Ag 8333
1.921

THIRTY-FOURTH ANNUAL REPORT

OF THE

SOUTH CAROLINA EXPERIMENT STATION

OF

Clemson Agricultural College

H. W. BARRE, Director

For the Year Ended June 30, 1921

Clemson College, S. C. December, 1921.

S. C. STATE LIBRARY
SEP 2 1981
STATE DOCUMENTS

THIRTY-FOURTH ANNUAL REPORT

OF THE

SOUTH CAROLINA EXPERIMENT STATION

OF

Clemson Agricultural College

H. W. BARRE, Director

For the Year Ended June 30, 1921

Clemson College, S. C. December, 1921.

CLEMSON AGRICULTURAL COLLEGE.

W. M. RIGGS, PRESIDENT.

SOUTH CAROLINA EXPERIMENT STATION.

BOARD OF CONTROL.

HON. J. E. WANNAMAKER HON. H. C. TILLMAN

HON. ALAN JOHNSTONE HON. R. I. MANNING

HON. A. F. LEVER.

EXPERIMENT STATION STAFF

H. W. BARRE, A. M., Botanist and Director.
C. C. NEWMAN, B. S., Horticulturist.
A. F. CONRADI, M. S., Entomologist.
R. O. FEELEY, D. V. S., Consulting Veterinarian.
C. P. BLACKWELL, M. S., Agronomist.
A. B. BRYAN, B. S., B. Litt., Agricultural Editor.
L. V. STARKEY, M. S., Animal Husbandman.
J. P. LaMASTER, B. S. Agr., Dairyman.
R. N. BRACKETT, Ph. D., Chemist.
C. S. PATRICK, B. S., Supt of Experiment Station Farms.
W. L. LIPPINCOTT, B. Chem., Chemist.
C. A. LUDWIG, Ph. D., Associate Botanist and Plant Pathologist.
W. B. AULL, B. S., Associate Bacteriologist.
GILBEART H. COLLINGS, M. S., Assistant Agronomist.
H. S. McCONNELL, M. S., Research Assistant Entomologist.
T. S. BUIE, B. S., Assistant Agronomist.
A. M. MUSSER, M. S., Associate Horticulturist.
W. D. SALMON, M. S., Assistant Animal Husbandman.
G. H. AULL, B. S., Assistant to the Director.
I. R. JONES, M. S., Assistant Dairyman.
W. B. ROGERS, B. S., Assistant Agronomist.
R. E. CURRIN, Supt. of Pee Dee Expt. Station, Florence, S. C.
J. A. RILEY. M. S., Supt. of Coast Expt. Station, Summerville, S. C.
E. D. KYZER, B. S., Research Assistant.
BURNS GILLISON, Foreman of Experiment Station Farm.

Mail and Telegraph Offices: Clemson College, S. C.

Freight and Express Offices: Calhoun, S. C.

The Bulletins and Circulars of the Station are issued at irregular intervals and are sent free to all citizens of the state who apply for them.

LETTERS OF TRANSMITTAL.

Clemson College, S. C., December 1, 1921.

Dr. W. M. Riggs, President.

Dear Sir:—I have the honor to submit herewith the Thirty-fourth Annual Report of the South Carolina Experiment Station for the fiscal year ended June 30, 1921.

Very truly yours,
H. W. BARRE,
Director.

Clemson College, S. C., December 1, 1921.

Hon. Alan Johnstone, President Board of Trustees, The Clemson Agricultural College.

Dear Sir:—I beg leave to submit herewith the Thirty-fourth Annual Report of the South Carolina Agricultural Experiment Station, which in accordance with the law, must be submitted to the Governor on or before February 1, 1922.

Yours very truly,
W. M. RIGGS,
President.

Clemson College, S. C., December 1, 1921.

Hon. Robert A Cooper, Governor of South Carolina.

Sir:—I have the honor to submit herewith the Thirty-fourth Annual Report of the South Carolina Agricultural Experiment Station in accordance with the requirements of an Act of Congress, approved March 2, 1887, for the establishment of Agricultural Experiment Stations in connection with the colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,
ALAN JOHNSTONE,
President Board of Trustees.

REPORT OF THE SOUTH CAROLINA EXPERIMENT STATION

The period covered by this the thirty-fourth annual report of the South Carolina Experiment Station for the fiscal year ended June 30, 1921, represents one of the most discouraging years in the history of agriculture. Crops and livestock produced at unprecedented high costs for fertilizer, labor, and feed had to be sacrificed at a fraction of what it cost to produce them. All farming operations were conducted on a large scale, so the financial losses were exceedingly heavy. Had it not been for the carrying out of the diversified programs promoted by our research and extension agencies, our people actually would have suffered for lack of food.

It is during periods of depression and uncertainty that agricultural research is most appreciated and the results of experiment station work are most in demand. During the recent world war, when every effort was being made to increase the food supply by stimulating crop production, very heavy demands were made upon all of our research agencies, and all scientific data bearing upon production were used. In like manner, during the past year when prices for agricultural products were at the bottom and the boll weevil had invaded a large part of the state, the people have turned to the research workers for advice and for plans with which to meet the situation. Fortunately our experiment stations have been working along the lines of diversification and have been studying the methods of producing and handling new crops and are in a position to furnish much needed assistance during these trying times when our agriculture is adjusting itself to the rapidly changing conditions.

All lines of our research work have made progress during the year, and much valuable information has been added to our agricultural knowledge through the efforts of our corps of scientists. The appropriation made by our last legislature for agricultural research has enabled us to continue important lines of work which were lagging for lack of support, and to add a few new projects which are yielding data of fundamental importance. Ever increasing demands are being made upon our staff, and we feel the need of increased facilities to enable us to meet these demands. Our research workers are looked to as the chief technical advisers along all agricultural lines—the business in which three-fourths of our people are engaged—and they can direct this great enterprise along safe and sound lines only in so far as they have scientific data upon which to base their conclusions and recommendations. Reliable agricultural information can of course be derived

only from intelligently planned and carefully conducted experiments.

The agricultural products of South Carolina for 1919 were valued at five hundred and seven million dollars ($507,000,000), and those of 1920 at two hundred and eighty-two million dollars ($282,000,000). If only one-tenth of one percent of this latter amount could be devoted to finding out new facts about this our chief industry, many puzzling problems which are now retarding the progress of our people could be solved and our future agricultural development assured. The average income from agricultural products in South Carolina in 1920 amounted to nearly forty-one dollars ($41.00) per acre for each acre of cultivated land. Less than one cent per acre of this amount was spent for agricultural research.

A summary of the accomplishments of the year, together with progress reports on the various lines of work under way, is given below. A list of projects now under way and a financial statement for the year will be found at the end of the report.

EXPERIMENTS WITH CROPS

Seventy-two percent, or two hundred and three million dollars ($203,000,000) of the two hundred and eighty-two million dollars ($282,000,000) worth of farm products produced in South Carolina last year was produced by ten of our principal field crops. Diversification is making rapid strides in our state, and yet we must expect that the larger share of our income will always be from what are termed our common field crops. Successful farming with us, therefore, is largely a matter of economic crop production.

There are many factors involved in economic crop production. The most important of these is the productive capacity of the soil as affected by crop rotations, soil building crops, winter cover crops, the judicious use of fertilizers, better terraces, and better drainage. Other important factors are more productive and better strains of crops and better tillage methods and cultural practices.

These factors are being investigated by the research department of Clemson College and by the experiment stations, and our experiments have already demonstrated methods of soil building which increase the average yields per acre from seventy-five to one hundred percent. These experiments have also proved that the yields of our field crops can be increased from fifteen to fifty percent by the use of the best seed of the better varieties, and have demonstrated cultural practices and methods of farm management which are leading to more profitable production.

A brief statement covering the progress of each of these experiments with crops is given below.

Factors Determining the Oil Content of Cotton Seed.—The cotton seed produced in South Carolina in 1919 were valued at forty-seven million, four hundred and sixty thousand dollars,

($47,460,000). The crop of 1920, due to the extremely low prices, was valued at only fifteen million, six hundred and thirty thousand dollars ($15,630,000.) In any case, however, cotton seed are an important source of revenue for South Carolina farmers, and the chief value of seed is the oil that they contain. It has been observed that the oil content of cotton seed varies to a considerable extent under different conditions and during different seasons. This investigation which is being conducted co-operatively by the agronomy and chemistry divisions of the experiment station, was undertaken with a view of determining if possible the factors which cause this variation in oil content. Samples of seed are taken from the thirty different varieties of cotton grown on our stations and from each of the fertilizer plots representing different fertilizer combinations and soil types, and these are analyzed for oil. The oil content of seven hundred and twenty (720) such samples was determined during the year and the data have been carefully tabulated and studied. No definite conclusions have been drawn from the work so far, but with the completion of this season's work we hope that the results can be summarized and published.

Barrenness in Corn.—For several years this station has been endeavoring to determine the reasons why many stalks of corn are found in the fields every season which do not produce ears. These are termed barrren stalks. The results so far in this investigation show clearly that this tendency not to produce —i. e. barrenness, is inherited in a more or less definite ratio. Where productive stalks were pollinated with pollen from barren stalks and the seed planted, three hundred and ninety-eight (398) stalks were produced which bore ears, while one hundred and seventy (170) were barren plants. This gives a 1 : 2.34 ratio. Similar planting last year gave a 1 : 3.38 ratio. Barren stalks can be detected before the tassels come out, so it would seem from these experiments that barrenness can be reduced eventually to a minimum by detasseling the barren stalks before the pollen is mature. This is especially true when seed are selected from the vicinity of these detasseled areas.

Cotton Variety Tests.—A test consisting of about 34 varieties is being conducted at the main station and at each of the substations. Good results were secured at both the Pee Dee Station and the main station at the college. This year the project has been carried out also at the Coast Station under a heavy infestation of the boll weevil and under very adverse conditions.

At the main station at Clemson College in 1920, the Wannamaker-Cleveland Big Boll gave the highest yield—1672 pounds of seed cotton per acre. The second highest yield was secured by the Piedmont Cleveland—1654 pounds. The lowest yield was that of the Toole from the N. L. Willet Seed Co., of Augusta, Ga.—872 pounds. One of the most interesting features of the test

at this station was the high yield secured from the Deltatype Webber, a long staple variety. This gave a yield of 1584 pounds of seed cotton per acre, and the Webber No. 49 gave a yield of 1314 pounds per acre.

At the Pee Dee Experiment Station, the Dixie-Triumph was our best variety, making 1927 pounds of seed cotton per acre, while the Wannamaker-Cleveland Big Boll was second in rank, with a yield of 1875 pounds. The lowest yielding variety in this test was the Hartsville No. 14, a long staple, which gave a yield of 1162 pounds. At this station our best yielding long staple was the Webber 49, which gave 1365 pounds as compared with 1350 pounds from the Deltatype Webber. Both of these long staple varieties are early, having large bolls and long staple which makes them very valuable varieties under boll weevil conditions.

This year's data are not yet complete, but the results under heavy boll weevil infestation check very closely with those of last year and justify us in recommending the following varieties of cotton under boll weevil conditions:—

Short Staple Varieties—

1. Cleveland Big Boll, for wilt free land.
2. Dixie-Triumph, for wilt infested land.

Long Staple Varieties—

1. Webber No. 49.
2. Deltatype Webber.

Variety test with corn.—A test including about 29 of the leading varieties of corn is being conducted at the main station and each of the sub-stations. The results of this test were published in the spring of 1921 as South Carolina Experiment Station Bulletin 207. During 1920 at the main station the largest yield was secured from Douthit, which gave a yield of 62.6 bushels per acre. The largest yield at the Pee Dee Station last year was made by Chappell's Garrick, of 54.6 bushels per acre. As an average of the past four years, the Douthit has been the best yielding variety at both the Pee Dee and main stations. The year 1921 was a very unfavorable year for corn at the Pee Dee Station and a very unfavorable one at the main station.

Variety Test of Wheat.—A test including the most productive varieties of wheat has been conducted at the main station in co-operation with a number of other stations of the Southeast and is being continued as a co-operative project next year. The best yield of grain made in this test at this station was made by the Alabama Blue Stem, which gave a yield of 16.5 bushels per acre. We feel that by co-operating with the other stations of this section we ought to get more rapid progress with this line of work.

Variety Test of Oats.—This test is being conducted at the main

station. During the year 1919-1920 the highest yield was secured with the Fulghum oats, and the second highest yield with Appler. During the year 1920-1921, the highest yield was secured from the Bancroft, of 44.26 bushels per acre, and the second highest yield was from Appler and Hastings with 42.2 bushels per acre. This test is being conducted again this year as previously planned.

EXPERIMENTS WITH FERTILIZERS.

Since South Carolina expends annually from twenty-five to fifty million dollars for fertilizers, an amount larger than that of any other state in the Union, it is but natural that the fertilizer problem should loom large before our farmers and that the South Carolina Experiment Station should devote a large share of its energy towards determining the most judicious use of fertilizers. The practices now in vogue in this state are quite largely based on the results secured from our experiments during the past years. Fertilizers, however, can be most efficiently used only after we understand what **combinations** and **amounts** are best suited to the different **soil types,** and to the different **crops;** the **time** and **method** of their applications; and the **relation** they bear to plant development. It is along these lines that we are now directing our experiments in the hope of determining a way by which our fertilizer investments will yield the highest rate of interest .

A Study to Determine the Influence of Trona Potash and Borax on the Yield of Crops.—Two years ago during the potash shortage in this country, a large quantity of Trona potash secured from Searles Lake in California and containing a large percentage of borax, was used to fertilize crops in this state. The fact that this material was being used in large quantity and was causing injury to crops in some sections was not discovered until during the late spring. Experiments were begun at once to determine the nature and if possible the cause of the injury that seemed to result when crops were fertilized with this material. Experiments were conducted at the Pee Dee Station last year, as well as in the greenhouse at Clemson College. Some of the results have been published as bulletin No. 201. A more intensive study of the project has been conducted in the spring and summer of 1921 and a number of the different phases of the question have been studied both in the greenhouse and under field conditions and some interesting things were found in connection with this work. We expect to check these results up more carefully before arriving at any final conclusions.

Contrary to the general belief, we found that borax when applied under corn, cotton, cowpeas, and peanuts on a Cecil clay loam soil, produced very marked injury from all rates of applica-

tion above 10 pounds per acre. We found also that lime did not prevent the injury from borax on this soil this year .

A Test of the Sources of the Potash Fertilizers at the Pee Dee Experiment Station.—This test was conducted with both cotton and corn. In 1920 the highest yield of seed cotton was secured with 2 percent of potash in the form of kainit, the yield being 2034 pounds of seed cotton per acre. The second highest yield, 1964 pounds, was secured with 4 percent of kainit; and the third highest yield, 1950 pounds, was secured with 4 percent of Trona potash.

In the corn test the highest yield, 38.9 bushels, was secured on the check plot where no potash was used. The second highest yield, 24.4 bushels, was secured with both 2 percent of carbonate and 2 percent of muriate of potash. In all cases the largest application of potash gave lower yields with corn.

A Study of the Time of Applying Potash Fertilizer to Cotton at the Pee Dee Experiment Station.—Observations made from time to time on the experiment station farms seem to indicate that potash applied to cotton at planting time sometimes injures the stand and retards the growth of the young plants. This test was undertaken in order to secure some data on the effect of potash fertilizer in cotton when applied at different times. The largest yield of cotton was secured where all the potash in the fertilizer was applied thirty days after planting. The yield in this case was 1530 pounds of seed cotton per acre. The second highest yield was secured where the potash was applied before planting, the yield being 1380 pounds of seed cotton per acre.

Comparative Test of Various Sources of Phosphorus Fertilizers.—There has been a great deal of discussion and considerable difference of opinion during the past few years as to the comparative value of phosphate and ground rock phosphate for fertilizer. Our general fertilizer test at the Pee Dee Station which is now in its eighth year, includes plots fertilized with these various sources of phosphorus, and the results there indicate that acid phosphate is the best form to use. In order to check up on the results obtained at Florence, however, we started a test here in which Tennessee rock phosphate, Florida soft rock phosphate, and acid phosphate were used as the sources of phosphorus. The first year's results check with our Pee Dee results mentioned above, and are as follows:—

With corn we secured with the use of Tennessee rock phosphate, 27.7 bushels; with acid phosphate, 28.1 bushels; and with the Florida soft rock phosphate, 26.9 bushels.

With cotton we secured with the use of Tennessee rock phosphate, 522 pounds; with the acid phosphate, 720 pounds; and with the Florida soft rock phosphate, 620 pounds.

Each of these yields was the average of four plots.

Comparative Tests of Nitrogenous Fertilizers at the Three Stations.—In many cases nitrogen is the first limiting factor in crop production in South Carolina. This station has conducted tests from time to time with the various nitrogenous fertilizers and some of these results have been published. This test was undertaken in co-operation with the United States Department of Agriculture with a view of comparing cyanamid with the other nitrogenous fertilizers. This is important at this time because of the proposed manufacture of cyanamid and other forms of nitrogen in this country.

At the Pee Dee Station in 1920, the best nitrogenous fertilizer for corn was a mixture of nitrate of soda and cyanamid. The second best was nitrate of soda alone, while both sulphate of ammonia and ammonium nitrate gave good results. With cotton the highest yield was secured with one-fourth nitrate of soda one-fourth cottonseed meal, and one-half cyanamid. The second largest yield was secured with one-fourth nitrate of soda, one-fourth ammonium sulphate, and one-half tankage.

At the main station in 1920 the highest yield of cotton was secured where cyanamid was used as nitrogenous fertilizer, with care being taken that none of the cyanamid touched the leaves of the cotton plant. The second highest yield was secured from nitrate of soda, and the third from ammonium sulphate. Each source of nitrogen was replicated six times.

During 1921 these tests are being carried out at the Pee Dee Station and at the main station.

A General Comparative Fertilizer Test at the Pee Dee Station.—This test, which includes 180 tenth-acre plots divided into four series, has now been in operation for eight years. Series A, B, C, are in a three-year rotation of cotton, corn, oats, and cowpeas. This test has given some very interesting results and the data are now being prepared for publication in a separate bulletin. The results of this test have indicated that the earliest and best yields of cotton have been secured where a well-balanced fertilizer has been used. They also indicate that on this soil nitrogen is our first limiting factor.

A Two-Year Rotation Study with Cotton and Corn at the Pee Dee Experiment Station.—For six years we have conducted a two-year rotation with cotton and corn at the Pee Dee Station. No winter cover crops have been used, but cowpeas have been sown in the corn middles each year and the entire residue turned under. The fertilized plots have received an 8-3-3 fertilizer at the rate of 1000 pounds per acre.

The average for the last rotation where the crops were rotated and the land fertilized, was 1935 pounds of seed cotton per acre; where fertilized without rotation, 1586 pounds per acre; where

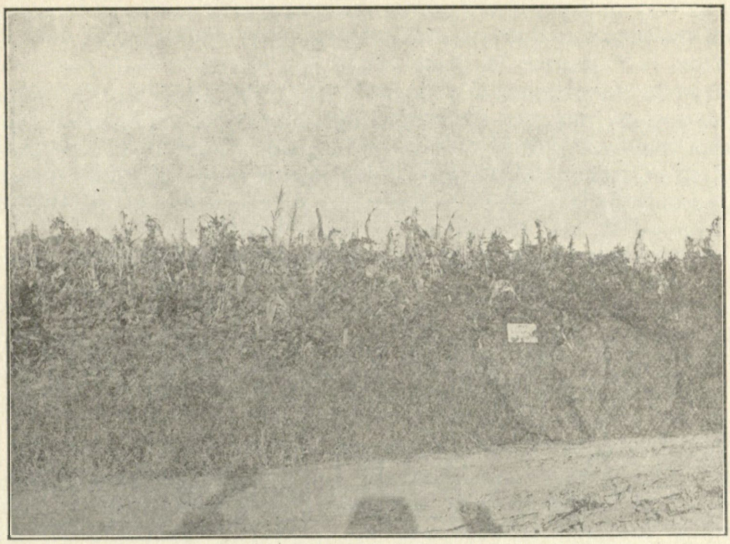


Fig. 1.—Corn and cowpeas in rotation studies at Pee Dee Station.

rotated and not fertilized, 1058 pounds per acre. The continuous cotton unfertilized made 908 pounds of seed cotton per acre.

With corn the best results were secured where the land was rotated and fertilized, the average for the last rotation being 39.1 bushels per acre; where the land was rotated without fertilizer, 25.8 bushels; where fertilized but not rotated, 24.8 bushels; where corn was grown continuously without fertilizer, 18.3 bushels.

Co-operative Fertilizer Tests.—One of the most important lines of work carried on by this department of the college is the series of co-operative fertilizer tests conducted in co-operation with some of the leading farmers of the state. South Carolina probably has a more varied soil than any other state in the Union. Of the fifty or more different soil types found in the state, about ten are of sufficient importance and cover sufficient area to justify us in using public funds for the purpose of studying their fertilizer requirements. These different soil types vary to such an extent in composition and in texture that the fertilizer which is best for one might prove of little value when applied to another. It is very important, therefore, that careful fertilizer tests be conducted on each of these major soil types so that we may know how to fertilize the different crops most profitably and most economically. We have demonstrated that the kind of fertilizer to

use is very important in fighting the boll weevil and that it varies with the different soil types in different parts of the state.

This year (1921) we succeeded in getting five experiments started as permanent tests on the leading soil types and including a three-year rotation with approximately 100 plots in each test. These tests cover the following soil types: Norfolk sandy loam, located at Allendale; Norfolk sand, located at State Park; Greenville sandy loam, located at Trenton; Ruston sandy loam, located at Bishopville; and the Cecil clay loam, located at Greer.

In addition to these five larger tests, we have conducted three tests with special crops, one with tobacco, one with peanuts, and one with sweet potatoes. The data from practically all of these tests are now available for this year and have given us very interesting results. As soon as this work has progressed far enough to make the results thoroughly reliable, the results will be published as a separate publication.

In all of these tests nitrogen has proved to be the principal limiting factor for both cotton and corn. Especially has this been true on the lighter types of soil; and at Allendale we have had a striking example of how well the necessary nitrogen may be supplied by growing legumes, such as velvet beans in our corn middles.

These tests are planned to give us not only the best fertilizer formulas to use for each of the crops grown, but also the most profitable rate of application and the lime requirements of the soil. We got very marked differences from different fertilizer treatments with cotton under boll weevil conditions in practically all of these tests. For example, at Bishopville, on plots receiving no nitrogen, only 770 pounds of seed cotton were secured per acre, while with 4 percent of nitrogen 1300 pounds were secured, and with 8 percent of nitrogen 1600 pounds were secured.

In the rate-of-application test in this field, we got the most profitable crop with 600 pounds of fertilizer per acre. We had a moderate infestation of the boll weevil in this field this year. At Greer, with no nitrogen a yield of 346 pounds was secured per acre; with 3 percent, 1104 pounds; with 4 percent,, 1228 pounds; with 8 percent, 1582 pounds; with 10 percent, 1755 pounds. With the rate-of-application test, no fertilizer gave 390 pounds of seed cotton per acre; 200 pounds gave 1102 pounds; 400 pounds gave 1064 pounds; 600 pounds gave 1121 pounds; 800 pounds gave 1432 pounds; 1000 pounds gave 1530 pounds; 1200 pounds gave 1668 pounds; 1400 pounds gave 1875 pounds; 1600 pounds gave 1801 pounds. This would indicate that on this soil the greatest profit was secured with the first 200 pounds of fertilizer. Other applications of fertilizer also gave profitable results, 1000 pounds of fertilizer giving an increase of more than a pound of seed cotton

for each pound of fertilizer applied. This would be a very profitable investment in fertilizer at the present price of cotton.

We hope next spring to be able to enlarge these experiments somewhat without increasing our force or the cost of handling, and we trust that they will be continued indefinitely and will give us very valuable information that will be of great service to the farmers of the state.

EXPERIMENTS WITH BEEF CATTLE AND HOGS

Diversified farming and livestock production go hand in hand. Wherever we find a great livestock country we find a prosperous people. The livestock business in South Carolina is developing as rapidly as good fences and home grown feeds will permit. We have at present more than a million hogs in the state. The livestock barns at the state fair, as well as at the local community and county fairs, are crowded with purebred hogs and cattle. This thoroughly demonstrates the increased interest in this very important phase of our agriculture.

There has never been such a demand for experimental results and reliable information relative to the production and feeding of livestock, as there is at this time. The demands are so insistent and the inquiries so varied that the experiment station finds it impossible to answer all of the questions, or to solve all of the problems which are confronting the South Carolina farmer at this critical time. There are many of the crops which are of special

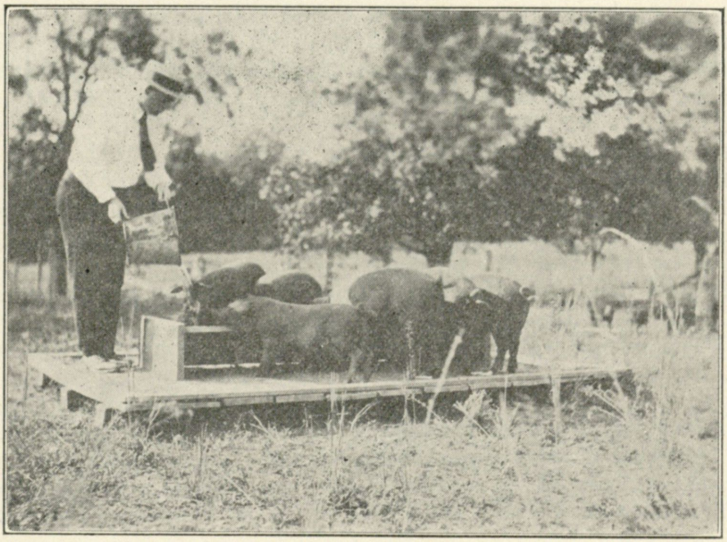


Fig. 2.—Pigs on feeding experiment.

importance in livestock production and feeding that have never been sufficiently tested in the South. In the work which this station is conducting at this time, we are emphasizing crops which are most productive in this section and are attempting to work out forage combinations and rations which will enable us to produce beef and pork economically.

This station has already produced results which mean a great saving to the livestock men of the state. Upon advice from the station, based upon experiments, many farmers have changed from the dry lot feeding to the free use of forage crops, thereby saving at least one-third of the grain ration. They have also learned from experiments to supplement corn with tankage and fish meal, in this way balancing the ration and producing more rapid and more economical gains. Some of the more important experiments along these lines, with the results obtained thus far, are discussed below.

Soft Pork Studies.—The soft pork question is the most important problem confronting the swine growers of the South. Many of our crops and feeds, such as peanuts and soy beans, which produce the most economical and most rapid gains of pork, produce hogs whose fat is soft and has a low melting point as compared with the fat of hogs produced on cereals and other grain. The packers and purchasers of pork discriminate against such hogs and offer from two to four cents less per pound for them than they pay for hard hogs. Our problem is to find some way to utilize these cheap and productive crops and feeds in such a way as to produce pork that will kill hard and bring the top of the market.

Our investigations along this line are conducted in co-operation with the United States Department of Agriculture and the other Southern experiment stations. One test already completed consisted of feeding, (1) corn and tankage, (2) whole Spanish peanuts, (3) corn, whole peanuts, tankage, and cottonseed meal to different lots of hogs. Hogs were taken from each of these lots from time to time and shipped to Washington, where they were killed and the carcasses examined by experts and fat tests made. The results as to hardness of the fat are not yet available, but gains made on the different rations are interesting. The lot fed on corn and tankage made the largest and cheapest gains. The lot fed on peanuts alone made a larger gain per pound of feed consumed but the pork produced cost more per pound.

The second test in this series is now in progress, and we have thirty-six hogs grazing on eight acres of peanuts. At the end of eight weeks they will be subjected to a period of dry lot feeding in an effort to harden the pork by the use of various rations.

Hogging down Various Crops.—Results already obtained indicate that hogs can be produced with one-third less grain by providing them free access to some growing crops, which they can gather

themselves, than by feeding them on grain alone in dry lot. The problem is to find out which of the crops available for us at the different seasons of the year will produce the most rapid gains and the largest amount of pork per acre. Much data along this line have already been secured and given out.

The following results obtained in 1921 at the Pee Dee Station with crimson clover and alfalfa are of interest. Twenty shoats averaging 103 pounds were turned on one-half acre of alfalfa and one-half acre of crimson clover February 26, 1921. At the end of twenty-eight days these twenty hogs had gained 695 pounds, or an average daily gain per hog of 1.24 pounds. During this period this lot consumed 1204 pounds of corn in addition to the alfalfa and clover. Thirteen shoats averaging eighty pounds per head were grazed on an acre of alfalfa for thirty-five days during March and April, making a daily gain of one pound, a total of 450 pounds of pork.

Along these same lines the following comparisons are now being made; (1) peanuts alone hogged down; (2) corn alone hogged down; (3) peanuts and corn together hogged down; (4) corn hogged down with tankage supplement in self-feeder; (5) sweet potatoes alone hogged down; (6) sweet potatoes with tankage supplement; (7) corn and tankage in dry lots; (8) corn and velvet beans hogged down. Results of these will be available as soon as the tests are completed.

Cost of Producing Hogs.—The majority of the feeding and grazing tests that have been conducted with hogs at the various experiment stations have been with hogs from six to twelve months old, the period when they naturally grow most rapidly. We are now making an effort to determine the costs covering the complete cycle of production. The problem is being investigated under the following phases: (1) cost of maintaining the breeding herd; (2) cost of raising pigs from farrowing to weaning; (3) cost of producing the market hog; (4) cost of raising purebred gilts to breeding age. Fifteen sows with litters are now being used in this experiment.

Rations for Pigs.—Tests are being conducted with (1) red dog flour, (2) wheat middlings, (3) wheat bran and ground oats, as rations for weaning pigs. Only one test has been completed so far. In this the pig receiving the red dog flour made the most satisfactory gains, with wheat middlings a close second. The pigs receiving ground oats and wheat bran made relatively poor gains.

Beef Cattle Feeding Tests.—On account of the prevailing high price of corn in the South as compared with other carbohydrates which might be substituted for corn in balancing the ration of beef cattle, we are investigating the relative economy of substitut-

ing rice meal or velvet beans for corn in the fattening ration. Twenty-four Shorthorn steers were purchased for this purpose and are now being fed the following rations: (1) corn silage and cottonseed meal and shelled corn; (2) corn silage and cottonseed meal with rice meal; (3) corn silage and velvet bean meal.

The beef cattle production and pasture development investigations are being conducted at the Coast Station, and a discussion of these will be found under the section of the report covering the activities of that sub-station.

Grade Percheron Mares for the Production of Farm Mules.—For several years we have been collecting data on the type of mare needed to develop the best farm mules for South Carolina. Purebred German Coach mares, Standard-bred and German Coach crosses, purebred Percheron mares and grade Percheron mares, have been bred for this purpose. We now have twelve mares of these various types which are being bred to the jack every year. Only a few of the mules are mature thus far, but there is every indication that the infusion of Percheron blood into the native stock results in the production of mares that foal a superior type of farm mule.

Fig. 3.—Percheron stallion and two mares used in mule breeding experiments.

PLANT DISEASES

The botany division continues to investigate various diseases of plants which are prevalent and destructive in this state. Fungous and bacterial diseases of plants take a much larger toll of our crops each year than is commonly realized. Last year the plant disease survey report of the United States Department of Agriculture, compiled in co-operation with this office, showed the following losses caused by plant diseases in South Carolina: Cotton, eight percent of the crop, 122,000 bales; corn, seven percent of the crop, 3,684,000 bushels; oats seven percent of crop, 784,000 bushels; wheat seven percent of the crop, 132,000 bushels; sweet potatoes, twenty-six percent of the crop, 3,246,000 bushels; Irish potatoes, nine percent of the crop, 306,000 bushels; peaches, twenty-one percent of the crop, 295,000 bushels. When converted into dollars and cents the losses last year from these seven crops alone, at present prices, totaled about twenty million dollars ($20,000,000), three times the total amount appropriated by our legislature this year for all purposes and four hundred times the amount appropriated for agricultural research.

These losses from diseases of plants are frequently attributed to other causes. If our peaches or grapes rot, if our cotton fails to open, if our corn turns yellow and dries up in the field and produces mouldy and rotten ears, or if our sweet potatoes are scabby, ill shaped and rough and rot when put in storage, we are apt to charge these troubles to poor seasons or bad luck, when as a matter of fact some definite plant disease is usually responsible for the loss.

These destructive diseases of plants, like the diseases of animals and of man, yield readily to scientific treatment when the causes are known and the habits and behavior of the organisms which cause them are understood. As a result of the research work of this division, cotton anthracnose, a fungous boll rot of cotton, which formerly caused from three to five million dollars loss each year in South Carolina, has been practically eliminated from the state and its ravages greatly reduced throughout the entire South.

Other destructive pests are being taken up and investigated in a similar manner and control measures worked out as rapidly as our time and facilities permit.

Cotton Anthracnose.—The work on cotton anthracnose during the past year has been continued along the lines discussed in the last annual report. This project has been conducted from year to year by attempting to work out special features of the problem as they have come up during the progress of the investigation. During the early phases of the investigation, data were secured which enabled us to develop practical control measures which have now

Fig. 4.—Cotton stalk badly diseased with anthracnose.

been enforced for several years. These control measures, which are based upon careful seed selection, crop rotation, and the planting of old seed, have come into such general use that anthracnose control is no longer the problem that it was a few years ago. There are, however, some features of the investigation which we feel should be cleared up before the project is finally closed. These have to do with the life history and behavior of the fungus on the seed and in the seed. During the past year a large share of the time of the associate pathologist and his assistant has been devoted to these studies. To this end we have made extensive tests of various seed treatments and methods of storage to determine their effect on the fungus. Seed have been treated according to the following methods: (1) dried in an electrical seed dryer, (2) dried in a hot air oven, (3) delinted with strong sulphuric acid and sterilized with corrosive sublimate, (4) delinted, sterilized, and dried in an electrical dryer, (5) untreated. These various lots of seed have been stored as follows (1) in the open laboratory,

(2) in an incubator at 30 degrees centigrade, (3) over a radiator in the open laboratory, (4) outside the laboratory window, (5) in a closed chamber containing a dish of water, (6) in desiccators in the open laboratory, (7) in desiccators in an incubator at 30 degrees centigrade. Samples have also been spread out in thin layers and exposed to sunshine for different periods. Frequent tests have been made to determine the amount of anthracnose in these samples by the method developed in this laboratory, which consists of germinating the seed and growing the seedlings in sterile test tubes containing a nutrient solution of agar. These studies have involved the testing and frequent examination of a large number of tubes containing seedlings. The total number of seedlings studied in the tests during the year amount to over eleven thousand (11,000). It has also developed that the different methods of drying have not reduced the infection to any marked extent, the disease developing on the seedlings from seed dried according to these different methods in about the same ratio that it does from seedlings from seed stored according to the ordinary method. This project should be brought to a close during the year, as it is felt that these seed studies have been carried about as far as they can with the hope of securing additional data that would be of value.

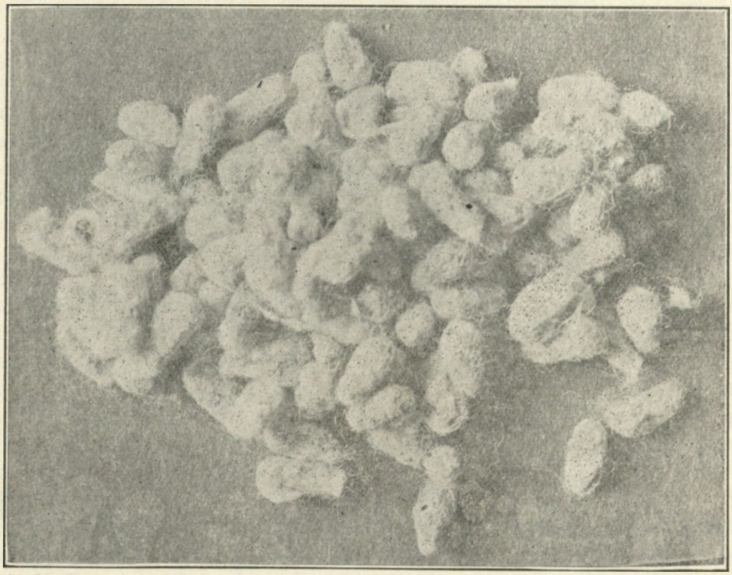


Fig. 5.—Cotton seed before delinting.

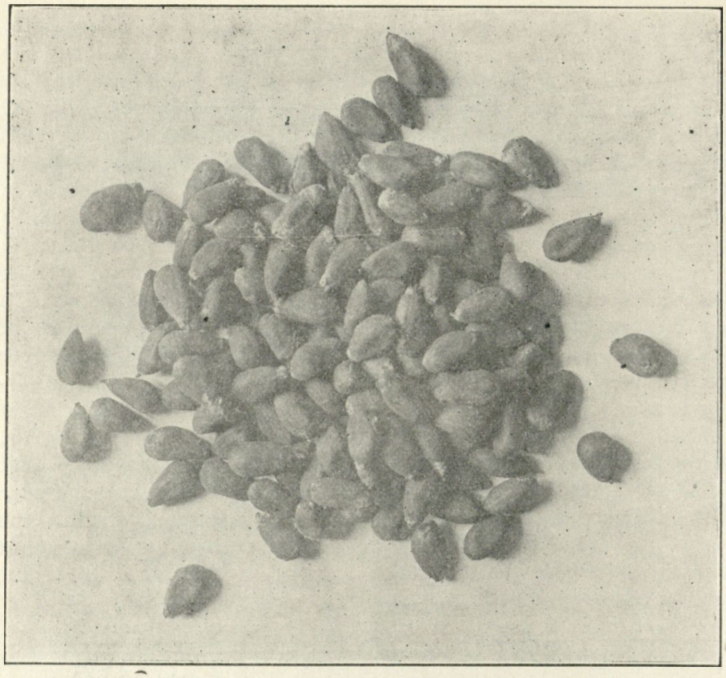


Fig. 6.—Cotton seed delinted with sulphuric acid.

The recent field studies of selections made from strains of diseased Cooke and Webber cotton, indicate that these badly infected strains have been entirely freed from anthracnose. The crop grown in the field this year from seed of the 1920 crop shows absolutely no sign of disease. Some of our previous studies indicate that this disease varies to a considerable extent in the same strain of cotton from year to year, and we are now continuing a strain that is badly infected with anthracnose, planting this from year to year without making any effort to eliminate the disease. This will give us a chance to study virulence of the fungus under different conditions, and a chance also to secure data on the behavior of the same strain of fungus on the same variety of cotton under different seasonal conditions.

Angular Leaf Spot.—This project was completed several years ago with the exception that we desired to repeat tests of the control measures in order to make sure that these would be effective under different seasonal conditions. The results of the previous work were published in South Carolina Experiment Station Bulletin 198, and the control measure as given out at that time consisted

of delinting the seed with sulphuric acid and then treating the seed in a corrosive sublimate solution of one part to one thousand for ten minutes. We treated lots of infected seed during the past season and planted them on the experiment station farms at Clemson College and at the Pee Dee Station. As our results are in complete agreement with the results of the previous test, we now feel

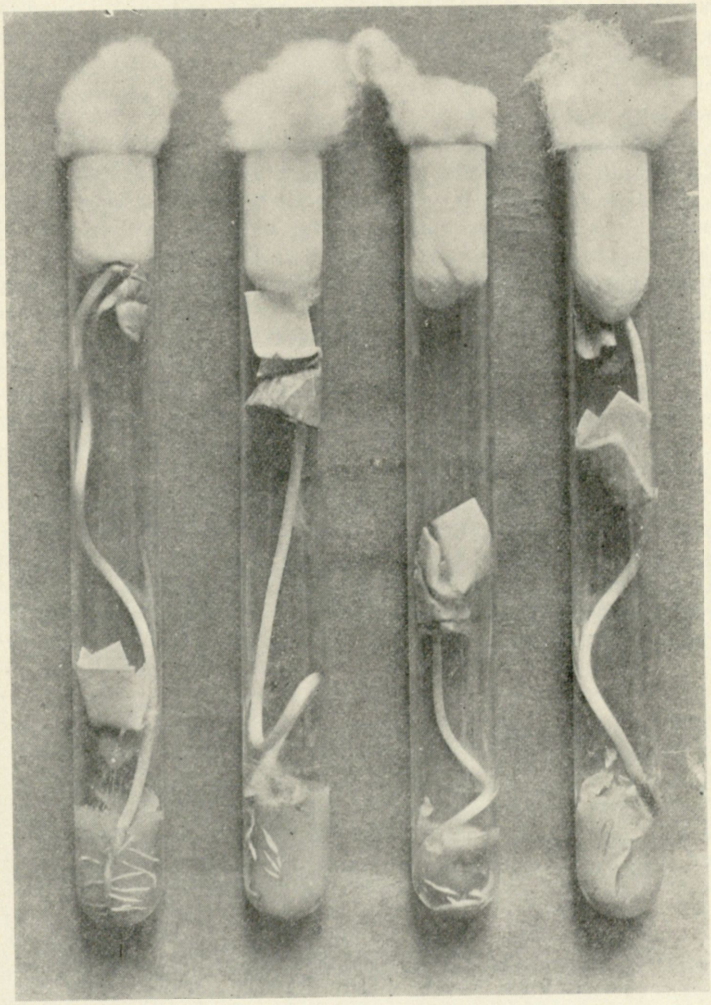


Fig. 7.—Laboratory method of testing cotton seed for anthracnose.

absolutely sure that this treatment will eliminate angular leaf spot from our fields. Since the results of our earlier experiments were published, the Arkansas Experiment Station has tested the effectiveness of this treatment and found that it gives absolute control of this disease.

We are now prepared to recommend the delinting of cotton seed with sulphuric acid, not only for the control of angular leaf spot, but also because of the effect that it has in reducing the anthracnose infection and in hastening germination of the seed. Cotton seed treated in this way will germinate much more quickly and the seedlings will grow off more rapidly than when the seed are planted without treatment.

A New Cotton Disease.—A cotton disease causing a constriction of the stalk that kills the plant at the surface of the soil has been reported every season for the past six or eight years and has been studied to some extent by the various investigators here and elsewhere in the South, came to our attention again in 1921 and a careful study has been made of it. The disease was found during the summer in a field near Walhalla and Mr. Tisdale and Dr. Ludwig have taken up the study of it in the laboratory and in the greenhouse. Several fungi have been isolated from this material and one of them seems capable of producing the disease on healthy cotton plants. This investigation is being continued now in the greenhouse, and we hope to have something definite in regard to it in a short time.

Plant Disease Survey.—The plant disease survey has been continuing in co-operation with the National Bureau of Plant Industry. Reports and observations made by the members of the staff and by others throughout the state who are interested in plant diseases, have been brought together and placed in the survey files. The county agents are co-operating in this work and have given a great deal of information which helps to make this survey complete. It is of course necessary to continue the survey from year to year in order to determine the progress made by the different diseases. The data secured in this way also serve as a basis for planning and conducting campaigns for disease control.

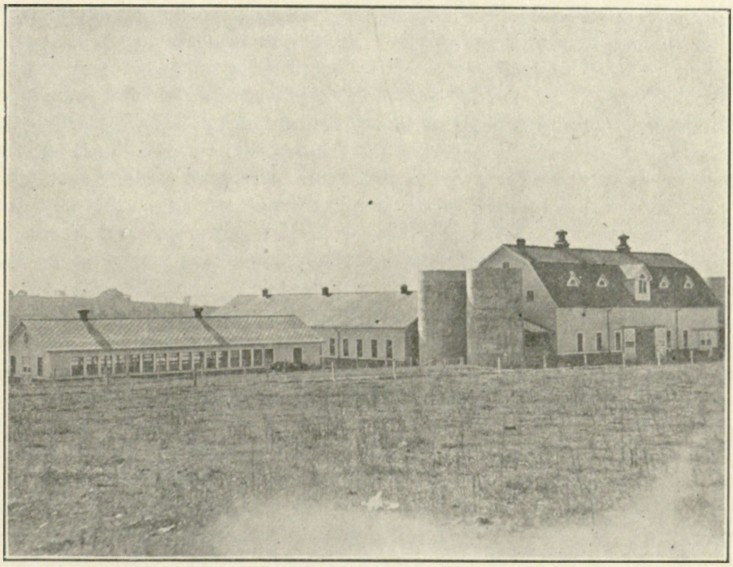
Some of the more common diseases of our crops have been unusually prevalent this year. Brown rot of peach appeared in epidemic form during the blooming period and completely destroyed the crop in some areas. Bacterial spot of bean caused serious loss in the commercial bean fields in Berkeley County. Pecan scab and pecan rosette in Calhoun and Bamberg Counties; tobacco wildfire in Florence and Williamsburg Counties; and obscure blasting of rice at Yemassee; and a rosette-like disease in several of the commercial peach growing sections, were found causing serious loss.

BACTERIAL CONTENT OF MILK.

During the past three years the associate bacteriologist of the station has conducted a study of the bacterial content of milk with a view of determining the behavior and development of bacteria during the different periods of handling milk from the time it is milked until it reaches the consumer. The dairymen of the South are concerned chiefly with the furnishing of whole milk to the nearby markets, and this project was undertaken with a view of determining practices and methods of handling milk which would keep down the bacterial content.

A careful study has been made of the so-called germicidal property of milk and the bacterial development during the first two to four hours after milking. Where the milk was drawn from the cows into sterile flasks and then plated out in the laboratory at two-hour intervals, the counts showed that when the initial bacterial content of the milk is low there is no marked increase in the number of bacteria during the first four hours. This would seem to give plenty of time to get the milk cooled down to a temperature which would inhibit bacterial growth.

The bacterial content of the milk from a number of individual cows has been determined and it is found that the milk from some cows contains a much larger number of bacteria than that from others. About forty different strains of bacteria have been isolated



Fi . 8.—Dairy barns, Clemson College.

from milk from different cows included in the project and these are being studied.

From these studies thus far it appears that the production of certified milk is largely a matter of sterile utensils, and cleanliness in milking and handling the milk.

EXPERIMENTS WITH DAIRY CATTLE.

During the years 1914—16, when cotton prices were low and our farmers were unable to make a living by the single crop system, many of them turned to dairying. Four creameries were established for the purpose of furnishing markets for the dairy products furnished by several thousand farmers of this state. This development was practically lost during the period of the war, when prices of cotton were high and labor was scarce, but since the advent of the boll weevil and the unprecedented decline in prices of all commodities during 1920, farmers are again turning to the dairy business, and the indications are that this will develop very rapidly into one of our most profitable lines of endeavor. It is estimated that we are expending about four million dollars ($4,000,000) annually for butter which is brought in from other states. The diversified method of farming which we are now advocating involves the growing of more feed, and the dairy cow will make a greater profit on this feed than any other animal to which we can feed it.

Advanced Register Testing.—The official testing of dairy cattle is the most important project we are conducting with cattle at present. This consists of keeping accurate records of the yearly production and butter-fat content of certain cows in our own herd at Clemson College and of a limited number of individuals in the herds of the most progressive dairymen of the state. All of the work is supervised and managed from Clemson College and all of the records are certified to by the head of the dairy division of the experiment station. The actual testing of the herds in the state is done by men employed by this office but paid by the cow testing association.

Since July, 1920, we have completed fifteen Jersey records in the experiment station herd which average 7901.2 pounds of milk and 386.63 pounds of butter-fat. Five of the records were made by two year-old heifers; six by three-years-old; and only four by mature cows. The best record completed during this period was by Plumage Inez, with 10,202.5 pounds of milk and 559.28 pounds of butter-fat in 318 days as a mature cow. Her daughter as a junior three-year-old finished with 7,897 pounds of milk and 426 pounds of butter-fat. At the present time, we have nine Jerseys on test for yearly records. All two-year-old heifers with first calf are being tested. This will give us a basis of comparing all records

Fig. 9.—Group of Guernsey cows on Advanced Register test, Clemson College herd.

since they are made under identical conditions and at same ages. Five Holstein records have been completed since July, 1920. The average for the five records is 10,830.3 pounds of milk and 374.95 pounds of butter-fat. Three of these records were made by two-year-olds and two by mature cows. The best Holstein record completed is 16,000 pounds of milk and 497.17 pounds of butter-fat. We have three Holsteins on test. We now have eight Guernsey cows and heifers which were secured since July, 1920. Three of these heifers are on test and making creditable records. The others will be put on test as they freshen.

By fostering the Advanced Register work in this state we are gradually raising the average production of the milk cows in South Carolina. It is the only accurate method we have for determining the actual value of a milk cow. In 1918 there were only three breeders in the state testing their cattle for advanced register records. Now there are twenty-five breeders doing this work. Since July, 1920, thirty-one yearly Holstein records have been completed in the state. These records average 14,262 pounds of milk and 486.44 pounds of butter-fat. During the same period twenty-nine Guernsey records have been completed with an average of 8,884.6 pounds of milk and 438.32 pounds of butter-fat; also twenty-one Jersey records with an average of 6,997.4 pounds of milk and

382.17 pounds of butter-fat. This makes a total of eighty-one records completed since July, 1920, with a general average of 10,048 pounds of milk and 435.64 pounds of butter-fat. The average dairy cow in the United States produces about 150 pounds of butter-fat in one year, so during this year we have developed in South Carolina eighty-one records which average nearly three times that of the average cow. At the present time there are ninety-seven additional cows on test.

This work is of special importance at this time because through it we are developing seed stock for our state, which we can depend on to increase the production of the future cattle and in this way make the dairy business more profitable. At the present time there are 213,000 milk cows in South Carolina and we need 240,000 more to meet the rural needs for milk and its products, to say nothing of the needs of the towns and cities. We need 2,560 more purebred dairy bulls in the state at the present time. By encouraging this Advanced Register work we may supply these bulls within the next ten years from our own herds. This is a much better way than to buy such seed stock at high prices from without the state and run the risk of bringing in diseases such as contagious absortion and tuberculosis.

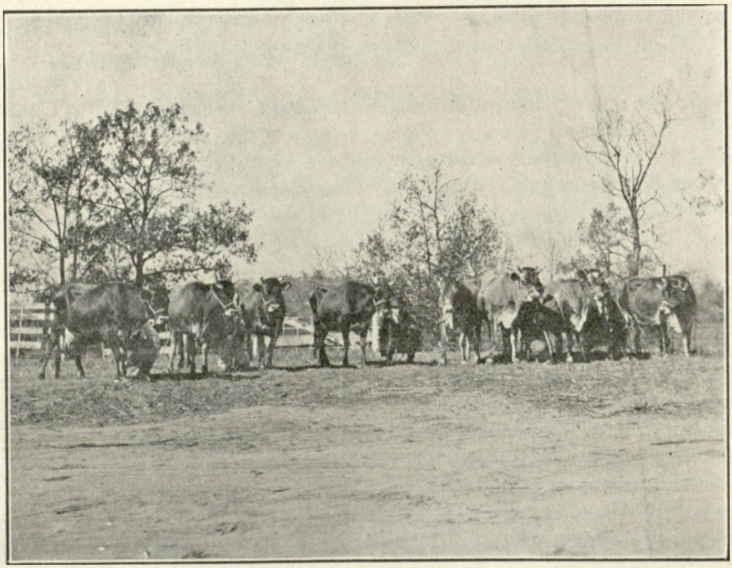


Fig. 10.—Group of Jersey cows on Register of Merit test, Clemson College herd.

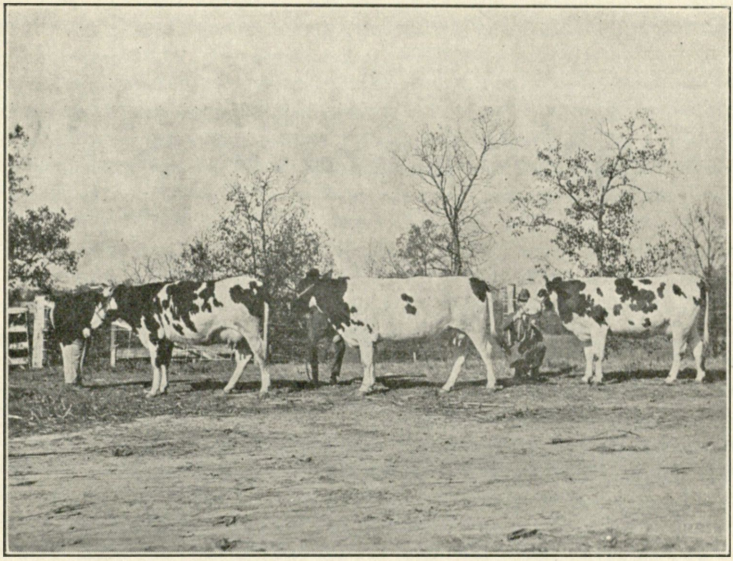


Fig. 11.—Group of Holstein cows on Advanced Register test, Clemson College herd.

A Comparison of Corn Silage and Sorghum Silage for Milk Production.—Sorghum cane in our tests this year has produced twice as much silage to the acre as corn, and the object of this test is to determine the value of this as compared with corn silage for milk production. Earlier tests indicate that sorghum silage is almost as valuable pound for pound as corn silage for producing milk, and if this proves to be uniformly true, sorghum will furnish us a means of producing a large tonnage of comparatively cheap silage.

Feeding Mineral Salts to Cows.—Preliminary studies made by the United States Department of Agriculture indicate that cows producing large quantities of milk do not get enough of certain minerals from their feed to supply the bodily needs. This is thought to be especially true in sections where these minerals are deficient in the soil. This experiment was undertaken with a view of determining whether or not such mineral salts as calcium and phosphorus when fed to dairy cows will increase the milk production.

The Cost of Raising Dairy Calves.—The majority of the dairy cows raised in the South are under-sized and weak of constitution because they were not properly cared for and properly nourished when they were calves. The object of this experiment is to de-

termine the amounts and kinds of feed required and the cost of raising dairy calves from birth until they are two years old. Since the new calf barn was completed in the spring of 1921 we have been able to keep accurate records of the amounts of feed consumed by the individual calves, and considerable progress has been made with this experiment. Fifteen calves are now included in this test.

Breeding Dairy Cattle.—The dairy cow is the most highly specialized animal in existence. Generations of careful breeding has increased her production of milk and butter-fat and changed her conformation to meet the ideals of both fancy and practical breeders. Although scientific breeding of our oldest and best established breeds has been conducted for years, there are many questions with reference to methods of breeding that still need further investigation.

This experiment station has two projects which are planned to shed more light on the systems of breeding. These are (1) a comparison of line breeding and out-crossing as systems of breeding Jersey cattle and (2) line breeding of Holstein cattle

We have some splendid animals backed up by excellent records for use in both of these experiments. For the line breeding with Jerseys we are using Chromo's Sensation, a son of Blue Fox's Eminent's Chromo, a cow with a record of 17,217 pounds of milk and 856 pounds of butter-fat in one year. We have also Goddington's Chromo, a daughter of the same cow. She will finish an official record in February, and is not only well bred and a splendid

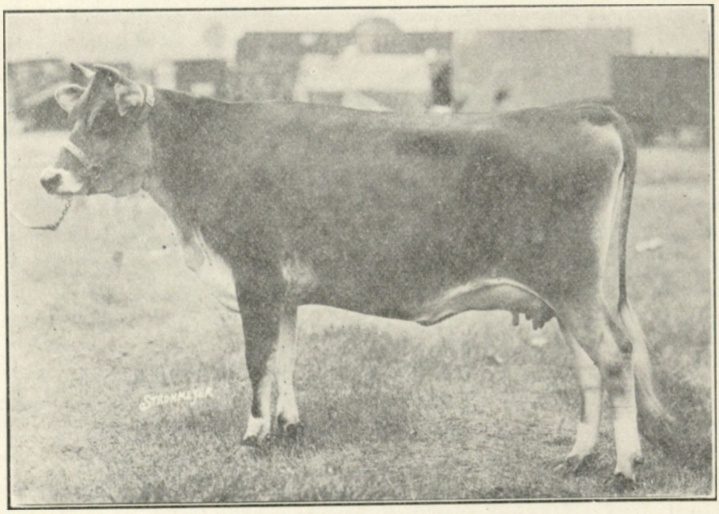


Fig. 12—Goddington's Chromo, grand champion Jersey Cow at South Carolina State Fair, 1921.

producer, but is a splendid individual, having been awarded senior grand champion Jersey female at the 1921 South Carolina State Fair. Her junior bull calf also took first premium in his class We now have twenty purebred Jerseys with official records and the majority of these are of the same blood lines. To out-cross this breeding we are using a young bull which we have recently brought in from Oregon, Vive Glow Golden Chief. He is unrelated to any animals in our herd and contains some of the greatest producing blood of the breed.

The line breeding of Holsteins is conducted in co-operation with the breeding specialists of the Dairy Division of the United States Department of Agriculture, who are also carying on similar projects with eight other experiment stations. We already have five heifer calves out of our Holstein cows with official records and sired by the bull which the Dairy Division furnished us for this work. Breeding work of this kind of course will have to be continued for a long period of years in order to yield data of fundamental importance, but we feel that this is the type of work that a public institution like ours is best prepared to do. The plans are made to cover a long period, and any change in the personnel of the staff need not interfere with carrying them out.

INSECT PESTS.

Insect pests, like plant and animal diseases, constitute an increasingly serious problem for the farmers of the state and for the people in general. Insects of one kind or another attack everything that grows, both plants and animals, and the damage caused to individual crops often amounts to millions of dollars in one season We not only have the native pests to deal with, but insects new to our state are constantly coming from other states and countries. To cope with these successfully taxes the skill, ingenuity, and technical ability of our scientists to the utmost. Even with the application of all of the available scientific knowledge, some of the pests can not be controlled successfully.

In our investigations of these pests at this station we have undertaken detail studies of the life cycle, habits and behavior of the insect in question as influenced by seasonal and weather conditions and farm practices. In this way we have been successful in some cases in working out what might be termed natural control measures which can be fitted in with the common farm practices. By use of a system of keeping accurate records on the natural enemies, weather conditions, etc., and noting the effect of these on the activity of certain insects, our entomologist has been able to forecast outbreaks of some of our most destructive pests, thereby enabling the farmers to institute control measures.

Wireworms.—An investigation on this very important group of insects was begun by this station ten years ago. Wireworms constitute a large group of destructive pests with varied habits and life histories. The two destructive species of the coast and near-coast counties were studied first, due to the urgent request of our farmers in the stricken areas. While the headquarters for this investigation were located in Colleton County, these studies covered practically the entire southern part of the state.

Wireworms are the young of click beetles or snapping bugs. Owing to the under-ground habits of these species, a careful technical study of their relations to soil, moisture, and temperature was necessary, and this showed: (1) that these species occur only in poor, light soil, and mainly on uplands; (2) that they have an annual life history passing through a complete life cycle from egg to full grown click beetle within twelve months; (3) that the females lay their eggs only in disturbed soil during May and early June; (4) that they pass the winter as wireworms in the soil at a depth varying from a foot to thirty inches, and are safely beyond the reach of farm implements; (5) that the pests are not destructive on land where a good program of soil building is practiced.

Applying these determinations to practical farming conditions, it has developed that the pests can be controlled by increasing the humus content of the soil and by intelligent use of cover crops and summer legumes. Barnyard manure and swamp muck are very valuable when available.

These investigations are now in progress with particular reference to another species of wireworm in the low lands of the central part of the state.

Red Spider.—The investigations by this experiment station to date show this pest to be mainly dependent on (1) the winter food plants and weeds which the farmer allows to grow on his farm; (2) winter minimum temperatures; (3) summer humidity. These factors are given in order of their importance as estimated according to our reports.

This work is prosecuted in the laboratory and in the field and is supplemented by a series of charts for studying the correlation between the red spider and seasonal weather conditions. These records have accumulated over a period of ten years, and indicate that red spider outbreaks may be expected to be more general and more severe during a season following a very cold winter; that the red spider was able to survive much lower winter temperatures than her insect parasites; that the existence of winter food and spring colonization plants is an important factor in developing red spider outbreaks.

Among the most important winter food and early spring colonization plants are long stemmed violets and poke weeds.

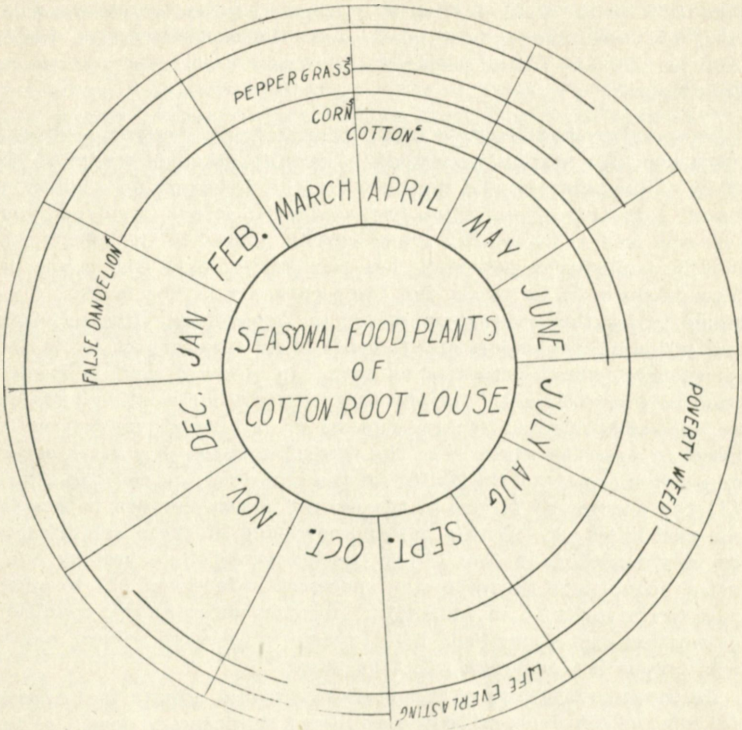


Fig. 13.—Food plants of cotton root louse.

Cotton Root Louse.—This root aphis, or root louse, is a serious pest throughout the greater part of the state whenever conditions favorable for its development exist. Though these investigations are conducted in various sections of the state, the principal studies were made in the Pee Dee section, where the injury was greatest. Since the aphis depends upon the various species of cotton and corn field ants for support and protection, it makes the problem an unusually difficult one. It involves a study of the life histories and habits of both ants and aphids above and below the surface of the soil.

It was clearly worked out how the ants transferred the aphids to the roots of certain winter food plants, such as life-everlasting or "rabbit tobacco," which are connected with the ant burrows by underground channels, so that in the spring the cotton fields are again stocked with these surviving aphids.

Applying these studies to farm practice, it was found that a successful winter cover crop eliminates these winter food plants

from the cotton field and greatly delays spring re-colonization. This, supplemented by frequent early shallow cultivation, which confuses the ant trails, reduces the losses from this pest to insignificance.

Temperature and Moisture in Relation to Insect Activity.—Several years ago this station undertook a careful detailed study of the effect of temperature and moisture on the behavior and habits of insects. As this investigation has progressed it has developed that heat and cold and humidity are so closely related in the effects that they have on insect behavior that our entomologist has connected them up in what he terms the temperature-moisture factor. This seems to be the dominating factor in determining life activities, and not until we understand these laws may we expect to be able to interpret insect activities on farm, in orchard, and in garden, from season to season. Temperature-moisture, or weather relations to insects, determines (1) the success or failure of any destructive insect to pass the winter, (2) the rate of increase in a given season on a given crop, (3) the ability of the crop to withstand the attack, (4) the success or failure of the natural insect enemies in keeping the pest in check. With a better knowledge of these relationships we may expect to be able (1) to check successfully a pest by eliminating conditions favorable for successful wintering, (2) to anticipate the severity of an impending invasion under known conditions of weather and parasitism, (3) to determine when, where, and on what crops the outbreak will take place.

In the investigations of this station it would appear that successful hibernation depends on the ability of the insect to lose a certain percentage of its body weight. This loss in our investigations ranges from 26 to 33 percent. This reduction in weight is most easily accomplished in partly saturated air. The heaviest death rate occurred in saturated atmospheres at low temperatures while hibernation under artificial conditions in higher temperatures with low humidity gave a much higher percentage of successful survival than varying conditions out of doors. The most favorable conditions for natural hibernation were secured in old stubble and stalks in good condition, in the underbrush and dead vegetation on terraces, ditchbanks, in woodlots, and in miscellaneous waste places. It is necessary to understand these relationships before we can hope to interpret seasonal insect activities in a practical way. The heredity factor is not underestimated in these investigations, especially when dealing with life histories and number of generations. These studies give us a better understanding of the relation of insects to the winter absolute zero temperature line, which has already been of so much value in boll weevil work. By comparing this line with that in sections of known damage, the probable weevil damage may be computed with reasonable accuracy.

Our studies with high and low fatal temperatures enable the station entomologists to advise as to the best conditions under

which to fumigate stored products, as well as to the destruction of insects by high temperatures. These recommendations result in the saving of seed stored in small quantities in innumerable homes. Heat properly applied kills every stage of every species of stored grain insects without injury to our most important agricultural seeds. With high temperatures even various individual articles of great value are effectively and economically saved. For example, many a valuable garment, rug or fur robe is saved from destruction by clothes moths by the simple use of the sad iron found in every home.

One phase of this work that has probably been seriously underestimated is the study of periodic recurrence of well known and easily observed phenomena. Insect life and plant life develop more or less in synchronism, and a better knowledge of this correlation which exists between the blooming of the trees and shrubs in the spring and the beginning of insect activity is enabling us to give more defiinite instructions as to the time of spraying and applying other control measures to insects.

Boll Weevil Studies.—Since our last report was written, the boll weevil has completed his migration over the northern and western parts of the state. The entire area of our state is now infested with this pest, and we are confronted with the problem of either producing cotton in spite of the weevil or discontinuing the growing of cotton entirely. The scientists of the United States Bureau of Entomology and the other experiment station workers in the cotton belt have worked away on control measures for this pest for the past twenty years and still have no single definite practice that can be recommended for its control.

We have continued the life history and hibernation studies made last year and we find that the weevil behaves here under our conditions much as it has done in the states south of us. Three hibernation cages placed out in the fields at the Coast and Pee Dee Stations and on James Island, and containing a total of ten thousand weevils, were operated during the winter and spring, and it was found that about twelve percent of the weevils placed in these cages in the fall of 1920 hibernated successfully and came out alive in the spring of 1921. This is the largest percentage ever known to pass the winter successfully, and this fact is attributed to the unusually mild winter. Dates of emergence from hibernation were carefully kept and our data indicate that the majority of the weevils came out during April and that they were all out of hibernation by June first. The parasites of the weevil are also being studied in an effort to determine conditions that might be favorable to their development and detrimental to the weevil.

Extensive experiments looking to the control of the boll weevil were conducted at the Coast Station at Drainland this season. One of the assistant entomologists made this station his headquarters

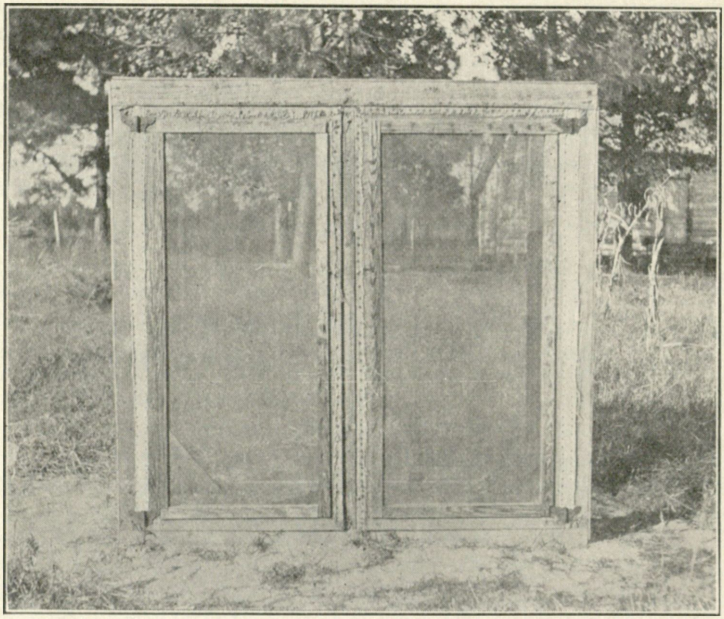


Fig. 14.—Boll weevil hibernation cage, Coast Station.

and spent his entire time conducting these studies. The experiments included variety studies, collecting weevils, stripping off the squares at certain stages of development, and poisoning with calcium arsenate. The season at this station was very disastrous for this work. A great deal of information was secured which may have an important bearing on the final solution of the problem, but no satisfactory control measures were developed. The heavy summer rains began just before time to make the first application of poison and continued for six weeks, so that the land remained too wet to operate the duster. Several attempts were made but the duster mired up so far in the soil that it could not be operated. After this work was so seriously interfered with, some poison was applied at the Pee Dee Station, and several applications there reduced the weevil infestation, but it was too late to affect the yield. Our studies of this problem so far since the weevil arrived in this state convince us that there is no one practice or operation that will control the boll weevil. He must be controlled by a dilligent application of all of the improved practices developed by the states south of us, such as destruction of stalks as early as possible, cleaning up all fields, terraces, hedge rows, etc., picking weevils and squares, early planting of the best varieties, proper fertilization,

rapid shallow cultivation and poisoning. One of our entomologists will be stationed at the Pee Dee Station next season for the purpose of devoting his entire time to assisting with boll weevil experiments.

Peach Tree Borer.—The station is continuing its investigations on the ruinous pest of our peach orchards. The work with mounding methods combined with trunk washes carried through a series of years has already been published. Through the work of the Department of Agriculture, paradichlorobenzine was brought forward as a promising agent for the control of this pest. We have over five thousand trees employed in experiments which have for their principal aim (1) the determination of the relation of the vapor to the age of the tree under varying weather conditions, (2) the determination of the period of time when it may be most effectively applied in this state, (3) the perfecting of a method if possible for its use on very young trees when the need for a simple and effective control method is very urgent.

Root Knot.—Investigations are in progress to determine the value of several methods of soil treatment for the control of root knot on small areas under intensive cropping. While sodium has given promise of value under proper conditions, the work with this and other materials has not been carried sufficiently far to warrant recommendations at this time.

Cottony Cushion Scale.—The experiments in colonizing Australian lady bird beetles against the cottony cushion scale show that this pest can be effectively and economically controlled by this method. The beetles were imported from Florida and colonized in specially constructed cages at Ashley Hall and Magnolia cemetery, Charleston, S. C. The cages were made of cheese cloth, of simple construction, and employed merely to enable the friendly beetles to obtain a sure footing to sustain them through the season.

Argentine Ant.—Experiments conducted in Charleston, S. C., using the poison formula devised and recommended by the Bureau of Entomology, Washington, D. C., gave much promise and would make it appear that this destructive as well as offensive pest might be eradicated by systematic and concerted community action. The pest is so far confined to Charleston and because of its destructive, as well as grave-yard infesting habits, special efforts at its eradication are warranted.

Beekeeping.—Investigations to assist in developing bee culture and honey production in this state were begun three years ago, and the progress that is being made is most satisfactory. South Carolina has always been rich in the number of bee colonies, frequently called bee gums or bee stands. The state has between 80,000 and 90,000 colonies yielding from one-half to three-fourths million pounds of honey. This industry is destined to furnish our South

Carolina homes with an abundant supply of the most delicious and most healthful sweet, besides yielding a material cash income. The investigations now in progress show (1) that South Carolina's main honey flow occurs in the spring; (2) that the failure to gather the state's great nectar flow is due to primitive hives, primitive management, and consequent winter losses; (3) that the importance of strong queens is underestimated, resulting in weak colonies, which have not the necessary bee population to gather a honey flow and sooner or later die from bee moth.

Our experiments with various hives lead us to recommend the standard ten-frame hive in this state. As the industry advances and methods in bee yard management improve throughout the state, larger brood chambers may be employed. The adoption of a standard hive with movable frames is the first necessary step in converting a worthless yard into a profitable one.

Our experiments in winter packing lead us to recommend this in all bee yards over the greater part of the state. Building up a strong colony in the fall and properly packing it according to improved methods produces a powerful colony for early spring with a worker population sufficiently strong to gather and store the honey flow. Intelligent management greatly reduces swarming during the honey flow. When it is the purpose of the beekeeper to secure a honey crop, he should not allow his colonies to divide their working forces by swarming previous to or during a honey flow. Such is **destructive** and not **constructive** beekeeping, and experiments have shown that this swarming can be prevented to a very great extent and sometimes altogether. The strength of a colony depends on a good queen. In our experimental work we have secured the best results by requeening after the heavy flow, which is some time during July and August, thus giving the colony ample time to build up for winter and eliminating the necessity of interfering with the colonies during the spring flow.

EXPERIMENTS WITH FRUITS AND VEGETABLES

The varied soil and climatic conditions of South Carolina permit the growth of a great variety of fruits and vegetables during practically all seasons of the year. With the advent of the boll weevil our people are undertaking the production of fruits and vegetables on a commercial scale for profit. Large peach orchards are being developed, especially in the sandhill region, and trucking is being engaged in on a large scale in some of the counties bordering the coast.

This experiment station follows the practice of conducting tests from time to time, with the principal fruits and vegetables with a view of determining which varieties are best for home use and for commercial plantings. We have also tried out a great many different kinds of plants introduced from foreign countries by the

Office of Seed and Plant Introduction of the United States Department of Agriculture. In many cases where fruit and vegetables are being grown on a commercial scale, fertilizer tests have been made and cultural practices studied. Much of this work is conducted at the Coast Station and at the Pee Dee Station, because these stations are in sections where trucking is engaged in to a large extent.

Variety Tests of Peaches.—We have conducted variety tests with peaches at Clemson College and at both of the sub-stations continuously for the past ten years. New varieties are tested out as they are introduced and these are compared with the older and more standard kinds. Over one hundred varieties have been included in these tests. The following varieties named in order of their ripening have proved most satisfactory for home orchards and for local markets: Mayflower, Red Bird, Greensboro, Mamie Ross, Carmen, Hiley, Belle of Georgia, Elberta, Chinese Cling, and Stinson's October. For commercial planting in this section four varieties are recommended: Carmen, Hiley, Belle of Georgia, and Elberta.

Peach Thinning Experiments.—These experiments carried on over a period of years show that thinning is a profitable orchard practice since peach trees have a tendency to set more fruit than they can develop properly.

Thinning was done after what is known as the "June drop" and when the young peaches were about the size of a hickory nut. The fruit allowed to remain was spaced as nearly as possible 4 to 5 inches apart so the fruit would not touch at maturity.

At picking time it was found that the yield on the thinned and the unthinned trees was about equal, but a great difference was found in size and color of the fruit. On the thinned trees 90 to 95 percent of the fruit was of good size, well colored and of a better quality, and the number of culls was negligible, while the fruit from the trees not thinned had 40 percent large, well colored fruit, and 60 percent small, pale colored fruit and culls. These differences were further augmented in the price received for the fruit, which was a third more for the thinned than for the unthinned fruit.

Test of Plum Varieties.—Over thirty varieties of plums have been tested at this station over a long period of years, and of all these the Shiro (Early Gold), Abundance, and Burbank have proved best for South Carolina from the standpoint of quality, productivity and disease resistance.

Experiments with Pears.—For the past twenty years experiments have been carried on at this station in growing pears by different methods, so as to control, if possible, loss from fire blight. This disease generally attacks blossoms, fruit spurs, and tender growth, and later kills back whole limbs and forms cankers on the limbs

and trunks. The blight, which is a bacterial disease, is the principal cause for the failure of our pear orchards.

The only satisfactory method of control found to date is to grow the trees in grass sod after bearing age has been reached. When grown on poor sandy soils, the annual growth is small and the blight is not so severe; but when grown on rich soil and the trees blight badly, grain sown around the trees and allowed to ripen tends to check the growth of the tree and the blight will be greatly reduced. After the grain is harvested, we find it best to allow the grass and weeds to grow up and to sow grain again the following fall.

When grown in this way we find that Kieffer will produce good crops regularly and blight very little. There are two Kieffer pear trees twenty-nine years old, growing on the college grounds which bear good crops every year. Some years the tender growth has blighted to some extent but not enough to prove serious.

A large number of varieties, many of them oriental pears, are being tested at this station, and it is hoped that some of these varieties will prove to be resistant to fire blight.

Spraying Experiments with Bunch Grapes.—Tests of various fungicidal sprays for the control of diseases of bunch grapes have been conducted, and so far we have found no spray to equal standard Bordeaux mixture. This spray controls diseases that attack the fruit as well as those that attack the leaves. We find it necessary to spray to control leaf diseases even though the fruit does not rot, for these sprayings cause the vines to hold their leaves until cold weather. We find that when the leaves are allowed to shed during the summer the vines will make a second growth in late summer, the wood will not mature, and as a result the vines will winter-kill.

Variety Tests of Bunch Grapes.—One hundred and twenty varieties of bunch grapes have been tested and most of them found unsuited for profitable production in this state. While a large number of varieties grow to perfection in South Carolina, we recommend the Moore's Early, Lucile, Delaware, Niagara, and Concord, (named in order of their ripening) for general planting, as these varieties do well under a wide range of conditions.

We find that the Delaware, Niagara and Concord are best for commercial planting. The vines of these varieties are very hardy and productive. The bunches are very compact, and the fruit is excellent in quality and ships well.

Varieties of the European wine grapes and the famous Malaga grapes have been tested but so far found to be unprofitable in South Carolina. At the present time the Armalaga grape, a hybrid of Armlong and Malaga, is being tested but has been susceptible to disease and has been a light producer.

Tests of Muscadine Grape Varieties.—From a large number of muscadine grape varieties tested at this station, the Eden, James, Scuppernong, Thomas and Flowers have given best results. The above varieties are named in their order of ripening.

We have found it best to prune muscadine vines each year, the best time being the month of November. If pruned later, the vines will bleed severely and as a result be greatly weakened. The pruning consists of thinning and not cutting back the spurs, as is the practice with bunch grapes. In thinning, we cut out a few of the larger canes each year, whether the vine is trained on a trellis or on an arbor.

Variety tests of Irish Potatoes.—During the past year we have made a careful test of twenty varieties of potatoes. We make these tests periodically in order to check the new productions against the standard varieties. Spaulding's Rose No. 4, Irish Cobbler, Bovee, and Early Rose, gave the best yields, producing 285, 273, 272, and 271 bushels per acre respectively. In this test the yields varied from 71 bushels to 285 bushels per acre. The poorer yields were made by Drew's New Early Standard, Red Bliss, and McCormick.

Variety Tests of Lettuce.—During the past two seasons practically all of the varieties of lettuce listed by the seedsmen have been tested. A careful record has been kept of the habits of growth of the different varieties. A bulletin has been prepared on this subject and is now ready for publication.

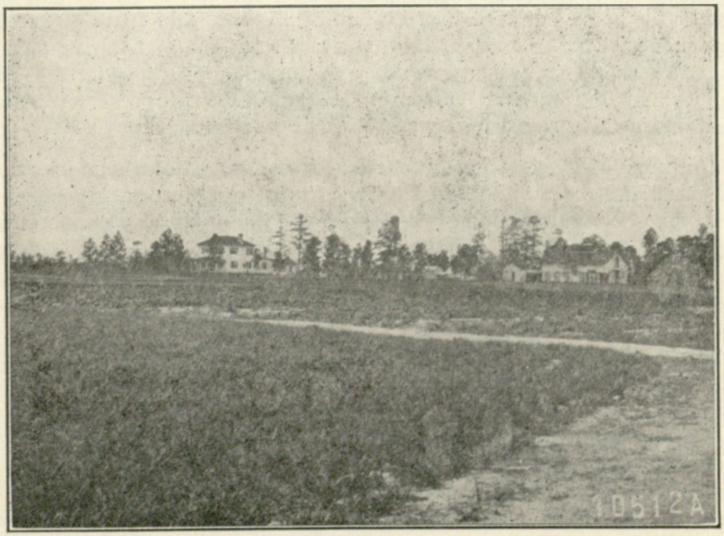


Fig. 15.—General view, Coast Station.

The following varieties are recommended for commercial purposes: Big Boston, Improved Hanson, Trianon (Romaine or Cos). The varieties considered best for home use and local markets are Big Boston, Improved Hanson, and Mignonette.

Variety Tests of Muskmelons.—Many varieties of muskmelons have been tested to determine which varieties are best adapted to South Carolina conditions from the standpoint of disease and drouth resistance, quality, and yield. The following varieties were found to be well adapted to this section: Emerald Gem, Burrel Gem, Jenny Lind, Rockyford-Pollock No. 25, Nutmeg, Extra Early Hackensack, and Hackensack. The Rockyford type is best adapted for shipping.

THE CLEMSON COAST EXPERIMENT STATION

The Coast Station is located on the cut-over pine lands of the lower coastal plain, at Drainland, twenty-four miles northwest of Charleston, on the Southern Railway. There are over two million acres of cut-over lands in South Carolina, and this station was started in 1908 for the purpose of conducting experiments in reclaiming these lands and utilizing them for agricultural purposes. Some splendid results have been obtained from the experiments with field crops, fertilizers, fruits, and vegetables, and these have been published from time to time. This station was established by the Board of Trustees of Clemson College and until 1920 was supported entirely with college funds. During the years since 1914, when the college has hardly had sufficient funds to run on, this sub-station suffered from lack of support and little progress was made with the experimental work. Since the legislature began at the session of 1920 to make an annual appropriation for the support of agricultural research, considerable progress is being made with the several important lines of work under way.

Drainage.—This station is located on low flat land about seventy-five feet above sea level and it is necessary to underdrain the entire area that is in cultivation. The drainage system which was installed during 1908 and 1909 had not been working satisfactorily during the past few years, and during the spring of 1920 the whole system was investigated by the Office of Drainage Investigation of the United States Department of Agriculture, and it was found that some of the tile in many of the lateral ditches were completely filled up with soil and sediment. In accordance with recommendations made by the drainage engineers, all of this tile was taken up in the fall of 1920 and cleaned out and relaid. Each joint was wrapped with building paper and covered with straw before refilling the trenches, and it is believed that no further trouble will result from the tile filling up with soil. This work involved the digging up, cleaning out, and relaying of 10,616 yards of tile at a labor cost of a fraction less than fifteen cents per lineal yard.

During the summer in co-operation with the United States Department of Agriculture, sixty-four observation wells were installed in drained and undrained areas in the fields for the purpose of observing the efficiency of the drainage system. An automatic flow recorder was installed at man-hole No. 1, through which all of the drainage water from the entire system flows, and this gives us a record of the actual water level at this point and the amount of water passing off through the outlet tile. A letter from Mr. G. L. Smith, the drainage engineer at Washington, contains the following information relative to the data.

"I have just completed plotting the data relative to ground water level elevations for the months of July, August, and part of September. These results of drainage show up even better than I had anticipated. Practically all drains are working and appear to be very effective."

During the very excessive rains which began June 25th and lasted through August 18th, our drainage system was given a very severe test. During this period of 55 days we had rain 41 days, the total precipitation for the period being 16.69 inches. In spite of this fact the crops on the areas which have tile drains at distances of 60 feet made fair yields and while of course they suffered considerably from wet weather, they did not suffer to the extent to which the crops suffered where the tile lines were 120 feet apart. While we feel that our drainage system has been greatly improved by the work which has been mentioned above, we feel that we would get very much better results by completing the work which was orginally designed and putting in additional lines of tile where they are now spaced 120 feet apart. Plans are under way for doing this.

Additional land for cultivation is badly in need for our experimental work with field crops and for growing forage for the beef cattle and hogs. During the summer work was begun on clearing and underdraining an area of approximately twenty acres of land situated on the front part of the property. This area which we are clearing will greatly facilitate the experimental work at this sub-station. This land, with that already cleared, will give us about 100 acres for cultivation.

Forestry Experiments.—The tests with methods of planting, and the natural reproduction studies with different species of pines, which were started some years ago in cooperation with the Forest Service of the United States Department of Agriculture, are progressing satisfactorily.

The pine seed have been planted from year to year and the seedlings are making good growth. We have secured some good results in methods and rates of seeding pine. In March, 1921, we planted one acre in long leaf pine and two and one-half acres in slash pine. These plantings were made on a more extensive plan

Fig. 16.—Natural reproduction of long leaf pine in forestry experiments, Coast Station.

for the purpose of determining the best rate and method of seeding. Protection is given to the forest area each year by establishing a fire guard around the area.

Pasture Development.—We believe that practically all of this cut-over pine land of the low country can be utilized profitably in the production of beef cattle. The native grasses, however, will not stand close grazing and carry a sufficient number of cattle to enable the industry to develop as it should. We have undertaken, therefore, to determine the best grasses and pasture plants to use and the best methods of developing permanent pastures in this section.

The three hundred acres of land purchased for this work last year have been fenced and subdivided into twenty-five-acre and fifty-acre pastures for these experiments. Fifty acres were sown to carpet grass and lespedeza. Where the land was burned over before seeding and the pasture grazed closely and the seed sown broadcast, satisfactory stands seem to be developing.

Tests of methods of seeding carpet grass and lespedeza were begun on fifteen acres. The stumps were removed from this area so that parts of it could be plowed and the objectionable weeds that develop on it could be cut with a mower. The following five methods of seeding are being used in preparation of the land for the seed: burning over, plowing, disking, cutting over, and no treatment. On the areas which are disked and plowed, it seems that we have secured a better stand of grass and clover. It may be,

however, that this is only apparent and that we are able to see the new grass better on the land on which the sedges have been partly killed out by cultivation.

In other tests several seeding mixtures were tried on land that had been plowed and disked. These tests have not been completed at the present time. In still other tests with carpet grass and lespedeza seeded on plowed land, lime and fertilizer were applied before planting. It appears that we have secured much better stands and certainly better growth where some fertilizer was applied before planting. The fertilizer used in this work was nitrate of soda and acid phosphate, different rates of application being made. In some of the plots of this series we have secured a very satisfactory stand of lespedeza and carpet grass.

Beef Cattle.—We are endeavoring to build up a producing herd of purebred and good grade beef cattle to use in our pasture and feeding experiments. The present herd has developed satisfactorily during the year so that we now have forty-eight head. About half of these are purebred Angus. The cattle were turned on pasture about the first of March, 1921, and can be kept there until November. when they will be turned in the fields for a month of two before going to the barns for the winter. Cattle ticks are still present on some of the lands adjoining the station, and this fact has interfered some with our plans for developing the herd and has necessitated the construction of a double fence along our line.

Twenty-five head of goats are being used very satisfactorily for clearing out the brush and undergrowth in some of our pastures.

Hogs.—We now have twenty-five head of purebred Poland China hogs on this station, and some of these are being used in grazing experiments. We are at present hogging off sweet potatoes and conducting other feeding tests with potatoes and corn and tankage.

Crops.—Twenty acres of cotton was grown this year, all of this being in experiments. Sixteen acres of this amount was used in experiments looking to control the boll weevil and the balance in fertilizer, variety, and spacing tests. The excessive rain interfered seriously with the growth of the cotton and prevented our getting into the fields to carry out the plans for boll weevil control, so that the crop was almost a complete failure, only three bales being produced on the twenty acres.

The variety tests with corn gave satisfactory results in spite of the seasons, and good yields were obtained from general crop corn.

Alfalfa sown on this station in the fall of 1920 has produced four cuttings of excellent hay, yielding a total of over three tons per acre. Where lime was not used on a part of the alfalfa, the crop was almost a complete failure.

A number of new grasses brought in from other countries are being tested. The most promising of these is "Fundi", a grass resembling crab grass in general appearance and brought in from South America. This gives a good yield of hay.

Irish Potatoes.—A fertilizer test was conducted with Irish potatoes at this station in the spring of 1921 with the following results —Phosphoric acid alone did not increase the yield; prosphoric acid and potash gave an increase of 22 bushels per acre. A complete fertilizer gave increased yields of from 57 to 71 bushels per acre, depending upon the source of ammonia used. The largest yield was produced with a complete fertilizer, one third of the nitrogen used coming from each of the following sources: cottonseed meal, blood, and soda. Blood gave better results than any other single source of nitrogen, nitrate of soda came second, and cottonseed meal third.

Fruit.—The variety tests with peaches and grapes at this station were completed last year and the trees and vines taken out to make room for crops of other kinds. These experiments showed clearly that peaches and grapes can be grown successfully and profitably in this section, if they are planted on high well drained land. The grapes especially when planted on land where the water table is not more than two or three feet below the surface did not do so well. Of the varieties of peaches tested, the best results were obtained with Greensboro, Carmen, and Elberta. With bunch grapes the best were Brighton, Concord, Niagara, and Lutie. With muscadines the best were Eden, James, Scuppernong, Thomas, and Flowers.

Since these tests were completed we have planted a one-acre demonstration orchard on the plan recommended by Prof. Newman for home use. This includes all of the common fruits.

The Washington Asparagus.—A rust-resistant variety developed by the United States Department of Agriculture has been grown here for two years and is now producing splendid yields of a good quality of asparagus.

Buildings.—We have just completed a beef cattle barn which is badly needed in connection with our livestock work. This barn has ten stalls for cows and calves, and grain room, and a large loft space for hay, with two open sheds thirty-eight feet long for feeding cattle. The barn is comparatively inexpensive, but is large enough and so arranged that it will take care of seventy-five head of cattle. We are very much in need of several small houses for laborers on this station and it is hoped we can build these next year.

THE CLEMSON PEE DEE EXPERIMENT STATION.

The Pee Dee Station is located in the heart of the Pee Dee section on the road between Florence and Darlington, about two miles from Florence. Its lands were once part of the old Gregg tract and as such were in a high state of cultivation when purchased in 1913. The soil is of fine sandy loam type and fairly uniform throughout, the land is level and fairly well drained, which makes it ideal for research work.

The work at the Pee Dee Station has made rapid progress, and the manner in which the people of the state and especially of the Pee Dee section have availed themselves of the facts about farming so aptly demonstrated there is indeed gratifying and encouraging. Almost daily there are interested visitors at the Pee Dee Station, often coming in crowds, and always expressing themselves as having been benefited by what they have seen, and going away more determined to be better farmers and more useful citizens.

The work from the outset has been largely with the field crops and fertilizers, because these were the most important problems of the Pee Dee section. Numerous experiments have been conducted, however, with fruits and vegetables, and some very interesting experiments have been made with hogs.

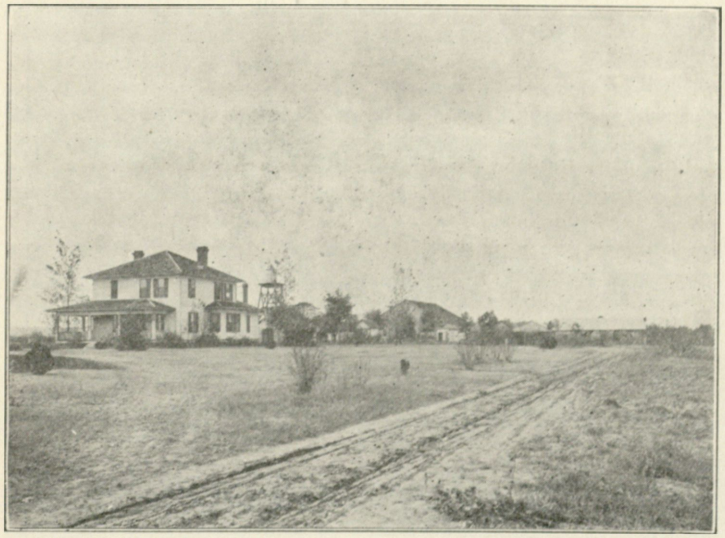


Fig. 17.—General view, Pee Dee Station.

Variety Tests.—Experiments have been conducted at the Pee Dee Station for the purpose of determining the best varieties of all the leading crops in that section. Variety tests have been made with cotton, corn, soy beans, peanuts, sweet potatoes, and velvet beans, in addition to a number of orchard and garden crops. In these tests sometimes as many as forty varieties of the same crop have been under observation at the same time.

The results obtained from our variety work with cotton have enabled us to recommend among the short staple varieties, the Dixie-Cooke and the Dixie-Triumph on wilt-infested land, and strains of the Cleveland on wilt-free land. Of the long staple varieties we recommend for this section the Webber 49 and the Delta-type Webber. Lightning Express also promises to be a valuable long staple variety. This variety has attracted much attention because of its open habit of growth and the absence from it of vegetative branches.

In the work with corn there were fifteen varieties under observation, from which we have selected six as best adapted to the Pee Dee section. These are Brunson, Douthit, Garrick, Pee Dee No. 5, Williamson, and Weekley.

The results of variety work at the Pee Dee Station tally with those of the main station, which goes to show that the soil has not been a great factor in causing variety superiority within the same crop.

Fig. 18.—Method of stacking peanuts at Pee Dee Station.

Breeding Work.—Breeding work has been undertaken at this station with cotton, corn, sweet potatoes, peanuts, and velvet beans.

The chief object in breeding cotton here is to develop an early productive wilt-resistant variety which could be grown successfully under boll weevil conditions. A Dixie-Cooke hybrid, which was developed several years ago in our cooperative work with the United States Bureau of Plant Industry, has stood up well on land severely infested with wilt and has shown considerable promise as to earliness and yield. We are devoting particular attention now to the breeding of this variety. We also have an excellent strain of Cleveland isolated by Mr. E. E. Hall of our Extension Service. This has done well under heavy boll weevil infestation this season and is partially resistant to wilt.

For a number of years we have carried on ear-to-row breeding work with our Pee Dee No. 5 corn. This strain has yielded consistently higher than other standard varieties and has come to be used to considerable extent in this section.

During the past year extensive breeding work for the purpose of studying hereditary factors in corn has been conducted here in cooperation with the United States Department of Agriculture. Mr. H. Stoneburg of the Office of Cereal Investigation of the United States Department of Agriculture has devoted his entire time to this work and has obtained very valuable data on inheritance. In this work corn had been inbred for a number of generations in order to intensify certain characters. Some out-crosses were made and these will be tested next season.

We are continuing our work with peanuts in cooperation with the Department at Washington. Improvement has been made in the Red Spanish variety and in the Valencia. Practically every known variety of peanuts has been given a trial at the Pee Dee Station, including several varieties sent in from foreign countries. In this breeding work particular attention is being paid to oil content of the seed.

Sweet potato breeding at the Pee Dee Station has been emphasized during the past year. The Porto Rica variety, which is the one most commonly grown, has been found to produce in varying degrees of color and in irregular sizes and shapes. We have conducted uniformity and selection experiments with a view of establishing more uniformity in this variety of sweet potatoes. This work will be continued in cooperation with the United States Department of Agriculture.

Fertilizer Experiments.—The fertilizer work has been in progress at the Pee Dee Station since 1913 without any appreciable alteration of the plans as they were originally perfected. The general comparative tests with fertilizers, consisting of one hundred and eighty (180) plots of one-tenth acre each, constitute what is perhaps one the most comprehensive fertilizer investigations in the country.

The detailed results of this work are being prepared for publication in bulletins. Important among these fertilizer investigations are those which are yielding valuable data on (1) rotations, (2) value of certain fertilizer combinations, (3) residual effects of fertilizers, (4) sources of essential elements, (5) theoretical amount of fertilizer necessary to produce a bale of cotton, and (6) time of applying.

A special test is being made on tobacco with the view of determining the relation of fertilizers to yield and quality of tobacco. This year as many as fourteen different formulas were tested under tobacco. From the results of this experiment we are convinced that the average farmer has been using too much fertilizer to make the best quality of tobacco. Fertilizer tests and rotation studies are also being conducted at this station with peanuts and sweet potatoes.

Grasses and Legumes at the Pee Dee Station.—Altogether about fifteen of the grasses and legumes have been under observation at the Pee Dee Station and we have found that practically all of them will grow more or less successfully in the Pee Dee section. Among the most valuable of these are alfalfa, cowpeas, crimson clover, soy beans, velvet beans, peanuts, and vetch. Sudan grass has proved a good forage and hay crop for this section.

Hog Crops.—The work with hogs has been continued along the same lines reported last year. This work is planned by the animal

Fig. 19.—Second cutting of Sudan grass, Pee Dee Station.

husbandry division of the experiment station and is closely correlated with that under way at Clemson College and at the Coast Station. Alfalfa, crimson clover, rape, and corn continue to give the best results when hogged off.

Fruit and Vegetables.—During the last few years variety experiments have been conducted at the Pee Dee Station for the purpose of determining the varieties of the various fruits and vegetables most adapted to the Pee Dee section. The work along this line has gone far enough to convince us that some variety of all the various fruits and vegetables can be grown successfully in the Pee Dee section. From the various fruit and vegetable crops we have been able to pick out a few varieties with superior bearing and keeping qualities. We have given attention to the growing of grapes, peaches, plums, strawberries, cabbage, Irish potatoes and onions, and find that with proper care and cultivation all of these crops may be produced at a profit. Our experiments with varieties lead us to recommend Moore's Early, Brighton, Lucile, Niagara, and Delaware varieties of grapes; Mamie Ross, Hiley, Belle of Georgia, Elberta, and Burke Cling varieties of peaches; Shiro, Abundance, and Burbank plums; and Lady Thompson and Klondyke strawberries.

Buildings.—During last fall two four-room tenant houses were constructed at this station for negroes, and we now have sufficient housing facilities to take care of the majority of the laborers needed on the station farm.

COST OF PRODUCTION STUDIES.

There has been a great deal of discussion within the past few years as to the cost of producing crops under different conditions. When a search is made in the agricultural literature, very little reliable information is found on this subject. Hoping to secure data that would be of value along this line, we have kept accurate records of all of the operations and costs involved in producing the crops in the different fields on the experiment station farms this year. On the college farm alone we have kept such detailed records on twenty fields growing ten different crops, and much valuable data are being secured. These records include the man hours, horse hours, and tractor hours needed for each operation as well as the actual cost of seed, fertilizers, and miscellaneous supplies. Record is also kept of the number of days each mule works during the year so as to arrive at the cost of horse-power.

These data are being worked up and will be published as soon as we have sufficient records to make the information representative of the different seasons and conditions.

LIBRARY.

The agricultural workers of the college and experiment station have for years felt the need of a working library where all of the publications from the various state experiment stations, the United States Department of Agriculture, and foreign countries were readily accessible and available for study and reference. Agricultural research as well as teaching and extension can be conducted satisfactorily only when the workers have ready access to all of the published information on any problem that engages their attention. This is the second year during which we have had a trained librarian engaged in classifying and cataloging the mass of valuable material which we have accumulated during the past thirty years.

The librarian's annual report shows books accessioned and made ready for the shelves, 797; volumes bound, 336; volumes in temporary binders, 73; volumes collated for binding, 169. The above does not include the routine work of checking and making accessible 7214 copies of bulletins and 2948 copies of agricultural journals, besides 10,562 pieces of minor mail, consisting largely of circular material on agriculture.

With improved provisions for agricultural reading and reference work, the library is being used more and more by teachers, research workers, extension workers, and students. The librarian's report shows a total of 2995 "readers," 2006 of which were students and 989 of which were faculty. Those classified as "faculty" include of course teachers, research workers, and extension workers.

PUBLICATIONS.

With the changing conditions in our agriculture, there is a greatly increased and increasing demand for publications showing the results of experiment station research. Our station publications are therefore in greater demand and seem to be more highly appreciated than ever before, and the distribution of the publications of this fiscal year has been noticeably greater than in former years. The result has been a rapid decrease of our supplies, many numbers being completely exhausted.

The mailing list now contains 5000 names, mostly South Carolina farmers. The list is classified so that publications are issued only to those who have asked for the class of material to which a given publication belongs. In this way waste of publications is largely prevented.

Five publications were issued during the fiscal year as follows:—

Bulletin 203, "Analyses of Commercial Fertilizers."

Bulletin 204, "The Slender Wireworm; Its Relations to Soils."

Bulletin 205, "Muscadine Grapes; Culture and Varieties."

Bulletin 206, "Products and Utilization of Muscadine Grapes."

Thirty-third Annual Report, for year ended June 30, 1920.

Besides these regular publications a number of articles have been published in scientific journals and periodicals and many news articles for the Weekly News Notes and the press of the state. There are three bulletins now ready for publication and others in process of preparation.

PROJECTS UNDER WAY.

The following is a list of projects now under way in the Research Department.

Agronomy Division—

Cotton variety tests
Corn variety tests
Peanut variety tests
Wheat variety tests
Velvet bean variety tests
Soy bean variety tests
Cowpea variety tests
Oat variety tests
Sorghum variety tests
A study of the inheritance of barrenness in corn
Inheritance in oats
Breeding corn
Breeding cotton (Cooke)
Breeding wheat
Breeding barley
Breeding peanuts
Breeding work with cotton (general)
Corn and cotton two-year rotation
Rotation and fertilizer tests
Cotton spacing and culture tests
Corn culture tests
Effects of companion crops on corn
Factors influencing oil content of cotton seed
Effects of soil stirring on moisture, nitrification, yield, etc.
General fertilizer tests
Comparative tests of sources of phosphorus
Comparative tests of sources of nitrogen
Tests of sources of ammonia for top-dressing cotton
Effect of Trona potash on cotton and corn
A test of methods of applying fertilizers
Test of theoretically correct fertilizer formulas
Cooperative fertilizer experiments, cotton, corn, oats, peas

Animal Husbandry Division—

Comparison of forage crops in pork production
Velvet bean meal vs. soy bean meal for fattening hogs

Permanent pasture experiments
Fish meal vs. tankage for hogs
Soft pork investigations
Bur clover and Bermuda vs. dry lots for growing gilts
Pig feeding experiments
Horse and mule breeding experiments
Hampshires vs. Southdowns in the South

Botany Division—

Plant disease survey of South Carolina
Cotton anthracnose investigations
A study of cotton root diseases
Bacterial diseases of cotton
Cotton shedding work
Cowpea and cotton resistance to root knot
Rust resistance in small grains
Tests with imported grass and forage plants
A study of the bacterial content of milk
Forestry plantings.

Dairy Division—

Economic concentrates to supplement cottonseed meal for dairy cows
Corn silage vs. sorghum silage
Cost of raising dairy calves
Prepotency of bulls used in our herd
Line breeding and out-crossing as systems of breeding
Advanced register testing of dairy cows

Entomology Division—

Temperature-moisture in relation to insect activity
Cotton root louse studies
The slender wireworm and its control
Root knot studies
Control of peach tree borers
Factors affecting boll weevil hibernation
Cotton boll weevil control by dusting with calcium arsenate
South Carolina honey flows
Winter packing of bees
The value of the aluminum honey comb

Horticultural Division—

Variety tests of peaches
Variety tests of pears
Variety tests of grapes
Variety tests of strawberries
Variety tests of pecans
Variety tests of potatoes
Variety tests of muskmelons
Variety tests of tomatoes
Variety tests of lettuce

THE SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH U. S. APPROPRIATIONS

1920-1921.

DR.		Hatch Fund.	Adams Fund
To balance from appropriations for 1919-1920			
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1921, under act of Congress approved March 1, 1887, (Hatch Fund) and March 16, 1906, (Adams Fund)		$15,000.00	$15,000.00
CR.	ABSTRACT		
By Salaries	1	$7,290.72	$10,731.76
Labor	2	3,423.30	1,414.82
Publications	3	365.62	
Postage and stationery	4	749.78	37.18
Freight and express	5	260.74	76.28
Heat, light, water, and power	6	22.50	253.51
Chemicals and lab'y supplies	7	24.58	765.02
Seeds, plants, and sun. supplies	8	353.71	216.73
Fertilizers	9		
Feeding stuffs	10	1,295.81	410.94
Library	11	479.75	7.50
Tools, mach., and appl.	12	264.79	400.92
Furniture and fixtures	13	201.79	132.26
Scientific appar. and spec.	14		436.20
Livestock	15		100.00
Traveling expenses	16	175.32	5.89
Contingent expenses	17		
Buildings and land	18	91.59	10.99
Balance			
Total		$15,000.00	$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Treasurer of the South Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1921; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $0.00 on the Hatch Fund and $0.00 on the Adams Fund; that the receipts for the

year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2, 1887, and $15,000.00 under the act of Congress of March 16, 1906, and the corresponding disbursements $15,000.00 and $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of $0.00 and $0.00.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, and March 16, 1906, and in accord with the terms of the said acts, respectively.

Signed.

W. W. BRADLEY,
State Auditor.

Attest:
S. W. Evans, Treas.
Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION.

(Including the Sub-Stations) 1920-1921.

(Supplementary Statement.)

This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriations and is necessary for compiling the station statistics. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable, such a summary of receipt and expenditures from the sources indicated below as can be conveniently prepared from the books of the station may be substituted. Whenever practicable it should be used for the fiscal year ended June 30.

DR.	
To balance on hand	$ 2,219.43
Receipts from other sources than the United States for the year ended	69,308.18
Total	$71,527.61
CR.	
By Salaries	$26,720.49
Labor	13,645.62
Publications	1,413.55
Postage and stationery	258.67
Freight and express	159.81
Heat, light, water, and power	3.30
Chemicals and laboratory supplies	34.87
Seeds, plants, and sundry supplies	7,852.59
Fertilizers	2,096.51
Feeding stuffs	4,496.29
Library	167.62
Tools, machinery, and appliances	5,551.00
Furniture and fixtures	302.50
Scientific apparatus and specimens	44.69
Livestock	800.00
Traveling expenses	2,906.90
Contingent expenses	
Buildings and land	5,495.05
Balance	
Total	$71,949.46

Difference of $421.85 this page represents excess expenditures over receipts on "Sales" fund.