AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

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HISTORICAL.

When the first agricultural societies were formed in this country, near the close of the eighteenth century, we find the beginnings of a recognition of the desirability of experimental inquiries for the advancement of agriculture. The society organized in South Carolina in 1785 had among its objects the establishment of an experiment farm. President Washington, who was a member of the first society for promoting agriculture organized in the United States, which was formed March 1, 1785, at Philadelphia, then the seat of the General Government, in pleading for the establishment of a national board of agriculture in his annual message to Congress in 1796, says that one of the functions of such a board is "to encourage and assist a spirit of discovery and improvement * * * by stimulating to enterprise and experiment." The distribution of seeds and plants, begun in 1839 through a Congressional appropriation secured by Hon. Henry L. Ellsworth, Commissioner of Patents, which afterwards resulted in the establishment of the Department of Agriculture, was primarily an experimental enterprise with a view to testing the adaptation of new varieties of agricultural plants to different parts of the country.

In 1849 the New York Agricultural Society established at Albany a chemical laboratory for the analysis of soils, manures, etc., and an elaborate examination of maize was made there by Dr. Salisbury. In 1855 a special agent was employed by the Patent Office "to investigate and report upon the habits of insects injurious and beneficial to vegetation, especially those infesting the cotton plant." The same office also employed a chemist and botanist, began a propagating garden, and arranged with the Smithsonian Institution for procuring and publishing records of meteorological observations. After the establishment of the Department of Agriculture in 1862, as a branch of the Government distinct from the Patent Office, the land on which its buildings now stand was for several years chiefly used as an experiment farm. As soon as agricultural colleges were established in this country experimental investigations in field and laboratory were undertaken, but for a number of years these were carried on with small means and for the most part by the voluntary labor of professors outside of their regular duties as instructors.
Establishment of Agricultural Colleges.

The act establishing an agricultural college which was passed by the legislature of Maryland in 1856 made it a duty of the board of trustees of the institution to conduct on the college farm "a series of experiments upon the cultivation of cereal and other plants adapted to the latitude and climate of the State."

The records of the college show that in 1858, immediately after the college was located and before building began, field experiments with corn, oats, and potatoes, "to test the relative value of the different manures offered for sale in the cities of Baltimore and Washington," were commenced on the college farm. This work continued for two or three years, but was interrupted by the financial distress which soon affected the whole country and by the disturbed condition of the State and nation.

In 1870 a school of agriculture and horticulture was established in connection with Harvard College in accordance with the provisions of the will of Mr. Benjamin Bussey, of Roxbury, Mass. This school was named "The Bussey Institution." The same year Harvard College received from the Massachusetts Society for Promoting Agriculture a considerable sum "for the support of a laboratory and for experiments in agricultural chemistry to be conducted on the Bussey estate."

Investigations were begun in this laboratory in 1871 by F. H. Storer, the professor of agricultural chemistry in the Bussey Institution, and his assistants, and the first report of their work was made December 3, 1871. The earliest experiments consisted of field tests of fertilizers upon the farm of the institution and chemical analyses of commercial fertilizers. A number of bulletins were published, including reports of field experiments and investigations on hybridizing plants, the composition of feeding stuffs and fertilizers, injurious fungi, and physiology. The great fire in Boston in 1872 and the commercial crisis of 1873 combined to cripple the institution financially, and for a number of years little was done in the way of original investigations. Recently, however, the financial status of the institution has improved, and investigations have been undertaken in several lines. Several bulletins have been published within the past three years, among which are those on the white pine (Pinus strobus), basket willow, systematic destruction of marmots and other vermin, and chemical substances in the trunks of trees. An extensive arboretum of indigenous and exotic trees, shrubs, and herbaceous plants has been developed on the grounds of the institution through a bequest made to Harvard University in 1872 by James Arnold, of New Bedford, Mass.

When the College of Agriculture of the University of California was organized it was understood that a part of its work would consist of experimental inquiries. In 1870 Prof. E. S. Carr, in an address at the State fair, stated that "the University proposes to furnish the facilities for all needful experiments; to be the station where tests can
be made of whatever claims attention." The university grounds at Berkeley were developed with reference to their use for experimental purposes, and in 1874 a considerable number of varieties of grapes and orchard and small fruits were planted, and a barn and two propagating houses were built. The same year E. W. Hilgard was chosen professor of agriculture. Professor Hilgard had previously been engaged for a number of years in conducting an agricultural and geological survey in Mississippi, in connection with which chemical examinations of soils, field experiments, and other agricultural investigations had been incidentally carried on in accordance with a plan inaugurated as early as 1857 and afterwards made the basis for the highly successful work of the California experiment station, which has been continued under his direction for a quarter of a century. "In the winter of 1875-76 the first field experiments were undertaken to determine the effects of deep culture and of the application of various fertilizers. In 1875 the laboratory branch of the experimentation work was inaugurated, the regents making provision for the expenses thereof for the first two years, and at the end of this time the legislature opened the way for the continuation and extension of the work by liberal special appropriations from year to year."

After the fund which had been established by the sale of the land scrip donated to Connecticut under the act of Congress of July 2, 1862, had been given to the Sheffield Scientific School of Yale College in 1863, a professor of agriculture was added to the working force of that institution. Samuel W. Johnson, M. A., professor of theoretical and agricultural chemistry, and William H. Brewer, Ph. D., the professor of agriculture, have for many years taken an active interest in all work for the promotion of agricultural science in Connecticut and elsewhere in the United States. Under their direction experimental work for the benefit of agriculture was carried on to a limited extent at New Haven more than thirty years ago, and it is doubtless safe to say that "through the influence of the professors and pupils trained in this school, more than to any other single cause, is due the recognition of the importance of the establishment of agricultural experiment stations, first in Connecticut and subsequently throughout the whole country."

THE FIRST STATE AGRICULTURAL EXPERIMENT STATION.

In 1872 at a convention of representatives of agricultural colleges held in Washington, D. C., in response to a call issued by the United States Commissioner of Agriculture, the question of the establishment of experiment stations was discussed, and the report of a committee in favor of such institutions was adopted by the convention. On December 17, 1873, at the winter meeting of the State board of agriculture at Meriden, Conn., Professor Johnson, of the Sheffield Scientific School, and Professor Atwater, of Wesleyan University, urged
the establishment of an agricultural experiment station in that State after the European pattern. A committee was appointed to consider the expediency of such a movement, and reported two days later that it was their "unanimous opinion that the State of Connecticut ought to have an experiment station as good as can be found anywhere, and that the legislature of the State ought to furnish the means for its establishment." A permanent committee was then appointed by the board to bring this matter to the attention of the public and the legislature. This committee held meetings in different parts of the State, and the following winter secured the introduction of a bill for an experiment station, which, however, was laid over until the next session of the legislature. Another year of agitation of the matter ensued. The project had many warm and enthusiastic friends, but the great mass of the farmers took little interest in the enterprise. When it had become apparent that it could not otherwise succeed, Mr. Orange Judd offered on his own part $1,000 to begin the undertaking, and on the part of the trustees of Wesleyan University, at Middletown, the free use of the chemical laboratory in the Orange Judd Hall of Natural Science.

These offers were made on condition that the legislature should appropriate $2,800 per annum for two years for the work of the station. It was thought that if by these means the work of agricultural experimentation could actually be begun the usefulness of the enterprise would be so clearly demonstrated that it would speedily receive more generous and permanent support. An act making the appropriation thus proposed was unanimously passed, and approved July 2, 1875. Early in October of the same year a chemist was on the ground, and as soon as practicable two assistants were secured. Professor Atwater was made director, and thus the first State agricultural experiment station in America was an accomplished fact. At the end of the two years provided for in the original bill the station was reorganized under the direct control of the State and permanently located in New Haven, where it has since been in successful operation, until 1882 in the chemical laboratory of the Sheffield Scientific School, and thereafter in buildings and on grounds provided by the State in the suburbs of the city.

ESTABLISHMENT OF EXPERIMENT STATIONS BY STATES AND COLLEGES.

The success which attended this first attempt to establish an experiment station in the United States was sufficient to attract the attention of advanced agriculturists throughout the country, and the example set by Connecticut was soon followed in other States. March 12, 1877, the State of North Carolina established an agricultural experiment and fertilizer control station at Chapel Hill in connection with the State University in accordance with an act of the legislature creating a department of agriculture, immigration, and statistics.
The Cornell University experiment station was organized in February, 1879, by the faculty of agriculture of the university, as a voluntary organization. From that time until the passage of the act of Congress of March 2, 1887, the work was carried on by the different professors in such time as could be spared from other studies. For a part of that time the trustees of the university appropriated money from the university funds to pay for the services of an analyst and for the purchase of supplies. All the other work was done without compensation.

The New Jersey State experiment station at New Brunswick, N. J., was established March 18, 1880, by an act of the State legislature and connected with the scientific school of Rutgers College.

The movement grew in favor with the people with each succeeding year, and in 1886 the Committee on Agriculture in reporting the Hatch bill to the House of Representatives was able to make the following statements:

Since 1881 the legislatures of several States have either recognized or reorganized the departments of agriculture in the land-grant colleges as "experiment stations," thus following substantially the course adopted by New Jersey. Such stations have been established in Maine, Massachusetts, Ohio, Tennessee, and Wisconsin. In three other States (possibly more), without legislative action, the college authorities have organized their agricultural work as experiment stations. This has been done in California, Missouri, and New York. But in addition to the twelve experiment stations specifically designated by that name a very large number of the colleges established under the act of 1862 are doing important work of a precisely similar kind. Many of them began such work immediately upon their establishment, and have since maintained it continuously; others have entered upon it more recently. The colleges in Colorado, Indiana, Kansas, Michigan, and Pennsylvania are carrying on what is strictly experiment-station work as a part of their ordinary duty.

ATTEMPT TO ESTABLISH AN EXPERIMENT STATION THROUGH PRIVATE MUNIFICENCE.

The only attempt in America to establish an agricultural experiment station through the munificence of one man, deserves recognition in this article, although it was short lived. In the year 1876, Mr. Lawson Valentine, a philanthropic and public-spirited native of Massachusetts, conducting a prosperous business in New York City, purchased a tract of several hundred acres in the township of Cornwall, Orange County, N. Y., to which he gave the name of Houghton Farm. Soon after, he conceived the idea of establishing at this place a series of systematic agricultural experiments. Mr. Valentine naturally took for his model the work of Lawes and Gilbert at Rothamsted, England, but with modifications suited to American conditions.

In the summer of 1879 Dr. Manly Miles, of Michigan, was engaged as director of experiments, and during the next eighteen months he laid out suitable fields, constructed a system of drainage, and visited the principal stations of Europe for the purpose of studying plans and methods of investigation. Early in 1881 the scheme was
reorganized, and Maj. Henry E. Alvord, of Massachusetts, was placed in charge as general manager, with these instructions from the proprietor:

First, conduct the farming operations in accordance with the best known methods and under the best possible organization and management, with a view of educating and enlightening others by furnishing valuable examples and results in practical agriculture. Second, organize and operate a scientific department, devoted to agricultural investigation and experiment, to be of the highest order, and such as to command the respect, interest, and cooperation of leading scientists of this and other countries.

Upon this basis Houghton Farm was conducted for about five years. The experiment department, with its own organization, assignment of real estate, and equipment, was maintained at an expense to the proprietor approaching $20,000 per annum. The experimental work inaugurated was grouped under four heads: (1) Agricultural physics; (2) plant growth; (3) diseases of plants; and, (4) animal growth and production. The scheme included four corresponding series of publications, issued at irregular intervals. Papers were published and distributed during 1882, 1883, and 1884 in the three series first named. The main work consisted of field experiments in growing maize. Thirty-six plats of an area of one-fifth acre each were continuously cultivated for several years, and the records were partly published. Extensive provisions were made for work in breeding and feeding dairy cattle and mutton sheep and in dairy products, but no pamphlet publications were issued on this line. The death of Mr. Valentine in 1888 put an end to this enterprise.

ESTABLISHMENT OF EXPERIMENT STATIONS BY CONGRESS.

The convention of delegates of agricultural colleges which met at Washington, D. C., in 1883 discussed and indorsed the project for the establishment of stations in connection with the colleges by appropriations from the National Treasury, in accordance with the terms of a bill already introduced into the House of Representatives by C. C. Carpenter, of Iowa. Congress, however, was not yet quite ready to undertake so large a scientific enterprise in this direction, and the bill was not put upon its passage. Meanwhile the number of stations was steadily increasing, and the interest of practical farmers as well as men of science was more and more excited by the reports of the results of the experiments which the stations had completed. On July 8, 1885, a convention of agricultural colleges and experiment stations met at the Department of Agriculture at Washington City, in response to a call issued by Hon. Norman J. Colman, the Commissioner of Agriculture. Almost the first thing which this convention did was to pass a resolution "that the condition and progress of American agriculture require national aid for investigation and experimentation in the several States and Territories; and that therefore this convention approves the principle and general provisions of what
is known as the Cullen bill of the last Congress, and urges upon the next Congress the passage of this or a similar act.” (The Cullen bill was in its general provisions similar to the bill afterwards passed by Congress and now popularly known as the Hatch Act.) So earnest was the convention in this matter that it appointed a committee on legislation, which was very efficient in securing the passage of the amended bill.

In a later session the convention passed resolutions urging the creation of a branch of the Department of Agriculture at Washington City, which should be a special medium of intercommunication and exchange between the colleges and stations, and which should publish a periodical bulletin of agricultural progress, containing in a popular form the latest results in the progress of agricultural education, investigation, and experimentation in this and in all other countries. Provision was also made for a permanent organization by the appointment of a committee to cooperate with the United States Commissioner of Agriculture in determining the time of meeting and the business of the next convention, and in forming a plan for a permanent organization.

At the next session of Congress the experiment-station enterprise was again called to the attention of the House of Representatives by the bill which was introduced by William H. Hatch, of Missouri, and referred to the Committee on Agriculture. This committee made a favorable report March 3, 1886, and nearly a year later the bill was passed by Congress, and was approved by the President March 2, 1887.

The Hatch Act provides that $15,000 a year shall be given out of the funds proceeding from the sale of public lands to each State and Territory for the establishment of an agricultural experiment station, which must be a department of the land-grant college, except in the case of those States which had established experiment stations as separate institutions prior to the passage of the act.

The duties of the stations are thus defined:

SEC. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories.

In order that the funds from the National Treasury might be for the most part devoted to agricultural investigations, only $3,000 of
the first year's appropriation for each station was to be expended for buildings, and thereafter only $750 a year could be so expended.

That the farmers of the country may receive prompt information regarding the work of the stations, it is provided that in addition to "full and detailed" annual reports of their operations and expenditures "bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit." The franking privilege is also given for the station publications. Financial and other reports of the stations are to be sent to the Secretary of Agriculture and the Secretary of the Treasury, but no provision is made for auditing the accounts by officers of the United States or for any supervision of their work by the federal authorities. It is, however, made the duty of the Secretary of Agriculture "to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purpose of this act."

Owing to the failure of Congress to make a specific appropriation to meet expenditures under the Hatch Act during the fiscal year in which it was passed, the Treasury Department ruled that no money could be paid to the stations during that year. It was therefore necessary to wait until the following session of Congress before active operations could be begun under the act. Meanwhile the State legislatures, one after another, gave their assent to the provisions of the act and designated the institutions which were to receive its benefits. Boards of management were organized, working staffs were appointed, buildings were located and planned, land was selected for field experiments, and in general the equipment of the stations was provided for. When the appropriation was made by Congress in 1888, it was included in the general appropriation act of the Department of Agriculture, though the head of that Department was at that time in no way responsible for the expenditure of this fund, and this precedent has uniformly been followed in succeeding years.

In 1894 Congress adopted the recommendation of the Secretary of Agriculture and gave this Department authority to examine the expenditures of the stations under the Hatch Act and report on their legality. This led to much closer relations between the Department and the stations than had hitherto existed. As soon as practicable after the passage of this act the required schedules were prepared on the basis of those already in use at the stations and distributed. In order that the Department might have accurate and complete information regarding the work and expenditures of the stations as the
basis for the required reports to Congress, it was decided that the stations should be regularly visited by representatives of the Office of Experiment Stations, and this has been done each year since. In connection with these visits inquiries are made regarding the management and work of the stations and their relations to the land-grant colleges. Their methods of keeping accounts are also examined. Conferences are held with the station officers and members of the governing boards, in which not only financial policy, but also lines and methods of work are discussed. On the basis of this visitation of the stations, together with their financial statements and published reports and bulletins, a report on the work and expenditures of the stations is annually made to Congress.

In connection with the examination of the expenditures of the stations it became necessary for the Department of Agriculture to define its views regarding the limitations of the Hatch Act, and this was accordingly done in a series of rulings issued March 10, 1896. The most important of these were to the effect: (1) That permanent sub-stations were contrary to the spirit and intent of that act; (2) that land could not be purchased or rented with the Hatch fund; (3) that farm operations were permissible only so far as they definitely constituted a part of agricultural investigations or experiments; (4) that funds arising from the sale of farm products or other property in the possession of a station, as the result of expenditures of the Hatch fund, rightfully belonged to the station, and therefore should be expended for station purposes.

**GROWTH OF THE EXPERIMENT STATIONS.**

In 1893 the stations for the first time united in making a collective exhibit of the methods and results of their work. This exhibit was made in connection with the World's Columbian Exposition at Chicago. The Office of Experiment Stations and the Association of American Agricultural Colleges and Experiment Stations acted in cooperation in the general management of the exhibit. The then Director of the Office of Experiment Stations, Prof. A. W. Harris, represented the Office, and the association was represented by a committee, of which Dr. H. P. Armsby, director of the Pennsylvania State College Experiment Station, was chairman. The station work was exhibited in nine sections—botany, soils, fertilizers, crops, horticulture, entomology, feeding stuffs, animal nutrition, and dairying. There were also botanical, biological, and chemical laboratories, in which some of the simpler station operations were carried on by way of illustration. The publications of the stations and of the Office of Experiment Stations were shown, together with a large number of photographs and charts illustrating the buildings, equipment, and work of the stations. The exhibit was in general of a popular character, and was installed in the Agricultural Building. In connection with
this exhibit a popular digest of the publications of the stations was made by this Office and published as Bulletin No. 15, entitled "Handbook of experiment-station work." At the same exposition a very extensive test of the different breeds of dairy cows was made under direction of a committee of station officers. In this test a daily record was kept of the food, milk, fat in the milk, and butter or cheese yield of each cow. A copy of this record, which comprises about 1,000 large sheets of tabulated matter, has been filed at the Department of Agriculture, where it is accessible to students and investigators.

The growth of the stations as regards their number, resources, personnel, and publications is shown by the following general statistics for the earlier years of their operations under the Hatch Act as compared with those for the year 1899. In 1888 the 46 stations in 38 States and one Territory received the national funds, making a total appropriation of $585,000, to which must be added about $125,000 derived from State appropriations, fees for fertilizer analyses, sales of farm products, etc., and $10,000 appropriated by Congress for the Office of Experiment Stations. The whole amount used for experiment-station purposes in the United States in 1888 was therefore about $720,000. In 1889 these stations published 45 annual reports and 237 bulletins.

In 1890, when more complete statistics of the stations were published by the Office of Experiment Stations for the first time, it was stated that the "stations employ 429 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 66; chemists, 101; agriculturists, 63; horticulturists, 47; botanists, 42; entomologists, 33; veterinarians, 19; meteorologists, 11; biologists, 4; viticulturists, 2; physicists, 3; geologist, 1; mycologists, 2; microscopists, 4; irrigation engineer, 1; in charge of substations, 16; secretaries and treasurers, 21; librarians, 5; clerks, 18. There are also 42 persons classified under the head of miscellaneous, including superintendents of gardens, grounds, and buildings; foremen of farms and gardens; apiarists; herdsman, etc. During 1890 the stations have published 36 annual reports and 225 bulletins. The mailing list of the stations now aggregates about 340,000 names."

In 1899 agricultural experiment stations were in operation in all the States and Territories and in Alaska and Hawaii. In each of the States of Alabama, Connecticut, New Jersey, and New York a separate station was maintained wholly or in part by State funds, and in Louisiana there were three stations receiving joint support from national and State funds. Excluding the branch stations established in several States, the total number of stations in the United States in 1899 was 56. Of these, 52 received the appropriation provided for in the act of Congress above mentioned. The total income of the stations during 1899 was $1,143,334.93, of which $720,000 was received from
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the National Government, the remainder, $423,334.93, coming from the following sources: State governments, $240,300.20; individuals and communities, $12,100; fees for analyses of fertilizers, etc., $75,294.42; sales of farm products, $60,312.60; miscellaneous, $26,327.71. In addition to this the Office of Experiment Stations had an appropriation of $40,000, including $10,000 for the Alaskan investigation. The value of additions to equipment of the stations in 1899 is estimated as follows: Buildings, $27,218.64; libraries, $10,796.15; apparatus, $16,917.07; farm implements, $10,784.88; live stock, $16,265.95; miscellaneous, $22,521.93. Total, $104,504.62. The stations employed 678 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work was as follows: Directors, 71; chemists, 148; agriculturists, 68; experts in animal husbandry, 9; horticulturists, 77; farm foremen, 21; dairymen, 23; botanists, 52; entomologists, 48; veterinarians, 26; meteorologists, 17; biologists, 7; physicists, 7; geologists, 5; mycologists and bacteriologists, 20; irrigation engineers, 5; in charge of substations, 16; secretaries and treasurers, 24; librarians, 9; and clerks, 43. There were also 48 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds, and buildings; apiarists; herdsmen, etc. Three hundred and eight station officers do more or less teaching in the colleges with which the stations are connected.

During 1899 the stations published 445 annual reports and bulletins. Besides regular reports and bulletins, a number of the stations issued press bulletins, which were widely reproduced in the agricultural and county papers. The mailing list of the stations now aggregates 523,970 names. Correspondence with farmers and calls upon station officers for public addresses at institutes and other meetings of farmers are more numerous than ever. The station officers continue to contribute many articles on special topics to agricultural and scientific journals.

The number of stations has increased from 46 in 1888 to 56 in 1899. The annual income of the stations, including the appropriation for the Office of Experiment Stations, has risen from about $720,000 in 1888 to $1,183,000 in 1899. Of this amount, about $125,000 was derived from State appropriations, fees for fertilizer analyses, sales of farm products, etc., in 1888, and $423,000 in 1899. In 1889, 393 officers were employed at the stations, while in 1899 their number had increased to 678. The stations published 282 annual reports and bulletins in 1889, and 445 in 1899.

The stations are at present conducting a wide range of scientific research in the laboratory and plant house and an equally large amount of practical experimenting in the field, the orchard, stable, and dairy. Practically all the stations are keeping a record of meteorological data, while 10 are making special studies of problems relating to meteorological phenomena and climatic conditions.
Thirty-six stations are at work investigating soils, their geology, physics, and chemistry, or conducting soil tests with fertilizers or in other ways. Twenty-one stations are studying questions relating to drainage and seepage or to irrigation in the field or greenhouse, and with orchard, garden, or farm crops. Thirty-three stations are making analyses of commercial and homemade fertilizers or are conducting field experiments with fertilizers. At least fifteen stations either exercise a fertilizer control in their respective States or make analyses on which the control is based. All the stations are studying the more important crops, either with regard to their composition, nutritive value, methods of manuring and cultivation, and the best varieties adapted to individual localities, or with reference to systems of rotation.

Forty-seven stations are investigating the composition of feeding stuffs, making digestion experiments, conducting feeding experiments for milk, beef, mutton, or pork, or studying different methods of feeding. Twenty-nine stations are investigating subjects relating to dairying, including the chemistry and bacteriology of milk, creaming, butter making, or the construction and management of creameries. Studies on the food and nutrition of man, including the composition and digestibility of foods and metabolism, are being conducted at 14 stations. Fifty-two stations are doing chemical work and often are studying methods of analysis. Botanical studies occupy more or less of the attention of 47 stations, including investigations in systematic and physiological botany, with special reference to the diseases of plants, testing of seeds with reference to their vitality and purity, classification of weeds, and methods for their eradication. Fifty-three stations work to a greater or less extent in horticulture, testing varieties of vegetables, and large and small fruits, and making studies in varietal improvement and synonomy. Several stations have undertaken operations in forestry. Thirty-six stations investigate injurious insects with reference to their restriction or destruction. Twenty-four stations study animal diseases and the methods for their prevention or cure. At least 5 stations are engaged in bee culture and 8 in experiments with poultry. One or more stations have made investigations on miscellaneous subjects, such as the following: Technology of wine, olive oil, and vinegar, preservation of fruits and vegetables, the draft of farm implements, road making, the manufacture of beet, cane, sorghum, and maple sugar, oyster culture, etc.

At first there was a disposition, especially in the region west of the Mississippi River, where the area of the States and Territories is large and the population scattered, to divide the Hatch fund and maintain substations in different localities. This greatly weakened the effectiveness of the station work and in some cases prevented the establishment of the stations on a firm basis. During the past few years, largely through the efforts of the Office of Experiment Stations, these
substations have been generally abolished. In California, Minnesota, Texas, Michigan, Ohio, and New Mexico one or more substations are maintained with the aid of State funds, which are used to supplement the national fund, and thus make the extension of the station work feasible and successful.

RELATION OF THE FEDERAL GOVERNMENT TO THE STATIONS.

The agricultural experiment stations in the United States are State institutions, supported in part by funds given by the National Government to the States to be used for their maintenance. They have also received the franking privilege under federal authority. The direct management of the stations is wholly in the hands of State officers. The stations, however, sustain certain definite relations to different branches of the Federal Government. The appropriations called for by the Hatch Act are made by Congress from year to year. They come under the head of annual, rather than permanent, appropriations, Congress having the right to refuse to make them at any time. The Congressional appropriations for the stations have thus far been included in the appropriation acts for the Department of Agriculture. After a State or Territory has given its assent to the provisions of the Hatch Act and designated the college which is to receive its benefits, the money is paid directly from the United States Treasury to the treasurer or other officer of the institution with which the station is connected, who has been certified to the Treasury as the proper person to receive this fund. The payments are made quarterly in advance, as provided by law.

Regulations governing the use of the franking privilege by the stations are made by the Post-Office Department.

As departments of the colleges receiving the benefits of the land-grant act of 1862, reports of the stations are annually sent to the Secretary of the Interior, who is represented in his relations with these institutions by the Bureau of Education.

The stations have much more intimate relations with the Department of Agriculture than with any other branch of the Federal Government. In its general relations with the stations, as well as in the supervision of their expenditures under the Hatch Act, the Department is represented by the Office of Experiment Stations, an account of which is given below.

From time to time Congress has given the Department of Agriculture funds for special investigations, with the provision that the Department shall, as far as practicable, cooperate with the experiment stations in carrying on these investigations. Notable instances of such appropriations are those for nutrition and irrigation investigations, which have been in charge of the Office of Experiment Stations, the inquiries conducted by the Office of Public Road Inquiries, and investigations with forage plants, in charge of the Division of
Agrostology. There has been an increasing amount of cooperation between the Department and the stations in other ways, including all the general lines of work in which the scientific Divisions of the Department are engaged. The Department has also afforded to station officers the privileges of its laboratories, collections, and Library to an increasing extent from year to year.

THE OFFICE OF EXPERIMENT STATIONS.

The Office of Experiment Stations was established as a branch of the Department to represent the Secretary of Agriculture in his relations with the experiment stations as provided for by the Hatch Act. After the passage of the Morrill Act of 1890 for the further endowment of the agricultural colleges, this Office was made the depository of the financial and statistical reports of these institutions, which are annually sent to the Secretary of Agriculture. The Office was thus furnished with considerable material upon which to base publications regarding the development of education in agriculture in this country. This work has since been broadened to include a survey of the institutions for agricultural education in foreign countries. More recently the Office has been charged with the supervision of experimental investigations in agriculture in Alaska and of special investigations on human nutrition and on irrigation, which are carried on largely in cooperation with the agricultural colleges and experiment stations.

RELATIONS OF THE OFFICE WITH EXPERIMENT STATIONS.

In its general advisory relations with the experiment stations in the different States and Territories, the Office of Experiment Stations endeavors to help the stations in a variety of ways. This work is performed partly by personal conferences with station officers and partly by correspondence. It includes such things as advice regarding the organization and management of the stations, the choice of officers, the lines of work to be undertaken, the planning, recording, and execution of special lines of work, the nature and form of publications, the plans for station buildings, the materials, apparatus, and literature required for use in connection with different kinds of agricultural investigation. By its work in this direction, the Office has been enabled to offset, to a certain extent, the difficulties in station management and work, especially those arising from frequent changes in the governing boards and staffs of the stations, and has secured an increasing amount of uniformity in the general policy of station management throughout the country. It has, at the same time, been clearly recognized that each station is an independent State institution, for the conduct of which the United States does not assume responsibility further than is involved in the requirements of the national law under which the stations are organized and the terms
on which appropriations toward their maintenance are made by Con-
gress year by year.

The Office has endeavored to maintain a broad and consistent pol-
icy regarding the general principles on which experiment-station
management and work should be based, and to aid the individual
stations in their attempts to adjust these principles to the varying
needs and conditions of the different States and Territories. It has
also sought to promote their cooperation with each other, with the
different branches of the Department of Agriculture, and with the
farmers; and as a central agency established for their benefit, it has
helped to bring them into relations with similar institutions abroad
and to promote their interests in matters involving transactions with
different branches of the United States Government.

As previously stated, the Office also has supervision of the expendi-
tures of the stations under the Hatch Act, and annually prepares a
report of the work and expenditures of the stations, which is made to
the Secretary of Agriculture for transmission to Congress. This
report briefly describes the work, income, and expenditures of each
station, with such criticisms as are deemed desirable, and also
includes a general statement regarding the condition and progress of
the station enterprise as a whole during the year.

The Office collects and catalogues all the publications of the sta-
tions. This is done partly that it may have the material for its own
publications and partly to make a permanent library of the station
publications.

PUBLICATIONS OF THE OFFICE.

The Office of Experiment Stations prepares a large number of pub-
lications which are largely based on those of the experiment stations
in this country and abroad, or are reports of the special investigations
in charge of the Office. One of the most important of these publica-
tions is the Experiment Station Record, which is issued in volumes
of twelve numbers each, and is now in its eleventh volume. It com-
prises abstracts of the bulletins and annual reports of the stations,
the publications of the Department of Agriculture, books, journals,
and miscellaneous publications containing reports of investigations in
agricultural science in different countries of the world; special articles
by American and foreign experts in agricultural science; editorials
on important matters regarding the progress of agricultural educa-
tion and science, with suggestions of lines of inquiry for the stations,
and notes on the organization, equipment, and development of institu-
tions for agricultural education and research at home and abroad.

Detailed author and subject indexes accompany each volume. This
journal is sent without charge to institutions for agricultural educa-
tion and research in this country and the officers of such institutions,
to similar institutions in foreign countries, important libraries, and
to a select list of scientists and specialists who cooperate with the Department by furnishing information, by exchanging publications, or otherwise. It is also sold by the Superintendent of Documents at 10 cents a number, or $1 per volume.

The technical bulletins of the Office include special reports to Congress as required by law, reports of the investigations in charge of this Office on the nutrition of man and on irrigation, monographs on special subjects based on the work of the experiment stations, bulletins containing statistics and general information regarding institutions for agricultural education and research, and the proceedings of the Association of American Agricultural Colleges and Experiment Stations.

In 1889 a series of Farmers’ Bulletins was begun in this Office with a view to making a popular record of the results of work at the experiment stations for general distribution among the farmers of the country. After the scope of this series was enlarged and it was made a general series for the Department, the Office continued to prepare, or to obtain from officers of the experiment stations, articles of a popular character on different subjects which might properly be included in this series. Latterly the Office has restricted these articles to subjects connected with the special investigations in its charge and résumés of the publications of the experiment stations. The latter are grouped together in a subseries entitled “Experiment station work.” This title has been given to Farmers’ Bulletins prepared in this Office, in which a number of short articles on different subjects based on the publications of the experiment stations are grouped together to form single bulletins. As stated in a note inserted in each number of this series, “The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side.”

Each article included in the “Experiment station work” is signed by the person who prepares it. The meaning of technical terms necessarily used in these articles is explained in an appendix. Illustrations are used as far as seems desirable. Whenever the number of these bulletins is sufficiently large to make a volume of convenient size an index will be prepared covering the numbers to be included in the volume. In this way, as time goes on, it is expected that there will be in libraries and in the homes of many farmers a series of volumes containing a popular record of the practical results of the work of the stations. Through this series the farmer in any part of the country is enabled to ascertain the most important practical things the stations are accomplishing wherever they may be located.

The Office also publishes a “Card index of experiment-station literature.” This is a subject index arranged on a decimal system. Each
card contains the title of the article, the name of the author, a bibliographical reference to the experiment-station publication containing the article, and also to the Experiment Station Record, and a brief abstract showing the nature and scope of the article. The number of cards thus far prepared is 19,000, covering the publications of the stations from 1888 to 1897. A set of the index is furnished to each agricultural college and experiment station in this country and to the boards or commissioners of agriculture in the several States. The index is also sold to subscribers at the rate of $2 per thousand cards, and $1.25 for a set of division cards. Three hundred sets are printed.

The Office also prepares a variety of brief documents in the form of circulars, schedules, articles for the Yearbook of the Department, etc.

From its organization in 1888 up to January 1, 1900, this Office issued 311 documents, which may be classified as follows: Experiment Station Record, 11½ volumes, 119 numbers; technical bulletins, 72; Farmers' Bulletins, 46; circulars, 43; schedules, separates, etc., 31. In 1899 the total number of copies of publications of this Office printed was 1,200,000, of which 1,000,000 were Farmers' Bulletins.

ALASKA EXPERIMENT STATIONS.

Beginning with 1897, agricultural investigations have been carried on in Alaska under the direction of the Office of Experiment Stations. These investigations have thus far consisted very largely of an agricultural survey, with a view to determining the agricultural capabilities of this region. Definite experiments in growing cereals, flax, and vegetables have been conducted at several points along the coast. During the past year this work has been organized on a more permanent basis with a view to the establishment of regular experiment stations in Alaska. The erection of a headquarters building to contain offices and laboratories has been begun at Sitka, and land has been cleared for experimental purposes at Sitka and Kenai in Cook Inlet. Oats, barley, and wheat have been successfully grown to maturity at both these places, and rye and flax have also been matured at Sitka. Definite information has been collated showing that a considerable variety of vegetables, such as potatoes, cabbages, cauliflower, turnips, lettuce, and spinach may be successfully grown in different parts of Alaska, including interior localities. Grasses and forage plants grow luxuriantly over large areas in Alaska, and live stock has already been kept there to a sufficient extent to warrant the belief that a large animal industry may be developed. Three reports on the investigations in Alaska have been published. The work in Alaska is in immediate charge of Prof. C. C. Georgeson.
In 1894 Congress made a special appropriation of $10,000 "to enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for human food." General supervision of this inquiry was assigned to the Office of Experiment Stations, and Prof. W. O. Atwater was appointed special agent in charge of nutrition investigations, with headquarters at Middletown, Conn. At the same time Congress authorized the experiment stations to conduct investigations on the food of man, and they were directed to report progress in their work in this line to the Secretary of Agriculture. The investigations, in charge of this Office, have been carried on in connection with colleges, experiment stations, and philanthropic organizations in different parts of the country. Technical bulletins containing accounts of investigations on food and nutrition of man have been published, as well as Farmers' Bulletins based on such investigations.

IRRIGATION INVESTIGATIONS.¹

In the appropriation act for the Department of Agriculture for the fiscal year ending June 30, 1899, $10,000 was appropriated by Congress for irrigation investigations by the Department of Agriculture, and this was increased to $35,000 for the current fiscal year. By order of the Secretary of Agriculture supervision of this work was assigned to the Director of the Office of Experiment Stations. It was decided to undertake work in two general lines: (1) The collation and publication of information regarding the laws and institutions of the irrigated region in their relation to agriculture, and (2) the publication of information regarding the use of irrigation waters in agriculture as determined by actual experience of farmers and experimental investigations. A headquarters for these investigations has been established at Cheyenne, Wyo. They are carried on under the immediate direction of Prof. Elwood Mead, and as far as practicable are made in cooperation with the experiment stations in different States. Work in this line has now been undertaken in fifteen States and Territories.

RELATIONS OF THE STATIONS WITH ASSOCIATIONS.

The experiment stations, as well as the colleges with which they are connected, are brought together so as to form a national system of agricultural education and research through the Association of American Agricultural Colleges and Experiment Stations. The work of this association is carried on by means of conventions composed of one delegate appointed by each of the land-grant colleges and agricultural experiment stations in the United States, together with

¹ More detailed account of these investigations are given in a separate article in this Yearbook.—Ed.
AGRICULTURAL EXPERIMENT STATIONS.

delegates representing the Department of Agriculture, the Office of Experiment Stations, and the Bureau of Education of the Department of the Interior. Annual meetings are held in different parts of the country, at which questions relating to the management and work of the stations, as well as of the colleges, are discussed in the general assembly and in a number of sections.

The proceedings of the association are edited by the chairman of its executive committee and the Director of the Office of Experiment Stations and are published by the Department of Agriculture as bulletins of this Office. In the interval between meetings of the association much useful work for the promotion of the general interests of the agricultural colleges and experiment stations is performed by the executive committee and standing and special committees of the association. The association has done much to establish and strengthen the stations and to aid in their administration on a permanent and substantial basis.

The stations are also largely represented in the associations of Official Agricultural Chemists, Economic Entomologists, and Experiment Station Veterinarians, through which the uniformity and efficiency of the station work in chemistry, entomology, and veterinary science, with special reference to the methods employed, are greatly promoted.

ORGANIZATION OF THE STATIONS.

The stations organized under the Hatch Act are by law departments of the colleges receiving the benefit of the land-grant act of July 2, 1862, and of supplementary acts relating to similar colleges established in the States which have been admitted to the Union since the passage of that act, as well as to those in the Territories. The Hatch Act, however, made an exception in favor of State agricultural experiment stations which had been established separate from the land-grant colleges prior to the passage of the act. In this way State stations are maintained in Connecticut, New York, and Ohio, which are not connected with colleges and yet receive, in whole or in part, the benefits of the Hatch Act. In New Jersey there is a station which is supported by State funds as distinct from the station which receives the Hatch funds, but both stations are located at the land-grant college and have the same director.

The stations, which are departments of the colleges, are, as a rule, under the general management of the governing boards of these institutions. The separate State stations have their own governing boards. The governing boards of the stations are quite commonly appointed by the governor of the State, but in a few cases are elected by the people. In a few instances the State board of agriculture is the governing board of the college and station. The more immediate supervision of station affairs is often intrusted to a standing committee of the governing board.
As a rule, the duties of the governing board are confined to deter-
miming in a general way the policy and lines of work, appointing the
members of the staff and fixing their terms of office and compensa-
tion, deciding on the character and extent of expenditures, and
approving and auditing the accounts. In some cases, however, the
governing boards determine and supervise the work and expenditures
of the station in considerable detail. This was more generally true
in former years than at present. As the stations have developed, it
has been found desirable to intrust the planning and execution of
their work more fully to the director and other expert officers.

The president of the college with which the station is connected, as
a rule, holds the same relation to the station that he does to other
departments of the college, that is, he is the chief executive officer of
the institution, including the experiment station, and represents the
institution before the governing board, of which he is often an ex-
officio member. In a few instances the president has been relieved
of all responsibility for the station, its director reporting directly to
the governing board. In fourteen States and Territories the president
of the college is at present also director of the station.

Elsewhere the director is a separate officer, who, in addition to gen-
eral executive duties connected with the station, carries on investiga-
tions in some special lines, or combines teaching in the college with
his work for the station. Thus, the station director may at the same
time be the chemist or agriculturist of the station and the professor
of chemistry or agriculture in the college. In some stations the direc-
tor has large powers and responsibilities in the management of the
station. In other States the planning of the work and even details of
administration are largely committed to a council composed of the
heads of the different divisions of the station, or these officers and
some members of the governing board.

Besides the president of the college and the director, the station
staff usually comprises several scientific experts in charge of special
lines of work (as dairying, horticulture, chemistry, entomology, or dis-
eases of plants and animals) and scientific assistants. The members
of the staff may be employed exclusively for experiment-station work,
but in a large number of instances they combine this with instruction in
the college. In addition to the scientific force there are usually per-
sons of practical experience employed as foremen of farms, dairymen,
feeders of cattle, etc., and clerical assistants, including accountants,
stenographers, and typewriters. Women are often employed in these
clerical positions. Laborers are employed regularly by the year or
month, or work as occasion may demand by the day or hour.

A considerable number of students of the colleges are employed as
assistants and laborers at the stations. Special experts, scientific
assistants, and other workers are from time to time employed by the
stations for the conduct of particular investigations.
Fig. 1.—Administration and Laboratory Building of Ohio Station.

Fig. 2.—Dairy and Biological Building of New York State Station.
FIG. 1.—CHEMICAL AND BIOLOGICAL LABORATORY OF KENTUCKY STATION.

FIG. 2.—DAIRY BUILDING OF WISCONSIN STATION.
FIG. 1.—BARN OF MINNESOTA STATION.

FIG. 2.—EXPERIMENT PLATS OF PENNSYLVANIA STATION.
In cooperative experiments with farmers, the station usually furnishes the plans of work and the seeds, fertilizers, fungicides, or other materials required by the experiment, and makes the chemical or other examinations of the soils, fertilizers, or crops necessary to determine the data or results sought in the experiment. The farmer on his part furnishes the land, orchards, labor, etc., most commonly without charge to the station.

EQUIPMENT OF THE STATIONS.

The stations very generally make use of buildings and land supplied by the colleges or by the States. Many of these buildings and farms are used jointly by the college and station. The buildings include administration buildings (Pl. XLIII, fig. 1), libraries, chemical, botanical, bacteriological, and other laboratories (Pl. XLIII, fig. 2, and Pl. XLIV, fig. 1); vegetation houses, insectaries, dairy buildings (Pl. XLIV, fig. 2), barns (Pl. XLV, fig. 1), silos, piggeries, and poultry houses, together with special buildings for particular experiments, such as those in sugar making, tobacco curing, and the treatment of animal diseases. The stations are generally well equipped with scientific apparatus, farm implements, and live stock. A portion of the station land is commonly laid out in permanent plats for experimental purposes (Pl. XLV, fig. 2).

LINES OF WORK OF THE STATIONS.

Speaking broadly, the work of the experiment stations in the United States corresponds in scope and extent with the complexity of their organization. It is therefore difficult to make general statements regarding their work which will apply to the actual operations of any one of the stations. A strict interpretation of the Hatch Act would require that the funds received from the National Government under this act should be devoted solely to original investigations and demonstration experiments and the publication of their results. In many States, however, the stations have funds, derived from the State government or other sources, which may be used for inspection work in various lines, the compiling of information useful to farmers, and miscellaneous purposes connected with the promotion of agriculture.

In a general way the work of the stations in the United States may be grouped under the following heads: (1) Scientific and practical investigations involving original features; (2) experiments for the verification or demonstration of the results of original investigations made at the stations or elsewhere; (3) studies of natural agricultural resources and conditions; (4) inspection and other control duties performed on behalf of agriculture; (5) the dissemination of original and compiled information.

It will, however, readily be understood that most of the enterprises of the stations are of a mixed character. Originality will, as a rule,
be found only in some particular features of an investigation or in
the adaptation of well-known facts or principles to special conditions.
In the following outline the investigations of the stations which on
the whole have most generally contained original features are grouped
together, though in many cases they might with equal propriety be
classified as demonstration experiments.

INVESTIGATIONS INVOLVING ORIGINAL FEATURES.

The investigations of the stations may be classified in a general way
on the basis of the different divisions found in their organization.
Thus, it may be said that the investigations of the stations comprise
studies in physics, chemistry, botany, zoology and especially ento-
mology, geology, meteorology, agronomy (plant production), horticult-
ure, forestry, physiology (of man and domestic animals), zootechny
(animal industry), veterinary science, agrotechny (agricultural tech-
nology), including especially dairying, and rural engineering.

In most of these lines the investigations have included studies with
reference to the improvement of methods of research, devising of new
apparatus and appliances, the relation of scientific principles to the
science and practice of agriculture, the working out of new practical
applications on the basis of well-known facts and principles, or the
solution of special problems. The statements following may serve
to indicate in what directions the investigations have chiefly been
pursued.

Under the head of physics, considerable attention has been given
in recent years to studies on soils, especially as regards the methods
for the physical examination of soils, the movement of soil water, and
the apparatus required for such investigations.

In chemistry, studies with a view to the improvement of methods of
analysis have occupied the attention of a considerable number of sta-
tions. This work has been done quite largely in connection with the
Association of Official Agricultural Chemists. It has related chiefly
to methods of analysis of soils, fertilizers, plants, foods, and feeding
stuffs. They have also cooperated with this association in determin-
ing food standards as a basis for the determination of adulteration.
A number of pieces of special chemical apparatus have been devised
at the stations. These have included apparatus adapted to particular
types of investigations or intended to increase the speed or multiply
the operations of laboratory processes for scientific or practical pur-
poses and devices for making the chemical examinations required in
agricultural industries. A very large number of analyses of economic
plants, foods and feeding stuffs, dairy products, fertilizers, and other
agricultural materials, especially those distinctively American, have
been made for the first time in the chemical laboratories of the sta-
tions. A considerable number of purely chemical investigations have
been conducted. Chemistry has usually been an adjunct to the investi-
gations in the fertilizer requirements of plants, human and animal
nutrition, and dairying.

In botany, considerable systematic work has been done, especially
in the newer States. New species of useful and injurious plants have
been discovered and described. Herbaria, showing with more or less
completeness the economic flora of individual States, have been col-
lected. New light has been thrown on the botanical relations of
species of economic plants. The botanical work of the stations has,
however, been most largely along the lines of vegetable physiology
and pathology and bacteriology. The studies in vegetable physiology
have included investigations of special problems and the devising of
methods and apparatus for such studies. In vegetable pathology
much has been done in working out the life histories of fungi inju-
rrious to cultivated plants and in devising methods and apparatus for
the repression of diseases of plants. The bacteriological work of the
stations has included the isolation, culture, and description of many
species of useful and pathogenic bacteria in air, soil, fertilizers, plants,
foods, feeding stuffs, and other agricultural products, and those
affecting useful and injurious animals. Methods and apparatus for
bacteriological investigations have been devised and means for the
repression of pathogenic bacteria have been worked out. The dis-
tribution and repression of weeds have been studied by numerous
station botanists.

In zoology, by far the most important work of the stations has been
along the lines of economic entomology. This has included the col-
lection of large numbers of specimens of insects with a view to the
determination of their economic importance in different regions; the
description of many new species and the working out of their life
histories in whole or in part; additions to our knowledge of many
beneficial and injurious insects, including in many cases the comple-
tion of their life histories; studies in the breeding of insects, espe-
cially as a means for their investigation; the discovery or invention
of methods and appliances for the repression of injurious insects;
and the devising of methods and appliances for the study of insects.

In other lines of zoological investigation systematic and other
studies have been made of injurious mammals (especially gophers
and rabbits) and useful and injurious birds. There have also been
special investigations relating to the life history and culture of
oysters and the life history of nematodes.

Under the head of agronomy (plant production) a large amount of
work has been done in the introduction of new varieties of crops
adapted to special regions or particular economic purposes. Investi-
gations in the improvement of varieties by selection and by plant
breeding have been undertaken. Fertilizer and tillage experiments
have been conducted, drainage and irrigation problems investigated,
and methods of harvesting and storage studied. Some work has also
been done in studying methods of investigation.

In horticulture, the stations have given most attention to testing the
adaptability of varieties to different regions. In addition to this there
have been studies of the selection and breeding of horticultural plants
and the methods of culture, grafting, and pruning. Considerable
attention has been given to questions relating to the growing of hor-
ticultural plants under glass. Valuable introductions of new and
hardy fruits have been made. Native fruits have been studied and
improved and wild species brought under cultivation.

Combinations of forcing-house and field methods of culture of a
number of American garden crops have been introduced. Irrigation
as a feature of truck gardening and fruit growing in regions of con-
siderable rainfall has formed a feature of horticultural work at several
of the experiment stations, and the value of subirrigation in green-
houses with certain forcing crops thoroughly demonstrated. Fertilizer
experiments with numerous horticultural crops have thrown much
new light on the subject of intensive manuring. The utilization of
fruits (more especially the unmerchantable fruits) in the making of
jelly, preserves, fruit sirups, and cider has been investigated. Some
of the stations have given considerable attention to the beautifying
of home and school grounds by the introduction of ornamental trees,
shrubs, flowers, etc., not previously grown in their localities.

In forestry, the work of the stations has been principally confined
to the testing of different varieties of trees with reference to their
adaptability to particular regions and problems connected with the
reforesting of treeless regions.

In the physiology of man and the domestic animals, the work of
the stations has been largely along the line of nutrition. The most
important piece of work in this line has been the devising of a spe-
cial form of respiration calorimeter at the Storrs experiment station,
in Connecticut, as described elsewhere. The experiments with this
respiration calorimeter already made with men have added important
data to the knowledge of the laws of nutrition.

Other studies have had to do with the substituting value of different
nutrients and the proper combination of nutrients in the diet. Many
dietary studies have been made with men and animals under different
conditions and performing different amounts of work in various
regions of the United States. A number of stations have made diges-
tion experiments with men and animals, and the coefficients of diges-
tibility for a considerable number of American foods and feeding
stuffs have been worked out as the result of these experiments. Studies
of the effect of different feeding stuffs on production of lean and fat
meat have been made. In connection with nutrition investigations
the composition of many American foods and feeding stuffs has been
learned. The effect of cooking on different foods and the losses
during cooking have also received attention. Much time has been devoted to the elaboration of experimental methods, the testing of methods already known, and the devising of new methods.

In zootechny (in the restricted sense of animal production), the work of the American stations has principally consisted of feeding experiments with different kinds of farm animals, in which various combinations of feeding stuffs have been tested with reference to the maintenance, growth, or the production of meat or milk. In this way the nutritive value of a large number of different kinds of American feeding stuffs has been worked out, largely on a practical basis. Important studies have been made on the nutritive value of crops of recent introduction, or crops which have recently assumed importance.

Digestion experiments have been conducted with horses, cattle, sheep, goats, and pigs. Attempts have been made at several of the stations to formulate feeding standards more suitable for American conditions than the German standards commonly in use. Tests of breeds of different kinds of animals have also been made, sometimes on a relatively large scale, and studies of types of animals best adapted to particular purposes have in some cases been made. The studies in zootechny have, to a considerable extent, been connected with the investigations in animal physiology.

In veterinary science, besides studies in bacteriology above referred to, investigations regarding the causes, nature, and treatment of various diseases of domestic animals have been made at the stations.

In agrotechny (agricultural technology), the most important work of the American stations has related to dairying. Besides the chemical and bacteriological studies of milk and dairy products referred to under the head of chemistry and bacteriology, the stations have made many studies relating to the methods of manufacture of dairy products.

Various kinds of dairy and creamery apparatus have been tested to a considerable extent, and in some cases demonstrations have been made of the method of conducting a hygienic dairy and milk route. Nearly every step in the handling of milk and in the manufacture of butter and different kinds of cheese has been investigated. In this connection they have done considerable work in studying methods of investigation and devising special apparatus and appliances for such work.

Other important investigations in agricultural technology have been those in sugar making by the Louisiana station, in the manufacture of wine and olive oil by the California station, and of vinegar and fruit sirups by the Virginia station. In these investigations the devising of new methods of manufacture and special apparatus and appliances have received large attention.

The American stations have as yet given comparatively little attention to problems in rural engineering. Studies of the form and construction of barns, silos, and other farm buildings have been made, as
well as of the construction and heating of greenhouses and the construction of cheese-curing rooms cooled by natural means. Questions relating to methods of drainage and irrigation have been studied. The draft of farm vehicles, especially as related to the comparative merits of broad and narrow tires, has been tested. A considerable number of practical tests of implements and machinery used on farms or in dairying have been made.

**VERIFICATION AND DEMONSTRATION INVESTIGATIONS.**

A considerable share of the work of the American stations has thus far consisted of the verification of the results obtained at the stations or elsewhere and the demonstration of the practical usefulness of these results. This work has been partly carried on at the stations, more especially on the farms under their control, and partly by experiments in different localities, largely with the cooperation of farmers. This demonstration work has included a wide range of subjects along most of the lines in which the stations have attempted more original investigations. Attention can be called in this general statement only to some of the larger enterprises of this kind in which the stations have engaged. Of this character, have been very many of the experiments with fertilizers, thousands of which have been carried on in the States east of the Mississippi River.

A very large number of practical tests of different field crops and horticultural plants have also been made by the stations in cooperation with the farmers after the stations had determined on a small scale the adaptability of these varieties to the regions in which they are located. Many of the experiments in the feeding of animals and in dairying have been made by the stations for the purpose of confirming the results obtained through previous investigations in this country or abroad. Often the chief purpose of these investigations has been to convince the farmers that the results which have been obtained elsewhere were equally applicable to their local requirements. In a similar way, many investigations along the lines of chemistry, botany, entomology, and veterinary science have been repeated at the stations, either for the purpose of more firmly establishing the correctness of the results previously obtained or of showing the farmers that these results could be successfully applied in practice. Thus, many means for the repression of insect pests and the diseases of plants or animals have been tried over and over again by the stations and among the farmers until they have become a part of regular agricultural practice, at least among the more progressive portion of the agricultural community. For purposes of verification or demonstration, thousands of cooperative experiments are now annually carried on in the United States, in which the farmers take part under the direction of the stations.
Closely united with the demonstration experiments of the stations have been those studies which have primarily had for their object the gaining of definite information regarding the natural agricultural conditions and resources of the different States. While the stations were not established for the making of agricultural surveys or the collection of agricultural statistics, yet in many cases, especially in the newer States and Territories, in the absence of accurate information acquired through other agencies, it has been necessary for the stations to do more or less work of this character as a preliminary to the scientific investigations and practical experiments which it is their real business to make.

In this way the stations have in the past done considerable work in the collection of general meteorological data, sometimes in cooperation with State weather services and the United States Weather Bureau. This work has, however, now been given up for the most part, and the stations are confining their meteorological observations to those taken on their own grounds. In a number of States data regarding the geologic formations and soils in different localities have been obtained, and in a few States this has been done with sufficient thoroughness to enable the station to make a soil map of the whole State, or of particular agricultural regions. Studies of the nature of the water supply available for household use, for live stock, or for irrigation, have engaged the attention of a number of stations. There has been a considerable number of botanical surveys for the purpose of obtaining information regarding the native forage plants and fruits of different States, which might be utilized for economic purposes.

Several stations have done some work on the study of life zones of their States and the suitability of varieties of crops to these zones. The largest enterprise of the stations which may be said to have been essentially a study of the natural agricultural conditions has been the determination of the regions in which sugar beets may be grown with a sufficiently high percentage of sugar to make it probable that they might be utilized in sugar making, provided the economic conditions were favorable. This investigation was carried on by the stations very largely in cooperation with the Department of Agriculture and farmers. Thousands of experiments were made for several years, covering the entire country, and in this way the capabilities of the United States with reference to the growing of sugar beets were quite definitely established.

The marl and phosphate deposits have been investigated in a number of States, with reference to their use for fertilizers where conveniently located.

In several States, legislatures have made special appropriations to
the stations for studies of the agricultural resources of particular sections as yet undeveloped or for overcoming natural obstacles to cultivation.

**INSPECTION WORK OF THE STATIONS.**

The experiment stations in thirty-six States and Territories are doing more or less work of inspection, either under special State laws or as a voluntary enterprise. The nature and amount of this service varies very greatly in different States. Sometimes the station conducts a complete inspection and control, sometimes it makes the chemical or other examinations on which control is based, and sometimes it simply makes the examinations and publishes the results for the information of the public, no system of control being provided by law. The fertilizer inspection and control was the first established in this country, is most extensively and thoroughly organized, and is most intimately connected with the work of the stations. More recently inspection of dairy products and other foods for man has been undertaken in a number of States, and the stations have been called upon in various ways to promote this work. In some of the Eastern States where concentrated feeding stuffs are largely used, laws for their inspection by the stations have been enacted within the past few years. Inspection for the prevention of diseases of animals and plants and the repression of injurious insects (especially the diseases and insect pests affecting nursery stock) and weeds has been begun in a number of States. Dairy apparatus and Paris green are required to be inspected in a few States, and there has been considerable voluntary inspection of seeds by the stations in different parts of the country.

The Hatch Act makes no provision for regular inspection work by the stations. The stations supported exclusively by this fund have therefore undertaken such work only incidentally with a view to showing its usefulness. Wherever it has assumed importance and the necessity for its regular performance has been made apparent, the States have made provision for its maintenance. Naturally the laws and regulations regarding this kind of inspection have varied with local requirements and opinions. In recent years there has been an increasing tendency toward greater uniformity in the general features of inspection laws and regulations.

**DISSEMINATION OF INFORMATION BY THE STATIONS.**

The Hatch Act requires that each station shall publish bulletins or reports of progress at least once in three months, and a full and detailed report of its operations, including a statement of receipts and expenditures, once a year. Most of the publications of the stations may therefore be divided into two general classes—annual reports and bulletins.

The annual reports of the stations vary greatly as regards the
character of their contents, their size, and the number of copies printed. In a number of States the annual report is a large document containing a detailed account of the investigations of the station, as well as statements regarding its administration and finances. In some States it is a brief document containing only short statements regarding administrative matters, finances, investigations, and publications.

The bulletins of the stations are of different descriptions and can not be definitely separated into classes. Each of the stations has, however, a regular series of bulletins, usually numbered consecutively, which comprises the greatest part of its publications. These bulletins contain a great variety of information. Some of them consist wholly of compiled matter, some are popular accounts of station investigations, and others contain quite technical and elaborate descriptions of their investigations. Some stations have attempted to separate their technical and popular bulletins into different series and in some cases new series have been begun after the station has been in operation a number of years. As a rule, however, the stations issue their regular bulletins in a single series. Illustrations are quite generally used in bulletins, and more attention has been given from year to year to improving the general appearance of the bulletins.

Many of the stations annually issue more than the four bulletins required by the Hatch Act. The bulletins are sent out to mailing lists containing from 3,000 to 35,000 addresses in different States, the aggregate number of addresses being about half a million. The stations endeavor to send their bulletins to all applicants within their own States and to satisfy outside demands for them as far as their means will allow. This outside demand has, however, grown to be so large as already to cause embarrassment. Each station has a considerable number of foreign correspondents to whom the bulletins are regularly sent.

In a number of the States the stations prepare press bulletins, which are either résumés regarding the station work or contain information of more general character. In cases in which the station receives a large number of requests for information on any topic it has been often found convenient to have answers distributed through the press rather than by correspondence.

Some of the stations have issued charts and posters illustrating special features of their work.

Station officers participate to a considerable extent in the meetings of farmers known as farmers' institutes, which are now regularly held in forty-three States and Territories, principally during the winter months. It is estimated that there are now annually held in the United States some two thousand institutes, which are attended by about half a million farmers. Through the institutes the stations are therefore able to largely supplement their publications by oral explanation of their work to large numbers of farmers. Station officers
also make a large number of addresses each year before State and local agricultural, horticultural, and dairy associations and miscellaneous meetings of farmers. The correspondence carried on by station officers is very large, aggregating hundreds of thousands of letters annually. A large part of these are replies to inquiries by farmers, which cover almost every topic relating to the theory and practice of agriculture. A considerable number of stations make exhibits of their work at State and other agricultural fairs.

GENERAL RESULTS OF THE WORK OF THE STATIONS.

During the past ten years more than $10,000,000 have been expended for the maintenance of agricultural experiment stations in the United States. Of this sum, about $7,000,000 came from the Federal Government and $3,000,000 from State sources. During that time the United States produced agricultural products valued at thirty thousand million dollars. The maintenance of the stations therefore involved the expenditure of $1 for every $3,000 worth of agricultural products. Considered in this light the funds used to improve the quality and increase the yield of our agricultural products do not seem disproportionately large. They are, however, sufficiently large to make it very important that the results shall clearly justify the continued expenditure of such great sums for the support of the stations.

Many of the results obtained in experimental inquiries in agriculture are of course of such a character that it is difficult, if not impossible, to give any exact measure of their value, especially on a financial basis. A large share of the work must necessarily give negative results, the practical value of which consists in showing the farmer the things which he ought not to do. Obviously many of the results which have a limited or local value, and which in the aggregate would go far toward justifying the maintenance of the stations, can not even be referred to in a summary statement like this. We shall, however, attempt to call attention very briefly to some of the more prominent results which the stations have obtained and on which their claims of usefulness to our agriculture must depend.

INTRODUCTION AND DEVELOPMENT OF AGRICULTURAL METHODS, CROPS, OR INDUSTRIES.

Beginning with the work of the stations in which the attempt has been made to introduce or develop new methods, crops, or industries, we may with good reason assert that the most important general result of experiment-station work has been along the line of dairying. The working out of practical methods and apparatus for the rapid determination of the fat content of milk, most perfectly accomplished by the Wisconsin station; the researches regarding the chemistry and bacteriology of milk and dairy products, the elaborate investigations on cheese making at the New York station, and on the ripening of
cheese at the Wisconsin station; the more practical experiments in butter making at the Iowa station—these and other investigations at the stations, combined with the dissemination of information regarding the results of work in similar lines abroad, have brought about a widespread revolution in the business of dairying in this country.

Closely connected with the improvement of dairying have been the investigations on nutrition, many of which have been directly made with dairy cattle. These have had to do with the effects of feeding stuffs on the quality of milk and the character of butter or have dealt with the economical production of dairy products. The highest point in the work on nutrition has been reached in the perfecting of methods and apparatus by the Connecticut Storrs station in cooperation with this Department. The respiration calorimeter devised at that station, having proved its usefulness in investigations on some of the fundamental problems of the nutrition of man, is now being adopted by the Pennsylvania station and the Department to use in similar investigations with farm animals. Two European governments have made liberal appropriations for the construction of respiration calorimeters after the plan of the Connecticut apparatus.

The Iowa, Maine, Massachusetts, Michigan, Minnesota, New York, Pennsylvania, Vermont, Wisconsin, and other stations have also made important investigations on the nutrition of dairy and other farm animals, which have widely changed the practice of feeding such animals. Among such investigations are those relating to the effect of the character of the food on the quality of the product and on the proportion of fat and lean meat in steers and pigs; the suitability of breeds of animals of different conformation to various purposes; effect of shelter and treatment on growth and gain, and the economy of a large number of different feeding stuffs, representing those generally at the disposal of the farmers; the effect of cooking and other methods of preparation. One very important result, on account of the enormous supply, has been the demonstration of the feeding value of corn stover when properly cared for, and the intrinsic feeding value of different by-products of wheat.

Notable instances of the successful introduction of new crops are the Manshury barley by the Wisconsin station, which has materially increased the yield of barley over a wide region, with results worth millions of dollars, and the Kafir corn brought in by this Department, but introduced to practical use on a large scale by the stations in California, Kansas, and Oklahoma, the crop being valued at about $6,000,000 in Kansas alone in 1898. The Minnesota and Wisconsin stations were instrumental in the introduction of rape as a forage plant for sheep, and it is now grown on thousands of farms in the Northwest to the great advantage of the farmer. The hairy vetch, introduced by the Mississippi station, has proved of great value to that State.
Important studies on the nutritive value and practical usefulness of alfalfa (lucerne) by the Colorado, Utah, and other Western stations have done much to extend the area and enhance the value of that crop in the irrigated region, while recent experiments by the New York and New Jersey stations and a number of stations in the Gulf States seem to indicate that it has a wider usefulness in the East than has hitherto been supposed. The value of crimson clover as a crop for forage and green manuring over a considerable area has been shown by the Delaware and other stations. The investigations on sugar beets conducted throughout the country by the stations and this Department have already had a practical outcome in the successful establishment of sugar factories in several States, and have shown in a very definite way in what regions this industry has the best chance of success. The work of the Louisiana station on methods and apparatus for making cane sugar and on the culture of the sugar cane have been so far successful as to secure for the station the financial support of the State Sugar Planters' Association.

The staple crops of the country, as maize, wheat, cotton, and tobacco, have been the subject of an immense amount of investigation touching nearly every phase of their chemical composition, improvement by breeding and selection, culture, manuring, harvesting and curing or storage. Many of the results have been of direct practical value and have materially influenced the methods followed by farmers. These investigations have also led to a greater diversification of agriculture in many regions.

The investigations which a number of our stations have made regarding the storage of forage crops in silos and the use of silage for feeding purposes have been of great importance in connection with the development of dairying in this country. These have related to the methods of constructing and filling silos, the best time for cutting the crops to secure the maximum amount of nutrients, increasing the richness of the silage by adding leguminous crops, and the feeding of the product. The results of the investigations on silage have done much to promote economy of production in dairying. The investigations of the Illinois, Ohio, Indiana, and other stations, which demonstrated the superiority of shallow over deep cultivation of maize, have produced widespread changes in the culture of that crop.

The stations have performed a very extensive and useful work relating to the use of commercial fertilizers. This is a subject of great economic importance in almost all the States east of the Mississippi River. The investigations of the stations have shown the fertilizer requirements of different soils and crops and have led farmers quite generally to recognize the desirability of a discriminating use of fertilizers. More recently the stations have shown the feasibility and general advantages of the home mixing of fertilizers by the farmers themselves.
In the States west of the Mississippi River the conservation of moisture in the soil is an important factor in successful agriculture, and the stations in that region have done valuable work in showing the conditions under which the moisture is largely conserved, and by introducing methods of tillage especially adapted to this purpose.

The investigations which the California station has made regarding alkali lands have led to the reclamation of large tracts of land in that State, which before were thought to contain alkali in such amounts as to make them useless for agricultural purposes.

Among the horticultural investigations of the stations which have given the most important practical results are those relating to the introduction of new kinds and varieties of fruits in different localities; the increase of hardness and resistance to disease by grafting; the culture and management of orchards; the storage of fruits, and the heating and subirrigation of greenhouses. Those investigations which have related especially to the forcing of vegetables in the field and under glass have been a considerable factor in the rapid development of the business of supplying markets in the United States with a large amount of green food at all seasons of the year, even in the States farthest North.

The work of the California station with reference to the culture of grapes and olives and the manufacture of wine and olive oil have proved a great aid to the development of the wine and olive-oil industries in that State.

REMOVAL OF OBSTACLES TO AGRICULTURAL INDUSTRIES.

The American stations have done a great work in aiding the farmers in their contest with the natural enemies to successful agriculture and in removing, in whole or in part, obstacles which hinder the progress of various agricultural industries. Under this head, the most important investigations of the stations have been those relating to insect pests and diseases of plants and animals.

The following examples of work in entomology conducted by the stations, which have been of great economic importance, may be cited. Much has been done in the development of effective means for the repression of such insects as the codling moth, plum curculio, chinch bug, Rocky Mountain locust, woolly aphis, cottonworm, cotton boll weevil, San Jose scale, forest insects, and insects affecting stored grain. Experiments with such insecticides as bisulphid of carbon, hydrocyanic-acid gas, petroleum, kerosene emulsion, Paris green, London purple, pyrethrum, and hellebore have brought out many useful facts regarding the best ways in which to use these materials in combating injurious insects. Much attention has been devoted to the study of spraying apparatus, and various improvements in spraying devices have been suggested by the stations, which have come into general use. Among the most successful investigations of the
stations on plant diseases and their treatment have been those relating to diseases of potatoes, cotton, cereals, sweet potatoes, beans, asparagus, celery, pears, and grapes.

Among animal diseases, the work of numerous stations on tuberculosis has had widespread practical results. The methods of application and the limitations of the tuberculin test have been thoroughly and widely studied. Much attention has been given to the prevention of hog cholera, using the serum made by the Department of Agriculture, and also a somewhat different one worked out at the Nebraska station, which is believed to reduce the percentage of infection very materially.

Many experiments have been made in rendering animals immune to Texas fever when taken into the region where it prevails, for breeding purposes or for grazing, and in preventing the spread of the disease to new regions through the movement of cattle. The source of infection of anthrax in Delaware has been traced to the pollution of streams with the wash water from morocco tanneries, and much effective work has been done in the repression of this disease in that State.

DEFENSE OF THE FARMER AGAINST FRAUD.

As stated elsewhere, the stations east of the Mississippi River have been largely engaged in the control of commercial fertilizers. The fertilizer business in this country involves millions of dollars, and the stations have largely prevented the sale of fraudulent goods. The stations have also done much to expose extravagant claims made for commercial fertilizers as compared with farm manures. More recently the stations in a number of States have been engaged in the inspection of feeding stuffs, dairy products, and nursery stock for fungous diseases and insect pests. Besides the prevention of fraud by a regular system of inspection, the stations have also done much useful work in this line in other directions. For example, their tests of varieties of grain, vegetables, fruits, etc., have often shown farmers how extravagant were the claims made for new varieties of plants. Their tests of the purity and vitality of seeds, while not systematically conducted, have yet done much toward making the farmer more careful in his purchases of seeds. From time to time the stations have exposed frauds relating to the sale of quack medicine for stock, creamery construction and equipment, dairy products, butter increasers and preservatives, adulterated foods and feedings stuffs, etc.

AID TO THE PASSAGE OR ADMINISTRATION OF LAWS FOR THE BENEFIT OF AGRICULTURE.

The experiment stations, as well as the agricultural colleges, have been largely instrumental in securing and administering State laws for the inspection of fertilizers, nursery stock, dairy products, foods
and feeding stuffs, creamery glassware, and Paris green; and for the suppression of plant diseases and injurious insects. They have also aided in the passage of laws establishing farmers' institutes, organizing associations for the promotion of agriculture, fixing a milk standard, quarantining animals for contagious diseases, regulating the sale of oleomargarine and kindred products, determining the apportionment and measurement of water for irrigation, securing the improvement of roads, etc.

**Educational Results of Station Work.**

Broadly speaking, the most important results of the work of the American stations during the past quarter of a century, and especially during the past decade, have been educational. As we have seen, they have distributed very widely in their own publications a vast amount of accurate and valuable information regarding the theory and practice of agriculture, and have thus directly contributed on a large scale to the technical education of farmers. As the result of the investigations and publications of the stations, the agricultural books and the agricultural journals published in this country have been largely revolutionized. Instead of depending as formerly almost entirely on foreign agricultural literature as the standard for agricultural theory and practice, we have now a considerable body of distinctly American agricultural literature. If we contrast the meager amount of up-to-date information on matters connected with his art which was available to the American farmer ten years ago with what we now possess, we will without doubt be convinced that as educating agencies the experiment stations have been a great success. No nation has ever attempted the free dissemination of agricultural information in so wide and thorough a way as has the United States, and it is believed that the results have justified the large expenditures which have been made for this purpose.

One large result of the educational work of the stations has been the general breaking down of the popular conception that agriculture is not capable of improvement through systematic and progressive researches in its behalf conducted on scientific principles. A widespread belief has been awakened that with the aid of science agriculture may be so lifted out of the ruts of a dead past that it will be able to hold its own amid the growing competitions and complexities of modern civilization. Some of the consequences of this new belief are likely to be very important and far-reaching. Already the farmer in this country is much inclined to demand that theories and assertions regarding the practice of his art shall be brought to the test of rigid and accurate investigation. Those who have in recent years followed up the agricultural press or the farmers' institutes, testify that articles or speeches which simply declare individual opinions or individual experience no longer satisfy the farmer.
Whenever new ideas or theories are brought to the attention of the farmer he is very apt to inquire if the experiment stations have looked into this matter, or he will at least demand that some sort of positive proof shall be presented that it is wise for him to accept the new proposition. While there has been at times widespread discontent among the farmers with regard to their economic condition, it may also be said that the experiment stations have done much toward inspiring a feeling of hopefulness. The stations are not only giving the farmer much information which will enable him to improve his practice of agriculture, but they are also leading him to a more intelligent conception of the problems with which he has to deal and of the methods he must pursue to successfully perform his share in the work of the community and hold his rightful place in the Commonwealth.

As regards the stations themselves, we may confidently assert that their past history gives great assurance of increasing strength and efficiency in the future. While they have encountered many difficulties in their development, and there has necessarily been much crudity in their work thus far, they have every year secured a better equipment and more thoroughly trained officers. With increasing resources they have been able to specialize their work more thoroughly and to increase its scope. They have succeeded in securing to a remarkable extent the confidence of the people for whose benefit they were primarily established, and have thus had no difficulty in obtaining financial support from Congress and the State legislatures. The people generally have come to regard the stations as permanent institutions and are convinced of the usefulness of their work. They will therefore enter upon the twentieth century with bright prospects for the development of their researches in scientific thoroughness and accuracy and for the securing of larger practical results.