

SB

945

.C8U7

1913

U. S. Dept. of Agr.

Bull. W. 211

Hog Cholera

1913



Class SB 945

Book C 8 U 7
1913

STUDY AND INVESTIGATION OF BOLL WEEVIL AND HOG
CHOLERA PLAGUES.

LETTER

FROM

THE SECRETARY OF AGRICULTURE,

TRANSMITTING

INFORMATION REGARDING THE STUDY AND INVESTIGATION OF
THE BOLL WEEVIL AND HOG CHOLERA PLAGUES, AS DIRECTED
IN HOUSE RESOLUTION NO. 254, DATED SEPTEMBER 16, 1913.

DECEMBER 10, 1913.—Referred to the Committee on Agriculture and ordered to be
printed.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., December 3, 1913.

DEAR MR. SPEAKER: Complying with House Resolution No. 254,
dated September 16, 1913, directing the Secretary of Agriculture to
communicate to the House of Representatives a full report as to the
methods used, results thus far secured, and the amount of money
expended in the study and investigation of the boll weevil and hog
cholera plagues, I have the honor to transmit the report called for
herewith. This report consists of statements from the three bureaus
of the Department which carried on the investigations in question;
that is, the Bureau of Animal Industry on hog cholera and the
bureaus of Plant Industry and Entomology on the boll weevil.

Very respectfully,

D. F. HOUSTON, *Secretary*.

The SPEAKER OF THE HOUSE.

THE WORK OF THE BUREAU OF PLANT INDUSTRY IN CONNECTION
WITH THE COTTON BOLL WEEVIL FROM 1904 TO 1913, INCLUSIVE.

The work of the Bureau of Plant Industry in connection with the
boll weevil was begun in 1904 under the act of January 15 of that
year making appropriations for the Department of Agriculture, which

included an appropriation "to meet the emergency caused by the ravages of the Mexican cotton boll weevil and other insects and diseases affecting cotton. While the work incident to carrying out the intent of the act was distributed among several of the divisions of the bureau, the branches now known as Farmers' Cooperative Demonstration Work and Acclimatization and Adaptation of Crop Plants and Cotton Breeding were specially charged with carrying on the work. In the case of the former branch the primary objects of its work were to prove that cotton could be grown with profit notwithstanding the presence of the boll weevil and to persuade the growers to adopt the cultural methods and means of control necessary to that end, and in the case of the latter to produce better types of early maturing varieties of cotton, adapted to the soil and climatic conditions of the boll weevil infested territory, the planting of early maturing varieties being a factor of great importance in reducing the ravages of the weevil.

Work of the Office of Farmers' Cooperative Demonstrations.—Immediately after the passage of the act above referred to steps were taken to inaugurate the work, the first being the establishment of headquarters at Houston, Tex. The plan followed was to establish cotton culture or cotton demonstration farms. These consisted of from 5 to 25 acres, and were selected near the principal town in each county so that the cooperation of business men in furnishing seed and fertilizers could be secured. Arrangements were entered into with the owners of these farms whereby they agreed, in consideration of the seed and fertilizers furnished by the business men, to prepare and cultivate the land under the direction of the Department of Agriculture. After the first two or three years the plan of supplying seed and fertilizers was abandoned, and thereafter the farmers carried on the work without any compensation and with no guaranty on the part of the department except that they would receive full instruction through its agents. Other farmers who were willing to follow the methods as laid down by the department were enrolled as cooperators and instructions furnished them by mail. By the end of the year several hundred of these cotton-culture farms were established and several thousand cooperators enrolled. Supervision of the farms was exercised by the department's field agents, each agent covering a territory embracing from 8 to 15 counties.

During the years 1904 and 1905 the work was confined to Texas and Louisiana, but in 1906 it was carried into Arkansas and Oklahoma and inaugurated in Mississippi, Alabama, and Virginia, the plan being to carry it on in weevil-infested territory and in sections which the weevil was expected to reach within a year or two.

Realizing that the problem of meeting the ravages of the boll weevil embraced not only the growing of cotton, but also the question of making the farm self-supporting, the provisions of the act making appropriations were broadened for the work of the fiscal year 1906 so as to include diversification of crops and the improvement of crops by breeding and selection in the Southern States and subsequently to cover improved cultural methods and the study of cotton diseases, and the scope of the work was correspondingly broadened, demonstrations being made in the growing of corn, cow-peas, and other crops, and farmers encouraged to raise more and better live stock.

D. OF D.
DEC 19 1913

see, p. 20
The county unit plan of organization adopted in 1908 and followed at the present time was inaugurated in 1907, local or county agents being appointed in one or two counties where local cooperation in paying the salaries of the agents was volunteered. Under this county unit plan the county agent establishes and supervises demonstration farms in each county and enlists as cooperators all other farmers who agree to follow the department's instructions.

The boys' corn clubs, now such an important factor in southern agriculture, and the girls' canning clubs, which are supervised by the department and financed by the general education board, were organized in 1907 and 1910, respectively. These two organizations have proved potent forces in promoting better methods of farming, diversification of crops, and the production of home supplies—all necessary factors in adapting southern agriculture to boll-weevil conditions.

By the close of the fiscal year 1913 the boll-weevil work had been enlarged so as to include Texas, Oklahoma, Louisiana, Arkansas, Mississippi, Alabama, Tennessee, Florida, Georgia, South Carolina, North Carolina, Virginia, and a portion of Maryland, with a force of 932 agents and approximately 102,708 adult demonstrators and co-operators, 91,196 members of the boys' corn clubs, and 33,060 members of the girls' canning clubs.

The work begun in Mississippi, Alabama, and Virginia in 1906 was at first carried on under a cooperative arrangement with the general education board of New York, by the terms of which the board furnished the necessary funds, and the department supervised and controlled the work. Under similar arrangements the work was later taken up in the States farther east. The policy of the department in regard to the use of the Government appropriation and the appropriation by the general education board was to use the former for the work in the weevil infested and adjoining States and the latter for the work in the cotton-growing States more remote from weevil infestation. As a result of this policy the work at the end of the past fiscal year was carried on with Government funds in Texas, Oklahoma, Louisiana, Arkansas, Mississippi, Alabama, Tennessee, Florida, and south Georgia, and with the funds of the general education board in north Georgia, South Carolina, North Carolina, and a portion of Maryland, the amount being \$133,000.

The agricultural colleges and other educational forces in the States in which the work with boll weevil is in progress are in close cooperation with the department in carrying on demonstrations, and these, and the States, counties, boards of trade, agricultural associations, and private citizens contribute annually over \$200,000 toward maintaining the agents and otherwise promoting the work.

Work of the Office of Acclimatization and Adaptation of Crop Plants and Cotton Breeding Investigations.—As previously stated, the growing of early-maturing varieties of cotton is an important factor in controlling the boll weevil. With a view to meeting the urgent demand for such early-maturing varieties, which would at the same time produce large yields, large bolls, good length of staple, and other desirable characteristics, this branch inaugurated extensive breeding and selection experiments, establishing headquarters, with a well-equipped laboratory, at Waco, Tex. This work was begun in 1904 and continued until 1908. Through these experiments several valu-

able varieties, having desirable characteristics, were secured and the seed of these varieties was distributed to farmers, and now these early-maturing, large-yielding, and large-boll cottons have almost entirely superseded the inferior types formerly grown in the boll-weevil-infested territory.

This branch also studied cotton culture in weevil-infested districts in Mexico and Central America and discovered several new types of Upland cotton that afford partial protection against the weevil through specialized adaptive characters and habits of growth. As there had been no previous knowledge of the existence of such characters, the publication of these discoveries encouraged further investigation of the possibilities of utilizing them in the United States either by direct introduction of some of the best of the foreign types or by crossing with American Upland varieties. Some of the new tropical cottons behaved under their native conditions like early, productive Upland varieties, and yielded lint of excellent quality. Experimental plantings in Texas and other States showed that a period of acclimatization would be necessary before any final conclusion could be reached regarding the possibilities of the new types in the United States.

Since 1908 these investigations have been continued as a regular part of the investigations of this branch and are now yielding results of great practical importance. Four new types of cotton from Mexico and Guatemala have been acclimatized in the United States and are being improved by careful breeding of select strains. In addition to the specialized weevil resistant characters, the new varieties afford valuable combinations of characters everywhere recognized as most desirable for purposes of producing earliness, productiveness, large bolls, long fiber, and abundant lint.

One of these varieties, the Durango cotton from Mexico, has been widely distributed in the United States and received with much favor, and is coming to be recognized as the best early maturing variety of long staple Upland cotton now available. It is adapted to the widest range of natural conditions and is giving excellent results, even at the extremes of cotton culture in the Imperial Valley of California, at Norfolk, Va., and in the intervening regions. If its present promise is sustained this single variety will abundantly repay the entire cost of all the expenditures made by the department on account of the weevil investigations.

Another line of investigation suggested by facts learned in the study of the weevil-resisting adaptations of the cotton plant has led to the development of improved cultural methods of securing protection against weevil injury. These improvements are of two kinds, those that make it possible to grow in drier parts of the Southwest, where the climatic conditions are unfavorable for the propagation of the weevils, and those that make it possible to shorten the crop season. Such problems as the relation of drought to weevil resistance and the local adjustment of varieties to secure uniform behavior and large yields have been worked out. Several different factors have been found to contribute to earliness, which, as previously stated, is recognized as one of the most important means of avoiding weevil injury. At first it was supposed that earliness could be measured directly by dates of flowering and that only the early flowering varieties could be grown in weevil-infested regions, but experiments

have shown that the most effective form of earliness is the setting of the crop in the shortest period of time, and that big-bolled varieties can be used under weevil conditions.

A new application of great agricultural importance is based on the recognition of the fact that the cotton plant has two distinct kinds of branches. Experiments have shown that it is possible to control the habits of growth and secure increased earliness of the crop as well as larger yields by suppressing the vegetative branches, and methods of accomplishing these objects have been worked out. The results of experiments in different parts of the United States show that earlier crops and increased yields, in some cases to the extent of 50 per cent, are secured by the use of these improved methods.

Work of other branches of the bureau.—With the advent of the boll weevil practical means of controlling certain special diseases of cotton, particularly root rot and wilt, which cause great losses annually to growers, became an urgent necessity, and special studies and investigations of these diseases were therefore begun by the Office of Cotton and Truck Disease Investigations. This work was inaugurated in 1904 and continued until 1908. In the case of the root rot, careful laboratory investigations of the causative organisms and extensive field experiments were made with a view to securing immune cotton, determining the beneficial effect of the application of various chemicals, and discovering cultural methods of checking the disease. These investigations developed the fact that the only practical means of controlling the disease is through the practice of certain cultural methods, including deep fall plowing, thorough aeration of the soil, and rotation of crops.

Studies and investigations of wilt were carried on in Georgia and other Southern States, the primary object being to breed wilt-resistant cotton of both the upland and long-staple varieties. Tests of great numbers of varieties were made for wilt resistance, and, as a final result of the work, two strains of wilt-resistant upland cotton were bred and the seed widely distributed, and these varieties are rapidly replacing others in the infested districts.

The San Antonio Farm, consisting of 125 acres, leased from the city of San Antonio, Tex., and conducted by the Office of Western Irrigation Agriculture, was established in 1904 as a part of the campaign against the boll weevil. Various studies and experiments relating to the production of cotton and the control of the boll weevil under semiarid conditions were conducted on this farm. The work demonstrated that profitable crops of cotton could be produced with very low rainfall, and that under average conditions, with good methods of tillage, excellent crops of cotton could be produced in this section every year.

During the fiscal year 1908 the Office of Forage Crop Investigations carried on some work in the South with a view to encouraging the greater use of winter legumes, especially crimson clover and vetch, and also some experimental work in testing soy beans for hay and as a seed crop in the South.

With a view to awakening interest in better methods of farming and encouraging the introduction of new crops and different types of farming in the Southern States as a means of combating the ravages of the weevil, the Office of Farm Management organized and conducted from 30 to 50 diversification farms, most of which

were in the weevil-infested States of Texas, Arkansas, and Louisiana. This work was begun in 1904 and continued until 1908. The general plan pursued was to select the most successful farms of the type desired and arrange with the owner for general supervision for a detailed record for a period of years, and for the holding of farmers' institutes on the farm in cooperation with regular institute workers in the various States. The supervisor of the district visited the farms periodically and looked after the records, copies of which were furnished the Bureau of Plant Industry and the experiment station in the State where the farms were located. Each farm was devoted to a distinct type of farming, the principal types being truck farming, mixed farming, stock farming, dairying, hog raising, and beef production.

Much was expected from this work, but the results were disappointing, and the work was abandoned. It was found that no matter how well conducted these farms failed to accomplish the purpose for which they were organized, and that the single large demonstration or object-lesson farm exerts but little influence on the methods or farm practice of the farmers. Although the work failed in its primary object, much good resulted from it through the collection and dissemination of information regarding forage crops, winter cover crops, cropping systems, and better methods of farm management adapted to southern conditions, and the consequent promotion of crop diversification and introduction of new crops.

Publications.—Next in importance to the field demonstrations as a means of disseminating knowledge regarding the methods of combating the boll weevil and incidental information comes the publications issued as a result of the work and widely distributed in the cotton-growing sections. The following is a list of those issued by the various offices of the bureau mentioned in connection with this work:

OFFICE OF FARMERS' COOPERATIVE DEMONSTRATION WORK.

Circular No.—

- A-51. Field Instructions for Farmers' Cooperative Demonstration Work. February, 1908. Revised April, 1908.
- A-52. Farm Fertilizers. March, 1908. Revised March, 1910.
- A-58. Familiar Talks on Farming—Cultivation of the Crop. April 15, 1908.
- A-59. Farm Fertilizers. April, 1908.
- A-60. Familiar Talks on Farming—More Teams and Greater Economy. April, 1908.
- A-61. Familiar Talks on Farming—Cotton Crop under Boll Weevil Conditions. May 1, 1908.
- A-62. Familiar Talks on Farming—Diversification. June 30, 1908.
- A-63. Seed Selection for Southern Farms. July, 1908.
- A-64. Deep Fall Plowing and the Seed Bed. October, 1908.
- A-65. Farm Fertilizers. February, 1909. Revised March, 1910.
- A-66. Farm Notes. The Corn Crop. June, 1909.
- A-67. The Selection of Cotton and Corn Seed for Southern Farms. June, 1909.
- A-68. Fall Breaking and the Preparation of the Seed Bed. March, 1910.
- A-69. Field Instructions for Farmers' Cooperative Demonstration Work. January, 1912.
- A-70. Southern Farm Notes. The Corn Crop. March, 1910.
- A-71. The Production of Cotton under Boll Weevil Conditions. January, 1911. Revised June, 1911.
- A-72. Farm Fertilizers. January, 1911.
- A-73. Crops for Southern Farms. The Corn Crop. December, 1910.
- A-74. Demonstration Work: The Corn Clubs. Organization and Instruction. March 4, 1911. Revised April, 1912, and March, 1913.

Circular No.—Continued.

- A-75. Results of Boys' Demonstration Work in Corn Clubs (in 1910) (in 1911) April, 1911, and May, 1912.
- A-76. The Corn Crop. February, 1911.
- A-77. Farm Fertilizers. August, 1911.
- A-78. An Effective Method of Preventing the Erosion of Hill Lands. December, 1911.
- A-79. Girls' Demonstration Work: The Canning Clubs. January, 1912. Revised January, 1913.
- A-80. The Corn Crop in the Southern States. March, 1912.
- Field Instructions for Farmers' Cooperative Demonstration Work in Western Texas and Oklahoma. November, 1913.
- Bureau of Plant Industry Document No. 865. Results of Demonstration Work in Boys' and Girls' Clubs in 1912. November, 1913.
- Bureau of Plant Industry Circular No. 21. Farmers' Cooperative Demonstration Work in Its Relation to Rural Improvement. December, 1908.
- Office of Secretary Circular No. 30. Hog Raising in the South. September, 1909.
- Office of Secretary Circular No. 33. The Mission of Cooperative Demonstration Work in the South. November, 1910.
- Bureau of Plant Industry Document No. 756. Emergency Crops for Overflowed Lands in the Mississippi Valley. May, 1912.

OFFICE OF ACCLIMATIZATION AND ADAPTATION OF CROP PLANTS AND COTTON-BREEDING INVESTIGATIONS.

Bureau of Plant Industry:

Bulletin No.—

88. Weevil-Resisting Adaptations of the Cotton Plant. 1906.
159. Local Adjustment of Cotton Varieties. 1909.
220. Relation of Drought to Weevil Resistance in Cotton. 1911.
222. Arrangement of Parts in the Cotton Plant. 1911.

Circular No.—

66. Cotton Selection on the Farm by the Characters of the Stalks, Leaves, and Bolls. 1910.
96. Results of Cotton Experiments in 1912.
111. Durango Cotton in the Imperial Valley. 1913.
115. A New System of Cotton Culture. 1913.
118. The Abortion of Fruiting Branches in Cotton. 1913.
130. Cotton Problems in Louisiana. 1913.
132. Cotton Farming in the Southwest. 1913.

- Farmers' Bulletin No. 501. Cotton Improvement under Weevil Conditions. 1912.
- Yearbook Article on Cotton Improvement on a Community Basis. 1911.

OFFICE OF COTTON AND TRUCK DISEASE INVESTIGATIONS.

Farmers' Bulletin No.—:

302. Sea Island Cotton: Its Culture, Improvement, and Diseases. 1909.
333. Cotton Wilt. 1908.

OFFICE OF FARM MANAGEMENT.

Yearbook Article on Diversified Farming in the Cotton Belt. 1905.

Farmers' Bulletin No.—:

299. Diversified Farming under the Plantation System. 1907.
310. A Successful Alabama Diversification Farm. 1907.
519. An Example of Intensive Farming in the Cotton Belt. 1912.

RESULTS.

The following is a résumé of the principal results obtained from the work:

- (1) The confidence of the farmers in their ability to grow cotton profitably in spite of the boll weevil has been almost entirely restored.
- (2) Adoption of diversification of crops and improved farm methods, and in consequence a great increase in the production of corn, alfalfa, clovers, and grasses, and number of live stock raised, and largely increased crops.

(3) Boys' corn clubs and girls' canning clubs were organized and are now most important factors in promoting better methods of farming, diversification of crops, and production of better home supplies.

(4) There are now cooperating with the department in carrying on the work 102,708 demonstrators, 91,096 members of the boys' corn clubs, and 33,060 members of the girls' canning clubs; besides, agricultural colleges and educational institutions, cities, counties, boards of trade, agricultural associations, and private citizens cooperate.

(5) Demonstration work, which is believed to be the best plan ever devised for instruction of farmers and their families and for general promotion of better rural conditions, has become a great force in rural education.

(6) Early-maturing varieties, which produce large yields, large bolls, and good length of staple, etc., were originated through the breeding and selection experiments, and these have now almost entirely superseded inferior types formerly grown in boll-weevil infested territory.

(7) Four new types of cotton from Mexico and Guatemala having weevil-resistant characters have been acclimated in the United States and are being improved by careful breeding and selection. One of these varieties, the Durango from Mexico, is coming to be recognized as the best early-maturing variety of long staple Upland cotton.

(8) Development of improved cultural methods of securing protection against the weevil, which makes it possible to grow cotton in dryer parts of the Southwest and shorten the crop season.

(9) Discovery of the fact that the cotton plant has two distinct kinds of branches, so that it is possible to control the habits of growth and secure increased earliness and larger yields by suppressing the vegetative branches.

(10) Control of the root-rot disease through deep fall plowing, thorough aeration, and rotation of crops.

(11) Development of two strains of wilt-resistant Upland cotton and their wide adoption in weevil-infested districts.

(12) Demonstration of the fact that profitable crops of cotton can be grown with very low rainfall and under average conditions, and with good drainage methods excellent crops can be produced in the section about San Antonio, Tex.

Money expended by the Bureau of Plant Industry in investigations of the cotton boll weevil.

Fiscal year.	Amount.	Fiscal year.	Amount.
1934.....	\$27,316.04	1909-10.....	\$49,878.82
1905.....	102,078.26	1910.....	173,677.72
1906.....	95,823.81	1910-11.....	9,694.04
1907.....	105,048.82	1911.....	242,223.40
1907-8.....	39,999.63	1912.....	349,648.48
1908.....	112,206.10	1913.....	353,536.23
1908-9.....	9,976.31		
1909.....	94,292.33	Total.....	1,765,399.99

A REPORT OF THE WORK OF THE BUREAU OF ENTOMOLOGY ON THE MEXICAN COTTON BOLL WEEVIL, IN PURSUANCE OF HOUSE RESOLUTION NO. 254.

METHODS USED.

The Bureau of Entomology has investigated the habits of the Mexican cotton boll weevil to determine the manner in which the losses it causes may be reduced. These investigations have included every phase of the life history and habits of the insect, its control by parasites and insect enemies, and also the effects of climate and farm practices upon the abundance and injury of the species. The effects of climate are various. They cause the weevil problem to take on local phases. Thus there are actually a number of weevil problems instead of one. The different problems have been studied as the insect invaded new regions.

Work prior to 1900.—The Bureau of Entomology began to study the ravages of the boll weevil and its habits and control in 1894. There was no special appropriation for the purpose, but the bureau set aside a portion of the regular appropriation and obtained the services of Mr. C. H. T. Townsend, then of the New Mexican Agricultural Experiment Station, for an investigation extending over two months. In March, 1895, Mr. Townsend recommended the isolation of the cotton region of the United States from that in Mexico by a strip of territory along the Rio Grande River, in which no cotton should be produced. If this recommendation, which was urged upon the Texas Legislature by the then Assistant Secretary of Agriculture, had been carried out, the boll weevil would probably never have spread throughout the country. At this time the bureau made the first proposal of a quarantine against the Mexican seed. The principles involved in this latter recommendation were adopted after a number of years by most of the Southern States.

In 1895, still in the absence of special provision by Congress, the bureau sent entomologists to Texas to study the weevil, and especially to determine the extent to which it had spread. On account of other pressing work the attention given the weevil was very limited. During this early period of the weevil's attack the chief of the bureau, Dr. L. O. Howard, made frequent visits to the infested regions. In 1896 Dr. Howard recommended the appointment of county commissioners with power to enforce remedial work.

The Bureau of Entomology continued its investigations of the spread of the weevil during the fall of 1898. At this time the Legislature of the State of Texas made provision for the appointment of a State entomologist and provided a limited appropriation for an investigation of means of combating the boll weevil. In view of this fact the Bureau of Entomology discontinued temporarily the work that had been carried on through agents kept in the field almost constantly for four years, and all correspondence was referred to the State entomologist of Texas. Unfortunately, however, the insect continued to spread, and it soon became apparent that other States were threatened. This caused the work to be taken up anew by the Bureau of Entomology in 1901, in accordance with an appropriation for an investigation independent of that which was being carried on by the State of Texas and with special reference to possible means of preventing the insect from spreading into adjoining States. The amount provided was \$10,000.

Establishment of a laboratory at Victoria, Tex.—In accordance with the provision mentioned an entomologist was sent to Texas in March, 1901, and carried on investigations of the weevil upon eight large plantations in regions infested by the weevil. As a result of the first year's work Congress made a larger appropriation and provided for the establishment of a laboratory at Victoria, Tex. From 1902 until the end of 1904 the investigations of the boll weevil were conducted from the laboratory at Victoria, Tex. The force of investigators was increased to about 20 men in 1904. During this period an exhaustive investigation of the life history and the habits of the boll weevil was begun. This resulted in the perfection of the so-called cultural system of control. In 1902 arrangements were made with two large planters in typical situations for the testing of the principal features of the cultural system upon a large scale. The result of this year's work led to the establishment of seven experimental farms, aggregating 558 acres. These farms were established in several distinct cotton districts in Texas. They were primarily experimental in their nature, but served as demonstrations of successful methods of combating the weevil. In 1904 a still larger number of experimental farms were conducted.

During the fall of this year the Secretary of Agriculture, with several advisers, visited Texas to determine what could best be done by the department to meet more efficiently the crisis caused by the weevil. It was decided to enlarge greatly the demonstrational work which had been conducted successfully by the Bureau of Entomology and to add assistance to the planters by instructions in better methods of cropping. This was the beginning of the large scale work of the department.

During 1904 the Bureau of Entomology arranged a system of cooperation with the Crop Pest Commission of Louisiana, which was under the direction of Prof. H. A. Morgan. This cooperative work consisted, principally, of a detailed study of the methods of dispersion of the boll weevil and of all possible means of artificial distribution. As a result of the study of the movement of the weevil, in the fall of 1904 a system of very complete quarantine measures was developed and put into effect by the adoption of the bureau's recommendations by the various States.

Removal of laboratory to Dallas.—Owing to the extensive spread of the boll weevil in 1904, it was deemed advisable to remove the laboratory to Dallas, Tex. This was done in the spring of 1905. The work on the boll weevil was directed from this laboratory from that time until April, 1913. The principal projects in 1905 were as follows: A study of the number of generations at Dallas, Tex.; a study of the weevil's ability to locate a food supply in the spring; test of the possibility of the weevil to feed upon other food plants; demonstration of temperature influences by using incubator and ice box; observations upon the limits of emergence periods from hibernation; studies of the spring flight of weevils; progress of infestation; studies of fall dispersion; effects of the severe winter of 1904-5 upon the hibernation of weevils; studies in the possible adaptation of the weevil to new conditions; determination of the temperature fatal to weevil life in various stages; investigations of parasites of other weevils with a view of employing them against the boll weevil; studies of the plant proliferation against the boll weevil; collecting of bird stomachs in cotton

fields to ascertain what species of birds were feeding upon the weevil; tests of Reinlein's trap-row system; tests of check-row cultivation; determination of effect of plowing under infested squares; determination of proper spacing of plants for north Texas; tests of insecticides; studies of the proper methods of the fall treatment of the cotton plants; investigations of improvements in machinery for field and general use; photographic record of all experiments.

The same projects outlined in 1905 were conducted in 1906.

In 1907 the following projects were conducted: A thorough study of the hibernation of the boll weevil at Dallas, Calvert, and Victoria, Tex.; studies of the flight of the boll weevil; life history studies of the boll weevil in the Red River bottoms of Louisiana; studies of the dispersion of the weevil; an investigation of the adaptive capacities of the weevil to various climatic conditions and food supply; insecticide investigations; studies of parasites and ants in their relation to the boll weevil; a study of cultural practices in relation to the control of the weevil, including preparation of the soil, fertilization, planting of the seed, topping or spacing of plants, cultivation of the crop, destruction of the plants in the fall; check-row cultivation; topping of plants; investigation of the deterioration of land and seed values where cotton is allowed to remain unpicked long after maturity; the study of machinery for the control of the boll weevil; a statistical study of boll-weevil damage; a determination of the most advisable methods of avoiding or preventing serious weevil injury by arrangement of cotton plantings with special reference to hibernation shelter on account of previously infested area, etc., and by alternation or rotation of crops.

A thorough investigation was made of the biological relationships between the boll weevil and the cotton plant, including a study of the weevil-favoring and weevil-resisting qualities in cotton, the efficiency of weevil-resisting adaptations, and the ability of the weevil to circumvent them; comparison of plant types and fruit types, including bud, bolls and seed, lint length and pilosity, thickness of carpels, toughness of carpel linings, size and appression of bracts, thickness of floral envelopes, proliferation, density and persistency of foliage, retention or shedding of infested fruit, determinate character of growth, etc.

The work also included a study of the control of various insects, the work of which complicates the boll-weevil problem; a study of the factors causing local variation in weevil abundance and injury; an investigation of the possibility of utilizing cotton stalks for the manufacture of paper, alcohol, etc.; preparation of rules and regulations to be presented to State legislatures with the aim of preventing artificial dissemination of the weevil and minimizing damage necessarily suffered with an infested area.

In 1908 the work was particularly marked by the establishment of a laboratory at Tallulah, La. This was made necessary by the fact that conditions in the Delta are peculiar and the weevil injury heavier than elsewhere. During this year the following were the principal projects under way: Farm experiments at various points, including investigations of the proportion of land, fertilization, varieties, time and method of planting, and final treatment; the perfection of a chain-drag cultivator, planned to draw the infested squares to the middle of the rows; a complete study of the best methods of fall

destruction of plants; check-row experiments at Dallas, Tex.; studies of many forms of machinery planned to assist in the fight against the weevil; comparisons of early and late planting in new regions, especially at Alexandria, La.; experiments with poisons and proprietary insecticides; a very thorough investigation of the effects of climate upon the weevil; an attempt to utilize the knowledge gained concerning the natural enemies of the weevil by distribution of parasites; a continuation of the hibernation studies; examinations of the condition of infestation at two periods during the season in order to obtain an estimate of the possible amount of damage and the direction of dispersion (a great deal of good has been obtained from this type of investigation); a study of the influence of the weevils upon general economic conditions.

During the fiscal year 1910 most of the investigations already outlined were conducted. A great deal of stress was placed upon the work in Louisiana which was conducted at Tallulah and Mansura. Farm experiments were conducted at Mexia, Dallas, Wolfe City, and Refugio, Tex.; Ardmore, Okla.; Shreveport, Tallulah, Bayou Pierre, Alexandria, Mansura, and Ballina, La.

In the fiscal years 1911 and 1912 the greatest part of the boll-weevil work was conducted at Tallulah, La., where more thorough studies were made in the life history of the boll weevil for comparison with similar studies made in former years at Victoria and Dallas. A very complete series of experiments in the use of arsenate of lead against the boll weevil were conducted. Experiments were conducted to ascertain a better method of fall treatment than that of burning stalks. Very extensive experiments were conducted to ascertain the economic value of square picking and weevil picking.

In the spring of 1913 the headquarters of the boll weevil investigations were moved to Washington, D. C. Two agents were stationed at Victoria, Tex., for studies of the life history of the boll weevil to ascertain the changes in habits that have developed since the early investigations. The work in the delta regions of Louisiana was continued by a considerable force of agents with experimental farms in many sections of the Mississippi and Louisiana delta. The experimental work covered the use of poisons, control during hibernation, picking of weevils, and infested squares.

The announcement during the year of the finding of the boll weevil upon a wild plant growing in Arizona led to the stationing of an agent in the cotton sections of Arizona and lower California. The work of this agent was, unfortunately, interrupted by his serious illness and death. In the fall of 1913 an investigation made was of the habits of the weevil upon this native food plant in Arizona. This investigation was of considerable importance, as it indicated the possibility of an even greater adaptation on the part of the weevil than had ever been expected.

Testing of methods of control in the field.—In the various experiments which have been outlined above for the testing of control measures, the bureau has usually selected farms in various localities and made an agreement with the owner that the bureau should have complete direction of the methods to be used in the cultivation of the crop during the season of investigation. Farm experiments in this manner were arranged in advance at practically every typical locality

in the infested sections. The experiments were watched carefully by bureau agents from the beginning of the season until the picking of cotton. In most cases picking was personally supervised by agents of the bureau in order to obtain absolutely correct weights and correct statements of the cost of production. In experiments with insecticides, such as Paris green, arsenate of lead, and arsenate of iron, the bureau agents personally superintended the application of the poison, making a complete record of the cost of poison and labor, surveying the area treated, and finally superintending the picking of the crop. In this manner it was possible for the bureau to obtain the absolute cost of all processes in the treatment of the weevil, and to ascertain what processes could be carried on at a profit. The bureau has never recommended as a means of control of the weevil any process which would not give a net increase in yield after all costs had been deducted. All experiments have been thoroughly checked by other field of practically equal size and conditions.

The larger economic problems.—Each year the bureau has followed very closely a study of the boll weevil throughout the season, issuing statements and maps to all parties concerned. By this means the bureau has been able to warn sections in advance of the progress of the weevil as to the probable time at which they would be infested, and the probable damage during the succeeding season. For a number of years the bureau was able to make a thorough study of the status of the weevil in July and August, and to report to all State entomologists and the Secretary of Agriculture as to the exact condition of the weevil at each of these seasons. The maps which accompanied these status reports generally were of such a nature that they indicated the probable directions of flight, and also gave a fair basis of estimate as to the amount of damage to be expected from the weevil. The status examinations were discontinued in 1912 owing to a lack of sufficient funds. The work upon the dispersion of the weevil and the status examinations have been of considerable value in assisting the various States in uninfested regions to frame quarantine measures which would be of value in preventing the artificial spread of the weevil. A very thorough cooperation has been observed with all of the State entomologists in the cotton belt. Meetings have been held at various times to consider the best means of preventing the spread of the boll weevil by artificial means, and at these meetings the bureau and the State entomologists have always consulted the needs of the various industries concerned.

A great deal of statistical work has been done to ascertain the amount of damage done to the cotton crop by the boll weevil. The most thorough investigation of the damage done by the weevil was made during the summer of 1913. In these studies it was found that the loss in yield per acre during the years of infestation by the weevil as compared with years in which the weevil had not been present, amounted to a total of over \$800,000,000. Since the boll weevil is the only pest of any importance which has damaged the cotton during the years of its infestation, and which was not present in the earlier years, it is considered that any decrease in average yield for a period of years can be attributed directly to the boll weevil. The statistics show an actual loss in the production per acre of the land which is in cotton.

RESULTS.

Formulation of cultural method of control.—As has already been stated, a system of cultural control was developed from studies of the life history and habits of the weevil. Every phase in the so-called cultural system of control is based upon some particular phase of the life history of the insect. Each recommendation in the system has been made after a thorough testing on many farms and in many places. It has been the policy of the Bureau of Entomology never to recommend any particular method of control until it has been tested for at least three years, it being considered that a method tested through three years, if proving successful, can safely be recommended in following years.

Briefly, the system consists of a preparation of the fields during the winter by plowing, and the destruction of weeds and undergrowth; the planting of an early crop with an early maturing variety; the thorough and intensive cultivation of this crop throughout the season; the hand-picking of weevils and infested squares when the infestation is great; the early picking of the matured crop; the destruction of the plants to prevent breeding in the field and winter; rotation of crops.

In addition to the methods of cultural control mentioned, two others of considerable value should be mentioned. There are circumstances under which poisoning with arsenate of lead can be done successfully. The prevention of the movement of the boll weevil by means of quarantine is also one of the principal methods of repression.

The basis for the first step in control, namely, winter preparation of the fields, is the fact that many weevils are known to hibernate in old cotton bolls, behind the shucks of corn, under clods, in piles of manure, or grass or weeds, under bark and stone. The clean cultivation of the field and its preparation for the spring is instrumental in destroying many stages of the weevil. Many farms have been observed during the years of investigation where this method has been carried out and other farms where it has not. Even the casual observer would be able to recognize the difference in the infestation of the fields, this always being in favor of the farmer who keeps his land clean over winter.

The next step in the cultural system is known as early planting. There has been much discussion of this phase of the boll weevil control system, and many opponents of the bureau's method have appeared from time to time. By early planting the bureau means the planting at a reasonable time to prevent the average killing frost from doing damage to the crop, and yet early enough to secure the earliest possible crop. The farmers in each section are recommended to study the average date of killing frost in their section, and to plant their crop at such a time as to reasonably avoid damage. The bureau includes in this portion of the system a selection of varieties which mature early, which have little foliage, which are determinate in growth and yet prolific in production. Early planting also means the use of fertilizers to hasten the crop.

Owing to the many objections raised to the early planting system, experiments have been conducted at a number of places to prove definitely whether cotton should be planted early or late. These

experiments were conducted at points in Texas and in southern Louisiana, principally Alexandria and Bunkie. Observations were also made on many farms where a comparison could be obtained between the early crops and late crops. There are several reasons why it is necessary to plant moderately early. In the first place, early planting enables the cotton to make a considerable growth before a majority of the weevils have emerged from hibernation. In the second place, the early crops of cotton mature before the usual fall dispersion of the weevil. Late crops, on the other hand, are not up until practically all of the hibernating weevils are present in the fields. These crops are then hampered by an excess of insect attack from the very beginning of their squaring period. When the usual fall dispersion commences, with its flights of multitudes of weevils, the late crops are still in a tender condition and soon are devastated by the swarming weevils.

The bureau has found that each typical section infested by the weevil requires a different variety of cotton for successful production in the presence of the weevil. The following varieties have given the greatest success in various localities: Cleveland Big Boll, Cook's Improved, Improved Triumph, Mebane Triumph, King's Improved, Rowden, Rublee, Foster, and Blanchard. Several other varieties have given indications of success in certain localities, but the tests of these have not been carried out very extensively.

The next phase in the system is known as thorough cultivation. One of the most important phases of thorough cultivation in many sections is known as check-row planting. In some sections this portion of the system involves general drainage, such as the use of tiles, or, on the other hand, the use of irrigation water to assist in the cultivation. The crop should be worked thoroughly, and where possible the ground should be kept in a pulverized condition. The method of cultivation varies greatly with different sections. The distance between the rows and the distance between the plants are also matters which have to be worked out in each particular section. These are points, however, which have been found to be of considerable importance in the boll-weevil problem. It has been found in the investigations of the bureau that the average farmer lays by his crop too early in the fall. With the boll weevil present the crop should not be laid by until the cotton is ready to be picked. This thorough cultivation is of great assistance in destroying the weevils in infested forms upon the ground.

In order to bring about a more perfect system of cultivation in the dryer sections the bureau perfected a machine known as "chain drag." This consisted principally of two sets of chains to be dragged through the field in such a manner as to cause the infested material on the ground to be drawn to the middle of the rows. It has been found that the control by the sun is much greater in the middle of the rows than under the plants. Although the bureau perfected this machine and succeeded in having one of the manufacturing companies place it upon the market, it is quite unnecessary for the average farmer to purchase a special machine of this type. If the farmer understands the principle of the chain-drag cultivation and possesses an ordinary disk cultivator or harrow, he can remove the disks or harrow teeth and place the chains upon this framework.

Many tests have been conducted to demonstrate the various details of the thorough cultivation part of the system. In order to prove that the cultivation of the crop is stopped too soon by the average planter, experiments have been conducted from time to time using certain fields for a thorough cultivation to the end of the season, and checking these by fields in which the usual method was practiced. The results have always been in favor of the more thorough cultivation.

The final phase in the cultural system is the fall treatment. The basis for the entire recommendation for fall treatment lies in the fact that the earlier the weevils are deprived of food in the field the fewer are able to pass through the winter. For a number of years the bureau has recommended very strongly the early picking of the crop and the destruction of the plants by burning. There is naturally some opposition to this recommendation on account of the loss of fertilizing elements. One of the principal lines of future work that should be undertaken is the perfection of some means of control which would remove the objection mentioned.

Many observations have been made upon the value of rotation of crops. It has been found that where farmers use proper methods of rotation the infestation by the boll weevil is considerably reduced, even in heavily infested sections.

Square picking and weevil picking can not be considered as a part of the cultural system of control, but these measures are found to be of importance in heavily infested sections. Within the last three years conditions have arisen in the delta regions of Mississippi and Louisiana where the infestation was so great and the labor so cheap that this has become a very practical means of controlling the weevil. The tests carried out by the bureau have been exceedingly thorough. They took place on many plantations in Louisiana. An accurate account has been made of the actual cost of picking the squares, and this cost has been deducted from the yield in order to obtain the net results. The square-picking tests in Louisiana have shown an average profit of over \$3 per acre when compared with the check plots under observation at the same time.

In the early years of the boll-weevil investigation much stress was placed upon the use of Paris green and London purple against the boll weevil. It was later found that the high expense of these poisons and their great toxicity to the cotton plant rendered their use inadvisable. More recently the entomologist of Louisiana found that he obtained a measure of success by using powdered arsenate of lead applied by a dust gun. The results, as published by the Louisiana State entomologist, were so striking that the Bureau of Entomology employed the agent who had conducted the Louisiana experiments and had him follow up these experiments by even a larger series for the next four years. During these six years of experimentation with dry poisons applied by dust guns, the bureau and the State of Louisiana have succeeded in obtaining an average net profit of over \$3 per acre. The limitations of the use of the poison have been worked out, and it is now possible to recommend advisedly the use of powdered arsenate of lead in the spring, when the weevils are very numerous. The number of applications should not exceed four and the time intervals should not exceed seven days. The poison should be

applied by a powerful dust gun. The bureau has also found that similar success can be obtained with the use of powdered arsenate of iron, which is even cheaper than the arsenate of lead.

The studies of the dispersion of the boll weevil and the advice based thereon have been largely instrumental in preventing any artificial spread of the weevil, with the exception of a very few cases. The result is that the spread of the weevil has been very regular on all sides of the line and that there have been no important sporadic outbreaks in new sections.

Demonstration of futility of proposed remedies.—A large part of the work of the bureau has been the investigation of proposed remedies. The majority of remedies suggested by various people have been quite futile. The bureau has been able, through this portion of its work, to save the public large sums of money.

Probably more serious injury to planters has been brought about by the advocates of late planting than any other method ever proposed against the weevil. Whole plantings have been absolutely destroyed by the weevil where the farmers have followed the advice of late-planting advocates. This is especially true in Louisiana in the vicinity of Alexandria. Advocates of the use of Paris green in a powdered form secured large sums of money from the planters in Louisiana for several years. Early in the investigations the use of trap lanterns was recommended, and large sums of money were paid by planters for patented lanterns.

Among the other miscellaneous remedies which have been suggested are the use of mineral paint as a specific against the weevil; of cotton-seed meal to attract the weevils; of pastes and various formulas to be used in the fields to trap the weevils; of soaking the seed in sulphur in order to force the sulphur into the system of the plants to make them immune to attack; the planting of tobacco plants, castor bean plants, and pepper plants in order to repel the weevils; or the use of X-ray machines to sterilize the weevils, and of electrocuting the weevils by passing heavy currents of electricity through the fields.

Publications.—The principal manner in which the bureau has been able to reach the public has been through its publications. Three large and comprehensive bulletins upon the entire subject of the boll weevil's life history and control have been published. These are known as Bulletins Nos. 45 and 57 of the Bureau of Entomology and Senate Document No. 305, Sixty-second Congress, second session. Farmers' bulletins and circulars have been issued almost every year, covering some particular phase of weevil control. The most important of these is Farmers' Bulletin No. 512. In this publication the system of cultural control is given a very thorough treatment. Bulletins upon several special phases of the problem have been issued from time to time. The principal bulletins dealing with the natural control of the weevil are Bulletins Nos. 73, 74, and 100 of the Bureau of Entomology. Bulletin No. 77 of the bureau is a very thorough treatise upon the hibernation of the weevil. It has been the custom of the bureau to publish each year a short circular, accompanied by a map, giving the distribution of the weevil up to the end of the growing season. The last circular of this class is No. 167.

In addition to these published bulletins, it has been the practice of the bureau for several years to mail mimeographed monthly statements of the condition of the pest to State and Federal officials.

Money expended by Bureau of Entomology in investigation of cotton boll weevil.

Fiscal year.	Amount.	Fiscal year.	Amount.
1903.....	\$8,000.00	1910.....	\$26,745.14
1904.....	11,734.49	1911.....	27,470.97
1905.....	63,213.97	1912.....	22,639.35
1906.....	59,043.49	1913.....	25,557.93
1907.....	64,682.78		
1908.....	38,243.00	Total.....	368,551.81
1909.....	21,220.69		

Of this amount approximately 20 per cent was expended in purely routine operations, such as determining the extent of the spread from year to year and in the testing of proposed remedies.

The total amount expended from 1903 to 1913 is less than 2 per cent of the loss caused by the boll weevil in any one of the years mentioned.

REPORT OF THE WORK ON HOG CHOLERA BY THE UNITED STATES DEPARTMENT OF AGRICULTURE FROM 1878 TO 1913.

The investigations of hog cholera by the Department of Agriculture extend over a period of 35 years, beginning in 1878. For convenience of consideration these investigations may be divided into three periods, as follows:

First period (1878-1885).—Fundamental studies concerning nature and cause of swine diseases.

Second period (1886-1903).—Immunity studies in the laboratory and field.

Third period (1904-1913).—Renewed investigations concerning the cause of hog cholera, culminating in the discovery of a successful serum treatment.

The work during the first two periods, while indispensable in determining the distribution and general characteristics of important swine diseases, has now become largely obsolete in view of the discoveries made during the last 10 years; therefore only the general nature of that work together with a statement of the results secured will be considered, while a more detailed report of the work of recent years is submitted.

FIRST PERIOD (1878-1885).

Prior to the year 1878, the department had no funds available for the study of contagious diseases of animals. On June 20, 1878, however, the sum of \$10,000 was appropriated for "investigating diseases of swine, and infectious and contagious diseases to which all other classes of domestic animals are subject." With the funds thus appropriated the Commissioner of Agriculture employed a number of scientists to investigate and classify the diseases of swine, the appropriation being renewed from year to year, although a considerable proportion of the available funds was used in the study of other animal diseases.

With regard to the work done and the results secured during the period from 1878 to 1885, it will suffice to say that laboratories were established in the department, the Bureau of Animal Industry was organized, and a comprehensive study of swine diseases was carried out. This early work consisted for the most part in studies of the distribution, classification, and mode of transmission of swine diseases, supplemented by laboratory investigations, which were intended to discover the cause or causes of those diseases. These investigations established the fact that one or more plagues of swine existed in practically all sections of the country. They showed further that those plagues were contagious, and led to the suggestion of quarantine and disinfection for preventing their spread. Coincidentally with the field observations rapid progress was made in the laboratory investigations and in the year 1885 announcement was made by the department that one of the great causes of losses among swine was a contagious disease designated "hog cholera," caused by a motile bacterium, which was named the "hog cholera bacillus." These fundamental researches received general confirmation from other institutions.

The first period of the department's researches culminated, therefore, in the establishment of the fact that at least a great proportion of the losses of swine was due to hog cholera and in the reported discovery of the micro-organism which caused that disease.

SECOND PERIOD (1886-1903).

Immediately following the discovery of the supposed cause of hog cholera the Bureau of Animal Industry began a long series of investigations which had for their object the development of a method of treatment or vaccination that would cure or prevent hog cholera. These investigations were all based upon the belief that the hog cholera bacillus was the cause of hog cholera, therefore that micro-organism was used for the production of vaccines and serums.

None of these experiments met with success, although at times the results in the laboratory were such as to encourage the belief that the problem had been solved. This was particularly true of a series of experiments in which large animals such as horses, cattle, and donkeys were inoculated with the hog cholera bacillus and its products. The object of these experiments was to cause the development of an antitoxin in the blood of the horses, cattle, or donkeys so that their blood serum might be used to cure or prevent hog cholera.

The serum thus produced was considered to be of such promise that in the year 1897 a series of field experiments was begun and carried out on a fairly large scale during the years 1898, 1899, 1900, and 1901. Though apparently yielding a certain measure of success, this serum was finally proved to be unsatisfactory for practical use.

The uniform failure to produce an effective vaccine or serum when taken in consideration with the fact that the natural disease, hog cholera, is always followed by complete immunity in recovered hogs led to the suspicion that possibly after all the true cause of hog cholera was not understood.

This suggested possibility that the hog-cholera bacillus was not the only factor involved in the disease gave rise to a series of experiments which resulted, in the year 1903, in the discovery that there existed

in the State of Iowa a fatal disease of hogs, indistinguishable in its characteristics from hog cholera, which was not caused by the hog-cholera bacillus but by an invisible microorganism which existed in the blood and other body fluids of sick hogs. This invisible microorganism is either so minute or else of such structure that it can not be discerned by the highest powers of the microscope, nor is it restrained by porcelain or earthen filters, which effectually prevent the passage of all visible bacteria.

THIRD PERIOD (1904-1913).

The discovery that there existed in the State of Iowa a fatal disease among hogs caused by an invisible microorganism and not by the so-called hog-cholera bacillus naturally suggested the idea that this invisible microorganism was concerned in all outbreaks of hog cholera and that the lack of success of earlier attempts to produce an effective vaccine or serum was due to a failure to recognize the presence of the invisible microorganism as a factor in the causation of the disease. Practically the entire year 1904 was therefore devoted to experiments which had for their object the determination of (1) the true cause of hog cholera; (2) the relationship of the hog-cholera bacillus to hog cholera; (3) the extent of the distribution of the disease found in Iowa and caused by the invisible virus. These experiments were exhaustive and led to conclusions of far-reaching importance.

It appears sufficient for the purposes of this report to record here merely the results of these investigations, the details of the experimental work being given in Bureau of Animal Industry Bulletin No. 72, which is attached hereto and marked "Exhibit A."¹

The results of the investigations of 1904 may be summarized as follows:

1. Hog cholera is caused by an invisible microorganism which exists in the blood and other body fluids of sick hogs.
2. The so-called "hog-cholera bacillus" is not the cause of hog cholera and at the most is merely an accessory factor in the disease.
3. Hogs that recover from hog cholera are thereafter immune. Hogs that recover from artificial infection with the invisible virus are rendered immune against the natural disease, whereas infection with the hog-cholera bacillus does not confer immunity against hog cholera.

The importance of these investigations can not be overestimated, for they at once indicated the cause of the earlier failures to produce effective vaccines and serums, and pointed the way for new experiments looking toward the development of reliable methods of prevention and control. The conclusions reached as a result of these experiments have been entirely confirmed by investigators in Germany, France, England, Austria-Hungary, and other countries where hog cholera exists.

In the year 1905 experiments which had for their object the development of a protective serum against hog cholera were begun. Even before this time suggestions had been made looking to the utilization of hogs themselves as a source of a protective serum, and efforts had been made to prepare a vaccine by using diseased blood which had been subjected to heat and to the action of various chemi-

¹ Not furnished.

cals for the purpose of attenuation. Toward the close of the year 1905 it was demonstrated conclusively that hogs can be protected from hog cholera by the following method:

A hog which is immune against hog cholera, either naturally or as a result of an attack of the disease, is injected with large amounts of blood taken from a pig sick of hog cholera. This injection when properly perfumed does no material harm to the immune. Within a week or 10 days blood is drawn from the immune hog, and this blood, after defibrination, is used to protect susceptible pigs. Only a few tests were possible in the year 1905, but the results of the experiments were so favorable that they were continued and extended into 1906. With the satisfactory progress of this method of protecting hogs from hog cholera, it appeared desirable to insure that the people of the country should have secured to them the free use of the method developed in the department's laboratories. Therefore an application for patent was made and granted by the United States Patent Office giving to the Government, or any of its officers or employees in the prosecution of work for the Government, or to any person in the United States, the right to use this method without the payment of any royalty thereon. The experiments carried out in the years 1905 and 1906 are all recorded in detail in Bulletin No. 102 of the Bureau of Animal Industry, a copy of which is attached to this report and marked, "Exhibit B."¹

The facts brought out by these experiments are, briefly, as follows:

1. When hogs immune against hog cholera are injected with suitable amounts of blood taken from hogs sick of hog cholera, the blood serum of the immune acquires the power to protect nonimmune hogs against an otherwise fatal exposure to the disease. This process of producing serum is known as "hyperimmunization."

2. The serum from hyperimmunized hogs may be used to protect susceptible hogs in one of two ways: (a) The serum alone is injected. This confers an immunity lasting from three weeks to two months. (b) The serum is injected simultaneously with a minute amount of blood taken from a hog sick of hog cholera. This is known as the "simultaneous method," and it produces an immunity which lasts for many months, if not for life.

3. The serum is essentially a preventive. It does not cure hogs already visibly sick, but it may be used successfully as a cure if administered in the very early stages of the disease.

Up to the year 1907 the work with this new serum was conducted entirely on hogs kept in experimental pens on premises controlled by the department. The results of the tests were so uniformly favorable that arrangements were made to test the effect of the serum when used under field conditions. Therefore a considerable quantity of serum was prepared and applied to approximately 2,000 hogs on 47 different farms in central Iowa. The method of carrying out these practical tests and the results, were briefly as follows:

Class 1.—Healthy herds treated for the purpose of protection against hog cholera which existed on nearby farms. In each herd a certain number of hogs were not treated, but were left to serve as controls. In most of the herds in this class the disease did not appear in either the treated hogs or the controls. In a few of these

¹ Not furnished.

herds, however, hog cholera appeared, some weeks after vaccination, among the controls, the average loss being 68 per cent of the untreated controls, while of the treated hogs in the same herd associating with the sick control animals, none died.

Class 2.—Herds which had been exposed to disease through the entrance of a sick hog from a neighboring diseased herd, but at the time of treatment were apparently well. In these exposed herds 4 per cent of the treated hogs died, while more than 89 per cent of the untreated control animals succumbed.

Class 3.—Herds in which hog cholera existed at the time of treatment. In these herds the effort was made to treat only those herds where disease had not progressed very far, as past experience had shown that the serum was essentially a protective agent rather than a cure. As a general rule, this third class of herds contained comparatively few visibly sick hogs, but yet a sufficient number to show clearly that hog cholera was present, this being confirmed by post-mortem examination in each case. In these sick herds 13 per cent of those that received the serum were lost, whereas of the untreated control animals, 75 per cent died.

The success of these practical tests, following the uniformly good results obtained in the previous experimental work, was sufficient to show that in this new serum the department possessed a substance which could be utilized to reduce, if not ultimately to entirely eliminate, losses from hog cholera. Therefore a notice of the department's findings was sent to each of the States of the Union, inviting these States to send a representative to the small experimental farm maintained by the department in Iowa in order that such representatives might observe the methods of serum production in actual operation and have explained to them the exact methods of application. Representatives of 25 States responded to this suggestion for a conference and had explained to them the departmental methods. These conferences with State officers were carried out during the year 1908. Since that time the department has continued its investigations uninterruptedly, the work being directed along two lines, namely, (1) laboratory investigations and (2) field demonstrations.

The recent laboratory investigations have resulted in the cheapening of the serum by the development of the intravenous method of hyperimmunization. The serum is now being produced at a cost of 1 cent per cubic centimeter, or from 15 to 40 cents for each hog. It has further been determined that the common disinfectants, such as carbolic acid and bichloride of mercury, are not effective against the virus of hog cholera. A cheap and effective disinfectant has been found, however, in the compound solution of cresol. The fact that the virus is resistant to carbolic acid is now being utilized to preserve virus for simultaneous inoculations in practice, as first suggested by the department, the addition of a small proportion of carbolic acid to virulent blood having the effect of preserving the blood from decomposition without affecting its virulence. The laboratory investigations are being continued, the principal objects aimed at being the further improvement of the process of serum production and the artificial cultivation of the virus of hog cholera.

Prior to the present fiscal year the field demonstrations have been few in number and restricted in extent owing to a lack of funds. The last Congress appropriated the sum of \$75,000 to enable the

Secretary of Agriculture to demonstrate the best methods of controlling and eradicating hog cholera. Although this appropriation became available on July 1, 1913, much unavoidable delay was experienced in instituting the actual work and in getting the demonstrations organized in an orderly manner. It was necessary in the first place to largely increase the capacity of the serum-producing plant of the department, and it was furthermore necessary to place a force of inspectors in each of the field areas where the experiments were to be carried out. The organization of the farmers in each area, which is one of the prime essentials to success, has taken much time, and it is only now, about four months after the actual beginning of the work, that the experimental areas are so organized as to permit of the most efficient work being done.

While the delay incident to the inauguration of the work has been considerable, this preliminary work has placed the department in a position where it should be able to successfully cope with the disease during the ensuing fiscal year, if this work is continued by Congress.

The following plan of carrying out these demonstration experiments has been adopted and the work inaugurated in four States, namely, Iowa, Missouri, Indiana, and Nebraska. The work in Nebraska is only just begun. The work in Iowa and Indiana began on July 1, and in Missouri about August 1.

PLAN FOR DEMONSTRATING THE BEST METHODS OF CONTROLLING HOG CHOLERA.

METHOD OF PROCEDURE.

I. Educational work: To be carried out jointly by Federal and State officials through lectures and demonstrations before farmers' clubs and special assemblages.

II. Restrictive regulations and quarantine: Restrictive regulations should be issued by State authorities and enforced by State officers and United States employees deputized for the purpose.

III. Immunization with serum: This work is to be under control of employees of the Bureau of Animal Industry, and serum is to be administered at such places and in such manner as they may decide to be necessary.

IV. Serum production: Antihog-cholera serum sufficient for the work to be prepared by the Bureau of Animal Industry and furnished to the United States field inspectors upon request.

ORGANIZATION.

I. Administrative: The general administration of the work to be under the general direction of the Chief of the Bureau of Animal Industry, United States Department of Agriculture.

II. United States Department of Agriculture: (a) Field force—one supervising field inspector and advisor, the force in each State to be an independent unit reporting direct to the Chief of the Bureau of Animal Industry and is to consist of one inspector in charge, one or more veterinary inspectors, and one clerk; (b) laboratory force—one inspector in charge with the necessary scientific assistants, clerks, and laborers to prepare sufficient serum to supply the various field inspectors.

III. Nondepartmental: (a) State officials—as many trained employees as the State can furnish for field work and lectures; (b) volunteer assistants—as many intelligent farmers as can be secured for general cooperation to be chosen jointly by the United States field inspectors in charge and authorized State representatives.

COOPERATION.

Generally the following principles are to be observed:

1. The preparation and application of serum will be under control of Federal officials.
2. Necessary quarantine and other restrictive measures to be under control of the proper State officials.
3. Educational work to be carried out jointly by Federal, State, and county representatives.

The practical results of the department's investigations are best shown by the fact that the protective serum described herein is now recognized, not alone in the United States but in foreign countries as well, as the only effective means of preventing hog cholera.

Thirty of our States are engaged in the preparation and distribution of the serum to farmers, and millions of hogs have been successfully treated. It is to be regretted that reports from all States that are distributing this serum are not available at this time; nevertheless an idea of the saving which has already been effected through the use of this serum may be gained from statements recently made by officers of three States engaged in the production and distribution of the antihog-cholera serum.

(1) A recent letter from the professor of veterinary science, Kansas Agricultural College, who is in charge of hog-cholera-serum production in the State of Kansas, contains the following statements:

I estimate that the average dose has been in the neighborhood of 30 cubic centimeters per hog, which gives as a result approximately 275,000 head of hogs vaccinated by the simultaneous method and 275,000 vaccinated with the serum alone. I estimate that under the conditions and the general infection of this State a conservative estimate of the number of hogs saved through vaccination would be at least half of the number vaccinated, or 275,000. This is certainly a conservative estimate.

Estimating the value of these hogs at \$10 each, there is indicated a saving to the farmers of Kansas of about \$2,750,000.

(2) The State veterinarian of Ohio writes as follows:

It is my opinion that at least 50 per cent of the animals in infected herds were saved by the serum, and I believe, further, that this is a very low estimate. Taking this as a basis, then, we have the following: Of the total number of swine treated to date (313,000) 72 per cent, or 225,360 swine, were in infected herds. It is reasonable to assume that at least two-thirds of these would have died from the effects of disease had they not been treated with serum. In other words, there would have been a loss of 150,240 swine with an average value of at least \$10, or \$1,502,400. This does not take into account the healthy herds which were treated, nor does it take into account the extra value of the large per cent of pure-bred or registered herds.

(3) The following statement is taken from the report of the college of agriculture and the agricultural experiment station of the University of California from July 1, 1912, to June 30, 1913:

A conservative estimate of the number of hogs saved by the antihog-cholera serum is 30,000 head. The cost of the serum to farmers, in addition to that distributed free as provided by law, has been about \$33,000. Estimating the average value of a hog in California at \$9.20, the protection provided these 30,000 hogs has meant a saving to

the ranchers of at least \$240,000. This does not include the profits resulting from the breeding and profitable feeding of the hogs saved.

If in all cases the serum had been used as the station recommends—that is, before the disease had gained entrance to the herds—then 99 per cent of all hogs owned by these farmers would probably have lived instead of only 50 per cent of the untreated hogs and 91.3 per cent of the treated; that is, about \$350,000 would have been saved in addition to the \$240,000 mentioned above.

The above instances are submitted not as exceptions but as examples of what is being accomplished through the use of this serum.

The great problem now before the department and the States is the utilization of the serum in such a way as to effectively control the disease.

STATEMENT OF THE MONEY EXPENDED BY THE UNITED STATES DEPARTMENT OF AGRICULTURE IN THE STUDY OF HOG CHOLERA.

Prior to the fiscal year 1887, the expenditures of the Bureau of Animal Industry were not classified in detail, or, if kept in detail at that time, the records are not now to be found. It appears, further, that although the records for the years 1887, 1888, 1895, 1896, and 1897 show expenditures for various lines of work, there is nothing to indicate the amount of money, if any, expended on hog cholera during those years.

1887.....	(¹)	1901.....	\$14,333.39
1888.....	(¹)	1902.....	9,751.26
1889.....	\$14,844.71	1903.....	8,411.32
1890.....	5,543.68	1904.....	8,345.12
1891.....	6,897.20	1905.....	5,920.20
1892.....	6,916.38	1906.....	4,597.63
1893.....	5,774.13	1907.....	7,567.86
1894.....	5,023.05	1908.....	10,061.99
1895.....	(¹)	1909.....	5,308.76
1896.....	(¹)	1910.....	10,339.82
1897.....	(¹)	1911.....	12,219.40
1898.....	17,123.54	1912.....	12,005.60
1899.....	17,787.29	1913.....	13,198.06
1900.....	27,647.91		

The above statement shows that the sum of \$229,418.30 has been expended by the department from 1889 to 1913, inclusive. From 1904 to 1913 the sum of \$89,564.32 was expended, thus indicating an average expenditure on hog cholera for the last 10 years of \$8,956.43.

¹ Not segregated.



Makers
Syracuse, N. Y.

PAT. JAN. 21: 1908

LIBRARY OF CONGRESS



00008884092

