper not exceeding the sum of $2,500 in any one year from the general fund, and such amount is hereby annually appropriated for that purpose.

Last year 18 institutes were held; 12 were one-day and 6 were two-day. The total number of sessions was 54 and the attendance 5,500. The State lecture force is composed of agricultural college and experiment station men. During the year four of these officials were in the institute lecture service and contributed fifty-four days of time. The expenses of the farmers' institutes were paid from the station funds, amounting to $350. There is no regular form of organization for the different counties. The director arranges the dates and places after consultation with individuals in the localities desiring institutes. Eight special meetings of farmers were held during the year with an aggregate attendance of 3,000.

PENNSYLVANIA.

Under the Pennsylvania law the deputy secretary of agriculture, who is appointed by the governor for a term of four years, is also director of farmers' institutes. He is required to "arrange them in

such manner as to time and places of holding the same as to secure the greatest economy and efficiency of service, and to this end he shall, in each county where such institutes are to be held, confer and advise with the local member of the State board of agriculture, together with representatives duly appointed by each county agricultural, horticultural, and other like organizations, with reference to the appointment of speakers and other local arrangements." The institutes are supported by biennial appropriations by the legislature to the department of agriculture. The number of institutes held last year was 196. Forty-four were one-day institutes, 150 were two day, and 2 were three day. The total number of sessions was 862, and the attendance was 150,932, not including special meetings. The amount appropriated for institute purposes last year was $17,500. This does not include the salary of the director, $3,000, and that of stenographer, $900. There were 56 lecturers upon the State force, 2 of whom were furnished by the State agricultural experiment station, who contributed sixty-two days of time.

Partial reports of institute proceedings are published in the annual report of the department. Thirty-one thousand six hundred copies of this report are published and distributed annually. The local organization consists of a county chairman, who is usually a member of the State board of agriculture, elected by the county agricultural society, and one representative from each of the other county agricultural organizations. All of the expenses of the institute work, including the local expenses in the several counties, are paid out of the State appropriation. The State director fixes the dates and the county committees select the places and prepare the programmes. A number of independent institutes were held during the year by farmers' clubs, granges, and county agricultural societies, with an aggregate attendance of about 30,000 persons. The State is divided into five sections for institute purposes, and the institute director furnished at least three lecturers for each section.

A round-up meeting of the institute lecturers was held, consisting of eight sessions. The number in attendance was 200. A feature of the work in this State has been the prescribing of one or two important topics and requiring them to be placed upon the local programmes for discussion throughout the State. "Improvement of country schools through centralization" and "Soil improvement" were the two leading topics presented during the past season. The topics selected for the coming year are "Lessons in dairying by actual practice in butter making and handling the dairy." The discovering and training of institute lecturers so as to increase the number of efficient instructors in institute work is made an important fea-

ture by the State director. Two hundred sessions of women's institutes were held during the year. The list of dates, places, and speakers is advertised four months in advance of the institute season.

PORTO RICO.

During the past year an agricultural society composed of Americans and Porto Ricans has been organized, with Mr. H. C. Henricksen, horticulturist of the agricultural experiment station, as secretary. Institutes under the auspices of this association will be held during the coming year, and it is expected that there will be, in connection with the institutes, an agricultural fair, lasting several days, held at Mayaguez.

RHODE ISLAND.

Farmers' institutes in Rhode Island are conducted under authority granted by the general assembly in an act passed May 19, 1892, section 4 of which is as follows:

> The board of agriculture shall hold one agricultural institute in each county annually, either independently or in connection with any society or association or other organization devoted to the same general objects, and may hold as many more as it shall deem expedient, and shall, as far as practicable, encourage State and local associations and societies in the interest of agriculture.

The secretary of the State board of agriculture is charged with the duty of arranging for and holding institutes, the expenses of which are paid by the board out of the $15,000 annually appropriated for the purpose of carrying out the several provisions of the act by which the board is constituted.

One institute, continuing through two days, and composed of six sessions, was held during the past year, with a total attendance of about 400. The cost of this meeting is reported at about $100, which does not include the salary and expenses of the State director. Two speakers were furnished by the State agricultural college and by the State experiment station. The dates, places, and programmes are arranged by the director.

SOUTH CAROLINA.

In 1887 the legislature of South Carolina made it obligatory upon the board of agriculture to hold farmers' institutes. A few were held under the provisions of that act. Several years later Clemson Agricultural College was established, and the duties of the board of agriculture, so far as related to the holding of farmers' institutes, were devolved upon the board of trustees of Clemson Agricultural College.

In the revised statutes of South Carolina for 1893, section 1132, paragraph 10, the law reads:

> They [the board of trustees of Clemson Agricultural College] shall have power to hold agricultural conventions composed of delegates from each county of the State. * * * ; and to conduct farmers' institutes at such times and places as may appear expedient, and they are authorized to use such parts of funds under their control as may be necessary to meet the expenses of conducting such institutes.

Institutes, therefore, are held under authority granted to the board of trustees of Clemson Agricultural College. A committee of this board makes out the programme for the year and appoints an officer to take charge of the work of conducting the meetings. The rule adopted by the board is to require that an invitation shall be received from not less than fifteen farmers in a locality before an institute will be granted, and it is also required that those desiring institutes must have their petitions in the hands of the president on or before June 10. These petitions must designate a suitable place for holding the institute, and the locality will be expected to provide either a suitable building or seats in some grove for the comfortable accommodation of those who attend the institute. The director appoints the dates at which the institutes will be held, giving due notice to the petitioners in each locality; thereupon they are expected to advertise the meeting throughout the territory which the institute is to reach. The appropriation for expenses is made by the trustees of the agricultural college from the college and station funds.

During the past year 33 one-day institutes were held, made up of 56 sessions. The total attendance was 7,460. Twelve lecturers were upon the State institute force, all members of the agricultural college faculties and the experiment station staffs. These lecturers contributed ninety-four days of time. The expenses of the institutes amounted to $1,194. A round-up institute, consisting of eight sessions, was held at the agricultural college, having a total attendance of 700 persons.

SOUTH DAKOTA.

The legislature of South Dakota by act approved March 3, 1905, creates a State farmers' institute board to be composed of the president of the agricultural college, and the two members of the State board of regents who are at the time acting on the committee for the agricultural college. The term of office as members of such institute board terminates with the expiration of their term of office. The board has authority to hold institutes of not to exceed three days each, at such times and places within the State as in their judgment the needs of the people demand. They are to be free to the public and shall consist of "practical and instructive lectures, addresses, dis-

cussions, illustrations, and demonstrations upon the subject of agriculture in all of its branches, and such other matters as are of interest to the farming people of the State." The necessary and actual expenses incurred in arranging for and conducting the institutes shall be paid out of the appropriation by the State, "provided that there shall be no expenditure for hall rent, fuel, lights, local advertising, or local speakers in connection with the holding of such institute, except when deemed necessary by the institute." The board has authority to engage such instructors as are needed for the institutes, each of whom shall be a specialist on the subject he is to present, and to allow them a reasonable compensation for their services, together with their necessary and actual expenses while employed. The board has authority to do such advertising and publish such matters for free distribution as they may deem advisable for the best interest of the farmers of the State. For the purpose of carrying out the provisions of the act "there is hereby appropriated out of any money in the State treasury not otherwise appropriated the sum of $5,000 annually." No institutes were held during the past year, but the institute board has been organized, and Mr. M. F. Greeley, of Gary, appointed superintendent of institutes, and empowered to secure such assistance as he deems necessary in order to prosecute the work. The board has decided to hold an institute in every county in the State during the coming year.

TENNESSEE.

An appropriation was made by the legislature to the department of agriculture to be used by the commissioner for institute purposes. The commissioner of agriculture selects the lecturers, arranges the programmes, and decides the times and places for holding institute meetings. The State is divided into three distinct geographical sections—eastern, middle, and western Tennessee.

The director reports that only a few institutes were held during the year which ended June 30, 1905, and that these were held by the county organizations. As a consequence he was unable to furnish the statistical data requested. The work is being systematized and it is hoped that during the coming year there will be held a large number of institutes distributed throughout the three geographical sections of the State in proportion to their several requirements.

TEXAS.

The legislature of Texas in 1903 made an appropriation of $5,400 to the agricultural and mechanical college for farmers' institute purposes for two years, 1904 and 1905. The control of the farmers' institute work in Texas is in the hands of the board of directors of

the agricultural and mechanical college. A member of the college faculty was appointed by the board of trustees two years ago to take charge of organizing and conducting institutes. The director and the president of the college arrange the dates, places, and programmes for institute meetings. All of the local expenses are met by the citizens of the community in which the institute is held, including very frequently the entertainment of the State lecturers. One hundred and ten institutes were held during the year. One hundred and four of these were one-day and 6 were two-day institutes. The total number of sessions was 146 and the attendance 8,500. There were 24 lecturers on the State force. The cost of the institutes for the year was $3,450. County organizations are found under a constitution and by-laws suggested by the State director. By the terms of this constitution the local societies agree to meet once each month for the discussion of agricultural questions. The special topics discussed during the past season were "Diversification," "Cotton and cotton insect pests" and "Swine and sheep growing." As a new feature in their institute work the director of institutes reports that they have adopted the rule of discussing a topic quite fully before taking up a new subject. A round-up institute was held at the college, extending through six sessions, attended by about 2,000 persons. No report of the institute proceedings is published.

UTAH.

Farmers' institutes in Utah are by law under the direction of the trustees of the agricultural college, who, "with the advice of the faculty of said college, are hereby authorized and required to hold institutes for the instruction of the citizens of this State in the various branches of agriculture." There must be held at least one institute in each county during each year, at such times and at such places as the trustees and faculty of the agricultural college may direct. They are authorized to make such rules and regulations as they deem proper for organizing and conducting institutes, and may employ an agent or agents to perform such work in connection with the faculty of the college. The sum of $1,500 is annually appropriated, to be expended by the board of trustees for institute purposes. Under the provisions of this act it is made the duty of those conducting the institutes to encourage and assist in the organization of local agricultural societies. A course of instruction must be so arranged as to "present to those in attendance the results of the most recent investigations in theoretical and practical agriculture." Fifteen institutes were held during the year, consisting of 40 sessions. All were two-day institutes, excepting three, which were one day. The total attendance was 8,000, and the entire cost $1,500, not including the salary of the State director. Fifteen lecturers were upon the State institute force, all

of whom were members of the college faculty or of the experiment station staff. Seven thousand copies of the reports of proceedings are printed and distributed. A committee of the faculty, under the direction of the president, arranges for all institute work. The dates, places, and programmes are fixed by this committee. All the local expenses incurred in holding meetings are paid out of the State appropriation.

VERMONT.

The farmers' institute work of Vermont is under the control of the State board of agriculture. This board is composed of the governor, the president of the University of Vermont and State agricultural college, and three other persons appointed by the governor. They hold office for two years. The board is required to "hold one meeting in each county annually, and others if deemed expedient, and may employ lecturers, essayists, or other aid in conducting said meetings, managing its affairs generally, and discharging its duties. At such meetings it shall present subjects for discussion, and, among other topics, forestry, tree planting, roads and road making."

Forty institutes were held during the year, consisting of 80 sessions. Seven thousand five hundred persons were in attendance. Twenty-six State lecturers were engaged in giving instruction. The appropriation for institutes was $5,000, of which $2,083.75 was expended. The board publishes annually 3,000 copies of its reports, which includes the proceedings of the farmers' institutes.

The dates, places, and programmes for institutes are arranged by the State director, who is also secretary of the State board of agriculture. The free use of hall is required to be provided by the community, the State board defraying the other local expenses. Three members of the faculty of the agricultural college assisted in giving instructions.

VIRGINIA.

Under an act of the legislature of 1893 the board of agriculture of the State of Virginia is required to hold "farmers' institutes at such times and at such places throughout the State as it may deem necessary for the advancement of agricultural knowledge and the improvement of agricultural methods and practices and publish and distribute such papers and addresses read or made at these institutes as promise to be of value to the farming interests."

The duty of arranging for and conducting farmers' institutes is placed in the hands of the member of the board in each Congressional district. Thirty-five one-day institutes were held, made up of 70 sessions. Institutes were held in 28 counties. The total attendance was 8,000. There were 9 lecturers upon the State institute force, all

of whom were members of the agricultural college faculties and experiment station staffs. The amount of money expended was $5,000. The appropriation for the coming year is $5,500. A State round-up institute was held in Roanoke, continuing through 6 sessions, with an average attendance of 150.

WASHINGTON.

The law of the State of Washington, in defining the purpose of the Washington Agricultural College and School of Science, declares that "one of the objects of the State college shall be to hold farmers' institutes at such times and places and under such regulations as the board of regents may determine." An act of the legislature of 1903 requires "that at least one institute shall be held in each county of the State in each year." Forty-six institutes were held last year. Seventeen were one-day, 26 were two-day, and 3 were three-day. The total number of sessions was 150, and the attendance is given at 7,282. The amount appropriated for institute purposes by the State was $2,500. Fifteen speakers are upon the State institute force, 9 of whom are from the faculty of the agricultural college and the staff of the experiment station. They contributed one hundred and fifty-six days. The president of the college is the superintendent of farmers' institutes, but the dean of agriculture is the field agent and has direct control of the execution of the work. No regular report of the institute proceedings is published, but an institute bulletin is annually prepared and distributed for information. County institute organizations have been established throughout the State, which are intrusted with the duty of making local arrangements for institute meetings.

WEST VIRGINIA.

The law of West Virginia places the control of the farmers' institutes in the hands of the State board of agriculture. Under this act the board is required to "promote and encourage as far as practicable the holding of farmers' institutes, the organization of agricultural and horticultural societies and other associations in the interest of agriculture in the several counties of the State." It is directed to "hold farmers' institutes for the instruction of the farmers of the State in the various branches of agriculture. Such institutes shall be held at such times and places in each year as the said board may direct. The said board shall make such orders and regulations as it may deem proper for organizing and conducting such institutes, and may employ an agent or agents to perform such work in connection therewith as they may deem best." The course of instruction in the institutes shall be so "arranged as to present to those in attendance

the results of the most recent investigations in theoretical and practical farming."

Sixty-three institutes were held last year. Sixteen were one-day and 46 two-day and 1 three-day, together comprising 199 sessions. Nine thousand nine hundred and fifty persons were in attendance. Twenty-two lecturers were upon the State force, 5 of whom were members of the agricultural college faculty and experiment station staff, who contributed twenty-three days of their time. The amount expended for meeting the expenses of the institutes for the year was $2,455.

There is no law regulating the formation of local institute associations, but the board of agriculture has had prepared a form of constitution and set of by-laws, which were printed in the institute bulletin, with the recommendation that they be adopted by local societies in the several counties. The director of institutes is appointed by the State board of agriculture for a period of two years. The board arranges the dates of the institutes and assigns two of its members to be present at each. The reports of the proceedings of the institutes are required to be sent in to the secretary of the board and are printed in an agricultural periodical issued under the direction of the State board of agriculture.

WISCONSIN.

The board of regents of the State university is authorized by the law of Wisconsin to "hold institutes for the instruction of citizens of the State in the various branches of agriculture. Such institutes shall be held at such times and at such places as said board may direct. The said board shall make such rules and regulations as it may deem proper for organizing and conducting such institutes, and may employ an agent or agents to perform such work in connection therewith as they may deem best."

Eighty-two institutes were held during the year. Eighty-one of these were two-day and one was a three-day, aggregating 270 sessions. The total attendance was 43,000. Thirty-one lecturers were upon the State teaching force, eight of whom were members of the agricultural college faculty and the experiment station staff. The amount expended for institute expenses was $14,942. Sixty thousand copies of the farmers' institute bulletin, containing the proceedings of the institutes, were published and distributed. The local expenses of the institutes are provided for by the citizens of the community in which the institute is held. The meetings are placed upon request of the various localities. Petitions are sent in to the director of institutes, and through these meetings are granted in the discretion of the State director. The arranging of the dates, places, and programmes is in

the hands of the institute director, and announcements of the times, places, and speakers are made about one month in advance of the institute season. Special topics for discussion last year were economical feeding, dairy cows, care of milk, tillage, corn, clover, and fertility. The institute director is elected by the board of regents of the university, nominated by the president of the university and dean of the agricultural college, and recommended by the farm committee. He takes a place regularly on the programme as a lecturer, and is in the field during the entire season in which institutes are held. The annual farmers' institute bulletin is a 320-page handbook of practical agriculture. A round-up institute was held extending over 11 sessions, with an attendance of 2,000. The papers and discussions at this meeting are edited and published, and make up the material used in the preparation of the annual bulletin or handbook. A number of independent institutes were held, with an estimated attendance of 5,000 persons.

WYOMING.

The legislature of Wyoming at its session in 1904 inserted the following item as section 47 of the general appropriation bill:

> The sum of $2,000, or so much thereof as may be necessary, is hereby appropriated for the purpose of holding farmers' institutes and short courses in stock judging, agronomy, and general farming, such meetings to be arranged at such places and at such times as will accommodate the people of the community in which the meetings may be desired. Such farmers' institutes or short courses shall be in charge of the agricultural department of the university, which shall arrange the necessary details of the meetings. In distributing the funds provided for this purpose, the board of trustees of the university shall have authority to provide instructors, lecturers, equipment, and to provide for any other necessary expenses incident to these meetings.

The first community to avail itself of this act was Cody, Bighorn County, where Director Buffum conducted a three-day institute March 29, 30, and 31, 1905. This was the first State institute held in Wyoming. Seven sessions were held, with a total attendance of 75 persons. The work is being organized under the new law, and as many institutes will be held during the coming year as possible with the appropriation granted.

STATISTICS OF FARMERS' INSTITUTES, 1905.

Number of institutes held and the approximate attendance during the year ended June 30, 1905.

State or Territory.	Number of one-day institutes.	Number of two-day institutes.	Number of three or more day institutes.	Total.	Total number of sessions.	Total attendance.
Alabama	23	1		24	48	3,820
Alaska [a]						
Arizona			1	1	12	250
Arkansas	30			30	60	7,650
California	37	70	3	110	429	43,494
Colorado	16	4		20	52	2,700
Connecticut	14			14	28	1,200
Delaware	20			20	23	4,199
Florida [a]						
Georgia	34	10		44	108	18,000
Hawaii	4			4	8	350
Idaho	5	19	1	25	113	4,000
Illinois		50	50	100	635	69,759
Indiana	133	117		250	883	79,964
Indian Territory [a]						
Iowa	5	23	32	60	207	[b] 18,000
Kansas	26	20	9	55	144	11,455
Kentucky		16	1	17	73	3,350
Louisiana	65	2		67	208	14,541
Maine	44			44	93	5,731
Maryland	8	18		26	73	5,741
Massachusetts	115			115	167	12,372
Michigan	200	68	2	270	827	55,004
Minnesota	105			105	227	52,125
Mississippi	150	2	1	153	311	30,000
Missouri	58	44	2	104	256	2,560
Montana	41	6		47	100	6,946
Nebraska	88	56	6	150	480	67,241
Nevada	7	2	1	10	20	665
New Hampshire	11	2		13	28	2,900
New Jersey	23	7		30	111	5,538
New Mexico	1			1	3	
New York	129	128	4	261	967	87,439
North Carolina	58	3		61	226	11,168
North Dakota	47	13	1	61	140	12,838
Ohio	2	279		281	1,399	92,593
Oklahoma	39	19		58	156	5,500
Oregon	12	6		18	54	5,500
Pennsylvania	44	150	2	196	862	150,932
Porto Rico [a]						
Rhode Island		1		1	6	400
South Carolina	33			33	56	7,460
South Dakota [a]						
Tennessee [a]						
Texas	104	6		110	146	8,500
Utah	3	12		15	40	[b] 8,000
Vermont	40			40	80	7,500
Virginia	35			35	70	8,000
Washington	17	26	3	46	150	7,282
West Virginia	16	46	1	63	199	9,450
Wisconsin		81	1	82	270	43,000
Wyoming			1	1	7	75
Total	1,842	1,307	122	3,271	10,555	995,192

[a] No institutes held. [b] Estimated.

Financial statistics of the farmers' institutes for the year ended June 30, 1905

State or Territory.	Funds appropriated.		Cost.		Appropriations for the season of 1905-6.
	State	College and other funds.	Total cost.	Cost per session.	
Alabama	$600.00		[b] $600.00	$12.50	$600.00
Alaska [a]					
Arizona					
Arkansas		$400 00	400.00	6.66	250.00
California	6,000.00	2,934.00	[b] 8,934.00	20.82	6,000.00
Colorado					4,000.00
Connecticut	428.00		428.00	15.30	
Delaware	750.00		750.00	32.60	750.00
Florida [a]					
Georgia	2,500.00	1,000.00	3,500.00	32.40	3,500.00
Hawaii		35.00	35.00	4.37	35.00
Idaho	1,000.00		[b] 1,000.00	8.84	1,000.00
Illinois	17,650.00	3,310.39	17,257.90	27.17	17,650.00
Indiana	10,000.00		10,000.00	11.32	10,000.00
Indian Territory [a]					
Iowa	7,425.00		3,814.60	18.42	7,425.00
Kansas	2,000.00		[b] 1,760.00	12.22	2,000.00
Kentucky	1,206.16		[b] 1,206.16	10.52	3,000.00
Louisiana	2,000.00	500.00	2,500.00	9.61	2,000.00
Maine	5,000.00		5,000.00	53.76	3,000.00
Maryland	6,000.00		3,618.70	49.55	6,000.00
Massachusetts	2,700.00		[b] 1,474.24	8.82	3,000.00
Michigan	7,500.00	1,800.00	9,300.00	11.24	7,500.00
Minnesota	18,000.00		18,000.00	79.29	18,000.00
Mississippi	3,000.00		3,000.00	9.64	3,000.00
Missouri	3,100.00		3,100.00	12.10	5,000.00
Montana	4,000.00	500.00	4,500.00	40.00	4,000.00
Nebraska	6,000.00		6,000.00	12.50	6,000.00
Nevada		379.00	379.00	18.95	
New Hampshire	1,600.00		[b] 1,500.00	53.58	1,500.00
New Jersey	1,838.15		1,838.15	16.56	3,500.00
New Mexico					
New York	20,000.00		20,000.00	20.60	20,000.00
North Carolina	2,150.00		[b] 1,971.52	8.72	1,700.00
North Dakota	3,931.94	240.00	3,948.17	28.20	6,000.00
Ohio	16,747.62	2,851.06	19,598.68	14.00	16,747.62
Oklahoma					
Oregon		620.00	620.00	11.48	2,500.00
Pennsylvania	20,500.00		20,500.00	23.78	20,500.00
Porto Rico [a]					
Rhode Island		100.00	100 00	16.66	
South Carolina		1,194.56	1,194.56	21.33	1,500.00
South Dakota [a]					5,000.00
Tennessee [a]					
Texas	2,600.00	1,250.00	3,850.00	26.37	1,500.00
Utah	1,500.00		[b] 1,500.00	37.50	1,500.00
Vermont	5,000.00		2,083.75	26.00	5,000.00
Virginia	5,500.00		5,000.00	71.42	5,500.00
Washington	2,500.00	500.00	3,000.00	20.00	
West Virginia	2,455.26		2,455.26	12.33	
Wisconsin	12,000.00	2,942.75	14,942.75	55.34	12,000.00
Wyoming					1,000.00
Total	205,182.13	20,556.76	210,660.44	988.47	219,157.62
Average				24.10	

[a] No institutes held. [b] Salary of directors and college and station speakers not included.

Comparative statement of farmers' institutes.

State or Territory.	Appropriations.			Number of sessions.		Number of institutes.			Attendance.		
	1902–3.	1903–4.	1904–5.	1903–4.	1904–5.	1902–3.	1903–4.	1904–5.	1902–3.	1903–4.	1904–5.
Alabama	$600	$600	$600	49	48	22	24	24	2,618	3,639	3,820
Alaska[a]											
Arizona	60	50		15	12	2	1	1	1,000	600	250
Arkansas			400		60			30			7,650
California	4,000	7,234	8,934	380	429	60	113	110	20,000	43,680	43,494
Colorado	385	517		36	52	10	15	20	1,300	1,660	2,700
Connecticut	700	200	428	36	28	9	18	14	4,000	2,500	1,200
Delaware	800	750	750	42	23	28	18	20	4,800	3,436	4,199
Florida[a]	2,500			32		21	15		2,900	1,605	
Georgia	1,000	1,000	3,500	68	108	15	34	44	3,500	7,000	18,000
Hawaii	35	30	35	8	8	4	4	4	160	200	350
Idaho	1,000	1,000	1,000	74	113	17	17	25	2,550	3,100	4,000
Illinois	18,150	18,173	20,960	609	635	108	105	100	42,876	84,681	69,759
Indiana	10,000	10,000	10,000	832	883	181	175	250	73,653	59,189	79,964
Indian Territory[a]											
Iowa	7,425	7,425	7,425	350	207	64	70	60	17,750	17,750	[b]18,000
Kansas	2,000	2,000	2,000		144	92	58	55	38,085	14,432	11,455
Kentucky	1,200	500	1,206	8	73	8	4	17	2,000	1,200	3,350
Louisiana	2,000	2,000	2,500	79	208	50	39	67	13,245	12,000	14,541
Maine	3,000	2,500	5,000	79	93	40	37	44	5,846	5,473	5,731
Maryland	4,000	4,000	6,000	71	73	40	23	26	11,222	3,250	5,741
Massachusetts	2,000	1,530	2,700	125	167	120	104	115	12,487	11,039	12,372
Michigan	7,500	9,825	9,300	812	827	284	292	270	53,037	52,236	55,004
Minnesota	16,500	18,000	18,000	378	227	100	154	105	35,171	46,210	52,125
Mississippi	1,500	1,725	3,000	214	311	58	107	153	10,000	11,326	30,000
Missouri	4,000	5,000	3,100	311	256	127	147	104	25,400	30,220	2,560
Montana	2,000	4,000	4,500	81	100	16	44	47	600	4,500	6,946
Nebraska	4,000	6,000	6,000	330	480	65	96	150	25,000	25,097	67,241
Nevada	120	83	379	10	20	3	4	10	983	453	665
New Hampshire	1,000	1,588	1,600	38	28	18	18	13	6,300	3,400	2,900
New Jersey	2,000	1,800	1,838	119	111	31	30	30	6,850	4,500	5,538
New Mexico	125	28		9	3	3	4	1	375	160	
New York	20,000	20,000	20,000	1,154	967	312	267	261	138,528	64,347	87,439
North Carolina	600	850	2,150	71	226	15	35	61	1,525	8,411	11,168
North Dakota	1,500	4,000	4,172	151	140	19	46	61	2,655	13,567	12,838
Ohio	16,981	16,747	19,599	1,225	1,399	263	245	281	81,752	75,360	92,593
Oklahoma	1,000	1,000		129	156	29	52	58		5,200	5,560
Oregon	300	350	620	46	54	20	14	18	4,000	4,500	5,500
Pennsylvania	15,000	20,500	20,500	805	862	327	204	196	112,550	70,380	150,932
Porto Rico[a]											
Rhode Island	44	600	100	21	6	1	12	1	20	1,260	400
South Carolina	1,150	600	1,195		56	50	33	33	14,390	8,690	7,460
South Dakota[a]											
Tennessee[a]	2,500	5,000		200		40	72		10,000	8,300	
Texas	2,100	3,950	3,850	178	146	64	144	110	5,376	15,130	8,500
Utah	1,500	1,500	1,500	65	40	40	59	15	3,200	12,000	8,000
Vermont	5,000	5,000	5,000	125	80	41	48	40	16,400	10,000	7,500
Virginia		3,500	5,500	100	70	72	50	35	18,000	10,000	8,000
Washington	2,500	2,500	3,000	259	150	12	57	46	1,800	15,922	7,282
West Virginia	5,451	4,556	2,455	386	199	158	97	63	15,750	12,095	9,450
Wisconsin	12,000	12,000	14,943	512	270	120	101	82	55,000	52,000	43,000
Wyoming					7			1			75
Total	187,226	210,211	225,739	10,622	10,555	3,179	3,306	3,271	904,654	841,698	995,192

[a]No institutes 1904–5.

[b]Estimated.

Number of lecturers employed by the State directors of farmers' institutes during the year ended June 30, 1905.

State or Territory.	Total number of lecturers on the State force.	Number of members of agricultural college and experiment station staffs engaged in institute work.	Number of days contributed to institute work by the agricultural college and experiment station staffs.	Total number of days of institutes held during the year.	Reports of proceedings.	
					Published.	Number of copies.
Alabama	9	7	100	25	No	
Alaska [a]						
Arizona	1	1	5	5	No	
Arkansas	4	4	36	30	No	
California	19	10	100	186	Yes	12,500
Colorado	12	11	50	24	No	
Connecticut	30	6		14	No	
Delaware	9	2	10	20	Yes	5,000
Florida [a]						
Georgia	13	7		54	Yes	5,000
Hawaii	4	4	16	4	No	
Idaho	10	10	50	46	Yes	5,000
Illinois	114	28	190	250	Yes	20,000
Indiana	46	8	23	367	Yes	1,000
Indian Territory [a]						
Iowa				147	No	
Kansas	19	19	320	93	No	
Kentucky	15	3	35	35	Yes	10,000
Louisiana	23	13	60	69	Yes	3,500
Maine	21	4	25	44	Yes	6,000
Maryland	16	8		44	No	
Massachusetts	71	10	40	115	No	
Michigan	47	21	90	342	Yes	9,000
Minnesota	10			105	Yes	35,000
Mississippi	24	22	396	157	No	
Missouri	26			152	Yes	10,000
Montana	18	10	122	53	Yes	5,000
Nebraska	29	18	82	218	No	
Nevada	6	5	17	14	Yes	750
New Hampshire	14	7	14	15	Yes	2,000
New Jersey	10	3	40	37	No	
New Mexico	10	1	1	1	No	
New York	60	20	195	397	Yes	25,000
North Carolina	18	6	22	64	Yes	25,000
North Dakota	8	5	22	76	Yes	10,000
Ohio	29			560	Yes	20,000
Oklahoma	8	5	65	75	No	
Oregon	8	4	54	24	No	
Pennsylvania	56	2	62	350	Yes	31,000
Porto Rico [a]						
Rhode Island	12	1	1	2	No	
South Carolina	12	12	94	33	No	
South Dakota [a]						
Tennessee [a]	9					
Texas	24			110	No	
Utah	15	15	75	27	Yes	7,000
Vermont	26	4	30	40	Yes	3,000
Virginia	9	9	60	35	No	
Washington	15	9	156	78	No	
West Virginia	22	5	23	111	Yes	12,000
Wisconsin	31	8	8	165	Yes	60,000
Wyoming	3			3	No	
Total	995	347	2,689	4,822		323,350

[a] No institutes.

Table showing the population of the several States and Territories in 1900, the total number of homes, the number of farm homes, the per cent of farm homes, and the approximate population in farm homes.

State or Territory.	Population.	Total number of homes.[a]	Number of farm homes.[a]	Per cent of farm homes.[a]	Approximate population in farm homes.
Alabama	1,828,697	374,765	217,464	58	1,[illegible],[illegible]
Alaska	63,592	13,459	27	.2	127
Arizona	122,931	29,875	7,391	24.7	[illegible],[illegible]
Arkansas	1,311,564	265,238	176,017	66.4	870,878
California	1,485,053	341,781	71,119	20.8	[illegible],[illegible]
Colorado	539,700	127,459	24,745	19.4	[illegible],[illegible]
Connecticut	908,420	203,424	26,609	13.1	[illegible],[illegible]
Delaware	184,735	39,446	9,677	24.5	[illegible],[illegible]
Florida	528,542	117,001	40,965	35	[illegible],[illegible]
Georgia	2,216,331	455,557	221,395	48.6	1,077,148
Hawaii	154,001	36,922	1,409	3.8	5,[illegible]
Idaho	161,772	37,491	17,153	45.8	74,[illegible]
Illinois	4,821,550	1,036,158	262,388	25.3	1,219,852
Indiana	2,516,462	571,513	221,451	38.7	[illegible],870
Indian Territory	392,060	76,701	47,591	62.1	187,[illegible]
Iowa	2,231,853	480,878	223,525	46.5	1,037,811
Kansas	1,470,495	321,947	167,006	51.9	[illegible],186
Kentucky	2,147,174	437,054	234,821	53.7	1,[illegible],[illegible]
Louisiana	1,381,625	284,875	114,214	40.1	[illegible],[illegible]
Maine	694,466	163,344	57,153	35	[illegible],[illegible]
Maryland	1,188,044	242,331	47,089	19.4	[illegible],[illegible]
Massachusetts	2,805,346	613,659	36,510	5.9	[illegible],[illegible]
Michigan	2,420,982	548,094	202,457	36.9	[illegible],[illegible]
Minnesota	1,751,394	342,658	152,393	44.5	[illegible],[illegible]
Mississippi	1,551,270	318,948	221,110	69.3	1,075,030
Missouri	3,106,665	654,333	282,840	43.2	1,340,079
Montana	243,329	55,889	13,909	24.9	60,588
Nebraska	1,066,300	220,947	116,854	52.9	564,072
Nevada	42,335	11,190	2,164	19.3	8,170
New Hampshire	411,588	97,902	28,271	28.9	118,948
New Jersey	1,883,669	415,222	35,337	8.5	160,111
New Mexico	195,310	46,355	13,102	28.3	55,272
New York	7,268,894	1,634,523	227,822	13.9	1,[illegible],[illegible]
North Carolina	1,893,810	370,072	223,831	60.5	1,[illegible],[illegible]
North Dakota	319,146	64,690	44,112	68.2	247,657
Ohio	4,157,545	944,433	280,068	29.7	1,[illegible],[illegible]
Oklahoma	398,331	86,908	63,094	72.6	289,188
Oregon	413,536	91,214	36,156	[illegible].6	[illegible],[illegible]
Pennsylvania	6,302,115	1,320,025	225,565	17.1	1,[illegible],[illegible]
Rhode Island	428,556	94,179	5,638	6	25,713
South Carolina	1,310,316	269,864	152,993	[illegible].7	[illegible]
South Dakota	401,570	83,536	51,937	62.2	249,776
Tennessee	2,020,616	402,536	226,027	[illegible].2	1,[illegible],[illegible]
Texas	3,048,710	589,291	341,889	58	1,[illegible],[illegible]
Utah	276,749	56,196	19,529	34.8	[illegible],[illegible]
Vermont	343,641	81,462	32,871	[illegible].4	148,[illegible]
Virginia	1,854,184	364,517	170,412	[illegible].8	867,758
Washington	518,103	113,086	33,931	[illegible]	[illegible]
West Virginia	958,800	186,291	94,566	50.8	487,070
Wisconsin	2,069,042	436,063	169,531	39.8	[illegible],478
Wyoming	92,531	20,116	5,939	29.5	27,[illegible]
Total	75,933,450	16,191,418	5,700,067	1,908.4	26,113,078
Average				37.4	

[a] U. S. Census, 1900, Population, Vol. II, p. CLXXXVIII.

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