SOME PRACTICAL RESULTS OF EXPERIMENT STATION WORK.

By W. H. BEAL,

Chief of Editorial Division, Office of Experiment Stations.

INTRODUCTION.

It may be justly claimed that the United States has in its National Department of Agriculture and the State agricultural experiment stations the most complete system of agricultural research in the world, and that the results obtained through these agencies have had a wider application and have influenced to a greater extent the masses of farmers than has been the case in any other country. Agricultural experiment stations are now in operation in every State and Territory of the United States, including Alaska, Hawaii, and Porto Rico, and steps have been taken under Government auspices to establish agencies for agricultural investigation in the Philippine Islands. There are 60 such stations, employing nearly 1,000 trained scientific and practical men in their work.

The annual income of these stations in 1902 was $1,328,847.37, of which sum $720,000 came from the Federal Government and $608,847.37 from State appropriations and other sources. During the fourteen years of their existence as a National enterprise there has been expended in their maintenance about $14,000,000, of which $10,000,000 came from the National Treasury and about $4,000,000 from State sources. The agricultural products of the United States during the same period are valued at over $40,000,000,000. In other words, the outlay for agricultural investigation has been at the rate of $1 for nearly $3,000 worth of product. This can not be considered an extravagant outlay in view of the magnitude and diversity of the agricultural interests of the country and the success which has been attained by the experiment stations in promoting those interests.

According to the Twelfth Census, there were in 1900 about 10 million persons, or about one-eighth of the entire population, engaged in agricultural pursuits in the United States. The total value of farm property (land, buildings and other improvements, implements and machinery, and live stock) in that year was, approximately, $20,500,000,000. The value of farm products in 1899 was, according to the same authority, $4,739,000,000, which represents an increase of over 50 per cent in ten years. This shows that the productive capacity of
American agriculture is rapidly increasing, and it is the purpose of this article to point out some of the ways in which the work of the experiment stations is assisting in bringing about this result. In doing this, however, it is impossible to draw a sharp line of distinction between what has been done by the Department of Agriculture and what has been accomplished by the stations, since the relations between the two are so close and the lines of investigation to such a large extent identical that they really form one system of agricultural research. In very few of the examples cited, therefore, can exclusive credit be claimed by the experiment stations. In many cases, and especially in the introduction of new varieties and industries, the Department has been the pioneer and leader, the stations, however, rendering most efficient service by testing the results of Department work on a large scale and adapting them to local needs and conditions, thus giving them a wider usefulness. This plan of cooperation, which is being strengthened from year to year, serves to unify the work and to build up a system of agricultural research which comprehends the nation as a whole, and yet meets the varied needs and conditions of an extremely diversified agriculture.

In attempting to show how and to what extent the work of the experiment stations has modified and benefited agricultural practice, it is necessary to take into account broad general educational results as well as special examples of their influence. "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;" but this subject has been very fully discussed elsewhere and need not be further considered here.

**Specific Examples of the Influence of Experiment Station Work on Agricultural Practice.**

In addition to the broad educational results just referred to, the benefits of which are evident to every student of agricultural affairs, although not capable of being measured in dollars and cents, there is no lack of specific examples of the beneficial influence exerted by station work in improving the agricultural practice and benefiting the farming interests of the country. The stations are conducting a wide range of scientific research in laboratory and plant house, and an equally large amount of practical work in field, orchard, stable, and dairy. Their investigations include studies of climatic and weather conditions as related to plant growth; soil investigations and fertilizer experiments to find the best means of maintaining and increasing the productiveness of the soil; irrigation and drainage experiments to increase the area of productive lands; breeding and culture of plants to increase the yield and improve the quality of farm, garden, orchard, and greenhouse crops of all kinds; breeding and feeding

---

*Yearbook of the Department of Agriculture for 1899, p. 547.*
of farm animals to increase production and improve the quality of meat, milk, and wool; dairying to improve the output of butter and cheese; inspection of fertilizers, foods and feeding stuffs, dairy products, etc., to protect farmers against fraud, and a large number of associated lines of work which it is not necessary to enumerate here. These various lines of investigation, which cover the whole field of agricultural operations, may be classified as follows: (1) Original investigations to discover new facts of value to agriculture; (2) experiments to demonstrate the scientific and practical value of facts already known and their applicability to special conditions; (3) studies of natural agricultural conditions, resources, and possibilities; and, (4) inspection and control work to protect the farmer against fraud. Investigations of the stations are intended primarily to supply information which it is impossible for each individual farmer to search out for himself, and the controlling purpose of their work has been (1) to develop the agricultural resources and promote the farming interests of the particular regions in which they are located, and (2) to advance the cause of scientific agriculture at large. The operations of the individual station are likely to be of a mixed character, including more or less of each of the general classes of work named, but varying in the prominence given to any particular class as the local and regional conditions and needs of the State or Territory in which it is located demand. Thus, in the more recently settled portions of the country special prominence is given to demonstration experiments and to the dissemination of information of a very practical character, while in regions where agriculture is more advanced original investigations naturally receive more attention; or, for example, in the older States, in which the use of fertilizers has become a necessity, a large amount of attention is given to the inspection of that commodity, a line of work which is of course unnecessary in those regions where fertilizers are not yet used to any considerable extent.

The following summary of some of the more prominent results of station work may serve to indicate the character and extent of station influence on agricultural practice. It should be clearly understood that this is a partial summary and mentions only a few of the many equally valuable results of the work of the stations to illustrate their varied activities.

SOILS AND FERTILIZERS.

Probably in no one particular has the work of the stations been of more direct benefit to farmers, especially in the older States, than in the inspection and study of fertilizers. The beneficial effects of this work are becoming more apparent every year. As a result of it, an industry the annual sales of which exceed $50,000,000 and which directly affects over thirty States of the Union is conducted on a high
plane of honesty, fraud and extravagant claims having been largely eliminated. The more successful farmers are buying fertilizers more intelligently and economically, and know what they are using in terms of nitrogen, phosphoric acid, and potash. For example, as a direct result of the investigations and advice of the New Jersey station, organizations of farmers have been formed in the truck-growing districts of that State for the purchase of unmixed fertilizing materials, and are thus effecting a saving of from 25 to 40 per cent in the cost of their fertilizers, while at the same time securing better results as regards earliness, yield, and quality of product. As the farmers of New Jersey pay annually about $1,200,000 for their fertilizers, this means a saving, if applied to the whole State, of from $300,000 to $480,000 each year, or ten to fifteen times as much as the two experiment stations in New Jersey cost the State and nation annually and nearly as much as they have cost from their organization in 1880 to the present time. Equally striking results have been obtained in other States in which the stations have given particular attention to the subject of fertilizers.

The work of the stations on fertilizers has been made to exert a widespread beneficial influence not only through the station publications, correspondence, personal advice, etc., but by means of cooperative experiments with the farmers themselves under widely different conditions of soil, season, and crop. The farmer has thus not only been taught the needs of the particular crop and soil experimented with and the relative merits of the fertilizers used, but, what is also of great importance, he has been taught how to plan and successfully carry out experiments for himself and to cooperate efficiently with the experiment stations in such work. A good example of the value and influence of such work is furnished by the experiments conducted by the Rhode Island station in cooperation with farmers in all parts of that State on the acidity and lime requirements of soils. These experiments have shown the very general distribution of acid soils in the State and have pointed out an effective remedy in the use of lime, information which is now being very generally applied in practice in that and other States with great benefit to their agriculture.

Many of the stations have given special attention to the economic utilization of the manurnal resources of the farm, with the result that there is now in the more prosperous rural communities a higher appreciation of the value of farm manures and better methods for their care and use. As the annual loss to the farmers of the United States from waste of barnyard manure alone is reliably estimated at over $7,000,000, the value and importance of work which points out more effective and profitable methods of preserving and using this product are obvious. This better understanding of the value and use of farm manures is usually accompanied by a more intelligent and profitable use of commercial fertilizers to supplement such manures in general
farming, and the wider employment of cheap practical means of restoring the fertility of worn soils without the use of commercial fertilizers. On the other hand, the station investigations in regions where intensive farming or market gardening is practiced—as, for example, in certain parts of New Jersey—have shown the wisdom and profit of the liberal use of commercial fertilizers to replace to a large extent the heavy manuring with stable manure, which was formerly the general practice.

The stations have from the beginning taken an active part in investigations relating to the extremely varied soil conditions of the country, studying distribution of types, physical and chemical characteristics and deficiencies, and adaptability to different crops. The influence of such work by the stations and by the Department is seen in the more discriminating choice of crops for particular soils and use of fertilizers for special crops; in the more profitable and rapidly growing utilization of land under irrigation in the so-called arid regions of the United States, and in the reclamation and profitable use of considerable areas of swamp lands and of lands rendered useless for ordinary culture by reason of the presence of excessive amounts of soluble salts (alkali). It is also seen in the increased attention given to green manuring, rotations, and tillage to maintain the humus content and improve the moisture conditions of the soil, particularly in the cotton-growing region of the South and in the grain-growing regions of the West and Northwest (see p. 598).

INTRODUCTION AND ORIGINATION OF NEW AND IMPROVED VARIETIES OF PLANTS.

A fundamental purpose of all agriculture is the production of a greater variety, larger yields, and better quality of crops. It is natural, therefore, that the stations have from the beginning given a large share of their time and energy to investigations having these objects in view. The work in this line has included testing of varieties of field crops, fruits, and vegetables, to find those best suited to given regions and conditions, and to protect farmers against extravagant claims for new varieties; the origination of improved varieties by breeding and selection; improved methods of culture and utilization of product, and protection against insect enemies and plant diseases. Attention has been directed persistently to the introduction of new crops, to the improvement of old varieties, and to finding new and more profitable uses for the crops commonly grown.

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

INTRODUCTION OF NEW VARIETIES.

In the introduction of new varieties a striking example is given of the valuable service the stations are rendering in supplementing and extending the work of the Department of Agriculture and giving it local application. The Department has from the beginning of its career been carrying on work of great value along this line, but this work is undoubtedly being greatly strengthened by the cooperation of the stations.

In no respect has the benefit from station work in connection with the introduction of new varieties been greater than in the case of cereals. Notable instances of the successful introduction of new cereal crops are Manshury barley, for which the Wisconsin station is mainly responsible, and which has materially increased the yield of barley over a wide region, with results worth millions of dollars, and Kafir corn, first distributed by this Department in 1886 and introduced to practical use on a large scale by the stations in California, Kansas, and Oklahoma. Kafir corn has been found specially suited to conditions in which the rainfall is too scanty for the most successful culture of corn. The crop in Kansas alone in 1899 was valued at over $6,000,000.

A variety of oats introduced by the Department, and tested and improved by the Wisconsin station among others, has been widely distributed and grown, with results which indicate that its general introduction will be followed by an average increase of yield which Professor Henry estimates at from 3 to 5 bushels per acre. As the area devoted to oats in Wisconsin alone in 1901 was, according to the Department Statistician, 2,290,288 acres, producing 66,647,381 bushels, estimated to be worth $25,992,478, this would mean, if maintained throughout the State, a gain to the farmers of Wisconsin annually of from $2,400,000 to $4,400,000 on the oat crop alone.

The macaroni wheats imported and distributed by the Department and carefully tested under varying conditions by a number of the stations have proved so successful as to give reasonable assurance that in a few years the United States will not only produce all of the macaroni it consumes, but will supply a considerable proportion of the macaroni and macaroni flour used abroad.

The investigations of the stations in Alabama, Tennessee, Mississippi, Louisiana, Florida, and other Southern States, supplementing the extensive work of the Department on grasses and forage plants, have done much to convince farmers that forage plants of many different kinds may be more successfully grown throughout the South than has heretofore been supposed possible, and thus have laid the
foundation for a wide development of the live-stock and dairy industries of that region. The hairy vetch, studied especially by the Alabama and Mississippi stations, promises to prove of great value to those States. Similar experiments on cowpeas by a large number of stations have had a marked influence in extending the use of this valuable plant for soil improvement, for soiling, and for hay, especially in the southern half of the United States, and in introducing better methods of culture of the crop.

Careful studies of the value and use of alfalfa by the stations in Colorado, Utah, and other Western States have done much to extend the area of culture and increase the usefulness of this crop in the irrigated region, while recent experiments by a number of stations in other parts of the country have shown that this crop has a much wider usefulness than has hitherto been supposed. The Turkestan alfalfa, distributed by the Department and tested by a large number of the stations, has been shown to have qualities of hardiness and vigor which will enable it to withstand frost and drought to a greater degree than the common variety, and will thus still further extend the limits of profitable production of this valuable forage plant.

The introduction of crimson clover, which has been found so valuable as a winter cover crop for grazing and for hay and seed, has been largely due to experiment-station influence.

In some of the Northwestern States, where successful fruit growing depends so largely upon hardiness, the stations have led in the introduction of hardy varieties of stocks and fruit, the Iowa station being the pioneer in this work. Importations by that station of hardy European fruits were made as early as 1882.

The Department and the Connecticut State station, cooperating with local tobacco growers, have within the last three years demonstrated the practicability of growing a fine grade of Sumatra wrapper tobacco under shade in the Connecticut Valley, thus adding a new and profitable industry to our agriculture and increasing the value of the light lands of the Connecticut Valley, according to Professor Whitney, over 200 per cent. a

The investigations on sugar beets conducted throughout the country by the stations cooperating with the Department have had a practical outcome in the successful establishment of over 40 beet-sugar factories in different States, and have shown in a very definite way in what regions this industry has the best chance of success. It is reported that the area devoted to sugar beets in 1901 was 175,000 acres, producing 1,685,000 tons of beets, worth to the growers probably $6,000,000 to $7,000,000. This industry has come into existence in the United States since 1890. For, although sugar beets were successfully grown in Massachusetts more than forty years ago, and Goessmann, at the Massachusetts Agricultural College, as early as 1870

---

demonstrated the feasibility of growing beets suited to the manufacture of sugar, it was not until about 1890 that the Department of Agriculture, with the cooperation of the experiment stations, commenced the systematic experiments which have put the industry on its present basis. Of this industry a recent writer\(^a\) says:

To diversify agriculture, as in the West; to succeed a waning industry, as in the lumber regions of Michigan; to add another item to the nation’s list of products, reducing its need of importation—these are some of the broader advantages claimed for the beet-sugar industry. With a large area adapted by soil and climate to sugar-beet raising, and with capital in abundance seeking profitable investment, it will be strange if the United States does not find a way to make the industry a prominent and permanent one.

Although the profitable production of beets for sugar making has received so much attention, the long-established cane-sugar industry has not been neglected. The work of the Louisiana stations has been so successful in preventing losses by improving sugar-house methods and methods of culture, and in introducing improved seedling varieties, that the Sugar Planters’ Association of that State has recognized the work by liberally contributing to the support of the stations.

**ORIGINATION OF IMPROVED VARIETIES.**

While the stations have done a valuable work for agriculture by introducing and promoting the culture of varieties which they have demonstrated to be of value, the best prospect for future advance with reference to plant production seems to lie along the line of the scientific origination of new varieties by breeding and selection, a feature of agricultural investigation which has been enthusiastically undertaken in recent years by a number of the experiment stations, but particularly those of the grain-growing region, cooperating with the Department.

Speaking of the work of the Minnesota station in breeding wheat, a recent writer\(^b\) says:

 Enough has been demonstrated at this station and upon the farms of the State in actual farm handling to show that the wheat crop of the world is now to be splendidly strengthened; that the theorists who have predicted ultimate starvation through impairment of the world’s dietary are driven to other speculations; that it is quite possible, indeed, that it is now an established fact, to produce wheats superior to the best the world has had. By the use of the new wheats the crop of the hard-wheat region of the Northwest may be increased by from 3 to 5 bushels per acre, which, reduced to a practical basis, assures an increase in the wealth of three States of from twenty-five to forty millions of dollars annually.

It is very evident that the yield and quality of wheat in Minnesota is undergoing a marked improvement as a result especially of the distribution of seed of two improved varieties originated by the experiment station of that State, and similar improvement, though probably

---

\(^a\)C. M. Harger (Outlook, 72 [1902], No. 2, p. 131).

\(^b\)W. S. Harwood (Scribner's Magazine, 31 [1902], No. 6, p. 651).
less marked, is undoubtedly resulting from similar work by other stations in the grain-growing region.

No less interesting and valuable is the work of the Illinois station in corn breeding, one practical result of which has been the formation of the Illinois Seed Corn Breeders' Association, a chartered organization, with a limited membership of reputable and well-known corn growers pledged to select and grow their seed corn according to definite rules formulated by the station, and to sell only their own crop. The success of this enterprise has been phenomenal. All of the available supply of the improved seed is rapidly disposed of to farmers, and much of it is engaged in advance. The work of this station on corn is proving to be far-reaching in its results, not only in improving the general quality of seed corn, but in inducing practical men to undertake breeding for special qualities—for protein, for oil, or for starch—which the station has demonstrated to be entirely feasible.

While perhaps the most striking and valuable results have been obtained in the origination of new varieties of cereals, some very useful results have been secured in similar work on forage plants, fruits, etc. Thus Hansen, at the South Dakota station, is making considerable progress in developing varieties of fruits suited to a region which presents almost insurmountable obstacles to the culture of ordinary varieties, and the value of the Ignotum tomato and the Hunn straw-berry, both originated by station men, is generally recognized.

IMPROVED METHODS AND SYSTEMS OF CULTURE.

The stations have not only been useful, as pointed out above, in introducing new and improved varieties of farm crops, but they have been very active in investigations which have led to the adoption of better methods of culture. A notable example of this is found in the substitution in the grain-growing region of rotations to conserve soil fertility for the exhaustive system of continuous grain cropping and bare fallow, practices which have heretofore been generally followed and which have caused some of the best wheat lands, such as those of the famous Red River Valley, to begin to show a marked decline in productiveness. In parts of the same region, subject to severe summer droughts, the stations have demonstrated the advantages and urged with considerable effect on practice the cultivation of winter wheat, which matures earlier than the commonly grown spring wheat and so in large measure escapes injury from drought. The more extended cultivation of winter wheat will largely increase the productive capacity of the grain-growing region.

The Georgia station has introduced in that State a method of spring seeding of oats which obviates the danger of winter killing that has heretofore rendered the culture of that crop very precarious in Georgia and elsewhere in the South.

The stations of the Northwestern States are doing much to extend
the limits of successful corn culture by showing that by careful selection of varieties and modified methods of culture suited to the conditions this crop may be grown successfully in regions heretofore considered entirely unsuited to corn culture. This is proving of immense value to those regions in increasing the available supply of food and forage. The investigations of the Illinois, Ohio, Indiana, and other stations, which demonstrated the superiority of shallow over deep cultivation of corn, have produced widespread changes in the culture of that crop.

The method of handling corn fodder in the South is being materially modified for the better by station work showing the costliness of the old practice of stripping and curing the blades and the advantages of using shredding machines which render a larger amount of good forage available at much less cost.

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 subsoiling and other methods of tillage especially adapted to this purpose.

Irrigation and diversified farming are working a revolution in the agricultural methods of the western half of the public domain, replacing the ranch and the range by the small farm, orchard, and garden. This change is of course an inevitable result of normal development, but the stations have had no small influence in directing the movement along safe channels and in securing the adoption of proper methods and practices. They have done much to correct errors in irrigation methods long in use and to introduce new methods which secure better measurement, distribution, and use of the water supply in a region in which water is more valuable than land and its just distribution and economical use essential to peace and prosperity. The stations in the arid region have also been of great assistance to newcomers not familiar with irrigation farming by furnishing information regarding methods applicable to the new conditions and crops most likely to succeed. Many of the early emigrants to the West were induced by interested persons to locate on lands and to attempt "dry farming" (that is, without irrigation) in regions in which the rainfall is in most years too scanty to supply the needs of crops. The result was general disaster, and many deserted towns and farmhouses on the semiarid plains bear silent testimony to the folly of the enterprise. That these lands, however, may in many cases be profitably utilized when properly managed and when "dry farming" is supplemented with irrigation farming has been shown by the work of several of the stations. The Utah station especially has achieved notable success in its study of the extent to which dry farming may be practiced with profit and of the conditions necessary to success. This
work is bearing fruit in the extension on a safe basis of what has heretofore been a very precarious system.

The investigations of the stations have given most important results in improving methods and practices in almost every line of horticultural operations. It can be reasonably claimed that present methods of orchard cultivation are due largely to the efforts of experiment station workers. The early spring plowing of orchards, followed by shallow cultivation during the most active period of wood growth, or until the middle or last of July, in most of the Eastern States, and the planting of leguminous cover crops at that time, as now practiced by most successful orchardists, can be quite clearly traced to the work and teachings of the experiment stations.

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 fresh vegetables at all seasons of the year, even in the States farthest north. Among the investigations of this character in which the stations have taken an active part are studies of proper methods of construction, heating, and watering of greenhouses, of crops best suited to forcing, and of the best methods of forcing. Professor Galloway\(^a\) says:

> Probably nowhere in the world has the growing of plants in greenhouses attained such importance as in the United States. Other countries may have more imposing structures and larger individual areas of glass, but, taking the business as a whole, it may be fairly claimed that in up-to-date methods in almost everything pertaining to this special field of horticulture this country leads.

The growth of the horticultural industry in recent years has been remarkable, probably 100 per cent in the last ten years, and no small proportion of the increase has been due to the extension of culture under glass. According to the Twelfth Census there was 96,230,420 square feet under glass June 1, 1900.

A notable example of the influence of station work on horticultural, and particularly greenhouse, methods is the practice, which is being widely adopted, of sterilizing greenhouse soils by means of steam or hot water. The methods which are now being used for this purpose with great success and profit were first worked out and brought to the attention of practical horticulturists by the Massachusetts station.

Another example of station influence in promoting the forcing of vegetables is found in the introduction, largely through station effort, of winter culture of lettuce in eastern North Carolina, an industry now said to yield an income of probably $100,000 annually. The North Carolina station also claims credit for inaugurating the now well-established and flourishing industry of growing flowering bulbs in the same region.

---

\(^a\) Yearbook of the Department of Agriculture for 1899, p. 575.
Following the work of M. B. Waite, of this Department, showing the sterility of many varieties of pears to their own pollen and the necessity of mixing varieties in orchard planting to secure proper fertilization, many of the stations have made investigations along the same lines with plums, grapes, apples, and many other fruits, and many varieties of these fruits have been shown to be self-sterile. This work must of necessity prove valuable, though there is no way of measuring its value. The facts, however, have been so widely published and discussed that it would seem unlikely that at this time any large blocks of fruit trees are planted without considering this point and mixing the varieties in such a manner as to insure cross-pollination.

Methods of onion culture have been modified by station investigations. The Ohio station discovered independently, but at the same time with T. Greiner, that onions started in the greenhouse or under frames from seed and then transplanted to the open field produced larger onions and earlier and heavier crops than by the usual method of field seeding. Experiments at other stations have largely confirmed these conclusions. The method has been found especially applicable to the growing of the large foreign varieties, like the Bermuda onions, in some of the Northern States, and is quite widely followed.

Other lines of station work that would appear to be influencing horticultural practice are studies of methods of olive pickling in California and, in general, the whole subject of olive culture; the irrigation of fruit and vegetables in Eastern humid regions close to cities, the winter irrigation of deciduous fruits in Arizona, subirrigation in greenhouses, bench grafting of resistant vines in California, and liberal manuring of early market garden crops with nitrogenous fertilizers in New Jersey.

PROTECTION AGAINST INJURIOUS INSECTS AND PLANT DISEASES.

The reduction of the enormous losses caused by the ravages of insects and plant diseases is a problem to which the Department and the stations have for many years been giving their earnest attention with most gratifying results. Through their efforts the application of insecticides and fungicides as means of protection against injurious insects and plant diseases has become very general, and the benefits and profits resulting from the practice are no longer questioned. The idea of spraying goes back more than a hundred years, but the system has come into general use only during the last ten or fifteen years. The experiment stations have made many spraying experiments with positive and striking results; their work has been published in bulletin form and sent out to farmers, the agricultural press has reprinted the essential parts of it with favorable comments, and farmers' institute workers have used the same data to justify their advice as to the
RESULTS OF EXPERIMENT STATION WORK.

desirability and profitableness of spraying. It is not assuming too much to say that the stations, with the Department, deserve a very large measure of credit for the present methods of controlling plant pests by spraying. Striking evidence of the readiness with which farmers and fruit growers will now adopt promising means of plant protection is furnished by the fact that the method of formaldehyde treatment of smut of oats, proposed by the North Dakota station, was almost immediately put into use by over 25,000 farmers in the State of Wisconsin alone, with the prospect that the number using the method will rapidly increase. As the estimated loss from oat smut in Wisconsin varies, according to Professor Henry, from $3,000,000 to $7,000,000 annually, according to the season and other conditions, the great value of an effective means of prevention of the disease is obvious.

A few years ago the farmers of the noted potato-growing region of Aroostook County, Me., found their business seriously menaced by the ravages of insects and of blight and other diseases. Through the advice and under the direct supervision of a representative of the Maine station they were led to adopt a system of spraying which has proved a very effective protection and has insured the profitable continuance of potato growing in that region, the annual output of which is over 6,000,000 bushels.

Examples of the beneficial effects of spraying and of its profitable application in farm practice could be multiplied almost indefinitely. There is hardly a serious insect pest or plant disease that the stations and the Department have not studied, and in most cases suggested a remedy for. The methods and apparatus for use in applying these remedies have been so simplified and perfected that the cost of treatment is almost insignificant, compared with the benefits derived. The outlay of a very small sum for spraying often means complete success as against total failure if such protection is not afforded.

STORAGE AND UTILIZATION OF FARM PRODUCTS.

The work of the Wisconsin station, following closely that of McBryde (now director of the Virginia station) at the University of Tennessee in 1879, was among the first to acquaint the American farmer with the process of storing green forage plants in silos and to explain the true value and proper use of the silage for feeding purposes. The station investigations on this subject have included 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 rapid extension of the use of silage, especially in connection with dairy farming, and the very general adoption of the round form of silo, proposed by King, of the Wisconsin station, is directly traceable to experiment-station influence. The better
methods of handling corn fodder and the higher appreciation of its value as a feeding stuff are, as already intimated, largely due to the influence of station investigations on this subject.

The stations in the South and elsewhere have done much good in demonstrating the value of cotton seed and its products as feeding stuffs and fertilizers, and have thus added materially to the value of the cotton crop. The cotton seed annually produced in the United States is estimated to have a combined feeding and fertilizing value of some $150,000,000, a value which is not materially reduced by the extraction of oil. It is largely due to station influence that there is a rapidly growing appreciation of this product and a more general and economical use of it.

The South Carolina station has shown the possibilities of the sweet potato as a starch-producing crop, and has devised a simple method of drying the potatoes so that they will keep indefinitely, and may be handled and shipped more easily and cheaply. This means, if successfully introduced, a wider distribution and more extended use of this product of the farm.

In its studies of the value of cassava for starch making and for feeding the Florida station has secured results which promise to be of considerable value to the agriculture of that State.

The subject of the cold storage of fruit is being agitated at the present time by a number of the experiment stations, and some work has been done on this subject. The Department has shown that early apples and peaches can be successfully shipped in cold storage to England and sold at a profit. This promises to open up an entirely new outlet for the fresh fruits of this country and may prove especially valuable in seasons of superabundant crops.

ANIMAL PRODUCTION.

Station investigations relating to animal production have covered the whole range of the breeding, feeding, diseases, and management of domestic animals, and the results obtained have been no less valuable from a practical standpoint than those yielded by the studies in plant production discussed in previous pages.

According to the Twelfth Census, the value of animal products in the United States in 1899 was $1,718,990,221, or 36.3 per cent of the total value of farm products, the value of crops during the same year being $3,020,128,531. The value of live stock in 1900 was $3,078,050,041, representing an increase of nearly 40 per cent since 1890. The rapid increase in the value of farm live stock and animal products in recent years is unquestionably due to a considerable extent to station influence. In many localities the stations have done much good by encouraging the introduction of improved breeds of animals. The wide dissemination of the accounts of their feeding experiments with all kinds of animals and all kinds of feeding stuffs has brought
RESULTS OF EXPERIMENT STATION WORK.

about a more general understanding of the principles of feeding and the adoption of more scientific methods of "balancing" rations of homegrown products with purchased concentrated feeds, with the result that better products are grown at less cost and with less draft on the fertility of the farm.

New methods have been adopted and old methods have in many cases been discarded as a result of such work. For example, the extensive experiments of the Wisconsin station showing that there is not only no gain, but an actual loss, in cooking corn, corn meal, barley meal, and wheat middlings for pigs have been widely quoted, with the result that much less food is now cooked for stock than formerly.

The work of several of the stations, but particularly those of Missouri, Texas, and Louisiana, on Texas fever, extending and making local application of the work of the Department, has materially aided in the improvement of the cattle industry in the region affected by this fever by furnishing a means of making cattle immune to the disease and thus rendering it comparatively safe to bring in high-bred animals for breeding purposes, and by preventing in large measure the spread of the disease to new regions through the movement of cattle.

Practically every other serious disease to which farm animals are subject in this country has at one time or another received attention by the Department and the different stations, and while the beneficial results are perhaps not so evident as in the case cited, they are clearly seen in the increased attention given by farmers to stable construction and sanitation and to the health and comfort of their animals, and by an increasing demand for information and advice regarding such matters. In short, farmers are to a larger extent than ever before discarding scrub stock for improved animals, feeding more economically and scientifically, and making more careful provision for the health and comfort of their stock, and no small share of the credit for this condition of affairs may be justly claimed by the experiment stations. With such results accomplished and such agencies at work, it is safe to predict that the next decade will show an improvement in the amount and quality of the output of animal products even more remarkable than that of the past ten years.

DAIRYING.

The stations have done work of great practical usefulness to farmers in the study of dairy problems, including the breeding and care of dairy animals, the handling of milk, and the manufacture of butter and cheese. 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, but participated in by a number of stations; the researches regarding the chemistry and bacteriology of milk and dairy products; the elaborate investigations on cheese
making at the New York State station and on the ripening of cheese at the Wisconsin station; the 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.

Following the perfection of the Babcock test, a large amount of work was done which showed the weight or volume of milk to be an unfair and illogical basis for paying for milk at creameries, and the "relative-value plan" was developed by the Iowa station, in which the fat content of the milk is taken into account, payment being made on the basis of the pounds of milk fat delivered. Subsequent work has shown that this, with a slight correction, is the proper basis for buying milk at cheese factories. This has resulted in a culling of herds, improvement of the cows kept, and increased profit.

The work in bacteriology has dealt with the extent and character of infection with micro-organisms, means of gaining access to milk, prevention by cleanliness in the stable and in handling, pasteurization, the use of pure or of definite cultures in butter making and cheese making, the nature of the changes in the ripening of cheese and the kinds of organisms causing them, and the means of controlling ripening.

By the discovery of the so-called curd test the Wisconsin station has provided an effective means of detecting tainted or defective milk at cheese factories, a matter which has caused a loss of from $100,000 to $200,000 each summer in Wisconsin alone.

The artificial cooling of cheese-curing rooms has received attention, resulting in practical suggestions for this purpose, which have been of much value to cheese makers. The demonstration by the Wisconsin station of the decided advantages of low-temperature ripening of cheese as regards safety and better control of the process and quality of the product promises to greatly modify and improve present practices in cheese making.

In many cases the stations have led in the introduction of dairying as an industry where it formerly received little or no attention. Thus, the credit for the successful establishment on a commercial basis of dairying in Utah may be fairly claimed as due largely to the efforts of the experiment station in that State; and the stations in other States have been equally successful in this respect.

In brief, it may be said that the farmers of the United States are keeping better dairy cows, feeding them more economically and scientifically, handling the milk in a better and more cleanly manner, and receiving a fairer price for it; and that more and better products—butter and cheese—are being made than ever before. In every one of these respects they have received substantial aid from the work of the experiment stations.
An idea of the present importance of the dairy industry of the United States and of the progress that has been made in the last ten years may be gained from the following figures from the Twelfth Census: In 1899 there were reported to be 17,139,674 dairy cows in the United States, producing 7,266,392,674 gallons of milk, or an average of 424 gallons for each cow. During the same year there were produced 1,491,871,673 pounds of butter and 298,344,654 pounds of cheese. The census figures show that the increase in milk production since 1889 was nearly 40 per cent, in butter production about 24 per cent, and in cheese production 16 per cent. The percentage increase in production exceeded that in the total number of dairy cows, indicating an improvement in the cows kept and an increase in the product per cow.

THE PROTECTION OF FARMERS AGAINST FRAUD.

The value of station work on fertilizers in protecting farmers against fraud and in disseminating correct ideas regarding the value and use of fertilizers has already been referred to. More recently the stations in a number of States have undertaken the inspection of foods, feeding stuffs, and dairy products, and of nursery stock for fungous diseases and insect pests, which promises to be as useful to farmers as the inspection of fertilizers has been. The effects of publication of the results of analyses of feeding stuffs found on the market, with explanations of the principles of feeding, and the nature and functions of feeding stuffs are becoming evident in a general way in the more intelligent purchase and use of feeding stuffs, but more specifically in the higher appreciation and larger and more rational use of meals of various kinds, corn by-products, such as gluten meal and feed, and by-products of the milling industry, bran, middlings, etc.

Besides the prevention of frauds by regular systems of inspection, the stations have also done much useful work in this line in other ways. 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 purchase of seeds.

CONCLUSION.

The foregoing is a brief and imperfect statement of some of the results accomplished by the stations in their efforts to meet the agricultural needs and improve the agricultural practice of the country. Enough has been said, it is believed, to show that the stations have abundantly demonstrated the wisdom of their establishment and maintenance on a liberal basis. They deserve the confidence and cordial support which they are winning in large measure from the
farmers of the land. With the encouragement of such support and
the active cooperation of the farmers their power for usefulness must
rapidly increase.

Regarding the cooperation of farmers with the Illinois station in
corn breeding experiments (see p. 597), and of prominent stockmen
with the Iowa station in experiments in fattening cattle for the market
on a large scale, a writer in one of the leading agricultural journals\(^a\)
says:

>A significant sign of the times is the growing disposition among farmers and
stockmen to cooperate with the agricultural experiment stations of their respec-
tive States. In this union of forces there is great strength. In no other way can
the stations so effectively serve the people for whose benefit they were organized.
Moreover, the assistance of farmers in conducting experiments to solve feeding
and breeding problems has the desirable tendency of making the results obtained
more practical and hence more acceptable among laymen. Until within recent
years there has existed between the experiment stations and the farmers a chasm
which in large measure precluded mutual aid. Station bulletins, burdened with
scientific minutiae and technical data, from which but few unscientific readers
could make practical deductions, did much toward establishing the pardonable
attitude of those who regarded experimental work chiefly as an occupation for
theoretical professors. Prejudice against the abandonment of old, traditional
methods also stood in the way of closer relationship between institutions and those
at whose expense they exist. It was natural that the initial work of the stations
should be characterized by a few shortcomings, just as newly invented machines
usually fail of perfect operation, but if proper consideration of this fact had been
given, there would not have so long remained that indifference to the develop-
ment of the stations which in recent years has rapidly been disappearing.

To-day the experiment stations and farmers are on substantial terms of recipro-
cal helpfulness, and the work of the former has been so intimately concerned in
late years with the practical affairs of the latter that credence in agricultural
investigational work has been greatly stimulated and the spirit of cooperation
aroused to splendid activity. It has become clear to farmers who have sought
improvement of their conditions through the larger use of brains that the land-
grant colleges and experiment stations are zealously striving to advance agricul-
ture and allied arts in every possible manner.

\(^a\) Breeders' Gazette, 42 (1902), No. 15, p. 643.