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ALABAMA

Agricultural Experiment Station

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THE SAN JOSE SCALE AND LIME-SULFUR WASH

BY

W. E. HINDS,

Entomologist

Opelika, Ala.:
The Post Publishing Company,
1909

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THE SAN JOSE SCALE AND ITS WORK.

[Fig. 1.—Peach tree with top killed by the scale. Fig. 2.—Peach twig, moderately infested, showing male and female scale. Fig. 3.—Peach limb badly infested with scale. Fig. 2, enlarged 4 times; fig. 3, enlarged twice.] (After Quaintance, U. S. D. A. Year Book, 1905.)

THE SAN JOSE SCALE AND LIME-SULFUR WASH

BY

W. E. HINDS, PH. D.

Entomologist to Alabama Experiment Station.

ORCHARD INTERESTS OF ALABAMA.—The culture of orchard fruits, particularly peach, plum, pear and apple, is already a very important factor in the agricultural prosperity of Alabama. As nearly as we are able to estimate from the data available there are about 8,000,000 trees of these four kinds now growing in this State. Soil climate and market conditions are exceedingly favorable to a large increase in the growth of these fruits. The extension of the present important movement for the production of a greater diversity of crops, the substitution of other, and more profitable, crops for cotton and the adoption of improved methods for the culture of all crops grown will undoubtedly result in a great increase in fruit growing within the next few years. The growth of these fruits for wholesale commercial shipments and for the supply of the home markets as well, should increase largely as a profitable business proposition.

DANGER FROM SAN JOSE SCALE.—The principal difficulty to be met in maintaining present and in increasing future fruit culture is the necessity for controlling the insect enemies which, if left uncontrolled, may partially, or entirely, destroy the crops of fruit or even the life of the trees themselves. The most important insect affecting the four species of trees mentioned is the San Jose scale (pronounced "San Hosay") known scientifically as *Aspidiotus perniciosus* Comst. This is the most deadly enemy of fruit-growing known. The name itself means "most injurious scale" and it was well chosen.

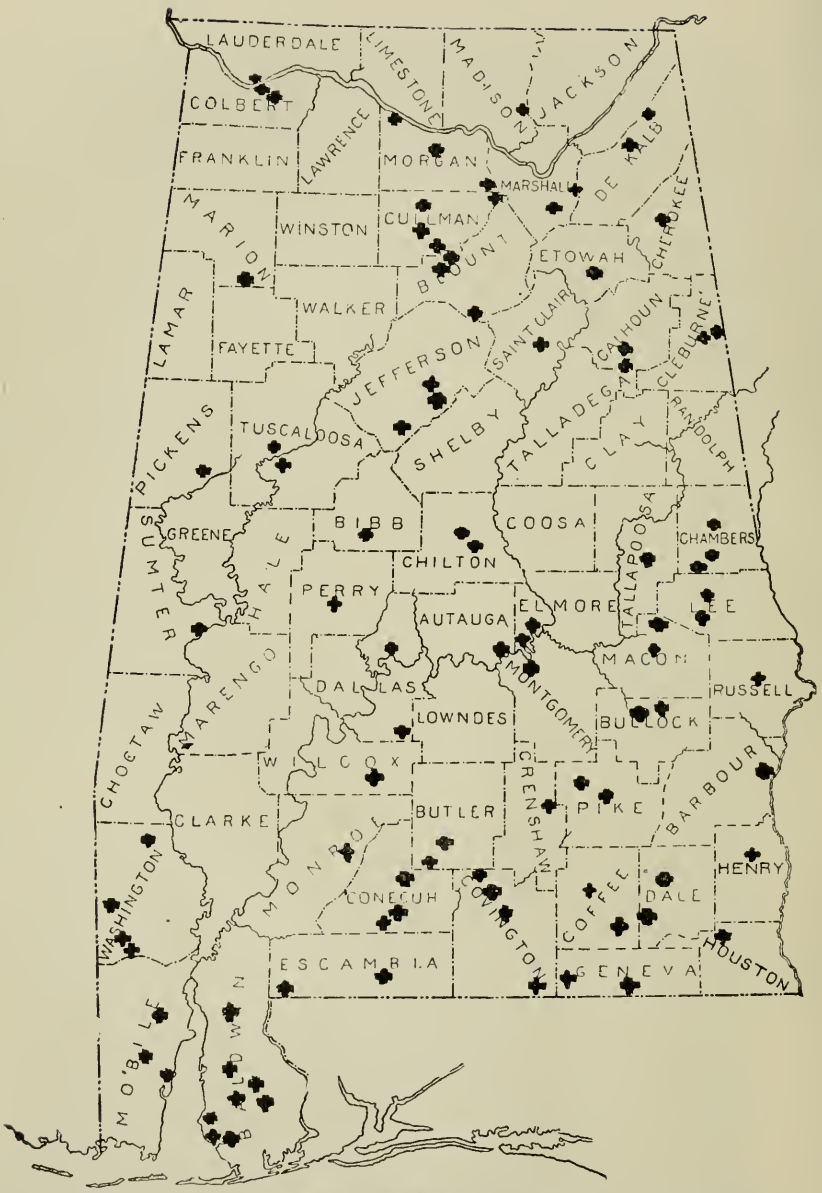

FIG. I. *Present known distribution of San Jose Scale in Alabama.*

Introduction and Spread of the Pest.—This insect is not a native of the United States but appears to have been brought here from China where it occurs commonly upon native food plants. It was introduced into the San Jose Valley, California, about 1870 and the name of that locality where it was first found has been adopted as the common name of the scale. From California the species was brought on nursery stock into the eastern states shortly before 1893. It has since been spread by nursery stock shipments until it now occurs in nearly every State in the Union. During recent years, however, most of the States have passed strict laws requiring the inspection of nurseries for the occurrence of the scale and the fumigation of stock so as to kill any scales which might possibly exist there before the stock can be legally sold and distributed. The nurserymen have co-operated heartily in this effort to prevent the further spread of the pest so that now the buyer of fruit trees is very effectually protected against the planting of already infested trees. Orchards may be started today much more safely than they could ten years ago.

Occurrence of the Scale in Alabama.—The known extent of its occurrence in this State is indicated upon the accompanying map (Fig. 1.). Without doubt it exists in many other places from which it has not yet been reported. Very frequently its presence in an orchard is not detected until some of the trees begin to die whereupon the cause of their death is sought for. A characteristic type of peach tree dying from this scale is shown in Plate I, fig. 1. The dying of the trees does not usually begin until some two or three years after the actual introduction of the scale and it has thus an opportunity to spread unchecked through the orchard.

What is the Scale.—The San Jose scale is a minute, inconspicuous insect which does not, to the untrained observer, appear to be a living creature. The body of the living insect is concealed beneath the circular, waxen scale which it forms for its protection. The largest scales

are smaller than an ordinary pin-head in diameter and are quite flat (See Pl. I, figs. 2 and 3). The scales are hardly more than 1-25 inch across and many of them are smaller still. Beneath the scale the body of the insect may be found as a small, immovable, yellow body (if still alive) which if crushed seems to be filled with a rather thin, yellow, oily liquid. The young of this species are born alive and their powers of reproduction are so remarkable that a tree bearing but few live scales in the Spring may become quite heavily infested by Fall and will then be liable to severe injury during the following season unless some method of destroying the scales is used during the winter.

Close observation with the naked eye shows that the scales are marked with rings of light and dark gray around a nearly black center. When very abundant they give a general ashy-gray appearance to the entire bark which is noticeable at some distance from the tree.

NATURE OF THE INJURY.—On living infested branches, especially on growth two or more years old, the surface becomes irregularly pitted or has depressions in spots where the scales are most abundant. The injury is of two kinds. Much sap is abstracted by the myriads of sucking insects, but more important than this is the effect which these scales have of causing a thickening of the cell walls which are penetrated by their slender mouth parts. This thickening checks the flow of sap in the branches, and this means the ultimate starvation of the parts of the branch beyond. The San Jose produces a distinctive red stain around the point of attack, either upon infested fruit or just under the scale in the bark. This appears upon lightly scraping off the outer bark.

NECESSITY FOR TREATMENT.—So serious is the injury of which this scale is capable that untreated, infested trees are certain to be killed within a very few years. The LIFE OF THE ORCHARD IS AT STAKE and the plain conclusion is evident that it is far more expensive to allow the trees to be destroyed than it would be to con-

trol the scale which can positively be done so as to continue the life of the orchard and the production of profitable crops. The average annual cost per tree for treatment depends mainly upon its size and ranges, for peach trees, from one-half cent to three cents, averaging between one and two cents. The man who will allow his total investment in trees, land and labor through three or four years to be absolutely destroyed for lack of an additional expense of a cent or two per tree each year, cannot be considered as conducting his work upon anything like business principles.

BEST METHOD OF TREATMENT.—The fight against the San Jose scale has developed several methods of treatment which are of positive value. Three points require consideration in determining which of these methods is best and should therefore be used. 1. Safety. 2. Efficiency. 3. Economy. The method which has been shown to best fulfill these conditions is "A WINTER SPRAYING WITH LIME-SULFUR WASH." In spite of numerous efforts to replace this Lime-Sulfur with some other material more easily prepared or less objectionable to handle in application, the fact remains that this is conceded by the great majority of orchardists, as well as by entomologists, to be the best treatment yet found.

It may be applied with safety at any time while the trees are in a dormant condition. A single thorough spraying with a properly prepared wash insures the control, if not the extermination, of the scale and is safer and more reliable than is any other treatment. The cost of treatment, varying in localities and with number of trees to be treated, need not exceed from one to thirty cents per tree according to their kind and size

SEASON FOR MAKING THE APPLICATION.—The safest and most effective time for treating trees for scale is during the dormant period, that is, between the time the leaves drop in the fall and the time the buds start in the spring. Experimental work has shown that a single treatment with Lime-Sulfur made in November or De-

cember is less effective than is a single treatment made in February or March, and that two treatments, one in the Fall and another just before the buds start, are but slightly more effective than is the later treatment alone. The exact time for spraying after January 1st may be decided by convenience as related to other work and by the continuance of the dormant condition of the buds.

A solution strong enough to kill the scale may be applied to the bark without injury at any time during the summer. It may be applied by painting or swabbing it onto the trunks and largest branches to check the summer development of the scale, but such a solution will destroy all foliage touched by it, and cannot therefore be sprayed on as in winter.

At about one-fifth of the strength recommended, however, it is thought by some that Lime-Sulfur can be sprayed upon even peach foliage which is fairly matured as at fruiting time, and that at that strength it will be a very effective agent in the prevention and control of the brown rot of peaches which is now one of the most serious problems in peach production in Alabama.

PREPARATION ON THE ORCHARD FOR TREATMENT.—This is a matter of considerable importance and the exact measures to be applied to each tree depend largely upon the degree of its infestation.

Slightly infested trees should be pruned before being treated as is best for their fruiting regardless of the presence of the scale. With heavily infested and badly injured trees, the pruning should be much more thorough. Trees which are nearly dead should be cut out and, in a young orchard, replaced if desired by new ones. All dead branches should be removed. Branches still alive but which have made very little growth during the preceding season should be strongly cut back, in some cases leaving them as mere "stubs" a foot or two long from the main trunk. If the cuts are more than three-fourths of an inch in diameter their surfaces should be painted over with White Lead. If there is still life enough in the tree

a new top may be formed out of several of the best and most vigorous shoots thrown out from these "stubs." In many cases it may be possible to control the scale and to thus renew the top of badly injured trees, so as to have them again of good size and bearing more fruit in two or three years than would young trees if put in their places. This is entirely a question of orchard management for the quickest and best production of fruit. It is certain that the scale may be controlled so the age and condition of the tree, etc., must decide the question whether it should be pruned and kept or cut out. It is advisable to burn removed trees and branches to get them out of the way and to prevent further spread of insect pests from them to living trees. The scale is not liable to spread if the trees and prunings are not burned but other injurious insects which may breed in the dead wood may spread from them, particularly to scale injured trees and thus cause the death of trees which might otherwise be saved from the scale.

Adjacent thickets or trees of wild plums or cherry, etc., should be cut and burned. Beside the trees mentioned many others are liable to attack by this scale. The following are some of those occurring commonly: Crab apple, apricot, persimmon, several kinds of walnut and of poplar, osage orange, chestnut, sumac, catalpa, cedar, several of the willows, ash, elm, pecan, orange, lemon, strawberry, gooseberry, currant, etc.

THE LIME-SULFUR TREATMENT.—This wash has been very extensively used in California during the past twenty years. In the eastern United States since about 1900 it has been recognized as the best agent for destroying San Jose scale. Its effectiveness depends upon a chemical combination of the lime and sulfur which is brought about practically only under high temperatures. In a general way, if the chemicals are pure, we may reckon upon using practically equal portions of lime and of sulfur. In practice, however, it has been found better to use a somewhat larger quantity of lime, since commer-

cial rock lime varies somewhat in purity and is cheap. The excess of lime simply forms a whitewash which shows plainly the trees that have been treated. An excess of sulfur would remain undissolved in the solution. While this would do no harm, its presence would do no good and it might be considered as a needless item of waste. Both lime and sulfur are effective for some insects and fungi when used separately, but when combined they act far more efficiently. The principal object in making the wash is to produce economically a safe and thoroughly effective spraying solution.

In planning for making and using this wash a number of practical points require consideration for best results.

ESTIMATION OF QUANTITIES OF CHEMICALS NEEDED.—Naturally this is a difficult matter for the man who has never used anything of the kind. The first consideration is the number and the average size of the trees to be treated. If the scale is known to occur anywhere in an orchard, the only safe thing to do is to spray all trees in it, and the treatment should include at least all of our fruit trees which shed their leaves in the Fall. The amount of spray required will obviously depend directly upon the size of the tree. We may take average three to four-year-old peach trees as our standard and estimate that such trees will require about one-half gallon of spray each for thorough work, and no other kind of work is worth while. Each gallon of spray solution will therefore treat two medium-sized trees, while large trees may require two gallons each. In this way an approximate estimate may be made of the number of gallons of spraying solution to be prepared.

The question of formula must be next considered. As a result of a vast amount of experimental and practical work, it appears that the following formula is safe, efficient and economical:

Rock lime	20 lbs.
Flowers of Sulfur or Sulfur Flour	15 lbs.
Water to make	50 gallons

In ordering our chemicals therefore we reckon upon 20 lbs. of lime and 15 lbs. of sulfur for every 50 gallons of spraying solution which we have estimated to be needed. Emphasis should be laid upon the ultimate economy of using only the best and purest chemicals obtainable, regardless of their slightly greater initial cost.

LIME.—This means always freshly burned rock lime or quick lime. The test of quality is the slaking. Good limes should not contain more than ten per cent of impurities. Poor limes may contain 25 per cent of impurities. It is partly on account of these varying percentages of impurities that more lime than sulfur is used in the formula given. A good lime will slake readily and form an even creamy solution with little sediment or coarse matter which is waste.

Much first-class lime is produced in Alabama, particularly that made in the vicinity of Calera. The addresses of several manufacturers may be found in the Appendix on page 20.

The best grade of lime is shipped and handled in barrels. This is the best form in which to buy it, and the cost should not exceed about $1.00 per barrel or 1c per pound for our spray formula. In nearly every town may be found someone who handles a good grade of lime.

SULFUR.—The sulfur used must be very finely powdered to combine readily and completely with the lime in the making of the wash. Two forms of sulfur to be found on the market are perfectly pure and answer this need equally well. The "Flowers of Sulfur" is the finest form and is largely used, but may cost slightly more than does "Sulfur Flour" or "Flour Sulfur" as it is called. The choice between these two depends upon availability and price. Either should be obtainable at about five cents per pound in lots of fifteen pounds or more. If not obtainable at a satisfactory price through local druggists, sulfur may be secured through the wholesale drug firms listed in the Appendix page 20, and from other firms probably as well. Crystalline Sulfur should not be used under any

circumstances, since it is so coarse that it will not combine completely with the lime even with prolonged boiling. The result is a direct waste of sulfur and a wash solution that is liable to contain too little sulfur to be efficient, thus wasting all the chemicals, the labor of application and possibly, too, the life of the trees through ineffective treatment.

Preparation of the Wash.—For this work some facility for boiling the solution is essential. Where it is to be made on a small scale, and even in the treatment of several thousand trees where only one barrel pump is to be supplied, the cooking may be done quite conveniently in two large cast iron kettles, one of which may hold about 20 to 25 gallons, while the other should hold 40 gallons. The smaller kettle can be used in heating water while the lime and sulfur are being boiled in the larger one. For treatment of from 5,000 to 10,000 trees it is better to have larger kettles holding 75 to 80 gallons and mounted in a brick frame work or furnace. The cooking should be done when possible near a convenient water supply, but it is better to haul the water than the wash. For more than 10,000 trees it will be far better to cook the wash by steam supplied directly from a portable boiler or some such source. the cooking may then be done in barrels placed side by side and preferably upon an elevated platform. The essential point is that the boiler supply about one horse power for each barrel to be boiled with about 30% surplus power for the pumping and heating of water, etc. Wherever possible the water supply and the cooking barrels should be elevated sufficiently to utilize gravity in the flow of the liquids into the cooking barrels and from them into the spray tanks.

The kettle method of preparation will be described particularly as it may be more commonly employed in this State. Much latitude is permissible in the details of the preparation for the cooking. The essential points are to secure the complete and rapid slaking of the lime and the mixture of the sulfur with the lime solution without the

lumping of the sulfur. To avoid this the sulfur should always be mixed to a thin paste with hot water before being poured into the large boiling kettle. If this be done it makes little difference in the final result whether it be added before, after or during the slaking of the lime. The following method is as good as any and easy to follow:

For each 50-gallon lot of spray solution to be prepared mix 15 lbs. of fine sulfur to a thin paste in hot water in some convenient receptacle. Heat about 12 to 15 gallons of water in the 40-gallon kettle and while it is heating add the sulfur paste taking care to break up any lumps that may exist. Then add, lump by lump, the 20 lbs. of best rock lime. By the time the lime is all slaked the solution should be boiling hot. Add about 10 gallons more of hot water and continue the boiling steadily for about one hour. During this time the mixture must be stirred almost constantly to keep it from burning and to insure the complete solution of the sulfur. When properly prepared there should be no residue of sulfur after this cooking. The wash will appear as a rather thick, reddish brown, or dark orange-colored liquid. It gives off a strong odor of sulfur and is caustic in its action. Impurities in the lime may vary the color of the liquid, as does also the excess amount of lime but a variation in color need not affect its efficiency if the wash has been properly stirred and boiled.

From the boiling kettle the wash goes to the spraying barrel into which it should be strained through a brass strainer having about 20 meshes per inch. See fig. 2. This may be purchased or made at home. The strainer should remove all impurities which might clog the nozzles and delay the work in spraying. Never strain the wash through burlap bagging as the lint from the bagging will soon clog the pump. In the barrel the wash may be finally diluted with cold, but preferably with hot, water to make the required 50 gallons of spraying solution. The amounts of lime and sulfur may be varied,

still keeping the proportion between them, in preparing larger or smaller quantities of the wash as may be needed. In general it is better to spray the wash while it is still

Fig. 2.

warm or quite hot. It works easier in the pump and by the time the spray reaches the tree it is cooled so that there is no danger of its doing injury. It is generally considered as desirable to use the wash upon the day it is prepared but this does not seem to be absolutely necessary. Undiluted wash standing till cold will crystalize but the crystals may be again dissolved by reheating thoroughly and the wash is then probably just as good for use as ever.

SPRAYING OUTFIT.—While it is possible to apply the wash by painting or swabbing it onto the trunks and larger branches. the smaller branches and twigs cannot be thoroughly treated in this way and this method of application is so wasteful of time and materials that it will be found more economical as well as efficient to do the work with a "bucket pump" such as may be bought for about $6.00. This may serve fairly for the treatment of from 25 to 50 trees if they are small but for large trees,

or more of them, every orchardist should have a "barrel pump." These may be had in different sizes and full de-

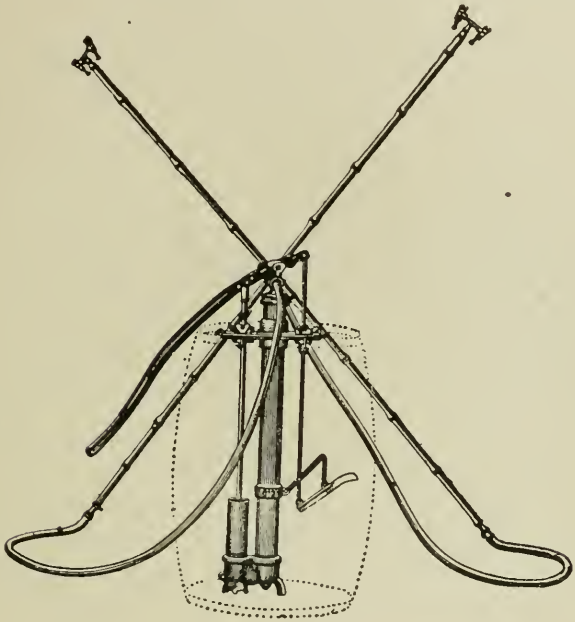

Fig. 3.

scriptions may be found in the catalogs of the various dealers whose addresses are given in the Appendix on page 20–21.

In selecting an outfit for Lime-Sulfur work it is essential that all of the working parts of the pump be of brass and that there be no leather packings or valves. The caustic action of the wash soon corrodes copper and destroys leather but affects brass only slowly. The best apparatus is the cheapest in this case. The most economical outfit for the average orchardist is a barrel pump that is powerful enough to carry two lines of hose with strong pressure for four nozzles. (See fig. 3).

The barrel in which the pump is mounted may well be an ordinary 50-gallon oil barrel such as may be obtained in any town and the mounting of the pump is a simple

operation. The hose should be one-half inch in diameter, inside measure, and of at least four-ply stock. Such hose may be secured of some of the firms mentioned at from 12 to 15 cents per foot. The best hose is not liable to burst under the pressure from the pump and will last much longer than cheaper grades. The length of hose usually furnished by manufacturers with their pumps is too short for satisfactory use. About 25 feet is a good working length for each line as it allows the sprayers more range and insures more rapid and more thorough work which more than offsets the slight extra cost for the longer hose. Each line should be provided with an extension rod from 6 to 12 feet long according to the size of the trees to be treated. There should be two "cut-offs" for each line of hose: one between the pump and the hose and the other between the hose and the extension rod. These save time and liquid and it is more economical to have them than to work without them.

The kind of nozzle to be used is a very important matter. That throwing the best spray is known as the "double Vermorel." There are several types of this nozzle made by various manufacturers which accomplish very similar results. One of these is shown in fig. 4. The

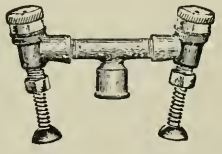

Fig. 4.

nozzle should be provided with plungers to clean them when they become clogged as is liable to happen occasionally even if the wash has been properly strained. The nozzle caps for Lime-Sulfur work should have an opening of 1-16 inch and extra caps should be kept on hand to replace old ones when they become worn so that they throw too coarse a spray. The pressure from the pump should be kept *strong* and especially when four nozzles

are being supplied care must be exercised to see that the pumper does not take his work too easily. The barrel outfit may be carried through the orchard in any kind of a one-horse wagon or on a drag. The driver does the pumping while a man is needed on the ground for each line of hose.

A thoroughly good outfit such as has been described will cost about $25.00 and with proper care it should last for a number of years. It will serve equally well in the application of all arsenical poisons for leaf and fruit feeding insects or for those attacking many of the garden or field crops. It may also be used for whitewashing. Altogether such an outfit is one of the most profitable pieces of equipment that any orchardist can own. Its intelligent use will go farther toward the production of *profits* with almost any crop than can any equal expenditure made in other ways without the spraying.

Information regarding "power sprayers" may be had from the catalogs of manufacturers and suggestions regarding them will be gladly given anyone upon application to the Entomologist, Alabama Experiment Station, Auburn, Ala.

Spraying Suggestions.—While much in regard to spraying can be learned only from experience, there are many suggestions that may be of aid to the beginner.

Only the most careful work is worth doing at all. Care should be taken to cover the twigs and small branches as thoroughly as the larger branches and trunks. If the tree is completely dormant, heavy drenching with the wash will not injure it and it is better to use more spray than is really needed than to use too little to do the work thoroughly. Do not undertake to spray when the prospects are for an immediate storm or severe cold spell since if these should occur before the wash has dried thoroughly on the trees the work will have to be repeated to be effective. Good work cannot be done when a strong wind is blowing. Select fair, calm weather for the work whenever possible or else make a second treatment when it is

calm or when the wind is blowing from the opposite direction to that during the first spraying. The spray solution must be continually agitated during the spraying and a properly constructed pump will accomplish this.

The disagreeable effects of getting the wash on the skin may be reduced by rubbing the hands and face with vaseline before spraying. Rubber coats and gloves are, of course, the best protection for the sprayers but if not available old clothes should be worn so that they may be discarded after the work is finished. Cheap canvas work gloves are a satisfactory protection for the hands. The mules, or horses, and the harness may well be protected by blankets made of old burlap sacks.

After the days work is over the remaining solution should be drawn or emptied out and clear water run through the pump, hose and nozzles to leave them in clean condition and reduce the corrosive injury to the outfit which would otherwise be as great through a night of standing as through a day of use. This cleaning should be particularly thorough at the end of each seasons work or when the apparatus is to be stored for any length of time. All working parts should be kept thoroughly oiled. These measures of care will reduce the expenses for repairs and improve the ease and quality of the work done.

General Usefulness of Lime-Sulfur Wash.—Its superior power of controlling the San Jose scale is but one of the many advantages of this wash. It adheres to the trees for a long time and its good effects are continued through several months after the application. It acts both as an insecticide and also as a fungicide.

As an insecticide it is effective for nearly all of the scale insects oscurring upon fruit trees. It destroys the winter eggs of the plant lice which attack the leaves and twigs of apple so abundantly in the Spring. It also controls the "pear-tree Psylla" and the "pear-leaf blister mite" as well as the ,'silvering mite" of the peach and the "peach-twig borer."

At the same time as a fungicide it is exceedingly effec-

tive against the "peach-leaf curl" and the "brown rot," also for the "apple scab" and "pear scab" and other fungous diseases of fruits.

These fruit pests cannot all be reached at the same time with any other of the numerous methods of treatment which are sometimes substituted for the Lime-Sulfur for controlling the San Jose scale. No other insectitude now known can equal in range of usefulness and in economy a single thorough application of Lime-Sulfur wash to fruit trees just before the buds start in the Spring.

Manifestly these important considerations in favor of Lime-Sulfur far outweigh all contrary ones based upon the inconvenience in its preparation and the disagreeableness of handling and applying it. To obviate the objections to the preparation of the wash any one who desires may now buy it in a concentrated solution ready to dilute directly with water for spraying. It is sold by several of the manufacturers of insecticides whose addresses are given in the Appendix on page 21–22. This might be particularly desirable for the man who needs but little of the wash. The commercial article has shown up favorably in experimental tests but apparently has no superiority in effect over the home-made article which, of course, costs somewhat less.

Determination of Specimens and Special Advice.—Specimens suspected of being San Jose scale, and any other insects attacking fruits, trees, garden and field crops, etc., may be submitted to the Entomologist, Alabama Experiment Station, Auburn, Ala., for determination. They should be mailed in a tight, strong box bearing plainly on the outside the name and address of the sender and separate from the letter of advice which should describe as fully as possible the nature and extent of the injury which the insect seems to be doing. The Entomologist will gladly and freely give any suggestions possible for combating insect pests thus brought to his attention.

APPENDIX

INSECTICIDE MATERIALS AND SPRAYING APPARATUS: ADDRESSES OF DEALERS AND MANUFACTURERS.

Believing that much of the failure to adopt recommendations for spraying treatment for insect and fungus pests is due to a lack of definite knowledge as to just where reliable materials and equipment may be secured, we give below the addresses of some of the many firms manufacturing or dealing in insecticide materials and apparatus. In doing this we do not mean to imply that other dealers do not make or handle just as reliable and satisfactory goods. Those listed may be depended upon and are as accessible as possible to the people of Alabama.

Lime Works.

Newala Lime Works, Calera, Ala.
Calera Lime Works, Calera, Ala.
Keystone Lime Works, Calera, Ala.
Longview Lime Works, Calera, Ala.

Wholesale Sulfur Dealers.

Durr Drug Co., Montgomery, Ala.
Greil Bros., Montgomery, Ala.
Jacob's Pharmacy, Wholesale Department, Atlanta, Ga.
Mobile Drug Co., Mobile, Ala.

Spraying Machinery.

Morrill and Morley, Benton Harbor, Mich. (Local agency G. W. Barnett Hardware Co., Montgomery, Ala.)

Goulds Mfg. Co., Seneca Falls, N. Y. (Goods handled by Beck & Gregg Hardware Co., Atlanta, Ga.; Alabama Machinery & Supply Co., Montgomery, Ala.)

The Deming Co., Salem, Ohio. (No local agency so far as we know.)

Frost Insecticide Co., Arlington, Mass. (No local agency.)

Dayton Supply Co., Dayton, Ohio. (Agency with Macon Implement Co., Macon, Ga.; Alabama agencies are being established also.)

F. E. Myers & Bro., Ashland, Ohio. (Agencies with Barney-Cavenaugh Hardware Co., Mobile, Ala.; Selma Hardware Co., Selma, Ala.; and Alabama Machinery & Supply Co., Montgomery, Ala.)

Insecticide Manufacturers and Dealers.

Graselli Chemical Co., Birmingham, Ala. (Make and sell Lime-Sulfur solution, Arsenate of Lead, Bordeaux mixture, etc.)

Bowker Insecticide Co., 43 Chatham St., Boston, Mass. (Sell a number of kinds of specially prepared insecticides.)

Frost Insecticide Co., Arlington, Mass.

Rex Co., Omaha, Nebraska. (Sell Lime-Sulfur solution and Arsenate of Lead particularly.)

Thomsen Chemical Co., Baltimore, Md. (Sell Lime-Sulfur solution.)

Fred. L. Lavanburg, 100 William St., New York, N. Y. (For Paris Green and Arsenate of Lead particularly.)

Merrimac Chemical Co., 33 Broad St., Boston, Mass. (Makers of Swift's Arsenate of Lead.)

Adler Color & Chemical Co., New York, N. Y. (Make Paris Green, Arsenate of Lead, etc.)

Acme Color Works, 100 William Sreet, New York, N. Y. (Paris Green, etc.)

A. B. Ansbacher & Co., New York, N. Y. (Paris Green, etc.)

F. W. Devoe & Co., New York, N. Y. (Paris Green, etc.)

Leggett & Brother, New York, N. Y. (Various insecticides.)

Sherwin-Williams Co., Newark, N. J. (Paris Green.)

American Horticultural Distributing Co., Martinsburg, W. Va. ("Target Brand" insecticides.)

B. G. Pratt Co., 11 Broadway, New York, N. Y. (Scalecide.)

BULLETIN NO. 145 FEBRUARY, 1909

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN.

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Local Fertilizer Experiments With Cotton in 1895, 1896, 1897 and 1898

IN 1905, 1906, 1907, AND 1908.

BY

J. F. DUGGAR, Director.

Opelika, Ala.:
The Post Publishing Company,
1909

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O. H. SELLERS .....Stenographer and Mailing Clerk

LOCAL FERTILIZER EXPERIMENTS WITH COTTON IN 1905, 1906, 1907, AND 1908.

By J. F. Duggar.

For a number of years this Station has conducted numerous local fertilizer experiments, furnishing material and instructions to farmers agreeing to make the tests.

The number of local fertilizer experiments with cotton, of which reports were received, was as follows: In 1905, ten; in 1906, thirteen; in 1907, ten; and in 1908, twenty-two. This does not include a number of experiments begun and not successfully completed. In all of these years fertilizer experiments were also made on corn and other crops, the results of which will be published later.

The chief object of these local fertilizer experiments or soil tests has been to ascertain the best fertilizer or combination of fertilizers for cotton, growing on each of the principal soils of Alabama.

Small lots of carefully weighed and mixed fertilizers were supplied to each experimenter. Detailed instructions as to how to conduct the experiments and blank forms for reporting results, were also furnished.

The following list gives the name and address of each experimenter who has reported the results of fertilizer experiments made under our direction during the past four years, with page of this bulletin where the results may be found.

County.	Post Office	Name.	Date.	Page
Autauga	Prattville	J. W. Young	1905–6	49-52
Barbour	Louisville	J. D. Veal	1906	69
Blount	Tidmore	Jno. W. Staab	1905	39-42
Bullock	Union Spr'gs	F. B Haynes	1908	78
Bullock	Three Notch	A. M. Cope	1906	68-69
Bullock	Suspension	O. M. Hill	1906	78
Chambers	Fredonia	E. W. Smartt	1905	78
Chilton	Verbena	G. H. Caffey	1907–8	49-50
Chilton	Verbena	J. H. Willoughby	1905–6–8	47-49
Conecuh	Betts	R. H. Betts	1905–6–7	75-76
Cullman	Cullman	L. A Fealy	1906	39-42
Cullman	Joppa	O. G. Roberts	1906-7-8	39 40
Fayette	Newtonville	J. B. Gibson	1906-7-8	45-47, 78
Franklin	Russellville	T. J. Willis	1905-6	29-30
Geneva	Geneva	M P. Metcalf	1905	69-70
Greene	Eutaw	W. W. Morgan	1908	48
Henry	Headland	W. F. Covington	1907-8	73
Henry	Columbia	T. Z. Atkeson	1908	71-73

County	Post Office	Name	Date	Page
Lauderdale	Florence	W. A. Parish	1905-6	30-31
Lauderdale	Florence	J. W. Haddock	1907-8	30-32
Lawrence	Hillsboro	F. T. Nealy	1905	35
Lee	Auburn	Ala. Expt. Station	1905-6	59
Lee	Auburn	Jno Jackson	1908	57-58
Lee	Bee Hive	T. W. Cox	1905-6	58
Macon	Notasulga	S. C. Jackson	1905	61-64
Macon	Shorter	Y. Swearington	1906	61-65
Macon	Society Hill	Robt. Floyd	1806-7	66
Macon	Hurtsboro	A. B. Floyd	1908	66
Madison	Huntsville	H. D N. Wales	1905	33-35
Marengo	Faundsdale	W. C. McNight	1905	53-54
Marion	Hamilton	6th Dist. Agr. School	1906	39-42
Morgan	Hartselle	J. O Burleson	1907-8	35-36
Montgom'ry	Montgomery	J M. Jones	1906-7	54
Montgom'ry	Montgomery	T. M. Oliver	1907	52-56
Montgom'ry	Naftel	W. C. Naftel	1905	78
Pickens	Gordon	D. W. Davis	1906	78
Tallapoosa	Notasulga	M. E Parker	1907	59
Tallapoosa	Notasulga	E. B Jackson	1907	61-63
Tallapoosa	Notasulga	J. W. Parker	1907	61-62
Walker	Cordova	J. L. Alexander	1908	39-44
Winston	Nauvoo	W. M Omary	1908	39-43

The directions stated that land employed for this test should be level and uniform, not manured in recent years, not in cowpeas the preceding year, and that it should be representative of large soil areas in its vicinity. The need of perfect uniformity of standard treatment for all plots (except as to kind of fertilizer used) was emphasized.

Fertilizers were applied in the usual manner—that is, drilled before planting.

The Rainfall.

The following data are taken from the records of the Alabama section of the Weather Bureau, and show the average rainfall for the state:

	Inches Rainfall.				
	1905	1906	1907	1908	
January	5.26	4.66	2.20	4.28	
February	7.24	2.39	5.04	6.30	
March	3.70	9.26	2 94	4.77	
April	3.69	1.03	6.26	5.84	
May	5.51	4.63	7.94	5.34	
June	4.56	3.45	2.85	2.75	
July	4.56	8.50	5.00	4.72	
August	5.30	3.78	3.50	3.44	
September	2.51	8.44	5.50	2.42	
October	4.39	3 54	1.44	1.76	
November	1.78	2.50	6.15	1.52	
December	6.46	4.19	6 01	5.02	
Average	55 38	56 56	54.66	48.16	
Average yearly normal					51

The Fertilizers Used.

The following prices are used, as representing approximately the average cash price in local markets during the last few years:

	Per Ton.
Acid phosphate (14 per cent. available)	$14.00
Cotton seed meal	25.00
Kainit	15.00

Prices naturally vary in different localities. Any one can substitute the cost of fertilizers in his locality for the price given above.

In each experiment two plots were left unfertilized, these being plots 3 and 8. When these yields differed widely the experiment was classed as inconclusive. The increase on plots 4 to 7 is calculated on the assumption that the graduation in fertility is uniform from plot 3 to plot 8. The following table shows what kinds and amounts of fertilizers were used on certain plots; the number of pounds of nitrogen, phosphoric acid, and potash supplied per acre by each fertilizer mixture; and the percentage composition and cost per ton of each mixture, the latter being given in order that these mixtures may be readily compared with various brands of prepared guanos.

Price Assumed for Seed Cotton.

The price assumed is $14.00 per ton for seed, and 10 cents per pound for lint, a price found by averaging prices of 9, 11, 11, and 9 cents per pound respectively, for the crops of 1904, '5, '6, '7, and '8. This is equal to 3.8 cents per pound of seed cotton turning out 33 1/3 per cent. of lint. Deducting 6/10 cents per pound as the average cost of picking and ginning, and we have left 3.2 cents as the net value per pound of the increase of seed cotton due to fertilizers. This latter is the figure used in all financial calculations.

Pounds per acre of fertilizers, nitrogen, phosphoric acid, and potash used and composition of each mixture.

Plot No.	FERTILILERS: Amount per acre.	FERTILILERS: KIND	MIXTURE CONTAINS: Nitrogen	MIXTURE CONTAINS: †Available phosphoric acid	MIXTURE CONTAINS: Potash.	COST OF FERTILIZERS: Per ton	COST OF FERTILIZERS: Per acre
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*		
1	200	Cotton seed meal	13.58	5.76	3.54	$25.00	$2.50
		*In 100 lbs. c. s. meal.**	6.79	2.88	1.77		
2	240	Acid phosphate	.....	36.12	.....	14.00	1.68
		In 100 lbs. acid phos.	.....	15.05	.....		
4	200	Kainit	.....	.....	24.60	15.00	1.50
		In 100 lbs. kainit.	.....	.....	12.30		
5	200	Cotton seed meal	13.58	41.88	3.54	18.99	4.28
	240	Acid phosphate					
		In 100 lbs above mixt.	3.09	9.52	.80		
6	200	Cotton seed meal	13.58	5.76	28.14	19.50	4.00
	200	Kainit					
		In 100 lbs. above mixt.	3.39	1.44	7.03		
7	240	Acid phosphate	.....	.....	.....	14.45	3.18
	200	Kainit					
		In 100 lbs. above mixt	.....	8.21	5.59		
9	200	Cotton seed meal	13.58	41.88	28.14	17.81	5.68
	240	Acid phosphate					
	200	Kainit					
		In 100 lbs above mixt.	2.12	6.54	4.39		
10	200	Cotton seed meal	13.58	41.88	15.84	18.24	5.93
	240	Acid phosphate					
	100	Kainit					
		In 100 lbs above mixt.	2.59	7.75	2.93		

*Average of many analysis.

†Counting all the phosphoric acid in cotton seed meal as available.

Those farmers who are more accustomed to the word ammonia than to the term nitrogen, can change the figures for nitrogen into their ammonia equivalents by multiplying by $1\frac{3}{14}$

FRANKLIN COUNTY, 5 MILES NORTH-WEST OF RUSSELLVILLE.
T. J. WILLIS. 1905–6, (See Table, p. 30.)

Dark gray sandy soil, with light colored clay subsoil.

These tests were made on a hilltop which had been in cultivation about 10 years. The forest growth was hardwoods.

It is evident that this soil responded freely to every fertilizer, whether applied singly, by twos, or all three together.

In both years a complete fertilizer (plots 9 or 10) was the most profitable application, closely followed in yield and profit by a mixture of acid phosphate and cotton seed meal. On plot 9 the complete fertilizer increased the yield by 1000 and by 792 pounds of seed cotton. After deducting the cost of the fertilizer (p 29) this left profits of $26.32 and $19.66 per acre. Phosphate was most effective, cotton seed meal next, and kainit least, but still useful.

	1905	1906
	Lbs.	Lbs
Average yield of seed cotton, unfertilized	352	376
Increase of seed cotton when cotton seed meal was added:		
To unfertilized plot	192	24
To acid phosphate plot	172	120
To kainit plot	204	144
To acid phosphate and kainit plot	167	176
Average increase with cotton seed meal	184	116
Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	664	456
To cotton seed meal plot	644	552
To kainit plot	739	600
To cotton seed meal and kainit plot	702	632
Average increase with acid phosphate	687	560
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	94	16
To cotton seed meal plot	106	136
To acid phosphate plot	169	160
To cotton seed meal and acid phosphate plot	164	216
Average increase with kainit	133	132

Experiment at Russellville (Franklin Co.) and near Florence (Lauderdale Co.) 1905-6-7-8

Plot No.	FERTILIZER		T. J. Willis Russellville 1905		T. J. Willis Russellville 1906		J. W. Parish Florence 1905		W. A. Parish Florence 1906		J. W. Haddock Florence 1907		J. W. Haddock Florence 1908	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acae	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal....	520	192	400	24	608	336	408	232	672	72	910	460
2	240	Acid phosphate.....	992	664	832	456	664	392	368	192	1032	432	650	200
3	....	No fertilizer	327	.....	376	.....	272	.....	176	.....	600	.....	450	.....
4	200	Kainit	432	94	392	16	608	308	352	179	1424	848	800	340
5	200	Cotton seed meal..	1184	836	952	576	1184	857	608	438	1840	1288	1550	1080
	200	Acid phosphate ...												
6	200	Cotton seed meal..	656	298	536	160	960	606	320	153	1256	728	1010	530
	200	Kainit												
7	240	Acid phosphate...	1200	833	992	616	920	539	456	293	.....	.....	710	220
	200	Kainit												
8	....	No fertilizer	376	.....	376	.....	408	.....	160	.....	480	.....	500	.....
9	200	Cotton seed meal..	1376	1000	1168	792	816	408	544	384	1208	728	1100	600
	240	Acid phosphate ...												
	200	Kainit												
10	200	Cotton seed meal..	1408	1032	896	520	824	416	528	368	872	392	980	480
	240	Acid phosphate...												
	100	Kainit												

LAUDERDALE COUNTY, 10 MILES WEST OF FLORENCE.

W. A. PARISH, 1905–6. (See Table, p. 30.)

In 1905 stiff light gray soil with red subsoil; in 1906 darker soil, with red clay subsoil.

Both fields had been cleared for 30 or 40 years. The original forest trees are said to have been post oak, red oak, black oak, and hickory. Every fertilizer considerably increased the yield in both years. In both years the largest increase, 857 pounds and 438 pounds of seed cotton respectively, was afforded by plot 5, fertilized with a mixture of cotton seed meal and phosphate. This represents a net profit of $23.14 and $9.73 per acre. In 1904 a test made by Mr. Parish on gray soil with reddish subsoil showed an average increase attributable to cotton seed meal of 249 pounds of seed cotton per acre; an increase deu to acid phosphate of 584 pounds; and an increase due to kainit of 212 pounds of seed cotton. This indicated a need for the complete fertilizer, while the later tests gave good results without kainit.

It seems that this soil needs chiefly phosphoric acid, but that this should usually be supplemented by nitrogen. The soil on which both Mr. Parish and Mr. Haddock made their experiments was that known locally as "The Barrens," and described in soil survey reports as "Clarksville Silt Loam."

	1904	1905	1906
Average yield of seed cotton per acre, unfertilized	452	340	168
Increase of seed cotton when cotton seed meal was added:			
To unfertilized plot	284	336	232
To acid phosphate plot	269	465	246
To kainit plot	237	298	—26
To acid phosphate and kainit plot	208	—131	91
Average increase with cotton seed meal	249	242	138

Increase of seed cotton per acre when acid phosphate was added:			
To unfertilized plot	696	392	192
To cotton seed meal plot	681	521	206
To kainit plot	494	231	114
To cotton seed meal and kainit plot	465	—198	231
Average increase with acid phosphate	584	236	188

Increase of seed cotton per acre when kainit was added:			
To unfertilized plot	334	308	179
To cotton seed meal plot	287	270	—79
To acid phosphate plot	132	147	101
To cotton seed meal and acid phosphate plot	71	—449	—54
Average increase with kainit	212	69	37

LAUDERDALE COUNTY, 10 MILES WEST OF FLORENCE.

J. W. HADDOCK, 1907–8. (See Table, p. 30.)

Gray soil, with red subsoil.

This field had been cleared about 40 years, and was of the same character as soil used in Mr. Parish's experiment. The stand was uniform. The results both years agree with Mr. Parish's experiments in showing that the most effective fertilizer was a mixture of acid phosphate and cotton seed meal, the phosphate being more important. It is curious and inexplicable that kainit when applied alone gave a large increase, but when combined with either or both of the other fertilizers it gave little or no increase. These tests, though presenting some figures that cannot be understood, confirmed the conclusions drawn from Mr. Parish's tests, namely, that acid phosphate is most important, that it should be supplemented by cotton seed meal, and that potash is generally unnecessary.

	1907	1908
	Lbs.	Lbs.
Average yield of seed cotton per acre, unfertilized	540	475
Increase of seed cotton when cotton seed meal was added:		
To unfertilized plot	72	460
To acid phosphate plot	856	880
To kainit plote	—120	190
To acid phosphate and kainit plot		380
Average increase with cotton seed meal	269	478
Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	432	200
To cotton seed meal plot	121	620
To kainit plot		—120
To cotton seed meal and kainit plot	0 0	70
Average increase with acid phosphate	576	193
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	848	340
To cotton seed meal plot	656	70
To acid phosphate plot		20
To cotton seed meal and acid phosphate	—560	—600
Average increase with kainit	315	—43

Madison County, 5 Miles West of Huntsville.

H. D. N. Wales, 1905. (See Table, p. 35.)

Red soil, with red subsoil.

This worn red lime soil responded freely only to applications of cotton seed meal. Other tests made in Madison County indicate a general need on such soils for both nitrogen and phospahte. Results from potash have been variable, the majority of the tests showing that little or no potash is needed.

	Lbs.
Average yield of seed cotton per acre, unfertilized	376
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	144
To acid phosphate plot	96
To kainit plot	144
Average increase with cotton seed meal	128
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	88
To cotton seed meal plot	40
To kainit plot	—32
Average increase with acid phosphate	24
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	72
To cotton seed meal plot	72
To acid phosphate plot	—48
Average increase with kainit	24

Experiments in Madison, Lawrence and Morgan Counties.

Plot No.	FERTLIZER		Hunts-ville		Hills-boro		Hart-selle Red land		Hart-selle Gray land	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs		*Lbs*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	520	144	272	48	798	112	780	210
2	240	Acid phosphate	464	88	264	40	776	120	1140	370
3	....	No fertilizer	376	....	224	....	656	....	570	....
4	200	Kainit	448	72	247	21	744	94	680	126
5	200 240	Cotton seed meal ... Acid phosphate	560	184	496	265	744	100	1210	672
6	200 200	Cotton seed meal ... Kainit	592	216	424	190	712	74	980	350
7	240 200	Acid phosphate .... Kainit	416	40	456	219	632	1	900	394
8	....	No fertilizer	376	....	240	....	624	....	490	....
9	200 240 200	Cotton seed meal ... Acid phosphate .... Kainit	.....	....	744	504	864	240	1070	580
10	200 240 100	Cotton seed meal ... Acid phosphate .... Kainit	.....	....	616	376	752	128	1010	520

Lawrence County, 1 Mile East of Hillsboro.

F. T. Nealy, 1905. (See Table above.)

Gray sandy loam soil, with yellow subsoil.

This field had been cleared about 70 years of its growth of hardwoods. It had grown up in weeds during the four years preceding this experiment. Rains were almost continuous throughout the season, making cultivation almost impossible. Under these unfavorable conditions a complete fertilizer was the most effective and profitable.

	Lbs.
Average yield of seed cotton per acre, unfertilized	232
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	48
To acid phosphate plot	225
To kainit plot	161
To acid phosphate and kainit plot	285
Average increase with cotton seed meal	180
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	40
To cotton seed meal plot	217
To kainit plot	198
To cotton seed meal and kainit plot	314
Average increase with acid phosphate	192
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	21
To cotton seed meal plot	142
To acid phosphate plot	179
To cotton seed meal and acid phosphate plot	239
Average increase with kainit	145

MORGAN COUNTY, 4 MILES WEST OF HARTSELLE.

J. O. BURLESON, 1907–8. (See Table, p. 35.)

In 1907, *soil, red, lime table land; Subsoil, red. The original growth was hickory, removed about* 80 *years before.*

The soil was the ordinary lime soil of the Tennessee Valley Region. A complete fertilizer afforded the largest yield. Apparently the greatest need was for nitrogen.

In 1908, *typical sandy mountain land, dark gray soil with red subsoil.*

The original growth was shortleaf pine and hardwoods, and the land had been in cultivation about 10 years. The largest increase was afforded by a mixture of cotton seed meal and acid phosphate. The chemical chiefly needed by this soil was acid phosphate.

	Lbs.	Lbs.
Average yield of seed cotton per arre, unfertilized	640	530
Increase of seed cotton when cotton seed meal was added:		
To unfertilized plot	112	210
To acid phosphate plot	—20	402
To kainit plot	—20	—20
To acid phosphate and kainit plot	239	230
Average increase with cotton seed meal	78	206
Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	120	370
To cotton seed meal plot	—12	462
To kainit plot	—93	268
To cotton seed meal and kainit plot	166	230
Average increase with acid phosphate	45	333
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	94	126
To cotton seed meal plot	—38	140
To acid phosphate plot	—119	24
To cotton seed meal and acid phosphate plot	140	—92
Average increase with kainit	19	50

CULLMAN COUNTY, 2 MILES SOUTH WEST OF JOPPA.

O. G. ROBERTS, 1906–7–8. (See Table, p. 39.)

Gray sandy upland with yellow clay subsoil.

The original growth was short leaf pines and hardwoods, characteristic of the Mountain Plateau Region. This field had been cleared for about 24 years.

In all three years the largest profit was made on plot 5 by using a mixture of cotton seed meal and acid phosphate. In every case there was no advantage in adding kainit to the other two chemicals. This inefficiency of potash in these tests is further borne out by the fact that, of the two complete fertilizers, the one with the smaller amount of potash each year afforded the larger yield. These results also agree with the results of Mr. Burleson's tests on similar gray plateau soil.

	1906.	1907.	1908.
	Lbs.	Lbs.	Lbs.
Average yield of seed cotton per acre unfertilized	248	360	312
Increase in seed cotton when cotton seed meal was added:			
To unfertilized plot	200	22	144
To acid phosphate plot	174	218	132
To kainit plot	190	58	166
To acid phosphate and kainit plot	—17	43	164
Average increase with cotton seed meal	137	85	152
Increase of seed cotton per acre when acid phosphate was added:			
To unfertilized plot	288	174	292
To cotton seed meal plot	262	370	280
To kainit plot	342	121	112
To cotton seed meal and kainit plot	135	114	110
Average increase with acid phosphate	257	195	199
Increase of seed cotton per acre when kainit was added:			
To unfertilized plot	75	182	156
To cotton seed meal plot	65	210	178
To acid phosphate plot	129	129	—24
To cotton seed meal and acid phosphate plot	—62	—46	8
Average increase with kainit	52	119	80

Fertilizer Experiments in Blount, Cullman, Marion, Winston and Walker Counties.

Plot No.	FERTILIZER		JOPPA 1906		JOPPA 1907		JOPPA 1908		TIDMORE 1905		CULLMAN 1906		HAMILTON 1906		NAUVOO 1908		CORDOVA 1908	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal...	416	200	438	22	472	144	[568]	[372]	544	152	288	32	490	90	1460	320
2	240	Acid phosphate....	504	288	590	174	620	292	276	80	588	196	310	64	595	195	1560	420
3	....	No fertilizer.....	216	....	416	....	328	....	196	.....	392	.....	256	.....	400	.....	1140	.....
4	200	Kainit	304	75	576	182	476	156	264	70	553	136	312	49	480	81	1270	120
5	200 240	Cotton seed meal. Acid phosphate..	664	462	764	392	736	424	380	188	904	[464]	632	362	790	392	1500	340
6	200 200	Cotton seed meal. Kainit	520	265	582	232	626	322	376	186	832	368	456	180	605	208	.....	.....
7	240 200	Acid phosphate.. Kainit	648	417	630	303	564	268	220	33	800	312	544	262	550	154	1630	450
8	....	No fertilizer.....	280	....	304	....	288	....	184	.....	512	.....	288	.....	395	.....	1190	.....
9	200 240 200	Cotton seed meal Acid phosphate.. Kainit	680	400	650	3450	720	432	372	188	872	360	592	304	820	425	1560	370
10	200 240 100	Cotton seed meal. Acid phosphate.. Kainit	720	440	684	380	726	438	352	168	912	400	528	240	860	465	1800	610

BLOUNT COUNTY, 2 MILES NORTH OF TIDMORE.

JOHN W. STAAB, 1905. (See Table, p. 39.)

Mulatto, fine sandy loam, with reddish yellow subsoil.

The rainfall was heavy. Apparently plot 1 was on richer land than the other plots. The chief need was for nitrogen. Phosphate and kainit were of little value.

On the other hand, in a similar experiment made by Mr. Staab the preceding year on apparently the same character of land, the increase in yield of seed cotton per acre averaged for cotton seed meal 215 pounds, for acid phosphate 282 pounds, and for kainit 77 pounds.

	Lbs.
Average yield of seed cotton, unfertilized	190
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	
To acid phosphate plot	108
To kainit plot	116
To acid phosphate and kainit plot	155
Average increase with cotton seed meal	126
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	80
To cotton seed meal plot	
To kainit plot	—37
To cotton seed meal and kainit plot	2
Average increase with acid phosphate	15
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	70
To cotton seed meal plot	
To acid phosphate plot	—47
To cotton seed meal and acid phosphate plot	00
Average increase with kainit	8

Cullman County, 1 Mile South of Cullman.

L. A. Fealy, 1906. (See Table, p. 39.)

Gray sandy loam, with yellow loam subsoil.

On this upland field, long in cultivation, a mixture of acid phosphate and cotton seed meal gave the largest yield; but this result may have been due to the fact that this plot occupied the lowest position in the field. On this account it is impossible to determine whether potash was needed on this soil.

In 1904 on similar land Mr. Fealy made a test in which the average increase from cotton seed meal was 180 pounds, from acid phosphate 176 pounds, and from kainit 98 pounds.

	Lbs.
Average yield of seed cotton, unfertilized	452
Increase of seed cotton per acre when cotton seed meal was added:	
To unfertilized plot	152
To acid phosphate plot	268
To kainit plot	232
To acid phosphate and kainit plot	48
Average increase with cotton seed meal	175
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	196
To cotton seed meal plot	312
To kainit plot	176
To cotton seed meal and kainit plot	—8
Average increase with acid phosphate	169
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	136
To cotton seed meal plot	216
To acid phosphate jlot	116
To cotton seed meal and acid phosphate plot	—104
Average increase with kainit	91

MARION COUNTY, HAMILTOON.

SIXTH DISTRICT AGRICULTURAL SCHOOL, 1906. (Table, p. 39.)

Sandy land with yellow clay subsoil.

For 3 or 4 years preceeding the experiment this land had been uncultivated and occupied by weeds.

The largest and most profitable yield was afforded by plot 5, fertilized with cotton seed meal and acid phosphate. A test made on the same farm in 1903 (Ala. Station Bulletin No. 131) showed a need for a complete fertilizer, in which, however, potash was less effective than either nitrogen or phosphate.

	Lbs.
Average yield of seed cotton per acre, unfertilized	272
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	32
To acid phosphate plot	298
To kainit plot	131
To acid phosphate and kainit plot	42
Average increase with cotton seed meal	126
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	64
To cotton seed meal plot	330
To kainit plot	213
To cotton seed meal and kainit plot	124
Average increase with acid phosphate	183
Increase of seed cotton per acre when kainit was added:	
Averge yield of seed cotton per acre, unfertilized	397
To unfertilized plot	49
To cotton seed meal plot	148
To acid phosphate plot	198
To cotton seed meal and acid phosphate plot	—58
Average increase with kainit	84

WINSTON COUNTY, 3 MILES NORTH EAST OF NAUVOO.

W. M. OMARY, 1908. (See Table, p. 39.)

Gray sandy soil with a reddish clay subsoil; "coal land."

This field had been in cultivation only about 6 years: the original growth is stated to have been short leaf pine.

While a complete fertilizer afforded the largest yield, yet the increase on plot 5, receiving only cotton seed meal and phosphate, was almost as large and the profit on plot 5 was even greater than on plot 9.

	Lbs.
Average yield of seed cotton per acre, unfertilized	397
Increase of seed cotton where cotton seed meal was added:	
To unfertilized plot	90
To acid phosphate plot	197
To kainit plot	127
To acid phosphate and kainit plot	271
Average increase with cotton seed meal	171
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	195
To cotton seed meal plot	302
To kainit plot	73
To cotton seed meal and kainit plot	217
Average increase with acid phosphate	197
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	81
To cotton seed meal plot	118
To acid phosphate plot	—41
To cotton seed meal and acid phosphate plot	33
Average increase with kainit	48

Walker County, 3 Miles South of Cordova.

G. L. Alexander, 1908. (See Table, p. 39.)

Gray sandy upland with red clay subsoil.

This field had been cleared for about 40 years. Evidently the land had been kept in a high state of fertility.

The stand was uniform.

It is clear that the chief need of this soil was for acid phosphate. There was no need for potash. The figures for nitrogen are confusing, probably due to the relatively productive condition of this land. Apparently plot 10 was on richer soil than the other plots.

Average yield of seed cotton per acre, unfertilized	1165
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	320
To acid phosphate plot	—80
To acid phosphate and kainit plot	—80
Average increase with cotton seed meal	54
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	420
To cotton seed meal plot	20
To kainit plot	330
Average increase with acid phosphate	257
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	120
To acid phosphate plot	30
To cotton seed meal and acid phosphate plot	30
Average increase with kainit	60

Fayette County, 1 1–2 Miles West of Newtonville.

J. B. Gibson, 1906–7. (See Table, p. 46.)

Dark sandy soil with red clay subsoil.

This level upland field, on which the original growth was oak and short leaf pine, has been cleared about 18 years.

There was an increase with either cotton seed meal, acid phosphate, or kainit, whether these were used separately or in every possible combination. Apparently the greatest need was for acid phosphate.

	1906. Lbs.	1907. Lbs.
Average yield of seed cotton, unfertilized	560	348
Increase of seed cotton when cotton seed meal was added:		
To unfertilized plot	784	576
To acid phosphate plot	24	86
To kainit plot	72	54
To acid phosphate and kainit plot	216	92
Average increase with cotton seed meal	274	202
Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	880	640
To cotton seed meal plot	120	150
To kainit plot	128	129
To cotton seed meal and kainit plot	268	167
Average increase with acid phosphate	349	272
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	720	611
To cotton seed meal plot	8	89
To acid phosphate plot	—32	100
To cotton seed meal and acid phosphate plot	160	106
Average increase with kainit	214	227

Fertilizer Experiments in Fayette and Greene Counties.

Plot No	FERTILIZER		Newtonville 1906		Newtonville 1907		Clint'n 1908	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	1304	784	912	576	768	144
2	240	Acid phosphate	1400	880	976	640	760	136
3	....	No fertilizer.....	520	.....	336	.....	624	....
4	200	Kainit	1256	720	952	611	672	49
5	200 240	Cotton seed meal .... Acid phosphate	1456	904	1072	726	696	74
6	200 200	Cotton seed meal .... Kainit	1360	792	1016	665	687	08
7	240 200	Acid phosphate ..... Kainit	1432	848	1096	740	622	14
8	....	No fertilizer.....	600	.....	360	.....	616	....
9	200 240 200	Cotton seed meal .... Acid phosphate ..... Kainit	1664	1064	1192	832	680	64
10	200 240 100	Cotton seed meal .... Acid phosphate ..... Kainit	1600	1000	1272	912	704	88

Greene County, 6 Miles North of Clinton.

W. M. Morgan, 1908. (See Table above.)

Dark soil with clay foundation.

The original growth, consisting chiefly of short leaf pine, was removed about nine years before the test was made. The two crops preceding the experiment consisted of cotton. No fertilizer very greatly increased the yield. From Mr. Morgan's notes it may be inferred that the land is in poor mechanical condition, much inclined to bake, and that on all plots there was much shedding of forms, but no rust.

	Lbs.
Average yield of seed cotton per acre, unfertilized	620
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	144
To acid phosphate plot	—62
To kainit plot	19
To acid phosphate and kainit plot	50
Average increase with cotton seed meal	38
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	136
To cotton seed meal plot	—70
To kainit plot	—35
To cotton seed meal and kainit plot	—4
Average increase with acid phosphate	7
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	49
To cotton seed meal plot	—76
To acid phosphate plot	—122
To cotton seed meal and acid phosphate plot	—10
Average increase with kainit	—40

Chilton County, 2 Miles West of Verbena.

J. H. Willoughby, 1905–6–7–8. (See Table, p. 49.)

Gray sandy soil with a red subsoil.

Every year this test was made on soil that had been long in cultivation. In each of the four years the complete fertilizer (plot 9) afforded a larger yield than the mixture of any two fertilizers. In every test the complete fertilizer afforded the largest net profit. When the chemicals were used separately or by twos their effect was variable, but when all 3 were combined each chemical in this mixture increased the yield more than enough to pay its cost.

	1905	1906	1907	1908
	Lbs.	Lbs.	Lbs.	Lbs.
Average yield of seed cotton per acre unfertilized	408	256	928	550
Increase of seed cotton when cotton seed meal was added:				
To unfertilized plot	384	104	64	230
To acid phosphate plot	104	85	60	142
To kainit plot	96	21	—36	—18
To acid phosphate and kainit plot	272	62	279	256
Average increase with cotton seed meal	214	68	60	153
Increase of seed cotton per acre when acid phosphate was added:				
To unfertilized plot	168	128	32	50
To cotton seed meal plot	—112	109	156	—38
To kainit plot	16	36	—101	—142
To cotton seed meal and kainit plot	192	77	214	132
Average increase with acid phosphate	66	87	75	1
Increase of seed cotton per acre when kainit was added:				
To unfertilized plot	136	206	158	186
To cotton seed meal plot	—152	123	186	—62
To acid phosphate plot	—16	114	25	—6
To cotton seed meal and acid phosphate plot	152	91	244	108
Average increase with kainit	30	133	153	57

Verbena (Chilton County) Experiments by J. H. Willoughby and G. H. Caffey.

Plot No.	FERTILIZER		Verbena W. 1905		Verbena W. 1906		Verbena W. 1907		Verbena W. 1908		Verbena C. 1907		Verbena C. 1908	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	752	384	376	104	640	64	820	230	888	144	790	160
2	240	Acid phosphate	536	168	400	128	736	32	640	50	653	91	710	80
3	....	No fertilizer.....	368	.....	272	.....	704	.....	590	.....	744	.....	630	.....
4	200	Kainit	520	136	472	206	832	158	760	186	904	196	650	40
5	200	Cotton seed meal	672	272	472	213	736	92	750	192	848	177	910	320
	240	Acid phosphate												
6	200	Cotton seed meal	648	232	380	227	736	122	710	168	848	214	740	170
	200	Kainit												
7	240	Acid phosphate	584	152	488	242	640	57	570	44	700	103	680	130
	200	Kainit												
8	....	No fertilizer	448	.....	240	.....	552	.....	510	.....	560	.....	530	.....
9	200	Cotton seed meal	872	424	544	304	888	336	810	300	1024	464	860	303
	240	Acid phosphate												
	200	Kainit												
10	200	Cotton seed meal	760	312	456	216	856	304	800	290	952	392	810	280
	240	Acid phosphate												
	100	Kainit												

CHILTON COUNTY, 1–2 MILE SOUTH OF VERBENA.
G. H. CAFFEY, 1907–8. (See Table, p. 49.)

Rather stiff, dark, sandy soil, with a red clay subsoil.

This piece of high upland was cleared 60 or 70 years ago of its original growth of longleaf pine, oak, hickory, and dogwood. The results for the two years suggest that the fertilizer which pays best one season is not necessarily the one most effective in a different season. In 1907 there was need for a complete fertilizer, in which the most effective constituent was nitrogen, closely followed by potash; phosphate was also helpful when used in combination, with *both* of the other constituents.

In 1908, on the contrary, kainit was of practically no value nitrogen being most important, followed by phosphate. A mixture of cotton seed meal and phosphate gave the greatest profit.

In 1907 the complete fertilizer on plot 9, costing $5.68 per acre, increased the yield of seed cotton by 464 pounds per acre, worth at 3.2 cents, $14.85. This leaves a net profit of $8.17 due to the complete fertilizer. Likewise in 1908 the increase on plot 5, with meal and phosphate costing $4.28, afforded a net profit of $5.96.

	1907 Lbs.	1908 Lbs.
Average yield of seed cotton unfertilized	652	580
Increase of seed cotton when cotton seed meal was added:		
To unfertilized plot	144	160
To acid phosphate plot	268	240
To kainit plot	18	130
To acid phosphate and kainit plot	361	200
Average increase with cotton seed meal	198	183

Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	—91	80
To cotton seed meal plot	33	160
To kainit plot	—93	90
To cotton seed meal and kainit plot	250	160
Average increase with acid phosphate	25	123
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	196	40
To cotton seed meal plot	70	10
To acid phosphate plot	194	50
To cotton seed meal and acid phosphate plot	287	10
Average increase with kainit	187	28

AUTAUGA COUNTY, 2 MILES EAST OF PRATTVILLE.
J. W. YOUNG, 1905–6–7. (See Table, p. 52.)

Reddish sandy soil with a red clay subsoil.

The stand each year was good and uniform. Results were somewhat obscured by unfavorable weather conditions in 1905 and by the September storm and the occurrence of early frost in 1906. Evidently the chief need of the soil, long in cultivation, was for nitrogen. Phosphoric acid was also needed. A mixture of cotton seed meal and acid phosphate, (plot 5), in all cases gave a profitable increase. In a complete fertilizer in 1905 and 1906 kainit increased the yield to the extent of 112 and 77 pounds of seed cotton respectively; but when used alone or in combination with either one of the other fertilizers, kainit was usually unprofitable, and it was also without effect in the complete fertilizer in 1907.

Autauga and Montgomery (Sandy Land) Experiments.

Plot No.	FERTILIZER		Prattville 1904		Prattville 1905		Prattville 1906		Montgomery Red sandy	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal ...	816	184	936	296	912	156	744	112
2	240	Acid phosphate	752	120	800	160	816	60	664	32
3	....	No fertilizer.....	632	....	640	....	756	.....	632	....
4	200	Kainit	640	24	680	34	780	12	552	66
5	200 240	Cotton seed meal . Acid phosphate ..	760	160	840	187	888	109	720	116
6	200 200	Cotton seed meal . Kainit	752	168	760	101	892	102	752	1620
7	240 200	Acid phosphate .. Kainit	744	176	696	30	708	93	643	73
8	....	No fertilizer.....	552	....	672	....	812	.....	560	....
9	200 240 200	Cotton seed meal . Acid phosphate .. Kainit	824	272	936	264	880	68	824	264
10	200 240 100	Cotton seed meal . Acid phosphate .. Kainit	768	216	856	184	800	12	840	280

	1905	1906	1907
	Lbs.	Lbs.	Lbs.
Average yield of seed cotton, unfertilized	592	656	784
Increase of seed cotton when cotton seed meal was added:			
To unfertilized plot	184	296	156
To acid phosphate plot	40	27	49
To kainit plot	144	67	90
To acid phosphate and kainit plot	96	234	151
Average increase with cotton seed meal	116	156	112
Increase of seed cotton per acre when acid phospahte was added:			
To unfertilized plot	120	160	60
To cotton seed meal plot	—24	—109	—47
To kainit plot	152	—4	—105
To cotton seed meal and kainit plot	104	163	—34
Average increase with acid phosphate	88	53	—32

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	24	34	12
To cotton seed meal plot	—16	—195	—54
To acid phosphate plot	56	—130	—153
To cotton seed meal and acid phosphate plot	112	77	—41
Average increase with kainit	44	—53	—59

MARENGO COUNTY, 2 MILES SOUTH OF FAUNSDALE.

W. C. MCKNIGHT, 1905. (See Table, p. 54.)

Yellowish, gravelly, prairie upland.

The largest increase and the only plot showing any decided profit from fertilizers was plot 10, which received 550 pounds of a complete fertilizer.

	Lbs.
Average yield of seed cotton per acre, unfertilized	414
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	62
To acid phosphate plot	170
To kainit plot	48
To acid phosphate and kainit plot	210
Average increase with cotton seed meal	122

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	—82
To cotton seed meal plot	56
To kainit plot	—42
To cotton seed meal and kainit plot	120
Average increase with acid phosphate	13

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	—20
To cotton seed meal plot	56
To acid phosphate plot	20
To cotton seed meal and acid phosphate plot	30
Average increase with kainit	21

Fertilizer Experiments in Marengo and Montgomery Counties on prairie or lime soils.

Plot No.	FERTILIZER		Faunsdale		Montgom'ry Prairie		Montgom'ry Prairie		Montgom'ry Prairie	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal.....	516	62	492	120	256	78	643	143
2	240	Acid phosphate.....	372	82	648	276	320	14	483	15
3	....	No fertilizer	454	....	372	....	334	....	498	....
4	200	Kainit	418	20	558	183	580	233	590	119
5	200 240	Cotton seed meal... Acid phosphate....	540	118	528	149	402	42	578	134
6	200 200	Cotton seed meal .. Kainit	434	28	528	146	694	322	663	246
7	240 200	Acid phosphate.... Kainit.....	328	62	648	268	690	306	593	203
8	....	No fertilizer	374	....	388	....	396	....	363	....
9	200 240 200	Cotton seed meal... Acid phosphate.... Kainit.....	522	148	694	310	672	276	853	490
10	200 240 100	Cotton seed meal .. Acid phosphate.... Kainit.....	638	264	726	338	618	220	723	360

Montgomery County, 6 Miles South East of Montgomery. Wesley N. Jones and Sons, 1906–7–8.

Black prairie soil in 1906; *reddish prairie soil in* 1907; *chocolate or "mulatto" prairie soil in* 1908.

In 1906 on black or dark gray prairie upland soil, the greatest increase, 338 pounds of seed cotton per acre, and the largest profit, was afforded by the complete fertilizer applied to plot 10. Apparently the chief need that year was for acid phosphate, though kainit was also helpful.

In 1907 the greatest increase was afforded by a mixture of cotton seed meal and kainit, closely followed by the plot receiving acid phosphate and kainit. In this test kainit was the only profitable fertilizer and was effective whether used alone or in combination with either acid phosphate or

kainit. The poor results on plots 1 and 2 and 5 appear to be partly due to the slightly poorer stand on those plots.

In 1908 a complete fertilizer was the most profitable; in this potash was most important, nitrogen next. Acid phosphate was ineffective when used alone or with meal, but profitable when combined with both kainit and meal, making a complete fertilizer.

In the 3 tests on this typical prairie soil, the most profitable fertilizer was in two cases a complete fertilizer and in one case kainit.

	1906	1907	1908
	Lbs	Lbs	Lbs.
Average yield of seed cotton per acre, unfertilized	380	365	431
Increase of seed cotton when cotton seed meal was added:			
To unfertilized plot	120	—78	145
To acid phosphate plot	—127	66	149
To kainit plot	—37	89	127
To acid phosphate and kainit plot	42	—30	187
Average increase with cotton seed meal	—1	12	152
Increase of seed cotton per acre when acid phosphate was added:			
To unfertilized plot	276	—14	—15
To cotton seed meal plot	29	120	—11
To kainit plot	85	73	84
To cotton seed meal and kainit plot	164	—46	144
Average increase with acid phosphate	130	33	50
Increase of seed cotton per acre when kainit was added:			
To unfertilized plot	183	233	113
To cotton seed meal plot	26	400	101
To acid phosphate plot	—8	320	218
To cotton seed meal and acid phosphate plot	161	234	356
Average increase with kainit	91	297	199

MONTGOMERY COUNTY, 7 MILES EAST OF MONTGOMERY.
THOS. W. OLIVER, 1907. (See Table, p. 52.)

Red sandy soil 4 to 6 in deep; red clay subsoil.

The field had been cleared perhaps 70 years before. The original growth was reported as short leaf pine and oak.

The season was unfavorable, the spring being very wet and the late summer very dry and hot.

A complete fertilizer, especially the one on plot 10, was the most profitable.

	Lbs.
Average yield of seed cotton per acre, unfertilized	596
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	112
To acid phosphate plot	84
To kainit plot	228
To acid phosphate and kainit plot	191
Average increase with cotton seed meal	154
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	32
To cotton seed meal plot	4
To kainit plot	139
To cotton seed meal and kainit plot	102
Average increase with acid phosphate	69
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	—66
To cotton seed meal plot	50
To acid phosphate plot	41
To cotton seed meal and acid phosphate plot	148
Average increase with kainit	43

LEE COUNTY, EXPERIMENT STATION FARM.

Results of fertilizer experiments in 1905 and 1906 are reserved for another publication. Expressed briefly the results showed that on gray sandy soil (Norfolk sandy loan), the greatest increase was from potash, next from nitrogen, and the least from phosphate. The latter fact may be due to an accumulation of phosphoric acid brought about by fertilization with acid phosphate each year.

LEE COUNTY, 2 MILES WEST OF AUBURN.

JOHN JACKSON, 1908. (See Table, p. 58.)

Gray sandy loam, long in cultivation.

The largest increase, 500 pounds per acre, was afforded by plot 9, on which was used 640 pounds per acre of a complete fertilizer. This represents, at 3.2 cents per pound of seed cotton, a net profit of $10.32 per acre above the cost of fertilizer. It should be added that the increased crop as measured by the scales was very much greater than the appearance of the plants would suggest to the eye.

Every one of the three constituents of the complete fertilizer was profitable in this mixture.

Average yield of seed cotton, unfertilized	560
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	190
To acid phosphate plot	10
To kainit plot	—140
To acid phosphate and kainit plot	320
Average increase with cotton seed meal	95
Increase of seed cotton per acre when acid phosphate was added.	
To unfertilized plot	100
To cotton seed meal plot	—80
To kainit plot	—118
To cotton seed meal and kainit plot	350
Average increase with acid phospha'e	63

Increase of seed cotton per acre when kainit was added:

To unfertilized plot 290
To cotton seed meal plot .....—40
To acid phosphate plot 80
To cotton seed meal and acid phosphate plot 390

Average increase with kainit 180

Fertilizer Experiments in Lee County.

Plot No.	FERTILIZER		Auburn J. Jackson		Beehive		Beehive	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	In rease over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal ...	800	190	428	156	280	96
2	240	Acid phosphate	710	100	424	152	304	120
3	....	No fertilizer	610	.....	272	.....	184	.....
4	200	Kainit	980	290	484	202	304	123
5	200 240	Cotton seed meal . Acid phosphate ..	680	110	552	260	560	382
6	200 200	Cotton seed meal . Kainit	700	150	692	392	400	225
7	240 200	Acid phospha e .. Kainit	710	180	608	297	444	273
8	....	No fertilizer.....	510	.....	320	.....	168	.....
9	200 240 200	Cotton seed meal . Acid phosphate .. Kainit	1010	500	624	304	640	472
10	200 240 100	Cotton seed meal. Acid phosphate... Kainit	750	240	560	240	560	392

Lee County, 4 Miles South of Loachapoka, at Beehive.

T. W. Cox, 1905–6.

Coarse sandy soil with yellow sandy subsoil.

This piece of upland had been in cultivation for many years. In 1905 rust was severe on all plots. The stand of plants was uniform. On this very poor coarse sandy soil

plot 6, fertilized with meal and kainit, gave the largest yield and the most profit in 1905, in which year every fertilizer was useful when applied alone or by twos.

In 1906 plot 9, receiving 640 pounds of complete fertilizer, afforded the largest yield and the greatest net profit. The latter test agrees with Mr. Jackson's in showing the need of a complete fertilizer on the coarse gray sandy soils of this region.

	1905 Lbs.	1906 Lbs.
Average yield of seed cotton per acre, unfertilized	296	176
To unfertilized plot	156	96
To acid phosphate plot	108	260
To kainit plot	190	2
To acid phosphate and kainit plot	7	201
Average increase with cotton seed meal	115	140
Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	152	120
To cotton seed meal plot	104	287
To kainit plot	95	150
To cotton seed meal and kainit plot	—88	247
Average increase with acid phosphate	66	201
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	202	123
To cotton seed meal plot	236	129
To acid phosphate plot	145	153
To cotton seed meal and acid phosphate plot	44	90
Average increase with kainit	157	124

TALLAPOOSA COUNTY, 8 MILES WEST OF NOTASULGA.

M. E. PARKER, 1905–6. (See Table, p. 61.)

Gray sandy upland; yellowish subsoil.

This field was on representative long-leaf pine land, and had been in cultivation about 20 years. The five crops pre-

ceding that of 1905 were cotton, fertilized with 200 pounds of guano per acre.

In 1905 cotton rust was severe and a complete fertilizer was most profitable, (plot 9 and 10); this year every fertilizer, whether applied alone, by twos, or all three together, greatly increased the yield.

In 1906 the test was conducted on land that had been in oats the year before. This was a rainy season on this farm. Plot 10, with a complete fertilizer gave the largest increase and greatest profit, while plot 9, receving a complete fertilizer with double this amount of potash, dropped lower in yield. There is no question of the effectiveness of phosphate and meal. But the results with kainit are here contradictory, this fertilizer making a satisfactory increase when used alone and also when used in the complete fertilizer on plot 10; but in other combinations kainit failed to increase the yield to any notable extent.

	1905	1906
	Lbs.	Lbs.
Average yield of seed cotton per acre, unfertilized	500	621
Increase of seed cotton when cotton seed meal was added:		
To unfertilized plot	320	127
To acid phosphate plot	128	104
To kainit plot	40	—26
To acid phosphate and kainit plot	160	88
Average increase with cotton seed meal	162	73
Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	264	189
To cotton seed meal plot	72	166
To kainit plot	16	—35
To cotton seed meal and kainit plot	136	79
Average increase with acid phosphate	122	100
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	336	224
To cotton seed meal plot	56	71
To acid phosphate plot	88	0
To cotton seed meal and acid phosphate plot	120	—16
Average increase with kainit	150	70

Fertilizer Experiments in Tallapoosa and Macon Counties

Plot No.	FERTILIZER		W. NOTA'GA M. E. Parker 1905		W. NOTA'GA M. E. Parker 1906		W. NOTA'GA J. W. Parker 1907		W. NOTA'GA E. B. Jackson 1907		W. NOTA'GA E. B. Jackson 1908		W. NOTA'GA S. C. Jackson 1905		SHORTER Swearington 1906	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	840	320	748	127	520	104	272	80	680	280	368	72	256	40
2	240	Acid phosphate	784	264	810	189	480	64	256	64	500	100	384	88	264	48
3	....	No fertilizer	520	.....	621	.....	416	.....	192	.....	400	.....	296	.....	216	.....
4	200	Kainit	848	336	845	224	512	123	216	25	530	112	368	75	544	325
5	200 240	Cotton seed meal Acid phosphate	896	392	914	293	632	270	296	106	500	84	552	262	464	244
6	200 200	Cotton seed meal Kainit	872	376	819	198	584	249	312	124	650	236	520	233	768	546
7	240 200	Acid phosphate Kainit	840	352	810	189	568	260	304	118	550	138	344	60	640	416
8	....	No fertilizer	480	.....	.....	.....	280	.....	184	.....	410	.....	280	.....	224	.....
9	200 240 200	Cotton seed meal Acid phosphate Kainit	992	512	898	277	656	376	400	216	680	270	536	256	768	544
10	200 240 100	Cotton seed meal Acid phosphate Kainit	1000	520	1026	405	576	296	416	232	720	310	536	256	768	544

TALLAPOOSA COUNTY, S 1–2 MILES WEST OF NOTASULGA.
J. W. PARKER, 1907. (See Table, p. 61.)

Gray sandy land; yellowish subsoil.

This typical piece of long-leaf pine upland had been cultivated for many years.

The complete fertilizer on plot 10 was the most profitable, affording a net profit of $6.35 per acre, (376 lbs. at 3.2 cents, less $5.68).

June and July were very dry. Rust and shedding were severe on plots 5, 9 and 10; plots 4 and 7 retained their foliage remarkably well.

	Lbs.
Average yield of seed cotton per acre, unfertilized	348
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	104
To acid phosphate plot	206
To kainit plot	126
To acid phosphate and kainit plot	116
Average increase with cotton seed meal	138
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	64
To cotton seed meal plot	166
To kainit plot	137
To cotton seed meal and kainit plot	127
Average increase with acid phosphate	124
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	123
To cotton seed meal plot	145
To acid phosphate plot	196
To cotton seed meal and acid phosphate plot	106
Average increase with kainit	143

TALLAPOOSA COUNTY, 6 MILES WEST OF NOTASULGA.
E. B. JACKSON, 1907–8. (See Table, p. 61.)

Gray sandy upland; yellowish subsoil.

This experiment was made on typical long-leaf pine land, which had been in cultivation for many years. The stands of cotton were good and uniform. There are no records to the presence or absence of cotton rust.

In both years a complete fertilizer was most effective and most profitable. However in a complete fertilizer, 100 pounds of kainit per acre (plot 10) was more advantageous than double this amount. (plot 9.)

	1907	1908
	Lbs.	Lbs.
Average yield of seed cotton per acre, unfertilized	188	405
Increase of seed cotton when cotton seed meal was added:		
To unfertilized plot	80	280
To acid phosphate plot	42	—16
To kainit plot	99	124
To acid phosphate and kainit plot	98	132
Average increase with cotton seed meal	80	130
Increase of seed cotton per acre when acid phosphate was added:		
To unfertilized plot	64	100
To cotton seed meal plot	26	—196
To kainit plot	93	26
To cotton seed meal and kainit plot	92	34
Average increase with acid phosphate	69	—9
Increase of seed cotton per acre when kainit was added:		
To unfertilized plot	25	112
To cotton seed meal plot	44	—44
To acid phosphate plot	54	38
To cotton seed meal and acid phosphate plot	110	186
Average increase with kainit	58	73

MACON COUNTY, 6 MILES WEST OF NOTASULGA.
S. C. JACKSON, 1905. (See Table, p. 61.)

Gray sandy pine woods soil with yellowish subsoil.

The original growth was long-leaf pine. The field had been in cultivation for many years. A mixture of acid phosphate and cotton seed meal (plot 5) was sufficient to give the largest yield and greatest profits.

Mr. Jackson noted that on plots receiving the complete fertilizer there were some spots where the plants died, probably from cotton wilt. This may explain why the complete fertilizer did not give a better yield.

	Lbs.
Average yield of seed cotton per acre, unfertilized	288
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	72
To acid phosphate plot	174
To kainit plot	158
To acid phosphate and kainit plot	204
Average increase with cotton seed meal	152
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	88
To cotton seed meal plot	190
To kainit plot	—15
To cotton seed meal and kainit plot	31
Average increase with acid phosphate	73
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	75
To cotton seed meal plot	161
To acid phosphate plot	—28
To cotton seed meal and acid phosphate plot	2
Average increase with kainit	52

MACON COUNTY, 9 MILES WEST OF TUSKEGEE.
YANCEY SWEARINGTON, 1906. (See Table, p. 61.)

Gray sandy soil with yellow loam subsoil.

This field was cleared of its growth of long leaf pine about 60 years ago. The stand was good on all plots. It is notable that the complete fertilizer on plot 6 nearly quadrupled the yield on the unfertilized plots. This complete fertilizer afforded the largest yield and the greatest profit, but was closely followed in yield and profit by plot 6, receiving a mixture of cotton seed meal and kainit. In this test kainit was the most useful single fertilizer, a fact which was probably due to its effect in restraining rust, as indicated by Mr. Swearington's careful observations. By July 10 plot 5 was ruined by rust. Plots 4 and 6 suffered least from rust and were the last to show it. The rust was considered worse on plots 9 and 10 than on plot 5. Apparently rust was worse and earlier on plots receiving phosphate.

Mr. Swearington draws the following conclusion from this test:

"Our lands need more liberal use of potash."

	Lbs.
Average yield of seed cotton per acre, unfertilized	220
Increase of seed cotton per acre when cotton seed meal was added:	
To unfertilized plot	40
To acid phosphate plot	196
To kainit plot	221
To acid phosphate and kainit plot	184
Average increase with cotton seed meal	160

Increase of seed cotton per acre when acid phosephate was added:	
To unfertilized plot	48
To cotton seed meal plot	204
To kainit plot	91
To cotton seed meal and kainit plot	54
Average increase with acid phosphate	99

Increase of seed cotton per acre when kainit was added:

To unfertilized plot 325
To cotton seed meal plot 506
To acid phosphate plot 368
To cotton seed meal and acid phosphate plot 356

Average increase with kainit 389

Fertilizer Experiments near Society Hill, Macon County.

Plot No.	FERTILIZER		R. S. Floyd 1906		R. S. Floyd 1907		A. B. Floyd 1908	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilizee plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal ...	512	160	472	168	420	30
2	240	Acid phosphate	464	112	832	192	580	30
3	....	No fertilizer.....	352	.....	640	.....	450	.....
4	200	Kainit	432	90	720	49	750	296
5	200 240	Cotton seed meal . Acid phosphate ..	552	220	1112	410	520	62
6	200 200	Cotton seed meal. Kainit	448	125	728	–4	610	148
7	240 200	Acid phosphate .. Kainit	424	111	856	94	550	84
8	....	No fertilizer.....	304	.....	792	.....	470	.....
9	200 240 200	Cotton seed meal. Acid phosphate .. Kainit	616	312	1168	376	990	520
10	200 240 100	Cotton seed meal. Acid phosphate .. Kainit	554	280	1224	432	900	430

Macon County, 5 Miles South West of Society Hill.
R. S. and A. B. Floyd, 1906–7–8.

Soil in 1907 *dark sandy loam*; *in* 1906 *and* 1908 *gray sandy soil*; *yellow subsoil in all experiments.*

All these tests were made on land that had been long in cultivation. The original growth is reported as probably short-leaf pine and hardwood.

On gray sandy soil in 1906 and again in 1908 the com-

plete fertilizer was by far the most effective and most profitable application. In both of these years rust was prevalent but least severe on the plots receiving kainia. On the other hand, in 1907, a year in which no rust troubled any plot, a mixture of cotton seed meal and phosphate on plot 5 gave the greatest increase, kainit being practically without effect.

In both years when rust prevailed, plot 10, receiving 200 pounds of kainit in its complete fertilizer, yielded more than plot 10, where only half as much kainit was used in the complete fertilizer.

	1906	1907	1908
	Lbs.	Lbs.	Lbs.
Average yield of seed cotton per acre, unfertilized	328	716	460
Increase of seed cotton when cotton seed meal was added:			
To unfertilized plot	160	—168	—30
To acid phosphate plot	108	218	32
To kainit plot	35	—53	—148
To acid phosphate and kainit plot	201	282	436
Average increase with cotton seed meal	126	70	73
Increase of seed cotton per acre when acid phosphate was added:			
To unfertilized plot	112	192	30
To cotton seed meal plot	60	578	92
To kainit plot	21	45	—212
To cotton seed meal and kainit plot	187	380	372
Average increase with acid phosphate	95	299	71
Increase of seed cotton per acre when kainit was added:			
To unfertilized plot	90	49	296
To cotton seed meal plot	—35	164	178
To acid phosphate plot	—1	—98	54
To cotton seed meal and acid phosphate plot	92	—34	458
Average increase with kainit	37	20	247

Bullock County, 9 Miles East of Union Springs.

A. M. Cope, 1906. (See Table, p. 69.)

Gray sandy soil with porous yellow sandy subsoil.

The original growth of short-leaf pine had been cleared many years before. The stand of cotton was very uniform There was need of a complete fertilizer. Of the two complete fertilizers the one containing the larger amount of kainit per acre was more profitable. The need for nitrogen and for phosphate was somewhat greater than for potash.

The increase from the complete fertilizer on plot 9 was 760 pounds per acre, thus affording a net profit of $18.61 above the cost of fertilizer and above the cost of picking the increase. Indeed every fertilizer, whether used singly or in any combination whatsoever, gave a profitable increase.

	Lbs.
Average yield of seed cotton per acre, unfertilized	240
Increase of seed cotton per acre when cotton seed meal was added:	
To unfertilized plot	256
To acid phosphate plot	232
To kainit plot	240
To acid phosphate and kainit plot	400
Average increase with cotton seed meal	282
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	288
To cotton seed meal plot	264
To kainit plot	168
To cotton seed meal and kainit plot	328
Average increase with acid phosphate	262
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	192
To cotton seed meal plot	176
To acid phosphate plot	72
To cotton seed meal and acid phosphate plot	240
Avrerage increase with kainit	170

Fertilizer Experiments in Bullock, Barbour and Geneva Counties.

Plot No.	FERTILIZER		Union Spgs A. M. Cope		Louisville		Geneva	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs*
1	200	Cotton seed meal ...	496	256	304	104	736	268
2	240	Acid phosphate	528	288	272	72	640	192
3	....	No fertilizer.....	240	.....	200	.....	448	.....
4	200	Kainit	432	192	232	24	720	265
5	200 240	Cotton seed meal . Acid phosphate ..	760	520	456	240	872	410
6	200 200	Cotton seed meal . Kainit	672	432	472	248	720	252
7	240 200	Acid phosphate .. Kainit	600	360	312	80	624	150
8	....	No fertilizer... ...	240	.....	240	.....	480	.....
9	200 240 200	Cotton seed meal. Acid phosphate .. Kainit	1000	760	456	216	920	440
10	200 240 100	Cotton seed meal . Acid phosphate .. Kainit	808	568	480	240	872	392

Barbour County, 3 Miles North of Louisville.
By J. D. Veal, 1905.

Gray, sandy soil, with stiffer gray subsoil.

This field had been long in cultivation.

The season was wet; rust was severe and all yields were small. Nitrogen afforded a larger increase than did phosphate or potash. The most profitable mixtures contained cotton seed meal, mixed either with acid phosphate or with kainit.

The year before, on the same or similar land, a complete fertilizer was the most profitable. Both years cotton seed meal and acid phosphate were needed.

In 1904 kainit was profitably used, giving an average increase of 100 pounds per acre, as compared with an average increase of only 38 pounds in 1905.

	Lbs.
Average yield of seed cotton per acre, unfertilized	220
Increase of seed cotton per acre when cotton seed meal was added:	
To unfertilized plot	104
To acid phosphate plot	168
To kainit plot	224
To acid phosphate and kainit plot	136
Average increase with cotton seed meal	158
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	72
To cotton seed meal plot	136
To kainit plot	56
To cotton seed meal and kainit plot	—32
Average increase with acid phosphate	58
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	24
To cotton seed meal plot	144
To acid phosphate plot	8
To cotton seed meal and acid phosphate plot	—24
Average increase with kainit	38

GENEVA COUNTY, 4 1–2 MILES NORTH OF GENEVA
M. P. METCALF, 1905.

Gray sandy pine land with stiffer red subsoil eight inches from surface.

The land had been in cultivation six years. Both cotton seed meal and acid phosphate were very effective, and a mixture of the two was the most profitable fertilizer. This year kainit was in most combinations useless.

In experiments on cotton made by Mr. Metcalf on similar land in preceding years the results indicated a need for phosphate; and in two of his experiments kainit was also very effective. Nitrogen was also needed except when supplied by a preceding crop of peanuts.

	Lbs.
Average yield of seed cotton per acre, unfertilized	464
Increase of seed cotton when cotton seed meal was added:	
To unfertilized plot	288
To acid phosphate plot	218
To kainit plot	—13
To acid phosphate and kainit plot	290
Average increase with cotton seed meal	196

Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	192
To cotton seed meal plot	122
To kainit plot	—115
To cotton seed meal and kainit plot	188
Average increase with acid phosphate	97

Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	265
To cotton seed meal plot	—36
To acid phosphate plot	—42
To cotton seed meal and acid phosphate plot	30
Average increase with kainit	54

HENRY COUNTY, 3 1–2 MILES NORTH OF COLUMBIA.
THOS. Z. ATKESON, COLUMBIA, 1908.

Light gray soil with yellow loamy subsoil.

The field had been cleared about 40 years, the principal growth having been long leaf pine. There was very little rain from the time the seed were planted, and cotton wilt and root knot further reduced the yield under these unfavorable conditions. All fertilizers increased the yield, but none to any large extent.

Yet the increase on plot 5 was sufficient to pay a fair profit over the cost of the fertilizer.

	Lbs.
Average yield of seed cotton per acre, unfertilized	94
Increase of seed cotton when cotton seed was added:	
To unfertilized plot	785
To acid phosphate plot	96
To kainit plot	254
To acid phosphate and kainit plot	148
Average increase with cotton seed meal	144
Increase of seed cotton per acre when acid phosphate was added:	
To unfertilized plot	35
To cotton seed meal plot	54
To kainit plot	74
To cotton seed meal and kainit	32
Average increase with acid phosphate	48
Increase of seed cotton per acre when kainit was added:	
To unfertilized plot	33
To cotton seed meal plot	209
To acid phosphate plot	72
To cotton seed meal and acid phosphate plot	124
Average increase with kainit	109

Fertilizer Experiments in Henry County.

Plot No	FERTILIZER		COLUMBIA HEADLAND 1907				HEADLAND 1908	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal ...	173	78	392	80	1015	130
2	240	Acid phosphate	130	35	208	104	1130	245
3	....	No fertilizer.....	95	.....	312	.....	885	.....
4	200	Kainit	128	33	424	105	1020	150
5	200 240	Cotton seed meal . Acid phosphate ..	225	131	416	90	1245	390
6	200 200	Cotton seed meal. Kainit	380	287	656	324	1130	290
7	240 200	Acid phosphate .. Kainit	200	107	536	198	1170	345
8	....	No fertilizer.....	93	.....	344	.....	810	.....
9	200 240 200	Cotton seed meal . Acid phosphate .. Kainit	3485	255	656	312	1425	615
10	200 240 100	Cotton seed meal . Acid phosphate .. Kainit	408	305	600	256	1410	600

HENRY COUNTY, 1 MILE EAST OF HEADLAND.
W. F. COVINGTON, 1907–8.

Gray sandy soil with yellow loam subsoil.

In 1907.—The experiment in 1907 was made on land that had been cleared about 40 years and was very poor, but otherwise representative.

The crop in 1906 was cotton fertilized with 500 to 600 pounds of a 9–3–3 guano. This probably explains in part why there was such poor response in 1907 to applications of phosphate. A further explanation is doubtless found in the observed fact that rust was worse on plot 2, fertilized with acid phosphate alone, than on other plots. Cotton seed meal and kainit both profitably increased the yield in whatever combination they were applied. The largest yield was made by a mixture of cotton seed meal and

kainit, on plot 6. Mr. Covington writes: "The kainit made good in every test, especially so on plots 4, 6, and 7. On these plots the leaves held longer and the bolls were larger and much better matured, this last being especially noticeable on plot 6."

In 1908. The field had been cleared about ten years. On this land, not so deficient in vegetable matter as that used the preceding year, a complete fertilizer gave the maximum yield and the maximum profit. Of the three constituents of the complete fertilizer, acid phosphate was most influential, closely followed by both of the others. It is notable that the complete fertilizer on plot 10, containing only 100 pounds of kainit, in addition to meal and phosphate, afforded almost as large a yield and a greater net profit than did the complete fertilizer on plot 9, which contained double this amount of kainit. The net profit due to 540 pounds of fertilizer on plot 10 was $14.27 (600 lbs. at 3.2 cents, less $4.93) per acre.

Apparently this soil needs a complete fertilizer and this conclusion is not shaken by the slight response to acid phosphate under the exceptional conditions of 1907, as stated above; this view is strengthened by the favorable results from complete fertilizers in earlier experiments on what seem to be similar soils in that part of the state.

	Lbs. 1907.	Lbs. 1908.
Average yield of seed cotton per acre, unfertilized	328	848
Increase in seed cotton when cotton seed meal was added:		
To unfertilized plot	80	130
To acid phosphate plot	194	145
To kainit plot	219	140
To acid phosphate and kainit plot	114	270
Average increase with cotton seed meal	152	172

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	—104	245
To cotton seed meal plot	10	260
To kainit plot	93	195
To cotton seed meal and kainit plot	—12	325
Average increase with acid phosphate	—3	256

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	105	150
To cotton seed meal plot	244	160
To acid phosphate plot	302	100
To cotton seed meal and acid phosphate plot	222	225
Average increase with kainit	218	159

Experiments at Betts, Conecuh County.

Plot No.	FERTILIZER: Amount per acre	FERTILIZER: KIND	Betts 1905: Yield of seed cotton per acre	Betts 1905: Increase over unfertilized plot	Betts 1906: Yield of seed cotton per acre	Betts 1906: Increase over unfertilized plot	Betts 1907: Yield of seed cotton per acre	Betts 1907: Increase over unfertilized plot
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs*
1	200	Cotton seed meal...	784	216	1048	168	440	56
2	240	Acid phosphate	792	224	1064	184	424	40
3	....	No fertilizer.....	568	.....	880	.....	384	.....
4	200	Kainit	704	139	920	37	392	9
5	200 240	Cotton seed meal . Acid phosphate ..	864	302	1080	193	456	74
6	200 200	Cotton seed meal. Kainit	832	273	1056	166	456	76
7	240 200	Acid phosphate .. Kainit	824	269	1040	147	440	62
8	....	No fertilizer.....	552	.....	896	.....	376	.....
9	200 240 200	Cotton seed meal . Acid phosphate .. Kainit	896	344	1216	320	464	88
10	200 240 100	Cotton seed meal. Acid phosphate .. Kainit	880	328	1200	304	456	80

CONECUH COUNTY, 1–2 TO 1 1–2 MILES NORTH EAST OF BETTS.

R. H. BETTS, 1905–6–7.

Gray sandy soil with red subsoil.

The land on which these tests were made had been cleared for 30 or 40 years. The original growth was reported hardwood and short-leaf pine; if so, probably this soil is different from the average soil of the long-leaf pine belt.

In 1908 there was so much rain and such small yields that all fertilizers were about equally ineffective and unprofitable. In 1906 when both fertilized and unfertilized plots yielded well, complete fertilizer (on plots 9 and 10) afforded the largest net profit. In 1905 a mixture of cotton seed meal and acid phosphate was nearly as effective and quite as profitable as a complete fertilizer.

	1905 Lbs.	1906 Lbs.	1907 Lbs.
Average yield of seed cotton per acre, unfertilized	560	888	380
Average yield of seed cotton when cotton seed meal was added:			
To unfertilized plot	216	168	56
To acid phosphate plot	78	9	34
To kainit plot	134	130	67
To acid phosphate and kainit plot	75	173	26
Average increase with cotton seed meal	126	120	46
Increase of seed cotton per acre when acid phosphate was added:			
To unfertilized plot	224	184	40
To cotton seed meal plot	86	25	18
To kainit plot	130	111	53
To cotton seed meal and kainit plot	71	154	12
Average increase with acid phosphate	127	119	31
Increase of seed cotton per acre when kainit was added:			
To unfertilized plot	139	36	9
To cotton seed meal plot	57	—2	20
To acid phosphate plot	45	—37	22
To cotton seed meal and acid phosphate plot	42	127	14
Average increase with kainit	71	31	16

Inconclusive Tests.

The following inconclusive experiments were made:

Bullock County, O. M. Hill, Suspension, 1906.

Bullock County, F. B. Haynes, 7 miles South of Union Springs, 1908.

Chambers County, E. W. Smart, Fredonia, 1905.

Fayette County, J. B. Gibson, Newtonville, 1908.

Pickens County, D. W. Davis, Gordo, 1906.

The yields in these tests are given in the next table.

Inconclusive Experiments in Bullock, Chambers, Fayette, Montgomery and Pickens Counties.

Plot No.	FERTILIZER		Suspension 1906		Union Springs Haynes, '08		Fredonia 1905		Newtonville 1907		Newtonville 1908		Naftel 1905		Gordo 1906	
	Amount per acre	KIND	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot	Yield of seed cotton per acre	Increase over unfertilized plot
	Sbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal ...	808	16	450	150	816	728	1090	650	336	72	608	72	880	256
2	240	Acid phosphate	872	48	580	20	888	200	1080	640	408	144	488	48	752	128
3	....	No fertilizer.....	824	.....	600	.....	688	.....	440	.....	264	.....	536	.....	624	.....
4	200	Kainit	856	37	740	180	912	152	1200	684	280	19	688	187	608	29
5	200 240	Cotton seed meal. Acid phosphate ..	1088	274	570	50	768	64	1320	728	272	14	336	130	688	38
6	200 200	Cotton seed meal . Kainit	984	175	630	150	192	288	1080	412	232	23	560	129	936	273
7	240 200	Acid phosphate .. Kainit	1000	195	540	100	1376	400	980	230	208	44	656	260	672	4
8	....	No fertilizer.....	800	.....	400	.....	1048	.....	820	.....	248	.....	360	.....	688	.....
9	200 240 200	Cotton seed meal . Acid phospaate .. Kainit	960	160	450	50	1256	208	1380	560	256	8	664	304	824	136
10	200 240 100	Cotton seed meal . Acid phosphate .. Kainit	1224	424	390	10	1096	48	1340	520	232	16	712	352	848	160

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ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN.

LIBRA
NEW YO
BOTANIC
GARDE

FACING THE BOLL WEEVIL PROBLEM IN ALABAMA

BY

W. E.HINDS,

Entomologist

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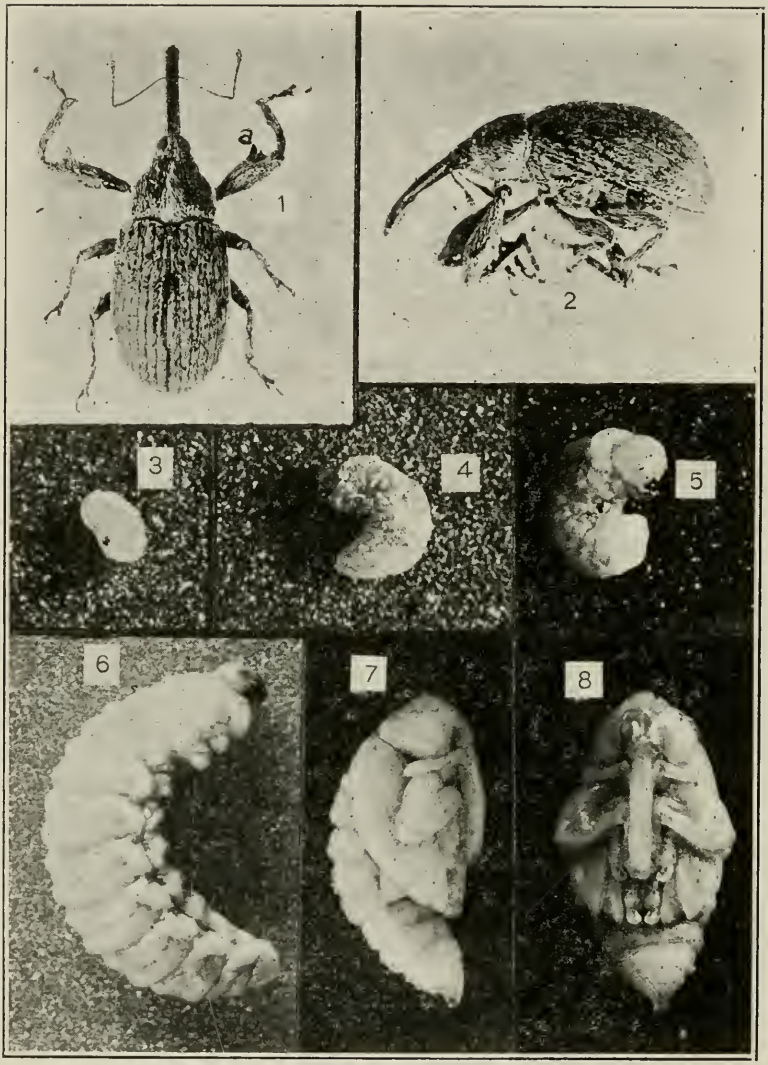
PLATE I.



THE BOLL WEEVIL AND ITS STAGES.

Fig. 1, Adult boll weevil, viewed from above; *a*, two teeth on fore femur; fig. 2, adult weevil, side view; fig. 3, egg of weevil; fig. 4, grub about two days old; fig. 5, grub at entrance to second stage after shedding first skin, about three days old; fig. 6, grub fully grown, about ten days from egg; fig. 7, transformation or pupal stage, side view, snout, legs and wings forming; fig. 8, pupal stage, front view of fig. 7. Figs. 1, 2, 6, 7 and 8 enlarged about ten diameters; figs. 3, 4 and 5 enlarged about twenty diameters. (Original).

FACING THE BOLL WEEVIL PROBLEM IN ALABAMA

INTRODUCTION.

That within three years the Mexican cotton boll weevil will have entered Alabama is as certain as it is that cotton will continue to be produced in this and adjoining states before that time. The certainty that the cotton planters of Alabama will soon have to contend with an enemy more difficult to fight and more destructive to the crop than anything which they have ever been forced to face should be a matter of deep and immediate interest to every citizen of the state regardless of his occupation. If we shall meet this grave problem in a manner to result in a minimum of loss to all branches of commercial and professional as well as of agricultural life, it is essential that we improve to the utmost the few years which may intervene in direct and united preparation for the great changes in agricultural practice and in economic conditions generally which the presence of this pest has invariably caused wherever it has gone. We may well be willing to profit by the experience for which our sister States of Texas, Louisiana and Mississippi, particularly have paid so large a price. We should by all means begin immediately to put into active operation some of the fundamental improvements in agricultural practice which have been worked out during the past few years as a direct result of the fight against the weevil. If these practices are advisable and profitable anywhere with the boll weevil present they may be made even more so here and now before the weevil arrives. The great opportunity for gaining experience and determining the immediate applicability of any of these practices to our local conditions is evidently the period before the weevil comes and while we do not have to suffer the losses which it is very certain to inflict wherever it exists.

It may be pardonable in this case to mention a few per-

sonal facts which may enable the reader to judge of the writer's competency in this subject. From July 1, 1902, until September 30, 1907, he was engaged constantly and exclusively under the U. S. Bureau of Entomology in the investigation of the Mexican cotton boll weevil in Texas. The seasons of 1902, 1903 and 1904 were spent principally in South Texas where the weevil had been abundant for several years and where it was doing great damage. The seasons of 1905, 1906 and 1907 were spent in north Texas, in a region which was then but recently infested. In this work he was associated with Mr. W. D. Hunter who has been in direct charge of the boll weevil investigation from 1901 to the present time. The most important of the boll weevil publications are referred to in the Bibliography, see page 100.

Within the limits of this brief paper it is impossible to touch upon many of the important and interesting points in the discovery, introduction, life history and control of this insect.

It spread into the Southern part of Texas from Mexico about 1892 and from that time to this nothing has occurred to more than temporarily check its annual advance into new cotton growing country. Its annual spread is mainly by flight and cannot be prevented by human effort. The best that can be done is to guard against assisting in the spread of the pest and to do everything possible to avoid and to minimize the injury which its very presence involves. As soon as the weevil entered Texas it became apparent that the investigation of methods for its control constituted a National, rather than a State problem. Since 1901 Congress has been making special appropriations for the investigation of the boll weevil and from one to twenty trained men have been giving their time constantly to the study of this most serious problem. The writer was personally engaged in this work for more than five years. Naturally the damage which it has done has increased from year to year with the increase in the area infested. It is safe to say that the loss which it now occasions cannot be less than $25,000,000 each year.

The National government has spent more than $1,000,000 in the investigations which have been made to discover effective methods of controlling the pest, and the various states affected have also expended large sums. The information and recommendations given in the following pages are gathered from the best that has been learned in this great struggle. A few of the important publications concerning the weevil are referred to in the Bibliography on page 100.

Since 1892 the weevil has spread Northward through Texas and the Southern half of Oklahoma and Eastward, crossing Louisiana, the Mississippi River and into Mississippi. From the infested territory each year it spreads ever onward as wave after wave spreads outward when a stone is cast into water. The old territory is not abandoned since only part of the host of weevils which is developed by fall will leave the field to seek new territory. Undoubtedly many fly back into previously infested fields where their presence is lost sight of but those which happen to fly in to new localities quickly establish a new line of infestation which can be quite readily marked.

The distance through which they have thus advanced has averaged fully fifty miles each year. The first weevils crossed the Mississippi River in the fall of 1907 and during the fall of 1908 eighteen counties in the western part of that State became either wholly or partially infested. The area now infested constitutes more than one third of the cotton growing area of the United States and produces nearly one-half of the annual crop. The limits of the infestation, the relationship which this bears to the entire commercial cotton growing area, and the annual progress of the pest during recent years are plainly shown upon the accompanying map, Fig. 1, which was prepared by Mr. W. D. Hunter during the fall of 1908 from data collected by the numerous field agents of the Bureau of Entomology investigating the spread of the boll weevil.

Fig. 1, The cotton growing area showing the area infested by the boll weevil during various years. (After Hunter, Farmers' Bul. 344.)

WHEN WILL THE WEEVIL REACH ALABAMA?

A brief study of this map with the facts stated relating thereto should be enough to convince anyone that the advance of the boll weevil will most certainly continue. The present northern limit of infestation is farther North geographically than is any portion of Mississippi, Alabama, or Georgia. The existence of the boll weevil depends primarily upon the occurrence of cotton which is its only known food plant. Besides its dependence upon this food supply the continued existence of the weevil depends also upon its ability to survive the winter climatic conditions in order to pass from the crop of one season to that of the next. The weevil has already shown that it can withstand successfully temperatures reaching nearly if not quite to Zero F. which is as low as is likely to occur anywhere in the cotton belt.

The eastward spread of the weevil therefore promises to be as certain and as rapid as was its northward spread through Texas and Oklahoma until ultimately it shall infest cotton wherever grown commercially in the Southeastern States. Its spread may be accomplished in two general ways.

In the first place the weevil will continue to spread by its own unaided flight which man is powerless to prevent. The entire area embraced within a line passing through the outermost points thus reached each year must be considered as constituting the "area of general infestation" although the weevil may not occur at many of the places included within but near the outermost edge of this area. The line referred to is "the line of general infestation" and this is what we reckon with in the annual spread of the boll weevil. It may be shown that this line has been steadily advanced through an average distance of about fifty miles each year. We may expect this rate to be maintained as the weevil continues eastward to the Atlantic Coast. From this basis we may easily and quite certainly determine that in two seasons more, that is by November 1910, we may expect the line of general infestation to reach the Mississippi–Alabama boundary. It is quite likely that some of the western tier of

counties in this State may then become partially infested. It will require only about three years more for the weevil to spread over the entire State and to reach Western Georgia. Therefore we may consider it practically certain that throughout the western third of Alabama by the summer of 1911, through the central third by 1912, and through the eastern third by 1913, and in each case constantly after those dates, every cotton planter will have to reckon with the presence of the boll weevil and some degree of injury by it.

In the second place, we must consider that the boll weevil is *liable* to be brought into the State at any time ahead of the general infestation by the various methods of transportation, principally by railroads, with persons, household goods, cotton and its products, or with any other articles which may contain or shelter them. This danger naturally increases as the line of infestation approaches more closely In numerous instances in Texas, Louisiana, Mississippi and elsewhere it has been clearly established that the weevil has been carried long distances in shipments of cotton seed from infested areas although fortunately it has not yet happened in the direction of uninfested territory. Infested cotton produced in the edge of the infested area has been hauled considerable distances beyond for ginning and planters bringing their cotton from other directions have carried away weevil-infested seed with them. Tenants and cotton pickers moving from infested to uninfested territory are very liable to carry weevils with them and thus establish new centers of infestation. These are among the considerations which have made necessary the establishment and strict enforcement of quarantine measures to guard against the accidental introduction of the weevil.

QUARANTINE REGULATIONS AGAINST THE BOLL WEEVIL.

Alabama passed such a law in 1903, and placed the enforcement of the act in the hands of the State Board of Horticulture, as at that time there was no special Ento-

mologist connected with the State Experiment Station.

TEXT OF ALABAMA BOLL WEEVIL LAW.

AN ACT to prevent and prohibit the importation of seed from cotton affected with the Texas boll weevil.

SECTION 1. Be it enacted by the legislature of Alabama, That no person shall import or bring into the State of Alabama any seed from cotton affected with what is known as the Texas boll weevil, nor the seed from any cotton from any place where the cotton has been affected with said boll weevil.

SEC. 2. Any person who violates the provisions of section 1 of this Act shall be guilty of a misdemeanor, and on conviction shall be fined not less than ten dollars ($10.00) and not more than five hundred dollars ($500.00).

(H. 877, No. 559, approved Oct. 6, 1903.)

In addition to the above, the State Board of Horticulture organized by Act of the Legislature No. 121, approved March 5, 1903, has established regulations governing the shipment into and through the State of cotton products, packing materials, household goods, etc. The text of the regulations which are at present in force is as follows:

RULES AND REGULATIONS

GOVERNING THE IMPORTATION OF ARTICLES LIABLE TO CONTAIN THE MEXICAN COTTON BOLL WEEVIL.

RULE 11. In accordance with an act of the Legislature of the State of Alabama entitled: An act to Further Protect Horticulture, Fruit Growing and Truck Gardening, and to Exclude Crop Pests of all kinds in the State of Alabama, approved March 5, 1903; the following rules and regulations relative to the Mexican Cotton Boll Weevil were adopted:

(a) That in order to prevent the introduction of the Mexican Cotton Boll Weevil into the State of Alabama, a rigid quarantine is hereby declared against all infested localities in Texas or Louisiana, and of other sections that are or may hereafter become infested.

(b) That cotton lint (loose, baled flat or compressed) cotton seed, seed cotton, hulls, seed cotton and cotton seed sacks (which have been used) and corn in the shuck, originating in cotton boll weevil infested localities, shall be excluded absolutely from the State of Alabama.

(c) All shipments of household goods from infested areas shall be prohibited unless the same is accompanied by an affidavit, attached to the way-bill stating that the shipment contains no cotton

lint, cotton seed, seed cotton, hulls, seed cotton and cotton seed sacks or corn in the shuck.

(d) All shipments of quarantined articles, mentioned in section (b) above, through the State of Alabama shall be made in tight, closed cars.

(e) No common carrier shall use for bedding, or feed for live stock, any of the quarantined articles when the shipments originate in regions infested with the cotton boll weevil.

(f) All railroads, steamboats, express companies and other common cariers, and all private vehicles, boats, etc., entering the State of Alabama from the states of Texas or Louisiana, or passing through the State of Alabama from any of the infested districts of the States of Texas or Louisiana, are especially enjoined to comply with the requirements of this order and of laws of the State of Alabama governing the same.

RULE 12. The State Horticulturist is hereby charged with the enforcement of the rules and regulations relative to the Mexican boll weevil.

The form of affidavit accompanying the waybill with shipments of household goods should specify the prohibited articles as not included, as follows:

State of....., County of .....
Before me .....Notary Public in and for said State and County, personally appeared .... who being duly sworn states on oath that the shipment of ..... waybill of which this affidavit accompanies, does not contain any cotton lint, cotton seed, hulls, seed cotton and cotton seed sacks or corn in shuck.

Sworn to and subscribed before me this.....day of ..... 190..

(Seal) ..... Notary Public.

At the bottom of all law lies the general consideration that the safety and welfare of the public is more important than the convenience or interest of any private individual. It is certainly of public advantage that every possible precaution be taken to prevent needlessly hastening the spread of so dangerous an insect pest as this. The advance of the weevil will gradually transfer states, counties, and localities from the uninfested to the infested territory and thus reduce the area in which quarantine measures apply. Within five years, therefore, the boll weevil quarantine may become a thing of the past in this State. In the meantime it

is of highest importance that we be able to definitely establish the limits of infestation and determine just where the application of the quarantine will do good instead of harm. Obviously no restriction of personal or commercial movement is justifiable or desirable if no protection or benefit may result. We therefore urge upon all concerns or individuals to whom the provisions of this quarantine may apply that they continue to give it their cheerful and complete support so long as may be necessary. More detailed information will be furnished all who may request it upon any specific points by the "Entomologist to the Experiment Station, Auburn, Ala."

DESCRIPTION OF THE BOLL WEEVIL.

It is of extreme importance that we learn of the presence of the weevil anywhere in the state as quickly as possible after its arrival. For information on this point we must necessarily depend principally upon the reports of cotton planters and others directly interested in this subject. As a rule we cannot depend for this information upon newspaper reports, even when these are vouched for by some planter who "came from the boll weevil country". With the boll weevil, as with most other insects, the ordinary casual observer fails to notice any but the most obvious characters on account of their small size. Therefore the characters noted are more than likely to be only those which are common to a group including hundreds of closely related species rather than those distinctive of a single species. By careful attention to the following brief description and to the illustrations given herewith we believe that the reader of average intelligence may be able to distinguish the boll weevil from the numerous other insects occurring on cotton, which are often mistaken for it (see appendix) and to recognize its attack on the plant with a reasonable degree of certainty. In any case of doubt specimens should be sent immediately in a strong, tight, tin or wooden box, with a letter of explanation to the Entomologist, Alabama Experiment Station, Auburn, Ala. He will gladly determine

such specimens and report to the sender entirely free of cost.

The boll weevil is a beetle belonging to a large group, all of which are characterized by having part of the head in front of the eyes greatly extended to form a long slender snout. There are many hundreds of species of these insects, all of which are commonly called "weevils", but the Mexican cotton boll weevil is the only one of these many species which is at all serious as an enemy of cotton. While other species may be found upon cotton plants, their occurrence there is mainly accidental. Rarely indeed does any other species breed upon cotton. The boll weevil breeds upon cotton and upon nothing else. Like all other beetles the boll weevil has four distinct stages in the development of each individual. These are the egg (Pl. I, fig. 3), which is only about 1-30 of an inch long, white and delicate. This is always deposited in a cavity which the female eats in the square or boll and upon no other part of the plant. From the egg there hatches in a few days a white, legless grub or worm (Pl. I, figs. 3-6) which does not at all resemble the beetle which it may finally become. The grub of the boll weevil resembles very closely that of the "plum curculio" which is so familiar a pest in peaches, plums, cherries, etc., working in the fruit and usually around the stone. The boll weevil grub grows steadily from its initial length of about 1-25 of an inch until it becomes fully grown and measures from 1-5 to 2-5 of an inch in length. The body is strongly curved in the form of a crescent, in this respect being more curved than the "worm" in peaches, etc. (Pl. I, fig. 6.)

In order to attain the beetle form the grub must pass through an intermediate "transformation stage" which is known as the "pupa." (Pl. I, figs. 7 and 8.) In this stage no food is taken, and there is a complete change of the appearance and of structure. The grub sheds its skin and instead of the legless, wingless, snoutless worm, the pupa appears with all of these organs forming in sheaths closely applied to the body. In this stage the insect is very delicate,

and perfectly helpless. It, as well as the egg and grub stages, is passed wholly within the interior of the square or boll. These three constitute the immature stages in the life of the weevil, but are as characteristic of the insect as is the adult form.

After a few days the pupa sheds its skin and becomes the fully formed adult weevil as shown in Pl. I, figs. 1 and 2, having the legs and snout free and usable, as are also the wings, which are folded back, under and protected and hidden by, the hard wing-covers, which meet in a straight line over the middle of the back of the beetle. For a few days the adult also remains protected within the square or boll while it becomes hardened and more able to care for itself. It then cuts a circular hole just the size of its body in the wall of its cell in the square, and through this opening makes its escape into the outer world, where from that time on it leads a free and active life.

The adult weevil, therefore, is the form most commonly seen around infested cotton, and this stage needs a more detailed description. The full grown weevils vary considerably in size and in color. In length they range between 1-8 and 3-8 of an inch, while the breadth of the body is approximately 1-3 of its length. The general color is uniform over the body and varies from a chocolate brown in the darkest specimens, which are usually below average size, to a grayish or yellowish brown in the lighter colored larger forms. The lighter colors are due to light colored scales or modified hairs which occur most abundantly in the larger specimens. If these are undeveloped or become rubbed off, then the dark brown ground color of the weevil appears. The slender snout is only slightly curved and is about 1-2 as long as the length from the head to the tip of the body. Neither the size, nor the structure or general appearance of the weevil changes at all after its emergence from the square or boll in its adult form. The adults feed and mate and the females then deposit eggs. This completes the "Life Cycle" and starts another generation all within a period of from three to four weeks.

THE EFFECT OF WEEVIL WORK ON COTTON.

The recognition of the presence of the boll weevil may depend upon the identification of the adults or the immature stages in squares and bolls or just as certainly upon the recognition of its feeding injuries or the effect of its work upon the fruiting of the cotton, as these are also characteristic. No other insect produces at all similar injuries to cotton.

The excrement deposited by the adult weevils on the squares upon which they work is of a bright orange color and so forms a conspicuous sign of boll weevil presence. The egg punctures, like those made for feeding, are eaten out but are only made large enough to receive the egg which is placed just inside of the floral coverings and usually near the base of the bud. The natural tendency of the green parts of plants to heal wounds in which decay does not occur causes a growth of plant cells to more than fill the canal leading to the egg cavity. The excess of this growth bulges outward so that it forms a distinct "wart". This "wart" is therefore characteristic of a boll weevil egg puncture. As the grub feeds and grows inside the bud it destroys the very heart of the square, until when about half grown its injury thereto becomes so great as to cause the destruction of that bud. The leaflets enclosing the bud spread apart, or "flare" as it is called, and the whole square turns yellow, wilts and is shed as are leaves when they can be of no further use to the plant. It is Nature's surgery in removing a diseased and useless member. Upon the ground the development of the grub continues and its transformation through the pupal stage to the adult beetle takes place. Practically one-half of the developmental period is spent in the square on the plant and the other half in the square after it has fallen to the ground. Badly infested cotton produces few, if any, blooms, while the infested squares shed by the plant as fast as they form are thickly scattered beneath it on the ground. Squares may be shed as a result of adverse cultural or climatic influences, but

when shed from such causes they show no signs of weevil or other insect injury such as have been described.

RECOGNITION OF THE WEEVIL.

We may summarize briefly the most important characteristics upon which we may depend for the prompt recognition of the weevils' presence in Alabama:

1. The adult beetles (Pl. I, figs. 1 and 2) probably found on cotton only, are about 1–4 inch long, with slender, slightly curved snouts, of dark brown, ashy-gray, or yellowish brown color.

2. The crescentic grubs (Pl. I, fig. 6) about 3–8 inch long and the pupal stages (Pl. I, figs. 7 and 8) occur only in squares and in bolls. This is the only insect which breeds in this way in cotton.

3. The occurrence of open cavities 1–16 to 1–20 inch in diameter and reaching down to larger excavations among the pollen sacs, the presence of "warts" marking the egg punctures of the weevil, the occurrence of the orange-colored excrement on the buds, the abundant shedding of squares and the consequent scarcity of blooms without accompanying rain or cultural conditions to cause the shedding; these are among the most conspicuous signs of boll weevil presence and injury.

Whenever any specimens of weevil or cotton squares or bolls showing weevil stages or the signs of their work are discovered anywhere in Alabama in advance of the general infestation by the weevil, it is of the utmost importance that they be immediately submitted to the Entomologist, Auburn, for positive identification. We must depend upon the hearty co-operation of cotton planters in this work, as upon the promptness with which the first occurrence of the weevil in a locality is discovered and reported to the Entomologist

depends entirely the possibility or advisability of undertaking any measures for the extermination of the weevil which might prevent the infliction of damage to that locality for several years before it would necessarily occur through coming within the area of general infestation.

Undoubtedly during the next few years local newspapers, as well as the leading papers of the State, will frequently receive reports of the occurrence of the boll weevil in their vicinity. Editors, before publishing such items, should secure specimens and forward them to the Entomologist and await his report as to their genuineness. Published statements, if untrue, can only do harm among their readers, and for a time the harm will be as great as though they were true, as they will affect all agricultural and business interests. This is too serious a matter to permit of the creation of undue excitement through the circulation of misleading impressions. The situation should be faced calmly, intelligently and courageously to safeguard the best interests of all who may be affected by whatever effects the production and sale of cotton. If faced in this spirit there is absolutely no need for the existence in Alabama of the feeling of "panic" which has heretofore accompanied the weevil during the first few years of its occupation of new territory.

HOW THE BOLL WEEVIL MAY BE SUCCESSFULLY CONTROLLED.

The great difficulty in fighting the boll weevil has arisen from the fact that the peculiar habits of the adult and the protection of the immature stages within the squares and bolls render it practically useless to attempt to destroy them by any usual methods of insecticidal treatment. Hundreds of remedies have been tested and found ineffective for the above reasons, if for no others. As in human warfare, one of the most effective measures of subduing an enemy consists in destroying their food supplies, so it is equally true in the case of an insect which is dependent upon one species of food plant as is the boll weevil. That the weevil can be effectively controlled and the culture of cotton continued at fully as great profit as has usually been realized without the weevil, has been proven possible through the practical application in many thousands of cases in the weevil area of improved methods in cotton culture and in general agricultural practice. Some of these measures take advantage of and increase the effectiveness of certain factors of natural control. Most of them, however, are merely **steps in a system of cotton culture** which prepare the way for the application of the **one most effective direct method of destroying immense numbers of weevils by cutting off their food supply at the only season of the year when the destruction of cotton is possible, practicable and most effective in reducing the number of weevils. The final step is the complete destruction of all green cotton at least three or four weeks before the usual date for the occurence of the first killing frost in the fall.** This has often been called the most important single step in the cultural system of controlling the boll weevil. It may seem to many that it cannot be successfully applied under the conditions existing in Alabama. That has been claimed

also in Texas, Louisiana and elsewhere, but it has been found always that **it is possible under almost all conditions if the necessary steps leading up to it are also employed.**

We must remember that the presence of the boll weevil inevitably produces a change in the conditions of cotton growth. Practically, there can never be "late cotton" in the infested area. The only portion of the crop to escape the weevils and mature is that which develops early in the season before the weevils have reached their maximum abundance. Therefore the very presence of the weevil tends to limit cotton production to the early crop and to clear the way for the proposed and necessary destruction of the stalks.

The effectiveness of this practice has been most positively established by the repeated experience of planters on large as well as upon small scales, and also through Nature's object lessons whenever through the effects of unusual climatic conditions or when by the defoliation of the plants by the cotton leaf caterpillar or cotton worm there has resulted the practically complete destruction of cotton at an unusually early date in the fall. In every such case the fall destruction has been followed by larger crops, less weevil injury and a great increase of net profit in the crop of the following year.

We have not room in this paper to give details regarding any of these great demonstrations, but can merely state that in many cases where the work has been conducted most carefully with adequate checks **the value of the increase in the crop on the area where stalks were destroyed has been from $15.00 to $20.00 per acre, as compared with the yield on the check areas on which the stalks were allowed to stand until the usual time of preparation for planting in the spring. In all other respects both areas received similar treatment and were grown under like conditions.**

STEPS IN THE CULTURE OF COTTON FOR CONTROLLING THE BOLL WEEVIL.

The immediate adoption of such improved agricultural practices, as rotation and diversification of crops, better culture and more careful selection of seed for cotton

as soon as the weevil is known to be within less than 100 miles of any locality.

In order to practice early destruction of stalks it is essential that part, at least, of the other steps be also adopted as they are of prime importance in leading up to the early maturity of the crop. It is impossible for us here to attempt to describe these steps at all fully. Much more can be learned regarding them from a study of the publications referred to in the brief Bibliography on page 100.

If we begin this work for the control of the weevil in the fall, as is desirable for securing its greatest effectiveness, it may involve the sacrifice of a small amount of cotton from the late maturing bolls. It is not necessary to make this sacrifice until the first year that the weevil is likely to reach the locality. After that time the possible loss of a few pounds of "scrappings" should not be allowed to count as against the necessity for and larger benefits of early destruction.

Destruction of Stalks.—The best method of destroying the stalks is by uprooting and burning them. The roots, if cut, should be cut below the surface to prevent their putting out sprouts later. The plants should be thrown into windrows or piles while still green so that the leaves, squares and bolls may not be scattered but will remain on to assist in the early burning of the stalks and also because it is desired to destroy immediately the immature stages which may be present. Sometimes it will be found worth while to apply crude oil to faciliate the burning before the stalks have time to fully dry.

Advantages of Early Burning.—1. It stops absolutely the development of weevils late in the fall by destroying the immature stages then present in squares and bolls. 2. By

the complete removal of their only food it forces the dispersion and starvation of the weevils already adult. Obviously the longer the period between the destruction of all green cotton and the occurrence of the first killing frosts, at which time the weevils may go into winter quarters with most assurance of survival, the more complete will be the destruction of the adults. 3. It removes a large amount of rubbish within which those weevils which escape destruction would find the most favorable conditions for their successful hibernation. 4. It prevents the development of adults emerging shortly before frost. These are the weevils which ordinarily stand the best chance of living through the winter. Where one weevil may live through the winter if stalks are destroyed by the 15th to the 20th of October, there will be at least ten survivors if the destruction of stalks is delayed until the middle of November. There is a constant increase in the percentage of survival between these dates.

Preparation of the Land for Cotton.—This should be more thorough than is usually given. On light soils fertilizers are needed for cotton, and those containing a relatively large percentage of phosphoric acid tend to promote the early maturity of the crop.

Planting.—Let this be done as soon as danger of frosts is passed. Early planted cotton invariably does better than even medium planted where the weevil occurs. It is desirable that the planting in a locality should be done as near the same date as possible, so that all of the cotton will be coming on together. The weevils thus have no chance to get a start upon any of the fields. Plant the rows at such distance apart as has been found to give best yields in any field.

Chopping.—Chop to a stand early, as this gives the plants that are left a better start. Space the plants as has been found best for yield in any field.

Cultivation.—This should be frequent and shallow. Its first object is to keep the soil in favorable condition for producing a steady and rapid growth of the crop. The destruction of weeds is accomplished incidentally. The surface

crust that may form after rains should be broken up as soon as possible.

Harvesting.—Let this be done as quickly as the bulk of the crop is open. Every effort should be made to have ready the necessary labor supply for this work as soon as it may be done. Remember always the need for keeping a winter cover crop on the soil and for clearing the way for the early destruction of the stalks. The earlier these may be destroyed the better. **Their destruction constitutes the last step in dealing with the cotton crop each year where the boll weevil is present and is also the first step in preparation for the next crop of cotton, even though the cotton may occupy some other field through the system of rotation.**

CONCLUSION.

We hope that we have made plain that the coming of the boll weevil is assured, and that we shall very soon have to reckon with it constantly in the culture of cotton. We hope also that what we have said may help the cotton planters of the State to face this serious question more intelligently and more courageously than they would otherwise have done. In spite of the admittedly serious nature of the weevil as an enemy of cotton, there is no need for a "feeling of panic" if the recommendations given herewith are put into practice immediately. Their general application will improve the conditions of farm life, increase the value of farm property and multiply profits to both owners and tenants. In most sections where the weevil has already gone there have been heavy losses during the first two or three years of infestation because planters have been slow in adopting just the changes in cotton culture which have been outlined herein. They have thought at first that they were perfectly familiar with the best methods of raising cotton, and that no "scientists" could tell them anything about it. As a result, they have been finally forced to give up cotton altogether, or to adopt part, at least, of the methods which

have been described. With the adoption of the improved practices the control of the boll weevil has ceased to be an exceptionally serious problem, and they have found that in this way it is entirely possible to raise as much, or even more, cotton per acre as they were accustomed to raise before the coming of the weevil. The diversifying of crops has helped to make the farmers of the boll weevil area more independent of cotton as a single crop, and in many sections they are now more prosperous than ever before. In many respects the advent of this pest has resulted in greater final benefits than its injuries, and there has been brought about within five years a greater agricultural development than would have been likely to have come in two or more times as long but for the coming of the weevil.

If it shall lead to the immediate application of many of the improvements herein recommended, then the coming of the boll weevil shall bring a blessing and not a curse to this State. May every agency be united in a helpful co-operative campaign of progressive education that shall prepare us to best meet and to most effectively overcome the boll weevil in Alabama.

BIBLIOGRAPHY.

This is intended to be only a very partial list of the publications relating to the boll weevil, but to include those available which may be most useful to the planters of Alabama.

Publications of United States Department of Agriculture, Bureau of Entomology, Washington, D. C.

Bulletin No. 51. The Mexican Cotton Boll Weevil. Hunter & Hinds. 181 pp. Published 1905. (Write your Congressman for a free copy.)

Bulletin No. 74. Some Factors in the Natural Control of the Mexican Cotton Boll Weevil. Hinds. 79 pp. Published 1907.

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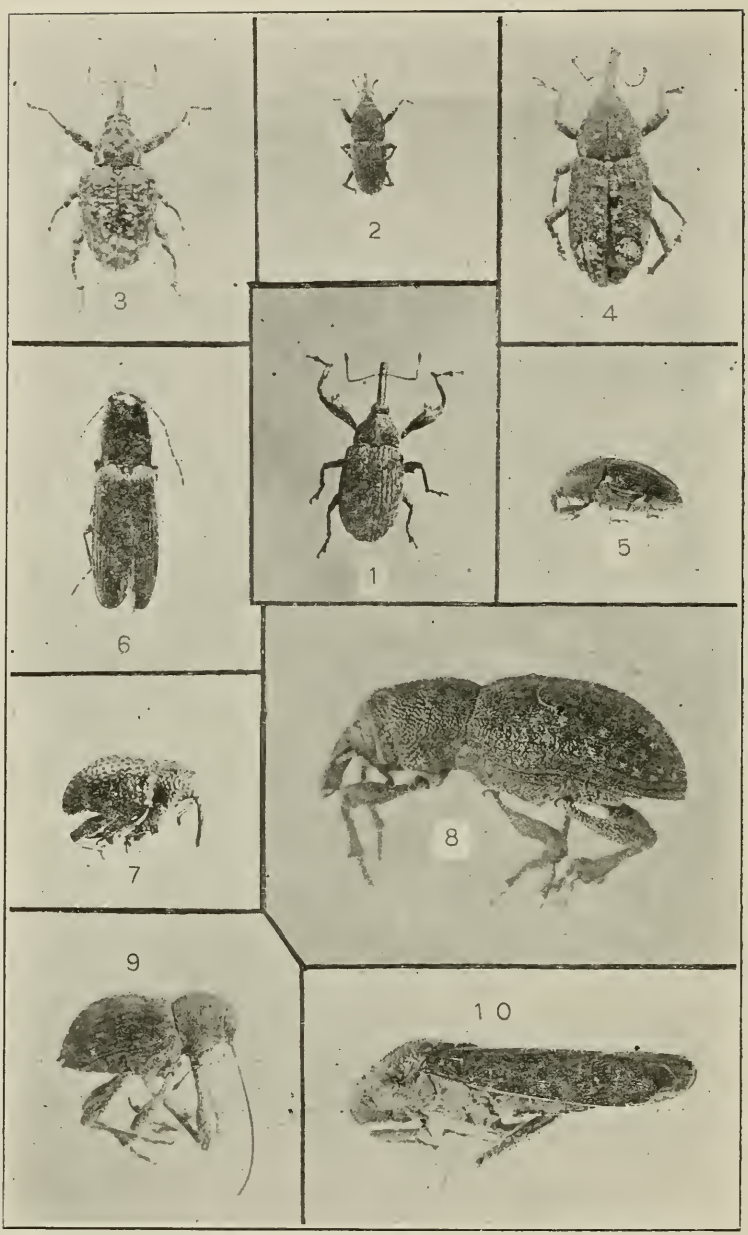
(All of the above relate to cotton insects, the boll weevil or to cotton culture, and may be obtained free upon request to the Department.)

Publications of Louisiana Crop Pest Commission, Baton Rouge. La. Circulars 8 and 23.



INSECTS OFTEN MISTAKEN FOR THE BOLL WEEVIL.

Fig. 1, Boll weevil (*Anthonomus grandis Boh.*); fig. 2, rice weevil which breeds abundantly in corn (*Calandra oryzae* Linn.); fig. 3, plum curculio (*Conotrachelus nenuphar* Hbst.); fig. 4, white pine weevil (*Pissodes strobi* Peck.); fig. 5, transverse Baris (*Baris transversa* Say); fig. 6, a click beetle (*Monocrepidius vespertinus* Fab.); fig. 7, cow pea pod weevil (*Chalcodermus aeneus* Boh.); fig. 8, Pales weevil (*Hylobius pales* Hbst.); fig. 9, an acorn weevil (*Balaninus* sp.); fig. 10, sharpshooter (*Homalodisca triquetra* Fab.). All enlarged about five diameters. (Original.)

APPENDIX

The Mexican Cotton Boll Weevil and Some of the Insects Most Frequently Mistaken for it.

For the sake of facilitating comparisons a figure of the boll weevil is included on Plate II. Fig. 1. All figures have been taken at the same magnification of approximately four diameters.

In this list the "rice weevil," (*Calandra oryzae* Linn), Pl. II, fig. 2, has been included not so much because it has been, or may be, mistaken for the boll weevil, as because its size and general appearance may be more familiar to the general reader than any of the other species mentioned. A comparison of the adult insect with the illustration may aid in conveying a more correct conception of the other less familiar species. This weevil breeds very abundantly in corn, but does not injure cotton.

The "plum curculio", (*Conotrachelus nenuphar* Hbst.), Pl. II, fig. 3, which attacks peaches, plums, etc., very commonly, is about the size of the boll weevil but is much darker in color with markings of white or light colored scales on its back and legs. It has a shorter, more strongly curved snout and but a single tooth upon the thigh of the fore legs. It never attacks cotton.

The "white pine weevil", (*Pissodes strobi* Peck.), Pl. II, fig. 4, occurs in Alabama and must attack also some southern species of pine. The body is longer and more cylindrical, while the snout is relatively much shorter than in the boll weevil. Its wing-covers bear each a prominent white spot toward their tips.

The "pales weevil", (*Hylobius pales* Hbst.) Pl. II, fig. 8, is another species which attacks pine. It is a large species, being from 1-3 to 1-2 inch long. Its color is a dark brown with small spots of light colored scales scattered over the wing-covers. This species is very common in Alabama.

The "cow-pea pod weevil," (*Chalcodermus aeneus* Boh.), Pl. II, fig. 7, is often taken on cotton following a crop of cow peas in the same field or near vicinity. It is the only one of the species mentioned herewith which may do some

slight damage to cotton. It sometimes feeds on the young cotton plants, boring into the main stems or leaf stems and causing the death of leaves and tips, but there is only one record of its having bred in a cotton square. The adults are shining black in color, somewhat shorter and more stoutly built than is the boll weevil, and the back of the body shows numerous small, circular pits arranged in several rows along the wing-covers.

The "transverse Baris", (*Baris tarnsversa* Say), Pl. II, fig. 5, is a small, black weevil much shorter, broader proportionately and flatter than the boll weevil. Its snout is very short and strongly curved. This species breeds in the roots of cocklebur, and the adults occur accidentally upon cotton as may another closely related and similar appearing species that breeds in the roots of ragweed.

There are several species of "acorn weevils" belonging to the genus Balaninus. One of these is shown in Pl. II, fig. 9. All have very long, slender snouts, sometimes even longer than the body. All breed in acorns, and are often attracted to lights, as the boll weevil never is.

Some of the "click beetles" have a habit of hiding during the day in cotton squares, and are therefore mistaken for the boll weevil, although they do not resemble it in the least. One of these (*Monocrepidius vespertinus,* Fab.), Pl. II, fig. 6, is most commonly mistaken. In its early stages it lives on the roots of grasses in the cotton field, and the adult hides around the plant, but it does not attack cotton at all. These are all long, slender, flat-bodied beetles which, if turned over on their backs, will spring into the air with a "click" and thus regain their footing.

The last species that we have space to mention here is a bug belonging to a group of insects known as "leaf hoppers". These insects have the habit of sucking sap from the stems of plants and may occur on cotton where they have sometimes been called "sharp-shooters". These are grotesque insects which do not resemble the boll weevil at all. One species, (*Homoladisca triquetra* Fab.), is shown in Pl. II, fig. 10.

BULLTTIN No. 147 AUGUST, 1909

ALABAMA

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CRIMSON CLOVER

BY

J. F. DUGGAR.

SUMMARY.

Crimson clover is an annual soil-improving plant. It suits most soils in Alabama. The seed are sown in September among the growing plants and covered.

The plants in early bloom can be plowed under about April 1, as a fertilizer for cotton, corn, sweet potatoes, or other summer crop; or the clover can be cut for hay in the latter part of April and the stubble used as fertilizer.

The yields of summer crops following the plowing in of either the entire growth, or merely the stubble, of crimson clover have been much greater than where no crimson clover has been sown.

The condition most essential to success in growing crimson clover consists in inoculation. This is most certainly effected by sowing with the seed as much as practicable of the soil from a spot where crimson clover, red clover, white clover, or annual white clover, has recently grown successfully. The last mentioned occurs in nearly all parts of Alabama, but is not easy to find after May, when its white heads turn brown and the plant dies.

White clover and annual white clover can usually be found in old lawns and spots in pastures. Both are low plants with white heads on the end of the short flower stem, and both have leaves consisting of three roundish or heart-shaped leaflets each about the size of the finger nail of one's little finger.

Soil from lespedeza (Japan clover) does not inoculate crimson clover.

Soil has been found to be a more reliable method of inoculation than the use of artifical inoculating material, called pure cultures.

INTRODUCTION.

The most urgent need of southern agriculture is the enrichment of the soil. To improve southern soils the principal additions needed are (1) vegetable matter and (2) nitrogen. Crimson clover adds both vegetable matter and nitrogen to the soil on which it grows. In fact, this method of improving the soil by the growing of crimson clover seems to be the most generally practicable method that can be put into immediate effect by southern farmers. This is partly because crimson clover is suited to a wide range of soils, because usually the seed are cheap, and because the seed can be sown in September among the growing cotton plants without special preparation of the soil.

During each of the last fourteen years numerous experiments have been made at Auburn, both on gray sandy soil (Norfolk sandy loam) and on reddish loam (Cecil series). In addition to these accurately conducted experiments, tests have been made by farmers throughout the State under the direction of the writer. Many of these local tests, especially during the past few years, have been made in co-operation with the Bureau of Plant Industry of the U. S. Department of Agriculture. The conclusions here presented are based chiefly on experiments at Auburn and on local tests in Alabama, full data for which would be too voluminous for recording in this bulletin.

WHAT CRIMSON CLOVER IS.

Crimson clover is also known as scarlet clover, and its botanical name is *Trifolium incarnatum*. It is an annual plant, making its growth between September and May. The seed must be sown each year, for while this plant seeds freely here, yet these seed on dropping to the ground in May and June, germinate promptly, and the young plants are killed by the heat of summer. Crimson clover produces abundant crops of seed and farmers can save their own seed. To do this the seed must be flailed or threshed from the plants, and the seed still in the chaff sown without re-cleaning.

Crimson clover is a leguminous plant, or legume, and is ranked with the other cultivated legumes, cowpeas, velvet beans, vetches, red clover, etc., as a soil-improving plant.

HOW CRIMSON CLOVER IMPROVES THE SOIL.

Crimson clover improves the soil on which it grows by the following means:

(1) Since it grows during winter, its roots utilize any nitrates or other soluble plant food which would be washed or leached from the soil.

(2) On account of its winter growth it decreases surface washing of the soil.

(3) When either the stubble or the entire plant is plowed under, vegetable matter of a kind that readily rots is added to the soil.

(4) Crimson clover, like all the other soil-improving legumes, is able, when properly grown, to take nitrogen from the air to add it to the soil.

HOW LEGUMES ADD NITROGEN TO THE SOIL.

Crimson clover, like cowpeas, when grown under proper conditions, adds much nitrogen to each acre of soil. It takes this nitrogen from the air, where it is unavailable to corn, cotton, and most other farm crops. The only cultivated plants that can thus utilize the free nitrogen of the air for their own growth and for subsequent soil enrichment are the legumes, or leguminous plants, such as cowpeas, clovers, vetches, etc. Even these legumes cannot make use of the nitrogen of the air and cannot improve the soil except when they bear on their roots certain enlargements or bumps, called *tubercles or nodules*. (See Fig. 2.) Familiar examples of nodules are the roundish enlargements on the roots of cowpeas. Tubercles may be regarded as fertilizer factories for the manufacture of fertilizer nitrogen from the unlimited quantities of free, or gaseous, nitrogen in the air above. The air penetrates all cultivated and drained soils and thus comes into contact with the tubercles on the roots of leguminous plants, where it is used as the raw material for the manufacture of fertilizer nitrogen, an

element which costs 15 to 18 cents a pound when bought as cotton seed meal, nitrate of soda, ammonated guano, etc.

INOCULATION.

The interior of these tubercles is swarming with microscopic life, called germs or bacteria. These bacteria, which belong to the vegetable kingdom, may be regarded as the workmen in these fertilizer factories. A tubercle does not develop on the roots of any legume unless the right kind of germ, suited to that particular kind of plant, is present on the seed sown or in the soil, ready to enter the tiny root. For example, the writer has examined scores of samples of crimson clover plants from all parts of Alabama that had no tubercles on the roots. These clover plants without tubercles, were dwarfed, pale or yellowish, and showed the crop thus grown without tubercles to be complete failures. The greater part of several hundred failures with crimson clover which the writer has investigated have been found to be due to the absence of tubercles. (See Fig. 1.)

Failures of this character need not occur. There is a simple, invariably remedy. It is called *inoculation*. Inoculation of this kind means the supplying of suitable germs to the seed to be sown or to the soil where crimson clover is to be grown, so that these germs thus supplied may penetrate the roots of the young plant and cause tubercles to develop. If the proper germ for causing tubercles on clover be present in the soil there will be no need of artificial inoculation.

However, large numbers of local tests under our direction made in almost every county in Alabama, lead to the conclusion that throughout most of Alabama the clover germ is not already present in the soil. But this germ is present in soils where any true clover has grown for several years and borne tubercles. Hence, the surest method of inoculating crimson clover consists in sowing on the field where this legume is to grow some soil taken from around the roots of any true clover. One may use the upper two or three inches of such soil. The true clovers may be

known by the fact that they bear their seed in compact heads at the tip of the flower stem. This excludes Lespedeza, commonly called *Japan clover*, which in our tests *has proved unable to inoculate crimson clover.*

SECURING INOCULATING SOIL NEAR HOME.

Among the clovers, from spots of which the earth may be taken to inoculate crimson clover, are the following:

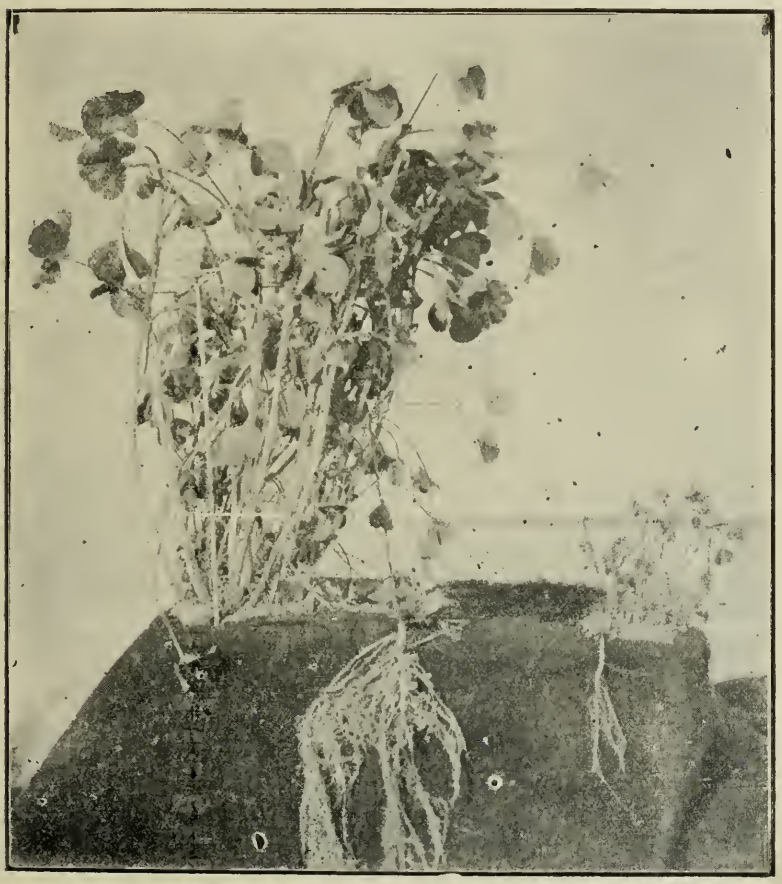

FIG. 1. *On the left, inoculated plant with severed root, showing tubercles; on the right, an average plant from an adjacent plot, not inoculated; there are no tubercles on the smaller plant.*

Crimson clover, red clover, white clover, and annual white or Carolina clover. Fortunately, careful search in April will usually be rewarded by finding the annual white clover in practically all parts of the State, in old lawns, old pastures, along roadsides, etc. Unfortunately, this clover dies in May, the white heads changing to brown and the plants soon disappearing until the next winter, or showing only a mass of short, slender, dead stems against the ground under the Lespedeza, or other summer growth.

White clover is not so widely distributed as the annual white clover, but the former may be found even up to midsummer in some parts of the State in old lawns and in old pastures where the soil is rich and moist.

DIRECTIONS FOR INOCULATING SOIL OR SEED.

The details of inoculation may vary according to the amount of soil available. If there is an abundance of soil it is only necessary to sow, immediately after the sowing of the seed and before covering the latter, at least one ton per acre of the inoculating soil. This method of inoculation may be made even more effective by combining it with the following method:

When there is only a limited amount of soil a gallon or more of it should be stirred into two or three times as much water; the seed should be thoroughly moistened with, or dipped into, this water and dried by mixing with another part of the very dry inoculating soil. Whatever soil remains should be sown broadcast before the seed are covered. This method is not well suited to seed as small as those of crimson clover. In this way a few pecks of suitable soil may partially inoculate the seed for an acre. A part of the seed would escape inoculation and plants from these would be small; the thinner stand of vigorous plants thus obtained would make the inoculated plants spread out more and grow not so tall as they would in a thick stand with all plants bearing tubercles. If much less than a ton of pulverized inoculating soil is used, one need expect only a *partial success* with crimson

clover the *first year*. By sowing seed a second year in succession on such a partially inoculated soil, without further inoculation, the second crop should be thoroughly inoculated.

START AT ONCE ON A SMALL SCALE.

The importance of getting a start of a small area thoroughly inoculated is obvious when we remember that soil from such a spot will suffice the next fall to inoculate several hundred times as large an area. Those who find any difficulty in securing any considerable amount of soil from a spot of red, crimson, white, or annual white clover, should sow only a small area of crimson clover, say one quarter or one acre. No pains nor expense should be spared to get this thoroughly inoculated by using a liberal amount of inoculating soil. This area should be fenced against stock. It may even be lightly dressed with stable manure, after the plants are well up, though this is not necessary nor practicable on large areas. This "starter" patch should not be located in an old garden spot, for fear of possible presence there of nut grass, root-knot organisms, or germs of plant diseases, which would thus be scattered over the entire farm in the soil from this spot used in future to inoculate larger areas. Especially avoid for this "starter" patch any spot where black-root, or wilt, of cotton occurs, or where cowpeas die permaturely, or where there are root-knot swellings on the roots of cotton, turnips, etc. Too much care cannot be taken to ascertain that the spot selected for a "starter" patch is free from all plant diseases.

This does not entirely prohibit the growing of crimson clover where certain plant diseases occur, provided the soil from such spots be not carried elsewhere as inoculating material. Crimson clover may again be sown the second fall on the area used the year before as a starter, not repeating the inoculation.

In brief, start with an area so small that it can be thoroughly inoculated; and, especially if it proves to be only

partially inoculated, again sow crimson clover there next season.

After one crimson clover crop, *well inoculated* as shown by abundance of tubercles, grown for one season on the "starter" patch, use soil from this to inoculate larger areas. Or, the next April locate in pastures, etc., spots of annual white clover in bloom, and place stakes at each corner of such spots, so that inoculating soil from these spots can be used the following September when the annual white clover is dead.

WHAT SOILS DO NOT NEED INOCULATION.

To sow crimson clover without inoculation means on most soils in Alabama complete failure. However, there are a few fields that do not require it. Such are fields where there have been, in the preceding year or two, successful growths of red, or crimson, or white, or other true clover, (not lespedeza).

BENEFITS OF INOCULATION TO CRIMSON CLOVER CROP.

There are two, viz., (1) increase in the yield of crimson clover, and (2), increased fertilizing effect of crimson clover, as shown in yields of subsequent crops of corn, sorghum, etc. All the experiments here mentioned were made on the Experiment Station Farm at Auburn. In all those mentioned in this section the inoculating material was soil from an older crimson clover field, applied broadcast at the rate of at least one ton per acre at the time of sowing the seed.

In May, 1903, on reddish sandy upland loam soil (Cecil series), where a moderate dressing of stable manure had been used on the preceding crop of small grain, the yields of crimson clover hay were as follows:

Inoculated	6100 lbs. per acre
Not inoculated	000 lbs. per acre
Gain from inoculation	6100 lbs. per acre

The inoculated plants were green, tall, and their roots were abundantly supplied with tubercles. The plants not inoculated were yellowish, not branched, two to four inches tall and there were no tubercles on the roots. There was not enough for cutting with scythe or sickle. Fig 1 shows the contrast between typical inoculated and non-inoculated plants.

In the fall of 1908, on poor, whitish, sandy, upland soil (Norfilk sandy loam), although too late for best success, a plot of crimson clover was inoculated with soil from an older crimson clover field, and another plot left without inoculation. These plots were not harvested, but the marked difference in appearance were as follows: The inoculated plants were green, thrifty, about 14 to 16 inches tall, and their roots were covered with tubercles; the yield was estimated at about one ton of hay per acre. The plants not inoculated had no tubercles, were yellowish, and had but one or two stems per plant, and were not tall enough to cut, most plants dying before blooming, or blooming at a height of only 2 to 6 inches.

PURE CULTURES, OR ARTIFICIAL INOCULATING MATERIAL.

In August, 1897, and in August 1898, the writer published results of inoculation of crimson clover by the use of pure cultures, or bottled material prepared in the laboratory. As these bulletins (Nos. 87 and 96 of the Alabama Experiment Station) are now out of print, some of the results of these earlier tests will we referred to here.

In both of the following tests the pure cultures used was imported from Germany under the name "Nitragin."

Results of inoculation experiments on crimson clover, using "Nitragin."

Date of Sowing	Kind of Experiment	Kind of Soil	Hay, per Acre: Inoculated Yield	Hay, per Acre: Not Inoculated Yield	Increase from Inoculation	
			Lbs.	*Lbs.*	*Lbs.*	*Per ct.*
Fall, 1896	In pots	Sandy, 20 years in cotton	.....	.....	.....	71
Fall, 1896	In pots	Sandy, 5 years since cleared	.....	.....	.....	74
Fall, 1896	In pots	Woodland, sandy	.....	.....	.....	326
Fall, 1896	In pots	Sandy, after cowpeas	.....	.....	.....	379
Fall, 1897	In field	Sandy, worn.....	4057	761	3296	433

Thus, it may be seen that when attempted inoculation with pure cultures is effective, the increase in crop is highly satisfactory. In the experiments tabulated above, inoculation in several instances increased the yield more than three-fold.

The above figures give the favorable side of inoculation with "Nitragin." Its use was, however, found impracticable because so often the germs in it were dead and inoculation did not result.

EXPERIENCE IN RECENT YEARS WITH PURE CULTURES OR ARTIFICAL INOCULATING MATERIAL.

In recent years the United States Department of Agriculture and a number of commercial firms have engaged in the manufacture of pure cultures, a special kind for the inoculation of each particular legume. At first these were sent out in the form of wisps of dried cotton, on which the proper germs were lodged. This Station had numerous tests of these cultures made on a great variety of soils. The result was a long list of failures, with few, if any, successes.

A later improvement was the sending of the cultures in liquid form in sealed tubes. The experience of this Station with these was, on the whole, unsatisfactory. For example,

attempts to inoculate crimson clover were made in the fall of 1908 with pure cultures from crimson clover, both from the Department and from a commercial firm. Parts of both plots were occupied by small pale plants without tubercles, and the spots that were inoculated may have accidentally secured their inoculation, by wind or surface water, from an adjacent check plot inoculated with soil. Both culture plots were distinctly inferior to the plot inoculated with soil.

Constant improvements are being made in the methods of manufacturing and distributing the pure cultures made by the U. S. Department of Agriculture. The improvement and the successes sometimes reported give reason to hope that in due time this may become the best means of inoculating legumes. Its advantages are convenience; economy of labor; avoidance of the danger that is inherent in the use of soil, namely, spreading disease germs, root-knot organisms, weed seeds, etc. The only objection to pure cultures is their frequent failures, at this and at other Experiment Station, to cause the formation of tubercles or the obvious fixation of nitrogen. Our experience compels us to advise that at present pure cultures be not relied upon as a means of inoculation. Inoculation with soil has never, in our experience, failed; pure cultures have often done so. Still less advisable generally is the purchase, at additional cost, of seed said to be inoculated.

CRIMSON CLOVER AS A FERTILIZER.

When grown largely for fertiizer, crimson clover may be disposed of as follows:

(1). It may be cut for hay, plowing under the stubble as a fertilizer.

(2). The entire growth may be plowed under as fertilizer.

(3). During the last few weeks of growth crimson clover may be grazed, probably without sacrificing a very large part of its fertilizing value.

At Auburn crimson clover is in full bloom and ready to be cut between April 15 and 30. Observation has indicated that at Auburn the first few days in April constitute a suitable average date for plowing under crimson clover that is to be followed by a cotton crop. At this date it should be just begining to bloom and 12 to 15 inches high. By plowing the entire growth under at this time, and allowing the land to settle for about two weeks, before planting cotton near the middle of April, the yield of cotton has ranged as high as one and one-half bales per acre on gray sandy upland, naturally poor. The cotton crop following crimson clover receives its quota of commercial fertilizers, which in this case should be especially rich in phosphoric acid.

By waiting until the clover should be in full bloom, say April 15, doubtless the amount of vegetable matter and nitrogen added to the soil would be greater than by plowing it under about the first of April.

Not all the land intended for cotton could have its preparation delayed until this date, but crimson clover can be followed by late cotton, by corn, sweet potatoes, sorghum, etc. Where it becomes necessary to plow under crimson clover before April 1, its fertilizing effect is greatly reduced.

If crimson clover is grown chiefly for fertilizer, with pasturage also as a consideration, the nearer it comes to the blooming stage before being pastured the greater the fertilizing effect.

The following table gives the results of several experiments at Auburn, showing the increase in the next crop due to crimson clover or crimson clover stubble.

Yield of sorghum hay grown after crimson clover stubble in 1901.

.....	*Yield Sorghum Hay Lbs.*	*Increase Per Acre %*
Yield crimson clover hay	2900	
Yield of sorghum hay after rye stubble	6460	
Yield of sorghum hay after crimson clover stubble	12710	
Increase due to clover stubble	6250	97

This shows that in 1901 on gray sandy land after crimson clover cut for hay, the yield of sorghum hay was practically twice as much as where the preceding crop was rye, used for hay.

On another field, also in 1901, on poor gray sandy soil, the results were as follows:

Yield of sorghum hay per acre grown after crimson clover and crimson clover stubble in 1901.

Preceding crop as fertilizer	Yield sorghum hay	Increase per acre	
	Lbs.	*Lbs.*	*%*
Rye stubble	5525		
Crimson clover stubble	9750	4425	76
Crimson clover, entire	10300	4775	86

This table shows that by plowing under crimson clover in April the yield of sorghum hay grown immediately after was nearly doubled. When the crimson clover was cut for hay the sorghum yield was increased by 76 percent. The yield of crimson clover hay on this stubble plot was 2741 pounds per acre, and the increase in sorghum hay due to the use of clover stubble as a fertilizer, was 4225 pounds per acre.

A third experiment on this line was made in 1903 on reddish loam soil which was naturally richer than the gray soil of the two experiments just mentioned. This reddish loam had also been helped by a light application of stable manure applied to the crop of small grain which preceded the crimson clover.

Under these favorable conditions the yield of crimson clover hay was 6100 pounds per acre. The adjacent plot had been treated exactly like the crimson clover plot as regards previous cropping and manuring.

Yield of sorghum hay per acre grown after crimson clover in 1903.

Preceding crop	Yield sorghum hay	Increase per acre.
	Lbs.	*Lbs.*
Winter and spring weeds	4400	
Crimson clover as fertilizer (stubble)	13000	8600

Here we have an extreme or maximum fertilizing effect

of the crimson clover stubble of 8600 pounds of sorghum hay per acre. By adding to this the yield of clover hay, 6100 pounds, we have a total of 14700 pounds per acre of the two kinds of hay, as the measure of the advantage of sowing the land in crimson clover as compared with permitting it to grow up in winter weeds.

Both the crimson clover hay and the sorghum hay when weighed were dry enough for safe storing in the barn. Even if we assume a shrinkage of 25 per cent in the barn we should have a total yield of more than 7 tons of hay per acre produced in one season and a gain of about 5 1–2 tens as the result of devoting the land to clover instead of to weeds.

CRIMSON CLOVER STUBBLE VERSUS ENTIRE GROWTH OF CRIMSON CLOVER.

In 1908 cotton was planted very late after oat stubble, after crimson clover stubble and after attempting to plow under the entire growth of mature and thoroughly dry crimson clover.

Only a part of the mature plants were covered by the plow, so that the full effects as fertilizer were not obtained. The late planting, the period of extremely unfavorable weather in August, when this late cotton suffered especially, and the necessity of preparing these plots before frost for another crop, obscured the full fertilizing effect of the crimson clover. In the part of the season for which records were kept the yields of seed cotton per acre were as follows::

After oat stubble ---------- 342 lbs.
After clover stubble ---------- 456 lbs.
After clover, entire growth ---------- 528 lbs.

The color and size of plants on these three plots gave promise of much larger yields and much greater differences, if the experiment could have been carried to a normal conclusion.

Measurements showed that the bolls were largest on the

plot where the entire growth of crimson clover was plowed under and smallest on the plants growing after oat stubble.

In one of the experiments described above the yield of sorghum hay after plowing under the entire growth of crimson clover was only 550 pounds greater than after plowing under crimson clover stubble, on land where the yield of crimson clover hay was 2741 pounds per acre.

In another experiment the superiority of the entire growth of crimson clover as a fertilizer over the stubble alone was measured by an increase of only 800 pounds per acre in the yield of sorghum hay. Here the yield of clover hay on the stubble plot was 1441 pounds per acre. Thus both experiments show that it was more profitable to cut the hay than to plow the entire growth under as a fertilizer for *sorghum*.

Doubtless the principal advantage of plowing under the entire growth, rather than the stubble, consists in the greater permanancy of the improvement in the land. The analysis of the entire plant of crimson clover, including the roots, and of the stubble alone, (Alabama Station Bulletin No. 96.), showed that only about 16 percent of the total nitrogen was contained in the stubble and roots of crimson clover. With stubble of the usual length, probably 20 percent or more of the nitrogen would be found in the stubble and roots. The conclusions suggested by considering together both field tests and analysis are the following:

(1). A greater immediate profit results from using only the stubble as a fertilizer.

(2). A much larger amount of nitrogen and of vegetable matter is added to the soil by plowing under the entire growth of crimson clover, and hence doubtless this course results in a greater and more permanent improvement of the soil.

(3). By plowing under the entire growth a farmer may prepare the land three or four weeks earlier than by waiting to cut the hay, thus making it practicable to grow cotton on a field where the entire growth is plowed under.

CAUTION IN USING CRIMSON CLOVER HAY.

Cases have been reported where horses eating hay from very ripe crimson clover have had trouble from the formation of balls of matted hairs in the stomach. These hairs stiffen as the seed approaches maturity. It is believed that this trouble can be avoided by cutting the hay before it is past full bloom and by feeding partly on some other hay, if that from this clover is overripe.

DIRECTIONS FOR SEEDING CRIMSON CLOVER.

The amount of seed required is 15 pounds, or one peck, per acre. We have more frequently sown 20 pounds. The time of sowing at Auburn has varied from early in September to late in October. From a study of the results of our many experiments the conclusion is reached that safe dates at Auburn are at least as early as September 10, and as late as October 10. Sowing the latter half of September is preferred. If crimson clover seed are sown too early, the hot weather of September sometimes kills the sprouting seed, or the young plants before they become well rooted. If the sowing is postponed much beyond the 10th of October at Auburn, the stand is sometimes injured by the cold of a severe winter. The following dates are suggested as suitable periods for sowing in different parts of Alabama:

September 1 to September 30 in north Alabama,
September 10 to October 10 in central Alabama, and
September 20 to October 20 in south Alabama.

SOILS.

Crimson clover thrives on a wide range of soils from sandy to black-waxy, or prairie. In the sandy regions it does better on the loam soils or those containing a medium amount of clay. In regions of stiff soils it requires good drainage. On deep gray sands it is apt to fail, though where the stiffer subsoil is not too deep, it may succeed here. It is not wise to risk large areas of crimson clover on acid soils unless lime is used.

PREPARATIONS FOR SOWING.

At Auburn crimson clover has grown equally as well when sown among the growing cotton plants as when the land was thoroughly plowed and harrowed.

Sowing of crimson clover seed in the cotton field should be done immediately after the first or second picking to avoid knocking any of the seed cotton out of the bolls. This crop has repeatedly succeeded well when the seed were harrowed in among the stubble on a field that had received clean culture while growing a crop of drilled sorghum.

The sorghum stubble or the cotton stalks, are, however, inconvenient if it is desired to mow the clover for hay. When this clover is grown for hay the land should be plowed if possible several weeks before the time of planting, and repeatedly harrowed until the seedbed becomes fine and settled. If the seed must be planted soon after the land is plowed, a roller or drag, as well as a harrow, may be needed to compact the soil. The best time to sow the seed is while the soil is moist from a recent rain.

The inoculating soil is best sown broadcast, immediately after sowing the seed, using, if practicable, a ton of soil from a spot of red, crimson, white, or annual white clover. Always cover the inoculating soil promptly. In a few tests we have succeeded in making a successful inoculation by scattering the inoculating soil over the growing plants during a period of wet weather in the early part of winter.

It is essential that the crismon clover seed be well covered with one-half to one and one-half inches of soil. In all of our tests attempts to secure a stand by sowing without covering the seed have failed. Failure has occurred even when a heavy rain fell soon after the sowing. When the seed are sown on a well prepared seedbed, covering is best done with a spike-tooth, two-section harrow. When the seed are sown among the growing cotton plants they may be covered by using any shallow-working one-horse cultivating implement, such as a five-tooth cultivator, a spring-tooth one horse cultivator, a wide heel scrape, etc.

It is not easy to get a stand of crimson clover either on prepared or unprepared soil where there is a large amount of vegetation; hence, it is not usually easy to sow crimson clover seed in a corn field laid by early, nor on old pasture land, nor on weed land.

A field where drilled or broadcast cowpeas have recently been cut for hay is probably, next to a clean cotton field, the best place for sowing crimson clover. Here it is better to prepare the surface by the use of a disk harrow than by the use of a turn plow. After disking, the seed should be sown, the inoculating soil and fertilizer sown, and all covered with a spike-tooth harrow.

FERTILIZER.

Crimson clover, if thoroughly inoculated, adds considerable nitrogen to the soil. But it does not add phosphoric acid nor potash. If the soil be so poor as to require these two forms of plant food for the successful growth of crimson clover, they should be applied at the same time that the seed are sown. A suitable amount of acid phosphate is 200 to 300 pounds per acre. If the clover is to be removed from the land as hay, it may pay, especially on the sandier soils, to employ at the same time either 40 pounds of muriate of potash, or 160 pounds of kainit per acre. In sowing the crimson clover among the standing cotton plants on soils in fair condition we have often used no fertilizer and yet obtained a satisfactory growth. In making a start with crimson clover it is advisable to fertilize it with acid phosphate.

When it is especially important on small areas to secure a good growth and thorough inoculation of the soil, it may even be advisable to apply stable manure, since stable manure will probably make a small amount of inoculating soil more effective than if the small amount of inoculating soil were applied to a soil deficient in vegetable matter. Stable manure should not be relied upon as a substitute for inoculation nor as a means of inoculation.

LIMING.

Most clovers prefer a soil rich in lime. If the soil should be so deficient in lime as to be acid it is advisable to use slacked lime for crimson clover. At Auburn on very poor gray sandy soil, not acid, but neutral, slacked lime at the rate of 1200 pounds per acre greatly increased the yield of crimson clover hay. On the same character of soil, but in a higher state of fertility, the effect of lime on crimson clover was not conspicious. There are large areas of acid soil in Alabama, especially in the southern part of the state and in the sandy "mountain" lands of north Alabama. On such acid soils it will probably pay to use, as a preparation for crimson clover, six to eight barrels of builder's lime per acre, first slacking the lime to a powder.

The lime is best harrowed into the soil before the seed are sown and should not be brought in immediate contact with the seed and fertilizer. To test a soil for acidity, press the soil in a natural damp condition against both sides of a narrow strip of blue litmus paper, which may be obtained from a druggist. If the blue litmus paper turns to a pinkish or reddish color the soil is acid, and a crop of crimson clover growing on it will probably be helped by lime.

VARIETIES OF CRIMSON CLOVER.

There is but one kind of crimson clover in general use in the United States. In a few localities another variety, called the white blooming crimson clover, or more properly white trifolium, is grown to a small extent. The white trifolium bears a long white head similiar in size and shape to the scarlet head of crimson clover. The white trifolium is several weeks later in reaching a suitable stage for cutting. At Auburn this white kind has usually grown a little taller and afforded a considerably larger yield of hay.

We have grown in Auburn three varieties having scarlet

heads and called early crimson, ordinary crimson, and late crimson; in 1909 these yielded practically two tons of hay each per acre, as follows:

Ordinary crimson ----------3888 pounds hay per acre.
Late crimson (S.P.I.No.21208) 4106 pounds hay per acre.
Early crimson (S.P.I.No.21282) 4288 pounds hay per acre.

In 1909 the yield of white trifolium was obviously greater than that of any other varieties, but the hay was ruined by continued rain. The date of mowing white trifolium averaged 22 days later than the date of cutting ordinary

FIG. 2. *On the right, a field of ordinary crimson clover in bloom; on the left, a field of late crimson clover, not yet in bloom.*

crimson clover. This disadvantage for a cover crop to precede cotton more than counteracts the larger yield of the white trifolium.

Early crimson clover was several days earlier than any other variety, which is a decided advantage in a winter cover crop, since it permits earlier preparation for the cotton or other summer crop.

YIELDS.

After the first year,—that is, after crimson clover has become thoroughly inoculated by using suitable soil the first year of its growth,—it is safe to count on at least one and one-fourth tons of hay per acre. Under favorable conditions the yield of hay should be nearly two tons per acre. In only two experiments at Auburn has the yield approach-

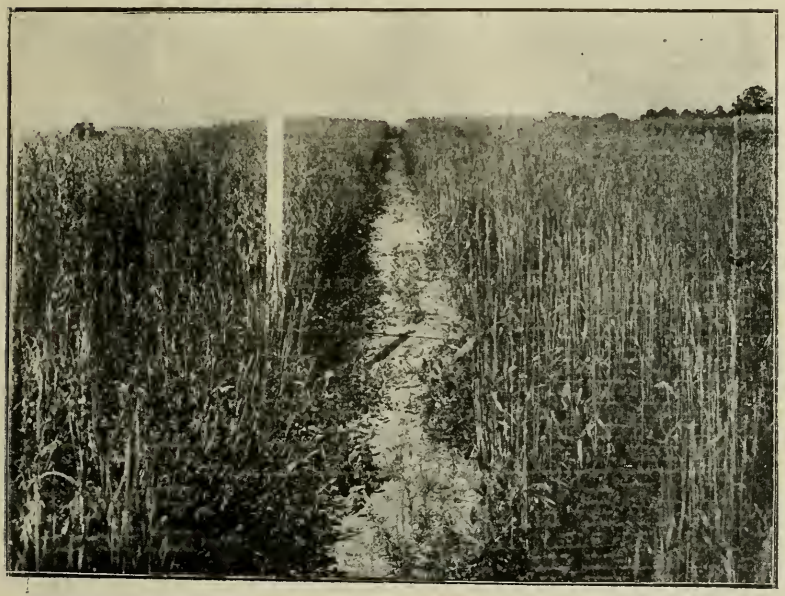

FIG. 3. *On the right, a mixture of crimson clover and Blue Stem wheat; on the left, a mixture of crimson clover and Red Rust Proof Oats; all ready for mowing.*

ed three tons of hay per acre, and in both cases this was on reddish clay loam where in preceding years some stable manure had been used.

PLANTS TO GROW WITH CRIMSON CLOVER.

For several years crimson clover has been sown broadcast in connection with either oats, wheat, rye, or beardless barley. The amount of clover seed used was 24 pounds per acre, when sown alone and also this amount in all combinations in 1909, but only 15 pounds per acre in all combinations in 1903. Oats were sown at the rate of 1 1–2 bushels per acre in 1903 and 2 bushels per acre in 1909. Blue stem wheat was sown at the rate of one bushel per acre in 1903 and 1 1–2 bushels per acre in 1909. Beardless barley was used at the rate of 1 1–2 bushels per acre in 1903 and 2 bushels per acre in 1909. Rye was sown at the rate of one bushel per acre. The following tables give the yield of hay:

Yield of hay per acre when oats, wheat, rye, or beardless barley was sown with crimson clover or with white trifolium.

	1906	1909	Average
	Lbs.	*Lbs.*	*Lbs.*
Crimson clover alone	2960	2713	2836
Crimson clover and Red rust proof oats	3280	5175	4228
Crimson clover and Blue stem wheat	3624	3918	3771
Crimson clover and Southern rye	2000		
Crimson clover and Beardless barley	3520	3872	3695
White trifolium		1200	poor stand
White trifolium and Blue stem wheat		2320	poor stand
White trifolium and Red rust proof oats		2600	poor stand

It is noteworthy that the yield has been increased whenever oats, wheat, or beardless barley has been sown with

crimson clover. Red Rust Proof oats have given the largest average yield, but this plant is a little too late to permit very early cutting of crimson clover. An acclimatized strain of the Blue Stem wheat is ready for hay at exactly the same time as ordinary crimson clover, and is probably the best combination for soils strong enough to grow wheat. Beardless barley ripens too early, and is too subject to winter killing to be recommended for growing with crimson clover. Rye can be sown with crimson clover for pasturage, but this makes an unsatisfactory combination for hay, the rye maturing too soon and being too coarse.

In other tests where the weights of hay could not be taken by reason of continued rain just after harvest, the following facts have been ascertained:

Burt oats are in condition for hay at the same time as crimson clover, and in regions where it is considered safe to sow this variety in the fall. Burt oats and crimson clover make a good combination for hay.

Cheat was too late in reaching the hay stage to be sown with crimson clover, and because of its weedy nature it should be avoided.

For sowing with white trifolium, Red Rust Proof oats are most satisfatory.

In growing crimson clover for hay or pasturage it is probably advisable to sow it with one of the grains as mentioned above. The consequent advantages are the following:

(1). An increased yield of hay, though this hay is somewhat lower in feeding value than pure crimson clover hay.

(2) The easier curing of the mixed hay.

Of course if crimson clover is grown chiefly as a fertilizer, no grain should be mixed with it. If it is intended chiefly for pasturage, it is well to sow it with either rye, turf oats, red rust proof oats, or wheat, using the ordinary

amount of seed grain per acre. This increases the amount and lengthens the period of pasturage.

WHERE TO GET SEED.

Crimson clover seed can be purchased from any Southern seedsmen and from most seedsmen in other parts of the United States. Among those who have supplied the Alabama Experiment Station with seed are the following:

Amzi Godden Seed Co., Birmingham, Ala.
Harvey Seed Co., Montgomery, Ala.
T. W. Wood & Co., Richmond, Va.
H. G. Hastings & Co., Atlanta, Ga.
Alexander Seed Co., Augusta, Ga.
Willett Seed Co., Augusta, Ga.

Usually the price of seed is $3 to $4 per bushel of 60 pounds. The partial failure of the last crop has about doubled the price. While this may discourage the planting of large areas in the fall of 1909, it should not keep any one from planting a small patch, say of one-fourth to one acre, largely for the purpose of securing inoculating soil with which to inoculate large areas next year.

The more thorough the inoculation on such "starter" patches and the thicker the stand there, the more effective will that soil be for purposes of inoculation a year later. Hence, not less than 20 pounds per acre should be sown on such small areas.

In view of the high price of seed, it may be advisable in the fall of 1909, for those who are prepared to sow large areas, *with thorough inoculation*, to reduce the amount of seed to 12 pounds per acre, an amount which is smaller than was used in any of our tests, but which has sometime been reported as giving a satisfactory stand.

WHERE TO GET INOCULATING SOIL.

Whenever possible get this in your own neighborhood. Most readers can find it by searching for white clover, or for the dead remains of annual white clover in old lawns and on the richer spots in old pastures.

Each of the parties mentioned below consents to furnish to each of a limited number of applicants, and for $1.00 per 200 pound sack, a single sack of soil from a patch of inoculated crimson or red clover. The Experiment Station has not inspected any of these fields and can give no guarantee as to the absence from them of disease germs, etc., nor any other guarantee.

Under no circumstances will the Alabama Experiment Station distribute any soil from its farm, for this is known to contain the organisms that produce various plant diseases and root-knot.

Name	*Postoffice*	*County*	*Railway*
J. O. Burleson	Decatur, R. F. D.	Morgan,	L. & N.
A. G. Diseker	Russellville	Franklin,	Southern
J. J. Edge	Loachapoka	Macon,	W. of Ala.
Yancey Swearington	Shorter	Macon,	W. of Ala.
D. W. Davis	Gordo	Pickens,	M. & O.
W. Tyrrell	Citronelle	Mobile,	M. & O.

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ALABAMA

Agricultural Experiment Station

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1. Raising Lambs in Alabama. Maintenance Rations for Ewes.
2. Feeding Cotton Seed Meal to Pregnant Ewes.

BY

DAN T. GRAY AND J. W. RIDGWAY

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1909

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PART I.

RAISING LAMBS IN ALABAMA.

By Dan T. Gray and J. W. Ridgway.

When one rides through the State of Alabama and sees the thousands of acres lying idle, growing up in brush and fine grasses, one wonders why there are not more sheep produced in the State than there are. It is usually stated that only 40 per cent of the area of Alabama is being cultivated or used to return wealth to the State. In some counties no more than 15 per cent of the total area is under cultivation. The other 85 per cent is lying idle. Money is tied up in the whole amount, but the farmer, on the average, is making use of but about 40 per cent of his whole capital invested. If sheep and other kinds of live stock were more generally introduced the usable area could be greatly increased, as these animals would make use of the present waste places and hill sides and help develop the pasture side of our farming operations. Even now thousands of acres under cultivation should be put down to permanent pastures and stock placed upon them. Hill-sides which wash should be put down to grass. This could be done without at all decreasing the cultivated area. The sheep need not occupy one foot of our already cultivateable area; he would but be a means of putting more of our land capital to work. The Alabama farmer can surely farm in such a way as to use more than 40 per cent of his land capital. What would we think of the business ability of a banker who used but one-half of his available capital, or the merchant who sold goods from but one side of his store?

Then, in addition to the fact that the sheep is probably the best animal known to put our waste areas to use, Alabama is just suited to sheep production. In any line of live stock production pastures must be made the base, and

Alabama can have permanent pastures for at least ten months in the year by the use of bermuda and burr clover. The remaining two months can be bridged over with temporary winter pastures. The Northern farmer must be contented with a grazing period of not more than six months. Then again our climate is so mild the year through that the lambs can be born in the mid-winter and suffer none from the cold. This permits the Alabama farmer to get the lambs upon the early spring market at the time when high prices are realized. In the North when the lambs come in December or January very expensive care must be given them to keep them from freezing, as they must be kept in a "hot house." In the South the early lamb is free to run at will throughout those months, and can even have green pastures to graze upon.

Still further, when the lamb is ready for the market good prices can be realized upon him. Some there are who claim there are no markets for lambs. But there is a great demand for the early lamb. The farmer should realize that a part of his business consists in finding a market for what he produces. The business man lays in his stock of goods and then looks for a market for it. The farmer must do the same thing. Many Southern cities offer as good a market for early lambs as does the St. Louis market. A following picture shows some spring lambs, that had nothing but their mother's milk and pastures, which sold in Birmingham for 10 cents a pound live weight on April 15th, 1908. Birmingham would use thousands of such lambs. These were good lambs, but no better than any other farmer could produce. They were raised by J. S. Kernachan, of Florence, Alabama. A good market can always be found for good fat stuff. The local market may not furnish a good sale for this class of stuff, but the cities are more than glad to receive it. The express charges do not prohibit the lambs being sent a good ways from home.

The Southern farmer depends too much upon one crop for a living. He is like the man with all his eggs in one

basket—if a mishap befalls the basket all of the eggs are broken and lost. So if the season should happen to be unfavorable for the growing of cotton the man who depends altogether upon cotton for a living finds that, at the end of the season, he has but a limited bank account to carry himself and family through the winter months. If this farmer has some pigs to sell, or a mule colt, or some wool or a few lambs, the short cotton crop will not be of so much importance. The farmer who is interested in more than one farm product suffers very much less in time of unfavorable seasons than the man who grows but the one crop, cotton. Even though it be too wet for the cotton to do its best, it may be, and probably will be, a very favorable season for the pastures, and the man who has a good flock of sheep out on the pastures raising some good fat lambs will not worry so much about the unfavorable season for cotton, as he feels that, although the cotton may be a partial failure, the sheep will bring him excellent returns.

There is yet another advantage in the sheep business. Spring is the time when the average farmer has not a cent coming in. This is the very time when the heavy expenditures must be made for machinery, fertilizers, mules, harness, etc., and to obtain these things the farmer usually asks some merchant to credit him until fall. The sales from the flock of sheep come in just when the money can be used for the above purchases. Both the wool and the early lambs are ready to sell and the money derived from these sales can be used to fit up the farm for spring work. From 100 ewes there could be sold, by the middle of April, from sixty to eighty dollars worth of wool and as many dollars from the early lamb sales, and probably much more from the lambs, provided they were dropped at a very early date.

Objects of Experiment.

Realizing the importance of the sheep industry to the State this Station began, four years ago, some experimental work with the following objects in view:

1. To study early lamb production in Alabama.
2. To study feeds and methods for carrying the pregnant ewe through the winter months.
3. To test cotton seed meal as a feed for pregnant ewes.

By an early lamb the authors mean one that is born in December or early January and ready for the market by the middle of April. Some farmers of the state are so fortunately situated that the second object will have little interest to them, as they already have abundant winter range supplied. The man who has a good winter range, or cane brake, needs no additional feed for the ewes. All such an ewe requires is care and attention and shelter at lambing time. But when sheep are generally introduced into the state, they will be introduced by the small farmer who is not supplied with an unlimited winter range. The small farmer will therefore be interested in knowing what are the best feeds for the winter months and the expense incurred in carrying the animals over the cold months. It might be said, in passing, that the sheep is the ideal animal for the man with the small capital. The business can be entered into with but a small outlay of money and large returns secured upon the outlay within a few months after the investment is made. The poor man cannot wait long for his investment to begin to return dividends. The sheep and the hog are the poor man's animals. Of course large amounts of money can be invested in them if desirable.

The work began in the summer of 1906 with the old flock of ewes which had been kept upon the Station farm for several years previous. This flock consisted of but 16 ewes, of mixed breeding, headed by a pure-bred Southdown ram. The pictures will show the general quality of the animals. Later on, in 1907, there was a flock of 30 scrub ewes added to these, headed by a pure-bred Dorset ram, but the Station is not yet ready to report upon the work done with this scrub flock, except with respect to some winter work in cotton seed meal feeding.

How the Old Flock Was Handled.

During the summer months, while the pastures were green, no attention was given the sheep at all except to see that they had plenty of water and a mixture of tobacco dust and salt before them at all times. The object in feeding the tobacco was to keep down stomach worms, as the worms are the bane of the sheep farmer, and it is claimed that tobacco dust will hold the pest in check. This was given them in proportion of one pint of dust to about four pints of salt. The sheep soon acquired a taste for the tobacco. It is well known that sheep should be changed from pasture to pasture as often as possible, unless the range be exceedingly large. The object in changing the pasture is to hold in check the stomach worms. The Station's pastures, or lots, are small, so the sheep were changed from one to the other as often as the grass became short. There was no regularity followed in making the change.

The period of gestation in the ewe is about five months, so if the lamb is to be dropped in December or the first of January she must be bred in July or early part of August. To be sure that she breeds in these months she should be turned upon a fresh pasture just before the time for breeding and then given a little cotton seed meal daily. As far as possible this plan has been followed with this flock. Of course there will always be a few late lambs, but if the ewes are in good breeding condition, neither too fat nor too poor, throughout July and August, the great majority of them will breed to drop lambs from Christmas to January the 15th.

The Station ram was allowed to run with the ewes at all times. If there had been as many as 50 ewes it would have been wise to have kept him away from the flock during the day time, and turned him in with them at night only. But with the few that we had he could be expected to be a safe breeder when running with the ewes both night and day. Some sheep farmers do not permit the ram to run

with the flock at all through the breeding season, but unless the owner has time to examine the ewes closely every day it is better for the male to be with them at least one-half of the time or the lamb crop will come on irregularly.

Winter Feeding of Ewes.

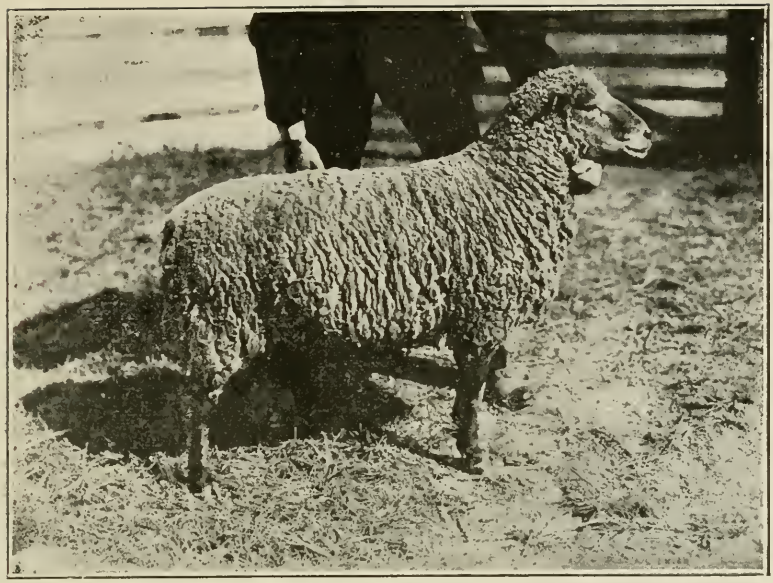
In the fall when the pastures became exhausted the ewes had to be managed as the small farmer would have handled them. There was no open range upon the Station farm so they had to be fed throughout the winter months. The man who has a farm with a winter pasture or range could have avoided this extra expense.

Some farmers in the state feed nothing but cotton seed meal and hulls to the pregnant ewes during the winter months. Others feed nothing but cotton seed. Still others are afraid to feed either cotton seed meal or cotton seed, thinking that cotton by-products are dangerous feeds for sheep. It is often claimed that cotton seed or cotton seed meal will cause blindness, dizziness, etc., and sometimes death when given to ewes. During the winter of 1906-'07 the old flock was divided into two lots of eight ewes each, and one lot was fed upon soy bean hay alone and the other lot upon cotton seed meal and hulls. The soy bean hay was of excellent quality but had no mature beans upon it, as it was cut before the beans were ripened. The cotton seed meal was fresh and bright.

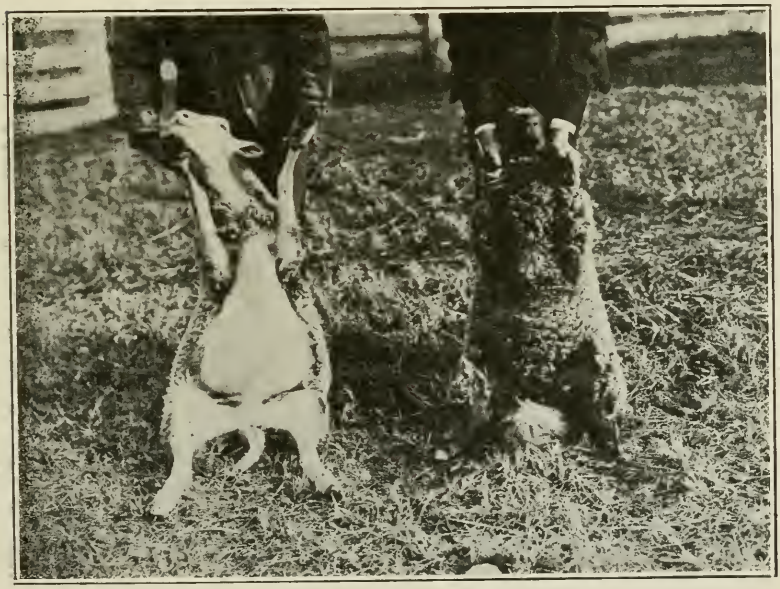
Local conditions determine, to a large extent, the prices of feeds. Any prices that the authors might assume would not meet all conditions, so actual Auburn prices were taken as a basis upon which to rest the financial estimates. The local prices were:

Cotton seed meal	$25.00 per ton.
Cotton seed hulls	$ 6.00 per ton.
Soy bean hay	$12.50 per ton.
Pasture rent per sheep per month	.10
Cotton seed	$12.00 per ton.

During the winter time the animals were enclosed in a small pen, with a shelter across one end, so they could get



Southdown Ram.



The pure-bred ram quickly improves the flock in both conformation and wool covering.

Lot I—*Wintered on Soy Bean hay.*
Hay per ewe daily, 1.9 *pounds.*
Expense to feed each ewe a month, 35 *cents.*

Lot II—*Wintered on Cotton Seed Meal and Hulls.*
Feed per ewe daily { .5 *pound cotton seed meal.*
1.3 *pound cotton seed hulls.*
Expense to feed each ewe a month, 30 *cents.*

no feed but that which was weighed out to them. Salt and water were kept before them constantly. No tobacco was used throughout the winter months, but perhaps it would have been wise to have used it. They were fed twice daily. The ewes were pregnant, and of course did not all lamb upon the same date. When one dropped a lamb she was taken out of her lot and put into a third lot, where the object was to learn how much the feed must be increased to maintain a ewe while milking.

The following table tabulates the results of the winter work—1906-'07:

Table 1. *Cotton seed meal and hulls versus Soy Bean hay for wintering pregnant ewes.*

Lot.	Ration.	Av No. ewes for 106 days	Feed eaten daily per ewe	Total gain each ewe for 106 days	Cost of feed per ewe per month
			Lbs.	*Lbs.*	*Cts.*
1	Cotton seed meal Cotton seed hulls	5.8	0.5 1.3	1.8	30
2	Soy bean hay	6.4	1.9	1.6	35

The ewes were not, of course, given all they could eat. The object was to feed them only enough to maintain them, that is, to keep them from either losing or gaining in weight throughout the winter months. The above ewes gained between one and two pounds each during the entire winter. It would, no doubt, have been better if they had been given enough feed to have made them gain from six to eight pounds each, as each one had to develop a foetus which weighed from five to nine pounds at birth.

The farmer could have cheapened the ration of lot 1, the cotton seed meal lot, by not feeding as much cotton seed meal as was fed in the test. It would have been cheaper to have cut down the meal and increased the hulls, but a large amount of meal was used in the test so that it would be possible to collect some data upon the effect of rather large daily feeds of cotton seed meal upon the health of the ewes. In this test the cotton seed meal ration was fixed at one-

half a pound daily per ewe and the hull part of the feed was varied so as to hold her at a uniform weight.

The test shows .5 of a pound of cotton seed meal and 1.3 pounds of hulls to be sufficient to maintain these pregnant ewes in the winter time. The ewes averaged about 95 pounds in weight. The animals were given this ration for 106 days and some of them even longer. One and nine-tenths pounds of soy bean hay per ewe per day proved to be sufficient to maintain the other lot. Both lots came through to the lambing period in excellent health and spirits, but the cotton seed meal lot seemed to be more spirited and alert than the soy bean lot. No objection, though, could be brought against either feed as far as their general effects upon the animals were concerned.

When the prices are quoted as heretofore given the cotton seed meal ration proved to be the cheaper of the two. In lot one it cost 30 cents a month to feed each animal, while with lot two the expense was 35 cents a month per ewe. A little change in the price of feeds would alter the financial statement, however. But, taking the above results and quotations as a basis, the soy bean hay proved to be worth $10.68 a ton for carrying the ewes through the winter when compared to the cotton seed meal and hull ration. In some parts of the state that price would be a good one for the hay, but in other portions of the state conditions are such that a farmer could well afford to sell the hay upon the market, and with the proceeds buy cotton seed meal and hulls to use in feeding the sheep. In many points in the state soy bean hay sells for $15.00 to $20.00 a ton. The farmer cannot afford to feed it to sheep, or, in fact, any other kind of live stock, except probably the work animals, when he can secure $20.00 a ton for it after a short haul. Other feeds are cheaper.

Feeding the Milking Ewe.

As stated above, when a ewe brought a lamb she was taken out of her lot and placed in a third lot, where she was given more feed than when dry. After the lamb came

she was a milking animal and had to be treated as such. The cow in milk requires much more feed than does the dry cow, and so the milking ewe must be fed more liberally than the dry one. The most economical thing to have done with the ewe when she dropped the lamb would have been to put her and the lamb out upon green pasture. This date would be around January the first. Green pastures can easily be provided at this time of year, as oats, vetch, rye, wheat, burr clover and barley pastures. The pasture method is the way the farmer should handle his flock for the greatest profit, but the Station wished to learn how much the feed should be increased after the ewe came into milk, and also study the effect of prolonged feeding of cotton seed meal upon the health of the animal, so it was not possible to employ the cheapest methods in this particular test. So the mothers were confined in a third lot and fed upon an increased amount of cotton seed meal and hulls. A small passage was made in the fence leading out into the pasture, which was composed of oats and vetch, and the lambs only were given the freedom of this run.

But it might be that the farmer would not be supplied with a green field when the lambs begin to come, and he would be interested in knowing just how much the feed should be increased when the ewe changes from a dry to a milking animal. The majority of owners allow their ewes, cows, sows and mares to run down rapidly in flesh when they come into milk.

It has been a rule of the writers to increase the feed of a mare or a cow twenty-five per cent. when the young animal was born, thinking that this increase in feed would be sufficient to maintain the mother in as good condition as she was before giving birth to the young animal, but the following data show that an increase of twenty-five per cent. was not sufficient:

Table 2. Amount feed required to maintain a ewe before and after lambing.

Lot	Ration	Am't feed eaten daily	Total gain each ewe for whole period	Cost to carry each ewe for one month
Before lambing:		*Lbs.*	*Lbs.*	*Cts.*
1	Cotton seed meal	0.5	1.8	35
	Cotton seed hulls	1.3		
After lambing:				
2	Cotton seed meal	.88	1.5	54
	Cotton seed hulls	2.35		

At the beginning of the test the feed of those ewes in milk was made just double the amount given the dry ewes so that the animals would be sure to not lose in weight, but it was soon learned, as the ewes begun to increase in weight, that an hundred per cent. increase was more than necessary, so the amount was gradually decreased until it was brought down to the above average figures. They were carried along upon this basis for a period of seventy-three days. The ewes were practically maintained, as far as total weight was concerned, as they gained but one and one-half pounds for the whole time. In the test it required 75 per cent. more cotton seed meal and 81 per cent. more hulls to maintain a ewe when suckling a lamb than when she was dry and pregnant. Of course there are several factors that would be controlling ones in determining the amount of feed required for an animal after lambing, as the amount of milk given, but under conditions as they existed in this test the necessary increase in feed, when the animal came into milk, was not less than 75 per cent. above that which she received when dry.

In some experimental work with grade angus cows, Professor Mumford, of the Illinois University, in bulletin III, says, "In this test it took approximately twice as much feed to maintain a cow suckling a calf as it did during her pregnancy."

Handling and Feeding the Lambs.

As a rule, the farmer feeds the early lamb nothing in addition to its mother's milk and what little pasture it can secure during the winter months. It will pay to feed the lambs though, and to feed them well. Any animal makes its cheapest gains when young. If it has a good pasture of oats and vetch to run upon it will eat but little grain in addition. But it will eat some corn and should have it, because this early lamb, to derive the greatest profit upon him, and at the same time lessen the risk of summer disease, should be pushed to an early market. The first lambs were dropped January the 8th. This was late, which fact gave greater cause for pushing them to an early market. From the sixteen ewes fourteen lambs were raised to a marketable age. Two of the ewes were too young to breed at this time. As soon as the lamb was born he was placed in a third lot with his mother. In the fence of this lot was a small hole which permitted the lambs to creep through and make use of the pasture of oats and vetch. The pasture, which had been fall planted, was ready for grazing by the time they could use it. As stated above, it would have been better and cheaper if the mothers had been allowed the run of this pasture also, but they were kept off for reasons heretofore mentioned. A small pen was also cut off in the corner of the lot where the mothers were kept and a creep made into this pen large enough for the lambs to go through. In this pen coarsely ground corn was kept all the time in a small trough. The pasture and grain should be given the lambs as soon as they are born and they will begin to eat by the time they are ten days old. The lambs did not eat much corn, but what they did eat helped to put the finish on them at an earlier date, so that they sold well upon the market. The 14 lambs ate but 6.6 bushels of corn during the whole winter and early spring. So the lambs had all of the corn, milk and green pastures that they wanted. With this combination of feed they, of course, did well.

They were sold at an average age of 101 days and had attained an average live weight of 51 pounds (Atlanta weights). They made excellent gains to be born of mothers that average only 95 pounds in weight.

It might have been more profitable to have carried them to a heavier weight, but that point could not be determined. If they had been born earlier they could have been fed longer and still been placed upon the early market. The object was to sell them as early in the season as possible and yet have a reasonable size. This is the reason why earliness of birth is such an important question. When warm weather comes on the price of mutton declines, as people do not like mutton during the warm months, so it is to the advantage of the owner to let the lambs go at the earliest possible date. And, too, when they are sold in the early spring the danger of losses from summer diseases is also considerably lessened. The earliest bunch was sent to Atlanta, April 23rd, 1907. The Station has succeeded, during the last two years, in getting some lambs ready for the market by the middle of April. Two of the bunch sold for nine cents a pound live weight, while three sold for eight and one-half cents a pound. The remaining ones were sent on later and sold for but eight cents a pound. The late ones were, in fact, better lambs than the first ones, but the weather was becoming warm and there was not as great a demand for them as there was for the early ones. The best prices prevail just before Easter time. The Station has not been able to secure as good prices for lambs as have some farmers of the state. A picture in another part of the bulletin shows some lambs which were sold, in April, 1908, in Birmingham, for ten cents a pound live weight.

It must be remembered, too, that these lambs were not fancy bred ones. They were just common lambs. In fact, two of them were out of scrub mothers by a pure bred Southdown ram. The others were out of grade mothers.

Salt Fed.

Salt was placed in small boxes and kept before the animals all the time. They are very fond of it, as the following table shows. Each ewe ate at the rate of 15 to 19 pounds of salt yearly, or a flock of 100 ewes would have consumed in one year's time from 1,500 to 2,000 pounds of salt.

Table 3. Salt eaten per month by each ewe.

Lot	Ration	Ponnds salt eaten per ewe each month
1 (1906)	Soy bean hay.....	1.35
2 (1906)	Cotton seed meal } Cotton seed hulls }	1.53
1 (1907)	Green sorghum plus mixed hay (summer work).....	1.23
2 (1907)	Cotton seed meal..... Cotton seed hulls (summer work)	1.29

Water Drank.

It is often thought that sheep will not drink much water, and that they will thrive as well without it as with it. Data were collected on the amount of water consumed by some ewes from August 21st to September 9th, 1908, while they were confined in small sheltered lots. The weather was about normal for this time of year.

Table 4. Water drank per ewe per day.

Lot	Ration	Pounds water used by each ewe per day
1	Green sorghum.....	2.5 (.3 gallons)
2	Cotton seed meal and hulls.....	6.1 (.95 gallons)

Financial Statement For Old Flock.
1906-'07.

The financial statement includes all the income and expenses upon the old flock of 16 ewes and one ram from October the first, 1906, to October the first, 1907,—a year's time. While the flock was not carried through the year with a view of rendering a financial statement at the end, still the statement points out what profit can be made upon

a small flock if profits be the only point in view. The authors had other questions to solve with the flock, so it was not carried through the year as cheaply as the farmer could have carried it through. If profits had been the only point in view the animals would have been handled more economically by feeding the ewes very little grain after the lambs were born. To secure the greatest returns the mothers should have been turned out into the oat and vetch pasture with the lambs and fed little, if any, concentrated feeds. But owing to the fact that the Station at that time owned no other flock, this same flock had to be used in the spring experiment of 1907, when a study was made of the amount of feed required to maintain a ewe after lambing.

This, of course, ran the expense up very materially—about 30 per cent. more than it should have been. But in the following financial statement all of the expenses have been counted against the flock.

Table 5. Financial statement of old flock—1906-1907.

Expenses:		
	Rent on pasture, 10 cts. per sheep per month	$12.24
Lot 1.	1503 lbs. soy bean hay at $12.50 per ton	9.39
Lot 2.	342 lbs. cotton seed meal at $25.00 per ton ..	4.27
	879 lbs. cotton seeed hulls at $6.00 per ton ..	2.64
Lot 3. (after lambing)	530 lbs. cotton seed meal at $25.00 per ton ..	6.62
	1332 lbs. cotton seed hulls at $6.00 per ton ..	3.99
	198 lbs. cotton seed at $12.00 per ton	1.19
	1 ton green hay at $2.00 per ton	2.00
Lambs	371 lbs. corn at 70 cents per bushel	4.63
	35 lbs. bran at $30.00 per ton	.52
	Death one ewe	3.00
	Express charges to send lambs to Atlanta	7.00
	Express charges to send wool to Atlanta	.60
	Total	$58.09
Receipts:		
	To 14 lambs	$53.56
	To 55 1-2 lbs. wool, 26 1-2 cts. per lb. ..	14.64
	Total	$68.20

Side view of average Alabama scrub ewe. Price $1.50—$3.00.

These ewes are excellent animals with which to start a flock of sheep. Use pure-bred rams upon them.

16 *lambs of this bunch sold for* 10 *cents a pound, live weight, at Birmingham, April* 15, 1908. *Belonged to J. S. Kernachan.*

Spring lambs running on a pasture of oats and vetch during the winter time.

The above tabulation shows every item of expense against the flock during the entire year except the labor required to look after it. It has been assumed that the value of the manure will offset the labor expenses. After all of these expenses were considered the flock gave a return of $10.11. What do these figures mean? Do they mean that the Station received but $10.11 on the whole flock? No, that is not all they mean. They mean that the Staton realized $12.50 per ton for all the soy bean hay eaten throughout the winter, that the pasture rented for ten cents per sheep per month, that 70 cents per bushel were realized upon the corn used and $12.00 a ton on the cotton seed—and finally, in addition to marketing the farm crops at the above prices, $10.11 were realized. The financial returns were satisfactory, but not as satisfactory as they could have been made if the feed bill had been cut down and pasture made use of after the lambs came. For instance the farmer would have almost entirely dispensed with the feed item of $13.70 for lot 3. Live stock should be looked upon as a means of marketing the farm crops at good prices while, at the same time, the manure is returned to the soil.

Experience of Two Alabama Sheep Farmers.

Many farmers will be interested in the following statements from good farmers who have tried the sheep business and are making a success of it—

Alabama Experimental Station.

Dear Sirs:—

About fifteen years ago I bought six head of ewes and one buck as a start in the sheep business. Up to that time I had never liked sheep, but experience has taught me to be more and more pleased wth them as time goes by. They have been great money makers for me. I kept all the ewe lambs for several years and today have one hundred and forty head of breeding ewes. For the last five years have sold both male and female lambs, keeping just enough ewe lambs to keep up the number where I want it.

I do not know of an investment that will make money faster than will sheep—with proper care and attention. We think an investment is doing wonderfully well if the original capital doubles itself in ten years. But see what the sheep did; if they had increased to twelve only within the ten years they would have doubled the investment. But they did much more than simply double. Within the ten years the ewe part of the flock—that part retained upon the farm—doubled about five times, to say nothing of the number of ewe and male lambs that have been sold from the farm within the ten years. I have realized, in the fifteen years, about one thousand dollars for lambs, while the wool has paid for the keep of the flock every year.

I have never been bothered by dogs. I have always kept the sheep upon my own lands, never allowing them to run upon the commons.

The animals have been perfectly healthy all the time. I have never lost a sheep except from old age. They run upon pasture about nine months of the year without any other feed in addition. The pasture keeps them in fine condition. During the lambing time the ewes need some extra feed, so I then give them some cotton seed—about three bushels to each one hundred ewes—and any good hay that I happen to have on hand.

The lands upon which the sheep have been running will carry twice as many head of stock now as it would ten years ago. The sheep is called the "golden hoofed" animal and I think they are entitled to the name; they have not only brought in the money, but have improved the land. The manure spreader is said to be a paying investment, but sheep are a decided improvement on any manure spreader, as they manufacture and spread the manure too. I have never had trouble arise from running other kinds of stock with the sheep. I keep horses, cattle and sheep in the same pasture all through the grazing season, except when the lambs are young, when I keep them away from all other

stock. The other stock do not object to eating the grass upon which the sheep have grazed.

Yours truly,

J. S. Kernachan, Florence, Ala.

Alabama Experiment Station.

Dear Sirs:—

In January, 1904, when we bought our farm, the man of whom we bought it had a small flock of forty-eight head of sheep and was very anxious to leave them with us on shares, but we had always heard that sheep would ruin a pasture, and so were unwilling for them to stay. But finally we agreed to keep the sheep for him for eighteen months on shares; we were to receive one-half of the wool and lambs and bear the expense of pasture and the labor to look after them.

The first year we raised fifty-four lambs and divided up about July first. As he intended to sell his part of the lambs he took the bucks and left us twenty-seven ewe lambs as our part of the first crop of lambs. Now, it is strange, but it is a fact, that the next spring every one of these twenty-seven ewes had lambs and some of them had twins. When we divided up again the next year, about July first, we had about seventy-five sheep, and besides had received some money for our part of the wool. In the meantime we had watched pretty closely and found that, instead of injuring our pastures, the sheep had benefited them by eating weeds and other things which our cattle would not eat.

So far, we were well pleased with our experiment and decided that, by breeding up our sheep, we could make some money, so we ordered two Southdown rams from Kentucky. We decided on the Southdown because, after reading and making inquiry, we thought they would suit us best as we prefer a dual purpose animal—one that would produce both wool and mutton. We have had no cause for regret in making this selection, as they have been very

hardy here and proved to be the ideal sheep for our needs. Every year we have put in new bucks, selected and kept our best ewe lambs, and sold the buck lambs and the old ewes.

Our investment in sheep has never paid us less than one hundred per cent. and many years has paid us even more than that. The higher we grade them up the better they pay us, notwithstanding the fact that the higher they are graded up the greater price we place upon the breeding flock. As evidence of this fact, we have sheared from one hundred and seven sheep six hundred and thirty-three pounds of wool in the grease, but free of burrs and dirt. Although our lambs were unusually late this season, they have been dressed and shipped, having made an average dressed weight of about forty pounds. Their quality has been such as to tax our capacity for supplying them, and we have received the best price we have ever obtained.

The sheep we started with were scrubs—just the ordinary sheep of the county. Our farm is no better than many other farms of the State, yet our sheep have proven to be a better investment to us than money at compound interest. Still it is a fact that some farmers contend that there is no money in live stock on the farm, and that, here in Alabama, we cannot afford to have anything but scrub cattle, sheep and hogs. If the farmer who thinks this will try in but a small way to improve and build up his stock—giving the business the same conservative thought and care that brings success to other undertakings—he will soon have a good balance to the credit of the live stock account, besides having the satisfaction of owning useful and pretty animals.

We try to keep only about one hundred ewes, and carry them in the pasture along with about one hundred and fifty cattle. The sheep benefit the pasture by keeping down weeds. There is no objection to having the sheep and cattle in the same pasture. We make our living from the farm, consequently everything upon the farm must pay its own

way and make something for us besides. We have found, and the Southern farmers who try it will find, that sheep are a paying proposition. They have the following advantages:

They require but a small capital to begin the business.

They will do well on hilly and broken lands.

Their manure is one of the richest animal manures that can be obtained.

The money comes in from them in the spring and early summer when money is scarce.

They subsist on things that other animals will not eat.

They afford us two sources of profit—wool and lambs.

Yours very truly,

J. B. McDaniel, Camden, Ala.

PART II.

FEEDING COTTON SEED MEAL TO SHEEP.

It is generally thought that cotton seed meal has a toxic effect on sheep similar to the effect it often has on hogs. Many farmers will not use it as a sheep feed because of the reported ill results. It is charged with producing illness, blindness, dizziness, etc., after being used for a few weeks. For the last four years this Station has been trying to determine whether cotton seed meal is an injurious feed for sheep or not, and, so far, no ill results have come from its use, with possibly one exception in 1906.

The old flock of ewes has been used in this work together with a flock of scrub ewes which were brought to the farm in the summer of 1907. The animals using the meal have been fed by the side of other animals which were being given rations without cotton seed meal so as to study the effect of the cotton seed meal upon the general health of the animals, even though no deaths should occur as a result of its use. The following table gives the details of the live weight, total cotton seed meal eaten and number of days that each ewe ate the cotton seed meal:

Table 6. Feeding cotton seed meal to sheep.

Ear No.	Live Weight	Total cotton seed meal eaten	Meal eaten daily	No. days on cotton seed meal	REMARKS
1906.	Lbs.	Lbs.	Lbs.		
5	120	68.5	.5	137	Excellent health throughout.
2	125	98.6	.5 for 53 das. .88 for 82 das.	135	Excellent health throughout.
15	90	94.2	.5 for 60 das. .88 for 73 das.	133	Excellent health throughout.
9	106	33.2	.5	66	Became sick; taken out of test, died within four months of stomach worms.

3	120	94.2	.5 for 60 das. .88 for 73 das.	133	Excellent health throughout.
28	47	67.5	.5	135	Excellent health throughout.
123	95	88.3	.5 for 78 das. .88 for 56 das.	134	Excellent health throughout.
61	75	78.8	.5 for 103 das. .88 for 31 das.	134	Excellent health throughout.
1907.					
5	120	105.0	.5	210	Excellent health throughout.
7	102	92.5	.5	185	Died Jan. 31-'08. No blindness, dizziness, etc. Cause of death probably worms, as worms were in stomach.
3	120	105.0	.5	210	Excellent health throughout.
4	132	73.5	.5	147	Died Jan. 11-'08. She seemed blind, staggered, would not eat well when fed in trough. Died fat. Would eat if feed placed before her.
96	32	17.5	.5	35	Died Sept. 19-'08. Death caused by getting head fastened in fence.
33	59	105.0	.5	210	Excellent health throughout.
29	65	105.0	.5	210	Excellent health throughout.
190	65	16.8	.25 for 44 das. .28 for 10 das. .33 for 9 das.	63	Excellent health throughout.
191	75	34.0	.25 for 44 das. .5 for 46 das.	90	Excellent health throughout.
192	65	16.8	.25 for 44 das. .28 for 10 das. .33 for 9 das.	63	Excellent health throughout.
193	83	16.8	.25 for 44 das. .28 for 10 das. .33 for 9 das.	63	Excellent health throughout.
194	85	31.8	.25 for 44 das. .28 for 10 das. .5 for 36 das.	90	Excellent health throughout.
195	65	16.8	.25 for 44 das. .28 for 10 das. .33 for 9 das.	63	Excellent health throughout.

196	70	16.8	.25 for 44 das. .28 for 10 das. .33 for 9 das.	63	Excellent health throughout
197	54	16.8	.25 for 44 das. .28 for 10 das. .33 for 9 das.	63	Excellent health throughout
170	74	18.2	.32 for 57 das.	57	Aborted after weigh day.
171	46	18.2	.32 for 57 das.	57	Had been on sorghum; became very weak before putting on cotton seed meal.
174	47	18.2	.32 for 57 das.	57	Had been on sorghum; became very weak before putting on cotton seed meal.
198	35	5.9	.28 for 21 das.	21	Had been on sorghum; became very weak before putting on cotton seed meal.
177	68	18.2	.32 for 57 das.	57	Had been on hay. Gained rapidly when put on cotton seed meal.
181	61	18.2	.32 for 57 das.	57	Had been on hay. Gained rapidly when put on cotton seed meal.
140	52	18.2	.32 for 57 das.	57	Had been on hay. Gained rapidly when put on cotton seed meal.
185	58	18.2	.32 for 57 das.	57	Had been on cotton seed before placed on cotton seed meal.
188	50	18.2	.32 for 57 das.	57	Had been on cotton seed before placed on cotton seed meal.
189	65	18.2	.32 for 57 das.	57	Had been on cotton seed before placed on cotton seed meal.
199	49	18.2	.32 for 57 das.	57	Had been on cotton seed before placed on cotton seed meal.
1908.					
185	95	65.1	.23 for 94 das. .8 for 33 das. .57 for 30 das.	157	Excellent health throughout.
48	100	65.1	.23 for 94 das. .8 for 33 das. .57 for 30 das.	157	Excellent health throughout.

182	110	80.5	.23 for 67 das. .80 for 60 das. .57 for 30 das.	157	Excellent health throughout.
177	96	79.9	.23 for 68 das. .80 for 59 das. .57 for 30 das.	157	Excellent health throughout.
194	84	16.6	.23 for 72 das.	72	Aborted. Taken out of test.
5	109	58.1	.23 for 165 das. .48 for 42 das.	207	Excellent health throughout.
186	100	84.3	.23 for 84 das. .80 for 43 das. .57 for 30 das. .48 for 28 das.	185	Excellent health throughout.
193	90	27.8	.23 for 121 das.	121	Died. No report on death.
58	81	77.1	.23 for 73 das. .8 for 54 das. .57 for 30 das.	157	Excellent health throughout.
190	68	19.8	.23	86	Aborted. Taken out of test.
178	95	77.1	.23 for 73 das. .8 for 54 das. .57 for 30 das.	157	Excellent health throughout.
61	99	74.2	.23 for 78 das. .80 for 49 das. .57 for 30 das.	157	Excellent health throughout.
30	102	65.5	.23 for 106 das. .57 for 30 das. .48 for 50 das.	186	Excellent health throughout.
33	93	31.1	.23	135	Aborted. Taken out of test.
17	60	16.8	.23	73	Taken out of test as she was young and was getting weak.
70	110	91.7	.23 for 71 das. .8 for 56 das. .57 for 30 das. .48 for 28 das.	185	Excellent health throughout.
71	100	101.1	.23 for 73 das. .80 for 54 das. .57 for 30 das. .48 for 50 das.	207	Excellent health throughout.
174	75	97.4	.5 for 71 das. .8 for 56 das. .57 for 30 das.	157	Excellent health throughout.

192	91	38.5	.50 for 77 das.	77	Excellent health throughout.
2	114	114.8	.50 for 93 das. .80 for 34 das. .57 for 30 das. .48 for 50 das.	207	Excellent health throughout.
195	75	98.6	.5 for 67 das. .8 for 60 das. .57 for 30 das.	157	Excellent health throughout.
47	85	47.0	.5 for 94 das.	94	Absorted. Taken out of test.
14	135	106.0	.5 for 109 das. .8 for 13 das. .57 for 30 das. .48 for 50 das.	202	Excellent health throughout.
196	70	118.1	.5 for 82 das. .8 for 45 das. .57 for 30 das. .48 for 50 das.	207	Excellent health throughout.
29	105	97.3	.5 for 116 das. .8 for 11 das. .57 for 30 das. .48 for 28 das.	185	Excellent health throughout.
59	85	102.1	.5 for 100 das. .8 for 27 das. .57 for 30 das. .48 for 28 das.	185	Excellent health throughout.
181	81	109.9	.5 for 74 das. .8 for 53 das. .57 for 30 das. .48 for 28 das.	185	Excellent health throughout.
36	101	102.6	.5 for 155 das. .57 for 2 das. .48 for 50 das.	207	Excellent health throughout.
199	80	105.5	.5 for 124 das. .8 for 3 das. .57 for 30 das. .48 for 50 das.	207	Excellent health throughout.
26	69	102.6	.5 for 162 das. .48 for 45 das.	207	Excellent health throughout.
191	99	104.8	.5 for 91 das. .8 for 36 das. .57 for 30 das. .48 for 28 das.	185	Excellent health throughout.

Sixty-five ewes have been fed upon cotton seed meal for different lengths of time, and in varied amounts and no ill results have occurred with the possible exception of one ewe (Ewe No. 4). After she had been on a cotton seed meal ration for 147 days (in 1907) she staggered and became blind, and finally died. Aside from the blindness and staggering she seemed to be in good health and was very fat when death occurred. There were, during the four years, six cases of abortion among the ewes eating cotton seed meal. Among the check lots (those eating no cotton seed meal) there were as many abortions. The ewes in 1908 were fed upon the same load of cotton seed meal that killed several hogs in the swine experimental work, but not a single ewe suffered any ill results from its use. It is true that the ewes did not receive as much cotton seed meal as did the hogs, per hundred pounds live weight, but still the sheep were kept upon the meal double the length of time the hogs were.

The roughage used in all of the above cases was cotton seed hulls.

While the results are but negative ones, still they seem to warrant the conclusion that there is very little risk to run, if any, in feeding cotton seed meal to ewes, when fed in amounts just sufficient to carry the animal through the winter in good breeding condition.

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TWENTY-SECOND ANNUAL REPORT

OF THE

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN, ALABAMA

1910

TWENTY-SECOND ANNUAL REPORT

OF THE

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ALABAMA POLYTECHNIC INSTITUTE

AUBURN, ALABAMA

JANUARY 31, 1910

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1910

ALABAMA POLYTECHNIC INSTITUTE.

Auburn, Ala., Jan. 31, 1910.

GOVERNOR B. B. COMER,

Executive Department,

Montgomery, Ala.

SIR:—I have the honor herewith to transmit to you the Twenty-Second Annual Report of the Agricultural Experiment Station of this College.

The report of the Treasurer, herewith included, is for the fiscal year ending June 30, 1909.

This report is made in accordance with the provisions of the act of Congress (approved March 2, 1887), establishing Agricultural Experiment Stations in the several States and Territories.

It contains the report of the Director, the Chemists, the Veterinarian, the Agriculturist, the Biologist, the Horticulturist, the Entomologist, and the Professor of Animal Industry, for the year ending December 31, 1909.

Respectfully,

CHAS. C. THACH,

President.

AGRICULTURAL EXPERIMENT STATION.

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REPORT OF HATCH AND ADAMS FUND FOR 1908-1909.

Receipts.

	Hatch.	*Adams.*
To amount from U. S. Treasury	$15000.00	$11000.00

Disbursements.

By Salaries	$ 8732.86	$ 7459.88
By labor	1361.71	542.58
By publications	1229.48	
By postage and stationery	438.66	30.24
By freight and express	435.09	98.38
By heat, light, water, and power	493.97	99.34
By chemical supplies	150.34	201.20
By seeds, plants, and sundry supplies	546.53	435.54
By fertilizers	356.20	38.40
By feeding stuffs		296.21
By library	523.05	15.02
By tools, implements, and machinery	39.24	6.35
By furniture and fixtures	169.30	225.50
By scientific apparatus	212.34	1132.18
By live stock		60.33
By traveling expenses	89.85	89.75
By contingent expenses	21.00	
By buildings and repairs	200.38	269.10
Total	$15000.00	$11000.00

STATE OF ALABAMA,
Lee Country.

Personally appeared before me, Welborn Jones, a Notary Public in and for said county, M. A. Glenn, known to me as Treasurer of the Alabama Polytechnic Institute, who being duly sworn, deposes and says that the above and foregoing account is true and correct.

Witness my hand this 10th day of February, 1910.

WELBORN JONES,
Notary Public.

(Seal)

This is to certify that I have compared the account with the ledger account of the Treasurer, and this is a correct transcript of the same.

C. C. THACH,
President A. P. Institute.

REPORT OF DIRECTOR AND AGRICULTURIST.

J. F. Duggar.

Dr. C. C. Thach,

President Alabama Polytechnic Institute, Auburn, Ala.

Sir:—I respectfully submit the following report for the past year of the work under my charge as Director and Agriculturist of the Alabama Experiment Station.

Publications.

During the calendar year 1909 the publications of the Alabama Experiment Station consisted of the annual report, five bulletins and one press bulletin. The titles and authors are given below:

Bulletin No. 144.—The San Jose Scale and Lime-Sulphur Wash; by the Entomologist.

Bulletin No. 145.—Local Fertilizer Experiments With Cotton in 1905, 1906, 1907 and 1908; by the Director.

Bulletin No. 146.—Facing the Boll Weevil Problem in Alabama; by the Entomologist.

Bulletin No. 147.—Crimson Clover; by the Director.

Bulletin No. 148.—Raising Lambs in Alabama, Maintenance, Rations for Ewes, Feeding Cotton Seed Meal to Pregnant Ewes; by the Chief and Assistant in Animal Industry.

Press Bulletin No. 34.—Tests of Varieties of Cotton in 1908; by the Director and Farm Superintendent.

Press Bulletin No. 35.—Tests of Varieties of Corn in 1909; by the Director and Farm Superintendent.

As stated in each of my reports for the last two years, a large percentage of the bulletins of the Alabama Experiment Station are now out of print. There is urgent need that a number of the bulletins now out of print be reprinted. However, this cannot be done unless a special fund be appropriated for this purpose.

An increase in the printing fund is also needed in order that the mailing list of the Station be permitted to grow

in proportion to the increased need for information shown by the farmers of Alabama. With an ample printing fund, much wider publicity could be given to the fact that these bulletins are intended for every farmer in Alabama; and bulletins could be published on a wider range of subjects than at present. In many states a state appropriation supplements the printing fund of the Experiment Station, so as to provide for the widest possible dissemination of agricultural information.

Staff.

The following changes in the staff have occurred during the past year:

During the latter half of the year the Assistant in Horticulture, P. F. Williams, has discharged the duties of Acting Horticulturist, in the absence of Prof. R. S. Mackintosh, who was granted a year's leave of absence. To supply the position of Acting Assistant in Horticulture, J. C. Price, a graduate of the Virginia Polytechnic Institute, was appointed.

L. N. Duncan, formerly Assistant in Agriculture, was promoted to the position of Professor of School Agriculture and Agent of the U. S. Department of Agriculture. His place in Station work was taken by M. J. Funchess, a graduate of Clemson College, S. C., and a post-graduate student of the University of Wisconsin.

C. S. Ridgway, a graduate of the Maryland Agricultural College, and a post-graduate student of Johns Hopkins University, was appointed Assistant in Botany.

Agricultural Department.

Because of the need of frequent repetition of field experiments, the work of this department has been chiefly a continuation of work previously reported as in progress. The most extensive single lines of investigation are plant breeding experiments with cotton, corn, and oats. These are supported by the Adams Fund from the Federal Government. A requirement of all investigations under this fund is that they look to the establishment of fundamental

principles, rather than to the attainment of immediate results. With this end in view, the detailed work in the field and in the office has been more elaborate than is necessary in plant breeding work intended merely for the improvement of a given variety of cotton, corn, or oats.

However, encouraging progress has been made in the improvement of the varieties of cotton, corn, and oats, that were chosen for this investigation. In the Cook cotton progress has been made in improving the form and uniformity of the plant, in increasing the percentage of lint, and in productiveness. Two of the strains thus bred up took the first and second rank in productiveness among the thirty varieties of cotton tested at this Station in 1909. This was done in spite of considerable loss from anthracnose, to which all strains of this variety are especially susceptible, and toward the reduction of which by selection attention will be directed in the future.

Gratifying progress has been made in improving the Experiment Station yellow variety of corn in the matter of productiveness and number of ears per plant; and significant data have been accumulated in a study of the correlation of qualities of corn, which latter investigation promises to establish principles that will serve as direct and practical guides in plant breeding with corn.

In addition to the large number of experiments in improving the Cook cotton, the past year has brought to maturity several thousand hybrid cotton plants of the second generation since the cross was made. A careful examination of the qualities of these hybrids is now in progress, and results up to this date are very encouraging for the prospect of uniting in one variety many of the various qualities required in a cotton suitable for boll weevil conditions. However, this line of work must proceed for several years longer before we can properly expect to demonstrate any marked superiority of any one hybrid or strain. Many hundreds of separate samples of cotton, including the offspring of single promising plants, have been separately ginned and recorded.

In addition to plant breeding, some of the most important lines of experiments in progress during the year 1909 in the agricultural department are the following:

Cotton, local fertilizer experiments.

Cotton, relative fertilizing values of ground phosphate rock and acid phosphate.

Cotton, continuation of the study of varieties.

Cotton and corn, relative fertilizer requirements.

Corn, variety, culture, and fertilizer experiments.

Oats, variety and culture experiments.

Crimson clover, variety and culture tests, and fertilizing value.

Cowpeas, variety tests.

Sorghum, variety tests.

Relative amounts of food produced by various crops suitable for hogs.

A study of numerous forage plants, including alfalfa, vetches, clovers, soybeans, kudzu, and grasses.

Experiments in the manufacture on the farm of drain tile.

Rotation of crops.

Effects of lime on acid soils, using a number of crops.

The season of 1909 was a most unfavorable one for cotton. Excessive rains during the first half of the year, a period of acute drought in the late summer, and the most severe injury from anthracnose, commonly called boll rot, ever known during the fourteen years of the writer's connection with this Station, all combined to cut short the yield of cotton. Yet, in spite of these obstacles, the Station farm averaged more than one and one-fourth bales of cotton per acre. This result is believed to be chiefly due to the use of crimson clover as a soil-improving crop preceding cotton and to the improvement of cotton by careful plant breeding.

Respectfully submitted,

J. F. Duggar,

Director and Agriculturist.

REPORT OF THE CHEMIST.

By B. Ross.

DR. C. C. THACH,

President Alabama Polytechnic Institute, Auburn, Ala.

SIR:—I beg to submit the following statement with regard to the nature and scope of the work of the Chemical Department of the Experiment Station for the year just ended:

This work, as heretofore, has embraced investigations conducted under the provisions of the original Hatch act, work carried out under authority of the Adams act, and inspection work performed under the police requirements of State laws, while, in addition, a considerable amount of miscellaneous analytical work has been accomplished.

The reports submitted by Dr. J. T. Anderson and Prof. C. L. Hare give the essential features of the work carried out by them under the provisions of the Hatch and Adams acts and a large amount of valuable data has been accumulated in connection with their investigations during the past year. In carrying out these investigations, as well as in connection with the usual routine work of the laboratory, a large number of specimens of agricultural products has been analyzed since the date of the last annual report.

In addition to the lines of investigation mentioned in the reports of Messrs. Anderson and Hare, some work has been and is being done in connection with the study of the relative availability of the phosphoric acid of the basic slag or cinder obtained as a by-product from the manufacture of steel by the basic open-hearth process.

For a number of years the basic slag obtained as a by-product of the Thomas-Gilchrist steel process has been successfully employed as a fertilizer both in Europe and in this country, but the slag obtained as a by-product of the

basic open-hearth process has not yet found any general application for fertilizing purposes.

This slag is produced in large quantities both at Birmingham and Gadsden, and should constitute an important economic source of supply of phosphoric acid, if the final results of investigations as to its availability should prove satisfactory.

The Tennessee Coal, Iron and Railroad Company has placed a considerable quantity of this material at the disposal of this department, and already considerable work has been done in connection with laboratory tests of its availability, while further practical field tests as to availability will also be carried out during the coming season.

During the fall some experimental and demonstration work was performed, as heretofore, in the manufacture of syrup from sugar cane, and this office has answered many inquiries which have been received with reference to improved methods in the manufacture of this important agricultural product.

The fertilizer work of the past season showed a considerable increase over that of the preceding year, the number of analyses, including duplicates, being well in excess of 2,000. The results of these analyses were reported as usual in the annual fertilizer bulletin issued by the State Department of Agriculture, and, in addition, a considerable amount of descriptive matter relating to the composition, sources and properties of the fertilizing materials marketed in the State was included in the same bulletin.

Besides the fertilizer work alluded to, this department has made analyses of a large number of specimens of miscellaneous materials sent in from different portions of the State, including marls, phosphates, ores, waters, feed stuffs, etc.

Very respectfully,

B. B. Ross,
Chemist.

REPORT OF VETERINARIAN.

C. A. CARY.

DR. C. C. THACH,

President Alabama Polytechnic Institute, Auburn, Ala.

SIR:—I herewith submit a synopsis of work of the Veterinary Department for the year 1909.

The work on the life history of the cattle tick in co-operation with the Bureau of Animal Industry has been completed. The material is now being prepared for publication by the Bureau.

The study of the effects of cotton seed meal on the health and various organs of pigs is being continued. We have collected quite a quantity of data, have repeated feeding tests and have made a large number of blood examinations and also examinations of sections of various organs, such as the liver, spleen, kidneys, heart, and lungs. We have also made some observations on the effects of cotton seed meal on the health and condition of horses and mules. An experiment is now planned for carrying out a feeding test in which cotton seed meal will be used as the chief or only ingredient of the ration. It has been observed for some time that hogs and pigs which are fed on peanuts become affected. This has been investigated and experimental tests will be made.

The sanitary conditions of farms in their relation to the health of the people and animals on the farm have commanded our attention. It has been especially noted that careless methods in the disposal of carcasses of dead animals on the farm are responsible for the extension and spread of a number of animal diseases. It should be especially noted that buzzards are carriers of infectious materials from farm to farm, and are consequently great factors in the transmission of infectious diseases.

The study of bacteria in cows' udders and morbid changes

in the udder has been continued. The various pathologic changes, the causes of these changes, and resulting effects on milk secretion and the milk are problems to be solved.

Farmers' Institutes for 1909 were greater in number than any year since the institutes began. The average, and the total attendance are below those of previous years. The necessity for live stock farming, diversification of crops, eradication of cattle ticks and the production of more cotton on less acreage have been the chief lines of instruction given in the institutes.

During 1909.

Farmers' Institutes held in Alabama	35
Counties in which they were held	28
Number of sessions at these institutes	57
Average attendance at each session	67
Total attendance	3,790

The Round-up Farmers' Institute was held at Auburn, July 23d to July 31st, 1909. At this institute there were 60 lectures and demonstrations given. Every day lectures and demonstrations were commenced at 8 a. m. and continued with brief intermissions for dinner and supper until 10 p. m.

The enrollment for the entire institute was 730. The new feature of having women to lecture on household economics and sanitation was very well received.

The Farmers' Institutes and the Round-up or Short Summer School for Farmers have about reached the limits of growth, unless more money can be secured. It is now almost impossible with present funds to secure the help in the way of lecturers to meet the demand of the farmers.

C. A. Cary,

Veterinarian and Director of Farmers' Institutes.

REPORT OF CHEMIST OF SOILS AND CROP INVESTIGATION.

J. T. Anderson.

Dr. C. C. Thach,

President Alabama Polytechnic Institute, Auburn, Ala.

Sir:—The following report of the work done in the division of the Chemistry of Soils during the year 1909 is respectfully submitted:

For reasons to be given later, the research work has been confined in the main to the Adams' project. As stated in previous reports, this project seeks to determine the fertilizer requirements of the soil by the chemical analysis of the plant grown in it. Cotton has been selected as the plant and was grown last season under the following conditions:

1. In plots in the open field.
2. In clean sand in clay cylinders imbedded in the ground.
3. In wire baskets.

1. To secure samples of analysis from field plots, use was made again of Prof. Duggar's series of Co-operative Fertilizer Experiments with Cotton. Thus were obtained samples from some twenty odd sets of ten plots each, located in widely separated sections of the state, and in all varieties of soil. Several of these sets were located in the vicinity of Auburn, and were under the scrutiny of this writer. Most of these samples have already been analyzed, some two or three sets, however, remain to be worked up.

2. An attempt was made to grow cotton in clean sand in clay cylinders which were imbedded in the ground, using the same system of fertilzation as is employed in the field plots. The attempt met with indifferent success, failing entirely, or practically so, on those cylinders where no fertilizer was used. A number of samples, however, were secured from cylinders which were completely or partially fertilized. With the experience of last season to guide us,

it is hoped that the attempt to be made next season will meet with better success.

3. Samples of the unfertilized soils from the plots located near Auburn were brought to the laboratory, and after proper preparation were used in series of small wire baskets. One of the soils used was a stiff clay, another a medium sandy loam and the other a sandy soil. Each of these soils was tested independently in a series of baskets, using the same system of fertilization as in the field plots. As samples for analysis from the field plots were drawn while the plants were small in the leaf stage, it was assumed that they could be grown normally to that stage in the small wire baskets. The assumption was found to be correct, and the analytical results obtained from the wire basket samples accord reasonably well with those obtained from the same soil in the open plots. The facilities for wire basket work are limited at present, and hence only a few comparisons of this with the open plot method have been made. Special attention to these comparisons in a larger number and variety of soils is to be given during the coming season.

With the purpose of securing whatever good that might be derived from it, samples of soil from each of ten plots from two of the locations near Auburn were obtained and analyzed for moisture and available potash. The data obtained will be published with the other.

The Hatch project, whose purpose was the study of the effect of the humification of certain nitrogenous substances in rendering insoluble phosphoric acid available to the plant, met with no advance during the last season. The ravages of the cut worm, which baffled all attempts to check, made it necessary to abandon rye and sorghum as the growing crops. An attempt was made to substitute turnips with no success, the young plants being destroyed in some way almost before appearing above ground.

The usual amount of time was given to the official fertilizer work for the State Department of Agriculture.

Respectfully submitted,

JAS. T. ANDERSON.

REPORT OF PHYSIOLOGICAL CHEMIST.

C. L. HARE.

DR. C. C. THACH,

President Alabama Polytechnic Institute, Auburn, Ala.

SIR:—The work in this department during the past year has been continued according to the plans set forth in the last annual report.

The work on breeding cotton for high oil content in the seed has made some progress and the results secured encourage a continuation of the experiments.

The determination of the properties of lard as affected by the ration fed to the hog has proceeded to such a point that there is possible a fairly accurate knowledge of the effects of such feeds as soybeans, peanuts, corn, cotton seed meal, and tankage, as far as regards certain of the properties of lards.

It has also given an index to some correctives for soft lards and the extent to which the corrective effect may extend.

Respectfully submitted,

C. L. HARE.

REPORT OF ENTOMOLOGIST.

W. E. Hinds.

Dr. C. C. Thach,

President Alabama Polytechnic Institute, Auburn, Ala.

Sir:—The following report relates to the work of the Department of Entomology in the Experiment Station for the fiscal year 1909:

Work during the past year has continued mainly along the lines inaugurated during 1908. There has been no change in the working forces. Mr. W. F. Turner, as Assistant, has given nearly all of his time to the routine station work, and especially to the Adams Fund investigation projects.

Correspondence.—Inquiries regarding the control of insect pests have increased during the past year, indicating that there is a general advance in agricultural and horticultural information along these lines. The entomologist has received and answered somewhat more than 1,200 letters during the year.

Publications.—During the year 1909, the Department of Entomology has issued two bulletins and one circular. Bulletin No. 144, entitled "The San Jose Scale and Lime Sulphur Wash," has been quite largely in demand. Bulletin No. 146, entitled "Facing the Boll Weevil Problem in Alabama," was designed to prepare cotton planters for the advent of the boll weevil, and this publication will be increasingly useful as the boll weevil enters the state. Circular No. 3 gives a list of "Manufacturers and Dealers in Insecticide Materials and Spraying Apparatus," for distribution in correspondence.

Besides these regular Station publications, the Entomologist has published articles in the reports of the State Department of Agriculture at Montgomery, two articles in the Journal of Economic Entomology, besides brief notes in the Southern Farm Gazette.

Farmers' Institutes.—The demand for addresses at institute meetings conducted by this college and by the State Department of Agriculture has been much greater than I have felt at liberty to take the time to supply. Meetings of the State Horticultural Society and Farmers' Institutes have been addressed by me. There is now considerable demand for illustrated lectures on the cotton boll weevil problem, and these should be given so far as may be possible.

The Cotton Boll Weevil.—The cotton boll weevil has continued its eastward advance during the past season and has been found within six or eight miles of the Alabama line, but so far as we know, it does not yet occur in Alabama. It is very probable that this important insect pest will invade the State during 1910, and every possible step should be taken to minimize the damage which it will certainly cause if present practices in cotton culture are continued unchanged.

Adams Fund Investigations.—During the past year project No. 4, entitled "Investigation of Life History, Economic Relationships and Injury of the 'Rice Weevil,' (*Calandra oryza, L.*). Attacking Corn in Alabama, with a Study of Methods for Its Control," has been approved by the Office of Experment Stations for this department and substituted for project No. 2, relating to the study of the fire ant (*Solenopsis geminata*), which was found to occur but rarely in this locality. The new project deals with a problem of great value to the planters of Alabama, and in many respects can be carried on simultaneously with project No. 3, relating to fumigation investigations. In the fight against the boll weevil, more corn must be grown, and this means that some method of preserving it against injury from corn infesting pests must be worked out for the South.

Material progress has been made in the fumigation project, upon which our efforts have been largely concentrated. The magnitude, as well as the importance, of this investigation becomes more evident as the work proceeds. The results thus far obtained, while only preliminary, are still

of much importance, and are so considered by entomologists in other states. Our advice in regard to work with carbon di-sulfid is quite frequently requested by workers in other sections.

There is urgent need of a station bulletin dealing with the rice weevil and its control to be available for distribution by August, 1910. We contemplate the publication of this bulletin.

New Quarters for the Department.—The new quarters provided in Comer Hall for the experiment station work in entomology consist of two laboratory rooms and a large office, library and collection room on the first floor in the western end of the main building, with a work room and insectary in the green house range immediately south of Comer Hall. The completion of these rooms has enabled us to do many necessary things which were impossible previously for lack of space.

Equipment.—Most of the equipment added for the Department of Entomology during the past year has been for the station investigation work. This has been increased by the value of fully $500 during the past year. The largest single item has been the construction of fumigation boxes for use in the project investigations. The items secured have been only those most essential to the continuance of the investigations. Many additional items would greatly facilitate the work.

Respectfully submitted,

W. E. Hinds,

Entomologist.

REPORT OF BOTANIST.

FRANCIS E. LLOYD.

DR. C. C. THACH,

President Alabama Polytechnic Institute, Auburn, Ala.

SIR:—In response to your request of recent date, I beg herewith to make my annual report as Botanist of the Agricultural Experiment Station for the year ending.

The importance of studying the plant diseases caused by plant parasites has become increasingly evident. Special attention has been given to the Grape Rot (*Guinardia bidwelii*) and to the Fire Blight of Pome fruits (*Bacillus amylovorus*), and two circulars on these diseases have been prepared and are about to be sent to press, and the best known methods of their control. Both of these maladies are the cause of great losses, and this is especially true of the Grape Rot, which is known to destroy the entire crop.

The Orange Rust of Apples has been studied with reference to the history of the alternate form, *Gymnosporangium*, on the cedar, which is known popularly as Cedar Apple. The biennial character of the cedar apple has been established, confirming, independently, the work of Heald in Nebraska.

The problem of meeting the pecan situation is becoming increasingly important. This tree has been assumed by many to be free from the attacks of fungous parasites, and this view has been used as an argument to plant the tree. It now develops that some varieties at least, if not all, are attacked by the same organism which produces the scab of apples, *Fusicladium effusum*. Whether the treatment given to apples may prove effective remains to be determined. The extent of loss has been so great in some quarters that it is of the highest importance that a careful study should be made of methods of control.

The two projects under the Adams Fund have been begun. Several attempts have been made to carry out certain

preliminary experimentation, but the severe weather and the difficulty of controlling the temperature in the green house during the winter have been a constant hindrance.

The routine correspondence of the Department contains a considerable number of botanical inquiries of a general nature. These frequently require a great deal of time and study for satisfactory reply. The chief material factor in this phase of our work is the Herbarium, and for this reason it is important that it should be put into shape for use. The Herbarium must not be thought of as extraneous to the work of the Station, as it includes, aside from general material, the working collection of plant parasites. Our greatest need at the moment is proper housing in the form of tightly constructed cases, since without these we cannot control the insect pests which are peculiarly bothersome here.

A paper embodying in brief form my studies of the desert rubber plant above mentioned was presented before the Botanical Society of America, at the recent meeting in Boston, under the title, "The Response of the Guayule, Parthenium Argentatum Gray to Irrigation." An article, "The Guayula Rubber Situation," was contributed, by request of the editor of the India Rubber World, to the twentieth anniversary number of that periodical.

Yours truly,

Francis E. Lloyd,
Botanist.

ANIMAL INDUSTRY DEPARTMENT.

DANIEL T. GRAY.

DR. C. C. THACH,

President Alabama Polytechnic Institute, Auburn, Ala.

SIR:—One bulletin has been issued from the Animal Industry Department the past year. This is bulletin No. 148, and deals with the subjects of spring lamb production and feeding cotton seed meal to pregnant ewes.

In the main, the experimental work continues as was reported in the last annual report. The present work of the Department may be summarized as follows:

WITH SWINE.

1. To study the results of finishing swine by dry lot method as compared to the method of using green pasture crops.

2. To study the subject of hardening flesh and lard after they have been rendered soft as a result of the animals having grazed green crops.

3. To note further the toxic effect of feeding cotton seed meal to hogs.

4. To study the effects of some of the Southern swine feeds upon the frame work of the body.

5. To determine the most profitable amount of grain to feed along with such green pasture crops as soybeans and peanuts.

WITH BEEF CATTLE.

The co-operative beef work with the Animal Husbandry Department at Washington is going forward in an exceedingly satisfactory manner. The work has been enlarged to include the subject of finishing beef cattle in the winter time. The main questions involved now are:

1. To study methods of carrying mature beef animals through the winter months, when the object is to fatten them on pasture the following summer.

2. To determine the profit, if any, in supplementing the summer pastures with certain cotton seed by-products in finishing cattle for the summer market.

3. To study methods of carrying calves through the winter months when the object is to finish them for the market the following summer or fall.

4. To determine the most profitable amount of cotton seed cake to feed steers while they are being finished on pasture for the market.

5. To compare silage, cotton seed hulls, and Johnson grass hay as feeds for finishing cattle for the market in the winter time.

Last winter and summer 175 head of cattle were used in the feeding work. The cattle were sold in September. The experiment terminated in a very satisfactory manner. The data are now being prepared for publication.

With Sheep.

The work with sheep continues about as reported in the last annual report. The most important points under consideration are:

1. Early lamb production.

2. Effect upon the pregnant ewe of feeding cotton seed meal to her.

3. A comparison of Alabama feeds for carrying the ewe through the winter months.

The Dairy Extension work, which is being carried on as a co-operative work between the Dairy Department at Washington and this Department, continues the same as last year. Many dairy farmers are being reached and helped. Interest in the work is increasing rapidly.

Very respectfully submitted,

Daniel T. Gray.

REPORT OF ACTING HORTICULTURIST.

P. F. Williams.

Dr. C. C. Thach,

President Alabama Polytechnic Institute, Auburn, Ala.

Sir:—I respectfully submit the following report for the year ending December 31st, 1909:

Adams Investigation.—The work of the Department has been along lines similar to those of the previous year. The meteorological records have been taken to assist in the work in Peach Breeding under the Adams Fund and complete records in the blooming periods and fruiting of the various trees in the orchards.

Personnel.—Prof. R. S. Mackintosh was granted a year's leave of absence to take up study at Ames, Iowa, and left August 15th, 1909. The writer has been in charge of the work of the Department since that time. On October 1st Mr. J. C. C. Price took up his duties as Assistant Horticulturist. In this capacity he has done very efficient work. He has been particularly concerned with the green house operations.

Nursery Inspection.—With the approval of the State Board of Horticulture I have carried on the inspection of nursery stock, and have been ably assisted in this work by Mr. E. E. Binford, Dr. W. E. Hinds, and Mr. J. C. C. Price. A list of the individual nurseries receiving Alabama certificates will be found in the report to the State Board of Horticulture at the close of the present nursery year. This includes the granting of 116 certificates to nurserymen outside of the State; 40 certificates in the State, and 17 dealers' certificates.

Greenhouse Work.—The new greenhouse was occupied in February. With the constant demand for cut flowers, both locally and in Opelika, an addition to the present house

would be more than self-supporting. About one-half of the material for this addition is on hand. A number of students are anxious to take up the study of growing vegetables and flowers under glass, and I respectfully request that provision be made for this imperative need.

Experiments.—An experment was started in October to test out several varieties of tomatoes for forcing under glass. We have the promise of some valuable results from this. Mr. Blake is making the experiment the basis of his thesis work. Another project started in December was an experiment testing cabbage varieties and cabbage fertilizers and work along this same line with tomatoes.

Citrange Investigations.—A number of Citranges have been received from the U. S. Department of Agriculture, and they will be set out in the citrus orchard next spring. Mr. Walter Swingle, who is in charge of this work at Washington, D. C., has requested the Department to take up this work of breeding new citrus fruits on a much larger basis than has heretofore been attempted. It is desirable that this work should be undertaken. A portion of this work will call for space under glass. An efficient worker is needed to conduct these investigations.

Publications.—The material for a bulletin of information on pecans has been prepared for publication and this will appear in a few months. Pecans have become a very important crop in Alabama, and a test orchard should be planted on the Station grounds. Co-operation along this line should be encouraged in every county, as there is such a diversity of soils, and the best variety for each county have not been determined as yet. Valuable statistics have been received concerning the pecan industry in Alabama through the co-operation of the U. S. Department of Agriculture with this Department. Statistics concerning the peach growers of the State have also been received from the same source.

There is a pressing demand for a truck survey of Alabama, especially in Mobile and Baldwin Counties. A station

man should spend considerable time in the above sections to make a close study of the conditions there and learn the methods now employed with the view of undertaking co-operative experiments to further advance this important industry.

A bulletin on School Improvement has been published and appears to have filled a much needed want. At present the work along this line is crowding the time and facilities of the Department. Provision should be made for this work and this emphasizes the fact that funds for extension work in connection with the Experiment Station are very much needed.

CERTIFICATES ISSUED 1909-10.

Alabama Nurserymen.

1. Chase Nursery Co., Huntsville.
2. Rolfe Nursery Co., Huntsville.
3. Oak Lawn Nursery, Huntsville.
4. Huntsville Wholesale Nurseries, Huntsville, Ala.
5. J. O Kelly & Sons, Jeff.
6. Frazer Nursery Co., Huntsville.
7. Welch Nursery Co., Madison.
8. Chas. A. Hughes, Getup.
9. Blount County Nursery, Blountsville.
10. Arley Nursery, Arley.
11. Owen Nursery, Ashland.
12. Ashland Nursery, Ashland.
13. Earnest Nursery, Roanoke.
14. Slay Nursery, Buffalo.
15. Cusseta Nursery, LaFayette.
16. Lipp Nursery, Roanoke.
17. Joiner Nursery, Wedowee.
18. Rosemont Gardens, Montgomery.
19. Eagle Pecan Co., Pittsview.
20. Park Floral Co,, Selma.
21. Wakefield Nursery, Flomaton.
22. Gravlee Nursery Co., Newtonville.
23. Joppa Nursery, Joppa.
24. C. Ravier & Sons, Mobile.
25. Industrial School Gardens, Mobile.
26. Little Gem Gardens, Mobile.

27. J. S. Gaylord, Barnwell.
28. J. M. Colmant, Birmingham.
29. C. R. Long, Montgomery.
30. G. E. Luffman, Birmingham.
31. J. P. Jones, Fabius.
32. Vinemont Nursery, Vinemont.
33. F. E. Welch, Roseview Nursery, Chunchula.
34. Arlington Nursery, Birmingham.
35. Waverly Nurseries, Waverly.
36. Alabama Nursery Co., Huntsville.
37. Birmingham Landscape and Nursery Co., Birmingham.
38. J. C. White, Fort Payne.
39. Orchard Hill Nursery, J. M. Crutchfield, Cullman.
40. Gwendolin Nursery, Carlos Reese, Birmingham.

Alabama Dealers.

1. W. F. Probst, Oakman.
2. J. M. Colmant, Birmingham.
3. C. R. Long, Montgomery.
4. G. E. Luffman, Birmingham.
5. H. A. Sparkman, Mobile.
6. A. M. Preston & Son, Blountsville.
7. M. M. Dawson, Montgomery.
8. J. H. Parker & Son, Vinemont.
9. J. J. Holmes, Montgomery.
10. E. Day, Birmingham.
11. W. D. Summerfield, Birmingham.
12. A. B. Webb, Scottsboro.
13. Homer N. Sneed, Pronto.
14. Judson Strock, Clanton.
15. G. W. DeVaughan, Prichard.
16. A. Swift, Fairhope.
17. John B. Stroud, Pass Christian, Miss.

Nurserymen Outside the State.

1. H. C. White & Co., DeWitt, Ga.
2. H. M. Simpson & Sons, Vincennes, Ind.
3. A. D. Williams, Yatesville, Ga.
4. Frank H. Wild Floral Co., Sarcoxie, Mo.
5. Southern Nursery Co., Winchester, Tenn.
6. Wild Brothers Nursery Co., Sarcoxie, Mo.
7. P. J. Berckmans Co., Fruitland Nurseries, Augusta, Ga.
8. Stark Brothers Nursery and Orchard Co., Louisiana, Mo.

9. Tennessee Wholesale Nurseries, Winchester, Tenn.
10. Biltmore Nurseries, Biltmore, N. C.
11. M. L. Spivey, Lynnville, Tenn.
12. T. S. Hubberd Co., Fredonia, N. Y.
13. Geo. S. Josselyn, Fredonia, N. Y.
14. Griffing Bros. Nursery Co., Pomona Nurseries, MacClenny, Fla.
15. The Nut Nursery Co., Simpson Bros., Monticello, Fla.
16. Hoopes, Bro. & Thomas Co., West Chester, Pa.
17. Andorra Nurseries, Chestnut Hill, Pa.
18. Ellwanger & Barry, Rochester N. Y.
19. Lewis Roesch & Son, Fredonia, N. Y.
20. Dreer Nurseries, Henry A. Dreer, Riverton, N. J.
21. Bluhm Nursery Co., Smithville, Tenn.
22. Morris Nursery Co., West Chester, Pa.
23. Jackson & Perkins Co., Newark, N. J.
24. Smith Bros., Concord, Ga.
25. Pike County Nurseries, Concord, Ga.
26. Excelsior Nurseries, G. H. Miller & Son, Rome, Ga.
27. T. V. Munson & Co., Denison, Texas.
28. The Barber-Frink Co., MacClenny, Fla.
29. Summit Nurseries, Miller & Gossard, Monticello, Fla.
30. Cedar Hill Nursery, Winchester, Tenn.
31. Thos. Meehan & Sons, Inc., Germantown, Pa.
32. Lamar Nursery Co., Pulaski, Tenn.
33. Bobbink & Atkins Nurseries, Rutherford, N. J.
34. Center Grove Nursery Co., Smithville, Tenn.
35. John Lightfoot, East Chattanooga, Tenn.
36. Chase Bros. Co., Rochester, N. Y.
37. A. C. Oelschig & Sons, Savannah, Ga.
38. Thos. Meehan & Sons, Inc., Dresher, Pa.
39. The Knoxville Nursery Co., Lowell Station, Tenn.
40. J. Van Lindley Nursery Co., Kernersville and Pomona, N. C.
41. Arcadia Nurseries, J. H. Girardeau, Monticello, Fla.
42. Glen St. Mary Nursery Co., Glen St. Mary, Fla.
43. Glenn Cliff Nursery, Winchester, Tenn.
44. Easterly Nursery Co., Cleveland, Tenn.
45. United States Nursery Co., Rich, Miss.
46. Forest Nursery and Seed Co., McMinnville, Tenn.
47. Prosperity Nursery, Smithville, Tenn.
48. New Hope Nursery, Daylight, Tenn.
49. J. L. Westbrook, Temple, Ga.
50. J. Steckler Seed Co., New Orleans, La.
51. Franklin Davis Nursery Co., Mullikin, Md.
52. Will F. Halliday Decherd, Tenn.

53. Pecan Grove Farm Nursery, Cairo, Ga.
54. Storrs & Harrison Co., Painesville, Ohio.
55. W. N. Scarff, New Carlisle, Ohio.
56. The Donaldson Co., Warsaw and Sparta, Ky.
57. Wagner Park Conservatories, Sidney, Ohio.
58. The G. M. Bacon Pecan Co., DeWitt, Ga.
59. The Wm. H. Moon Co., Morrisville, Pa.
60. James Cureton, Cureton Nurseries, Austell, Ga.
61. Tullahoma Nursery, Tullahoma, Tenn.
62. W. W. Thomas, Anna, Ill.
63. Peter Henderson & Co., Jersey City, N. J.
64. Joe Shadow Nursery Co., Winchester, Tenn.
65. Chattanooga Nursery Co., Chattanooga, Tenn.
66. Continental Plant Co., Kittrell, N. C.
67. Jackson County Nursery, J. G. Justice, Jefferson, Ga.
68. L. H. Garretson, Fall River, Tenn.
69. Alexander Seed Co., Kittrell, N. C. (Augusta, Ga.)
70. Greensboro Nurseries, Greensboro, N. C.
71. Morey & Son, Danvile, N. Y.
72. R. A. Eubank, Prospect Station, Tenn.
73. Old Dominion Nurseries, W. T. Hood, Richmond, Va.
74. H. C. Hastings, Kittrell, N. C. (Atlanta, Ga.)
75. Wick Hathaway, Madison, Ohio.
76. Moss & Allen, Smithville, Tenn.
77. Union Nursery Co., Smithville, Tenn.
78. Commercial Nursery Co., Winchester, Tenn.
79. Mt. Olive Nursery Co., Smithville, Tenn.
80. Carroll County Nursery, C. P. Turner, Carrollton, Ga.
81. Oakland Nurseries, W. Y. C. Grant, Columbia, Tenn.
82. F. R. Pierson Co., Tarrytown, N. Y.
83. Geo. A. Sweet, Danville, N. Y.
84. Bremen Nursery, T. J. Anderson, Bremen, Ga.
85. Hartwell Nurseries, S. W. Peck, Hartwell, Ga.
86. Keltonburg Nursery Smithville, Tenn.
87. Cumberland Nurseries, Winchester, Tenn.
88. Fruit Farm Nursery, J. E. Gregory, Cabot, Ark.
89. Cumberland Mountain Nursery Co., Smithville, Tenn.
90. White Elm Nurseries, Oconomowoc, Wis.
91. Monticello Nurseries, Standard Pecan Co., Monticello, Fla.
92. Sneed's Wholesale Nursery, John F. Sneed, Tyler, Texas.
93. Bechtel Pecan Nurseries, Ocean Springs, Miss.
94. Mt. Arbor Nurseries, E. S. Welch, Shenandoah, Iowa.
95. Shenandoah Nurseries, Shenandoah, Iowa.
96. B. W. Stone, Thomasville, Ga.
97. The Jefferson Nursery Co., Monticello, Fla.
98. J. W. Adams & Co., Springfield, Mass.

99. C. Forkert, Ocean Springs, Miss.
100. Southern Floral Nursery Co., Bucatunna, Miss.
101. Peachwood Nurseries, A. C. Coles State Line, Miss.
102. Ramsey Pecan Co., Ocean Springs, Miss.
103. Columbia Nurseries, P. B. Simmons, Gainesville, Ga.
104. Toomsuba Nurseries, Toomsuba, Miss.
105. Rood Pecan Groves, C. M. Rood, Albany, Ga.
106. Southern Nut Tree Nursery, C. A. Rouzer, Thomasville, Ga.
107. Stafford & Howard, Barnesville, Ga.
108. J. Henry Walker Griffin, Ga.
109. Alvin Japanese Nursery, S. Ari, Alvin, Texas.
110. F. W. Meneray, Crescent Nursery Co., Council Bluffs, Ia.
111. Winter Haven Nurseries, A. M. Klemm, Winter Haven, Fla.
112. Gainesville Nurseries, H. S. Graves, Gainesville, Fla.
113. The Kilian Nurseries, Newton, N. C.
114. Vadesian Nurseries, Bostic, N. C.
115. James A. Bear, Palatka, Fla.
116. Texas Nursery Co., Sherman, Tenas.
117. The Livingston Seed Co., Columbus, Ohio.

Respectfully submitted,

P. F. Williams,
Acting Horticulturist.

V.2.17

BULLETIN No. 149 FEBRUARY, 1910

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

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TESTS OF VARIETIES OF COTTON IN 1909

BY

J. F. DUGGAR, Director,

AND

E. F. CAUTHEN, Farm Supt. and Recorder.

Opelika, Ala.:
The Post Publishing Company,
1910

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J. C. PRICE .....Assistant in Horticulture

TESTS OF VARIETIES OF COTTON IN 1909.

BY

J. F. Duggar and E. F. Cauthen.

In 1909 thirty varieties of cotton were tested on plots on the Experiment Station Farm at Auburn. The cotton was left one plant in a hill in checks 3 1-2 by 3 1-2 feet. The fertilizer per acre consisted of 240 pounds acid phosphate, 120 pounds nitrate of soda and forty pounds of muriate of potash, making a total of 400 pounds.

The rather large yields (up to about 1 1-2 bales per acre) for this grade of naturally thin, gray, sandy land were attributable chiefly to plowing under with a disc plow early in April, 1909, a crop of crimson clover, which was then ten to eighteen inches high and beginning to bloom. Seed of crimson clover had been sown on this inoculated land September 9, 1908, and merely cultivated in between the rows of corn.

After making allowance for vacant hills, the varieties ranking highest in combined value of lint (at 14 cents) and seed (at $25.00 per ton) were the following: Cook, No. 206; Cook, No. 221; Dixie; Hardin; and Poulnot.

Cook, No. 206, and Cook, No. 221, are both strains of Cook Improved that have been bred up at the Alabama Experiment Station. In yields of lint per acre, (793 pounds and 736 pounds), and in total value of seed and lint per acre, ($125.58 and $117.36), and in per cent. of lint (40.6 and 39.1 per cent.), they show superiority to the parent variety and to the other varieties tested.

These two improved strains of Cook suffered severely from anthracnose, generally called boll rot; so did all strains of Cook, whether improved or not; also Brown, No. 1, Blue Ribbon and Hardin. All varieties were attacked by this disease, but to a smaller extent than those mentioned.

Varieties of cotton in 1909, ranked according to total value per acre of seed and lint.

VARIETY	Actual Yield per Acre. (Stand variable)		Percentage of lint.	Corrected to Uniform Stand.	
	Lint	Value per acre of lint at 14c. and of seed at $25 per ton		Lint per acre	Value per acre of lint at 14c. per pound and of seed at $25 per ton
	Lbs.		*Per ct.*	*Lbs.*	
Cook, No. 206	746.7	$117 73	40.6	793.5	$125 58
Cook, No. 221	687.9	109 29	39.1	736.1	117 36
Dixie	602.5	98 59	31.9	681.3	113 75
Hardin	693.2	110 22	38.8	693.5	110 96
Poulnot	602.6	96 69	37 1	666.6	107 35
Peterkin	654.9	104 68	37.8	658.1	105 63
Cleveland	634.5	102 77	35.4	643.1	104 65
Layton	661.2	104 83	39.4	659.1	103 85
Cook	607.9	97 43	37.3	629.0	101 26
Texas Bur	602.5	98 41	34.8	610.4	100 22
Brown, No. 1	597.2	95 87	37.4	606.1	97 72
Broadwell's Double Jointed	575.9	92 77	36.1	599.6	97 21
Georgia Best	586.5	94 37	36.6	591.5	95 60
Cook, No. 232	55[illegible].9	88 05	41.2	596.2	94 06
Toole	581.2	92 03	39.7	587.3	93 36
Truitt	575.9	94 61	33.1	565.2	93 35
Russell	522.6	86 89	31.4	556.5	93 13
Cook, No. 239	527.9	83 50	39.9	585.1	92 95
Blue Ribbon	521.5	85 37	31.6	541.5	90 54
Dillon	479.9	77 32	36.3	557.9	90 28
Gold Coin	533.2	85 50	37.2	545.4	87 78
Rowden	525.5	85 15	34.4	526.9	86 28
Strickland	485.2	79 22	32.6	514 0	85 20
Drake (Defiance)	474.6	77 97	36.2	506.1	83 59
Simpkins	511.9	82 79	35.7	512.7	83 33
King	474.5	76 77	35.6	502.4	81 69
Triumph	495.9	80 88	34.3	499.7	81 92
Allen Long Staple	469.2	78 62	30.4	485.8	82 00
Keenan	399.8	67 05	30.3	414.1	69 87
Trice	400.0	66 58	31.2	390.0	64 71

On account of the amount of anthracnose on the Station farm in 1909, and because the seed is believed to be one of the means of conveying this widely spread disease, the Station must decline to send out seed of these strains of Cook until further selection has been made for resistance to this disease.

Dixie, which ranked third in total value of products and fourth in yield of lint per acre, is a strain of wilt-resistant cotton developed by the U. S. Department of Agriculture.

In our variety tests in 1909, Dixie ranked third in value of products. The plant is compact and well supplied with fruit limbs, on which the bolls are borne close together. Its conspicuous merits are (1), its ability to thrive on land where most other varieties are killed by cotton wilt or black root, and (2), its productiveness, the results of scientific selection. The chief faults are lateness, small bolls and a low percentage of lint.

Hardin, which ranked fourth in corrected yield, is a small-bolled, semi-cluster variety. In none of the previous tests at Auburn has it shown conspicuous productiveness nor given nearly so high a percentage of lint, (38.8) as in 1909.

Poulnot is a semi-cluster variety, with medium to large bolls. It has usually ranked rather high in our variety tests. Its worst fault is its rather late maturity.

The other varieties that stood above the middle of the list in 1909 ranked, in value of total products per acre, in the following order: Peterkin (6th), Cleveland, Layton, Cook Improved, Texas Bur, Brown No. 1, Broadwell Double-jointed, Georgia Best, Cook No. 232 and Toole.

Fifteen other varieties ranked below all of those mentioned above. The ranking varieties in the last four variety tests at Auburn are as follows:

1905.	1906.	1908.	1909.
Toole	Cook	Dillon	Cook, No. 206
Cook Improved	Cleveland	Gold Coin	Cook, No. 221
Cleveland	Layton	Dixie	Dixie
Bancroft Herlong	Toole	Cook Improved	Hardin
Christopher	Poulnot	Hart	Poulnot

From this it appears that Cook was in the list of "five best" in each of three years; Toole, Cleveland and Poulnot, each occurred twice in the list of most productive varieties.

Each of the most productive varieties has some shortcoming. Cook is more susceptible than most varieties to

boll rot; Toole has small bolls; Cleveland readily drops the seed cotton from the burs; Dixie and Poulnot are late. Each grower can decide which of these faults he considers least objectionable, or whether, to avoid all of them, he will choose some good variety which, at this Station, has proved less productive,—for example, Triumph.

The earliest varieties grown in 1909 were Trice, Broadwell Double-jointed, Simpkins and King; the last two appeared to be practically identical.

A number of varieties additional to those mentioned in the table were grown for observation on areas too small to determine the yields per acre.

NUMBER OF DISEASED BOLLS.

Anthracnose of the bolls, generally called boll rot, was so prevalent on the Station farm in 1909 that an unusual opportunity was offered to test the relative susceptibility of different varieties to this disease. The figures in the following table are based on counts made in winter of the total number of burs and of the number of bolls that had been so injured as to cause the loss of one or more locks. Diseased bolls as here reported consisted chiefly of those injured by anthracnose, but the figures include also smaller losses due to another disease. They also doubtless include a small number of bolls damaged by boll worms.

Percentage of diseased bolls; varieties arranged in order of freedom from diseased bolls.

Varieties.	*Per cent.*
Rowden	5
Cleveland	5
Dixie	5
Simpkins	5
Strickland	6
Trice	6
Drake Defiance	7
Truitt	7
King	7

Cook, No. 206 8
Broadwell Double-jointed 8
Blue Ribbon 8
Gold Coin 8
Texas Burr 9
Poulnot 9
Peterkin 9
Triumph 9
Toole 9
Russell 10
Dillon 11
Allen Long Staple 11
Layton 11
Keenan 11
Georgia Best 15
Hardin 17
Cook Improved 23
Cook, No. 221 28
Cook, No. 239 33
Brown, No. 1 33
Cook, No. 232 35

ADDRESSES OF GROWERS.

The Experiment Station has no seed for distribution. The seed used in the variety test was secured from the following parties:

Cook Improved—J. R. Cook, Ellaville, Ga.

Cook, Nos. 206, 221, 232, and 239—Alabama Experiment Station, Auburn, Ala.

Brown No. 1—M. L. Brown, Decatur, Ga.

Hardin—W. P. Letson, Glen Allen, Ala.

Dillon—U. S. Department of Agriculture, Washington, D. C.

Dixie—U. S. Department of Agriculture, Washington, D. C.

Keenan—U. S. Department of Agriculture, Washington, D. C.

Poulnot—J. E. Bradberry, Athens, Ga.

Drake's Defiance—J. C. McAuliffe, Harlem, Ga.

Broadwell Double-jointed—J. B. Broadwell, Alpharetta, Ga.

Blue Ribbon—South Carolina Experiment Station, Clemson College, S. C.

Allen Long Staple—Amzi Godden Co., Birmingham, Ala.

Layton Improved—R. D. Layton, St. Mathews, S. C.

Gold Coin—Excelsior Seed Farm, Bennettsville, S. C.

Peterkin—J. A. Peterkin, Fort Motte, S. C.

Cleveland—Alabama Experiment Station, Auburn, Ala.

Rowden—Ben Crawford, Blake, Okla.

Texas Bur—R. D. Tatum, Palmetto, Ga.

Strickland—J. R. Strickland, Pleasant Grove, Ala.

Triumph—Wade Brothers, Alexander City, Ala., and Chas. L.Gay, Montgomery, Ala.

Georgia Best—G. W. Stone, Oxford, Ga.

Russell,—A. M. Troyer, Calhoun, Ala.

King—J. W. Mitchell, Youngsville, N. C.

Simpkins—W. A. Simpkins, Raleigh, N. C.

Trice—W. N. McFadden, Warren, Tenn.

Toole—W. F. Covington, Headland, Ala.

Truitt—G. W. Truitt, LaGrange, Ga.

BULLETIN No. 150 JUNE, 1910

ALABAMA

Agricultural Experiment Station

OF THE

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RAISING BEEF CATTLE IN ALABAMA

BY

DAN T. GRAY,

Professor of Animal Industry,

AND

W. F. WARD,

Junior Animal Husbandman, Bureau of Animal Industry.

Opelika, Ala.
Post Publishing Company
1910

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J. C. PRICE ..... Assistant in Horticulture
L. W. SHOOK ..... Assistant in Animal Industry
O. H. SELLERS ..... Stenographer

*In co-operative beef work with Bureau of Animal Industry.

Some Alabama grass steers. In Experimental work in summer 1909.

RAISING BEEF CATTLE IN ALABAMA

By Dan T. Gray and W. F. Ward.

INTRODUCTION.

The work of eradicating the "Texas-fever" tick is progressing satisfactorily in the South; every year new areas are freed from the tick, and with the progress of the work there comes an added interest in all kinds of cattle production. When the ticks in a county are exterminated, renewed interest begins to be immediately manifested in the beef cattle business, as the Southern farmers now realize that the "Texas-fever" tick has been practically the only drawback to the cattle business in the past. When the tick is finally exterminated no section of the United States will be as well suited to beef production as the South, because of its mild climate, long grazing season, and cheap lands.

At the present time the South produces but a small proportion of the meat that her people consume. In Alabama there are but 544,600 head of cattle other than milk animals; or, in other words, there are about 1.2 head of cattle in the State to each family. If no outside meats were

shipped into the State, the people would consume all of this beef in less than a year's time. There is a wide field open to the Southern farmer who wishes to produce beef.

There are many reasons why the Southern States should raise more beef cattle than are being raised at the present time. First, the South, under the present system of farming, has thousands of acres—and good ones, too—which are not being used at all. Statistics tell us that only about 40 per cent of the tillable or arable land of the South is being used. Sixty per cent of the land is lying idle and returns to the owner not a cent in wealth. All of the lands cannot be used as cotton lands, because, first, there are not enough people to work the lands in any such way, and second, many of these pauper acres are not suitable for cultivation. In fact, many acres that are now under cotton cultivation should be turned into permanent pastures and grazed with live stock. No state can become wealthy when only 40 per cent of the land capital is being used. The grocer, or the banker, or the hardware merchant, could not possibly make a profit on his business if he used only 40 per cent of his capital. And the farmer cannot hope to be successful in his operations until he begins to make use of at least a reasonable proportion of his capital. No farming business can be made successful when only $4,000 out of a possible $10,000 is being used.

Then again beef cattle should be more generally introduced because of the good they do in building up and maintaining soils. Under the present system of cotton farming the soils are becoming poorer and poorer. With the introduction of cattle the soil will begin to be built up. Director Thorne, of the Ohio Station, has been making tests with barnyard manure for several years, applying the manure upon a plat of ground upon which was running a three years' rotation of corn, wheat and clover. Eight tons of manure an acre were applied. The average yearly increase an acre, following the one application, was as follows:

Corn, 14.7 bushels at 70 cents a bushel	$10.29
Corn stover, 744 pounds at $6.00 a ton	2.23
Wheat, 8.36 bushels at $1 a bushel	8.36
Wheat straw, 897 pounds at $4 a ton	1.79
Clover hay, 686 pounds at $12 a ton	4.12
Total value 8 tons of manure	$26.79
Total value 1 ton of manure	3.35

He further states (Bul. 183, Ohio Experiment Station) that the value of farm manure can be materially increased by balancing the manure with the addition of a carrier of phosphorous. The farm manures are too high in nitrogen as compared with the other elements. By balancing stable manure, the value of 8 tons was increased $12.20 after deducting the cost of the material used for the balancing of the manure. This is $1.53 a ton, or when added to the $3.35 above, brings the total possible value of each ton of manure up to $4.88. During a feeding period of 100 days each steer will produce at least 1.5 tons of manure. This profit should be added to the feeding or direct profits. The Arkansas Station (Bul. 68) made a test to determine the value, to each succeeding crop, of growing peas in the corn, gathering the corn and then grazing both the peas and the stalks by the steers. The steers were being fed some cottonseed in addition to the grazing. As the result of this crop of peas and the grazing, the succeeding cotton crop was increased 626.5 pounds of seed cotton over the area where corn alone had been grown. A third lot was planted to corn, and the increase in corn, due to the pea crop and the grazing, was 14 bushels per acre.

A third reason why beef should be more generally produced in the South, is that there is a demand for it, and the demand should be met in order that the money may be kept at home. "During the year of 1907 there were about 15,151 home raised animals slaughtered in the city of Birmingham (this includes cattle, veal, hogs, sheep and kids), while there were 36,097 live Western animals brought into the city and slaughtered. In addition to all this, thousands

of pounds of cured meats were also retailed over the city." (Farmers' Bulletin No. ...) This money should be kept at home and added to the Southern wealth. Packing houses are now being built throughout the South, and good markets are assured for the beef animals which the farmer produces.

The fourth reason offered in favor of beef production is, that as our farmers learn the value of diversification in farming operations, there will be an increased amount of roughage, as corn, fodder, cowpea and clover hays, soy beans, etc., which, many times can be marketed more profitably through the beef animals than in any other way. The beef cattle serve as important machines for converting the surplus fodders into valuable barnyard manure, which gives to the growing crops not only the benefits of its fertilizing elements, but increases the mechanical condition of the soil by the addition of that important compound—humus. No animal can take the place of the beef steer in making use of the winter corn and cotton fields.

Beef cattle are peculiarly suited to fit into the farming operations of the South. The farms are large, and many acres are not being used because of the lack of sufficient labor. At present there is no better way to put the whole farm to work than by introducing beef cattle into the system of farming. They require but a small amount of labor in addition to that used upon the average cotton farm. The hog, while he deserves a prominent place upon almost every farm, cannot be made to use all of the large uncultivated areas on the farms, for he is not strictly a grazing animal. Many farmers who have the large uncultivated areas are not now sufficiently skilled in the handling of live stock to introduce sheep or dairy cattle, as the sheep and dairy business require more skill than the beef business. Then, too, the dairy business requires an increase in the amount of labor used upon the farm; and the labor item is one that many farmers are trying to reduce.

DETAILS OF THE TEST.

Object of the Work.

The primary object of this work was to learn what it would cost to raise a grade steer to the feed-lot period, under average Southern conditions. After this was determined, it was expected that suggestions could be made and plans offered by which beef animals could, in the future, be produced more cheaply than were the ones in this test.

In order to obtain definite information regarding beef

General view of cattle used in experiment.

production in the South, which would enable them to logically outline work for the future, the Alabama Experiment Station, and the Bureau of Animal Industry of the United States Department of Agriculture, jointly undertook a co-operative experiment with a large stock farmer in the Tennessee valley.

Cattle Used.

The animals used in the work were a herd of grade Aberdeen-Angus cows, headed by two pure-bred Aberdeen-Angus

bulls. Mr. J. S. Kernachan, of Florence, Alabama, the farmer with whom the work was conducted, began in 1900 the work of grading up some Holstein and scrub cows by the use of pure-bred Aberdeen-Angus bulls. The Holstein cows had been used for dairy purposes. The scrub cows were bought from some of the neighboring farmers. The scrub and Holstein mothers were not included in the experimental work. Their grade offspring were used. The experimental herd, at the beginning of the test in 1906, consisted of the following animals:

Cows (that had dropped calves) 15
Two year old heifers (18 to 30 months) ...13
Yearling heifers (12 to 18 months) 12
Heifer calves (recently born) 14

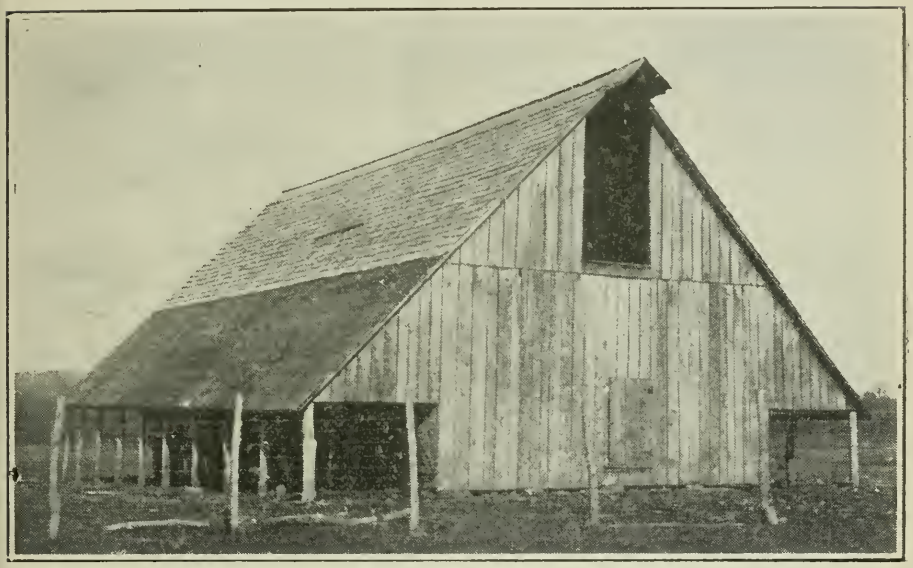
Three of the above cows were five years old; the others were less than five years of age. All of them were grade Angus. Some of the young ones were three-fourths pure, but the majority were but one-half pure. While Mr. Kernachan had some pure-bred Aberdeen-Angus cows upon his farm, they were not included in the test. No pure-bred animals except the bulls were used.

Management of the Herd.

During the summer months the herd grazed upon a good pasture; no feed was given in addition to the pasture. This pasture was made up principally of white clover, bermuda and lespedeza. This afforded the animals abundant pasture for about seven months of the year. During the winter months all of the cattle, young and old, had the run of the range. This range, which was inclosed, consisted of the old corn and cotton fields, with some cane along the river and creek banks. In addition to the winter range, hay and cottonseed were fed (See statement later for the winter feeds). The cattle were not made to go through the winter on range alone, so when spring came they were in reasonably good flesh. It might have been profitable to

have kept all the animals gaining throughout the winter months; as to this the authors cannot say since this test does not cover that point. The young stuff did make gains during each winter, but the cows and older animals usually lost in weight during the latter part of the winter.

The shelter was of such a nature that none of the animals suffered from the cold. During the mild winter weather the canebrake afforded ample protection from the cold. During severe storms or continued wet spells the cattle barn was used.



The barn used to store hay and shelter cattle. Note the open sheds on each side. 50 x 70 *feet.*

During the first year of the test the bulls were not allowed to run with the cows. The males were kept in a pasture separate from the cows and the cows brought there to be bred. It was learned, however, that many of the cows went through the year without bringing calves, as the other farm work prevented the owner from keeping in close touch with the cows. During the second year's work the bulls were allowed to run with the cows; thereupon the per cent

of calves born during the first quarter of the year increased very materially over what it was when the bulls were kept in a pasture to themselves.

No effort was made to completely eradicate the ticks. When the cattle became badly infested with ticks they were greased on the parts of the body where the ticks were most numerous.

How Data was Collected.

The farm was visited at least every three months by a representative from either the Bureau or the Station, and data secured about the births, deaths, weights, feeds used, etc. Each animal was numbered by means of a metal tag in the ear so that individual records could be secured. Soon after a calf was born it was tagged and weighed. All feeds were weighed or measured out to the animals. Vast amounts of manure were produced, but no account was kept of it, as most of it was dropped out in the fields and pastures. During the winter months some manure was collected around the barns and lots; this was all hauled onto the cultivated fields.

Price of Feeds.

Local conditions determine, to a large extent, the price of feeds. Any prices that the authors might assume would not meet all conditions, but the following prices have been taken as a basis upon which to rest the financial estimates:

Mixed hay	$ 6.00 a ton
Cottonseed	14.00 a ton
Green sorghum	1.50 a ton
Pasture	2.50 an acre for season

The hay, which consisted of a mixture of sorghum, crab grass, Johnson grass and cowpeas, was not of good quality, so a rather low farm price was placed upon it. Six dollars a ton was all it was worth. The green sorghum was used one fall (1906) for several days to supplement a short pas-

ture which was rendered short on account of an extreme drouth, and an early frost. The sorghum was cut and immediately thrown to the cattle. No price was placed upon the winter range. One hundred sheep, and about thirty horses and mules used the winter range in common with the cattle.

Weights and Gains.

Table I. *Average Weights and Gains of Cattle for Two Years*

CLASS	No. of animals	Average final weight	Summer gains		Winter gains		Summer and winter gains	
			Average total gain per head for summer	Average daily gain	Average total gain per head for winter	Average daily gains	Total gain	Daily gain
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1 12 months	44	402	224	1.24	52	.29	276	.77
12-24 "	42	645	219	1.22	—16	—.089	203	.564
24-30 "	30	773	196	1.09	— 25	—.14	170	.472
24-33 "	18	832	170	.95	—35	—.19	136	.40
Cows*.			116	.65	—104	—.58	12	.034

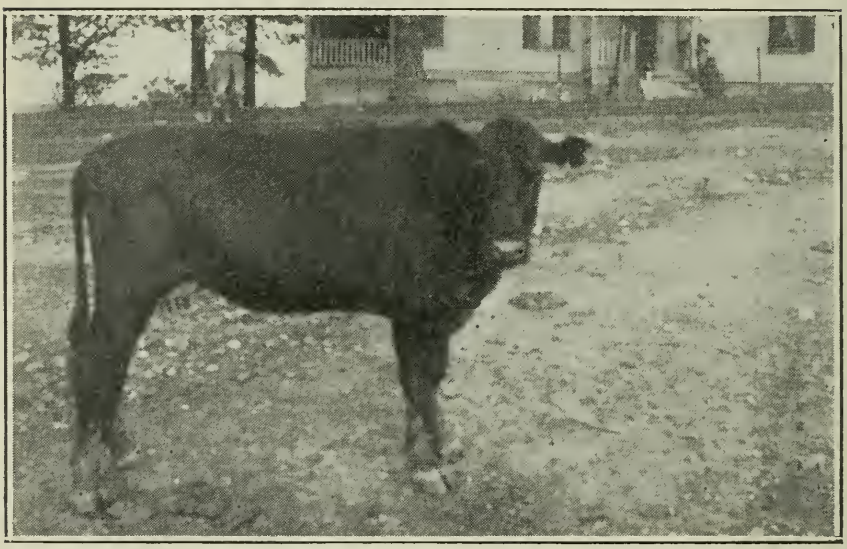
*Number of cows varied from time to time.

From the above table (Table 1) we see that at twelve months of age the calves averaged 402 pounds in weight, while the 24 months old steer averaged 645 pounds, the 30 months old steers averaged 773 pounds, and the animals which were 33 months old weighed 832 pounds. These were light weights, which were due, in part at least, to the fact that the animals had ticks on them during the summer months.

During the summer the gains were heaviest with the calves, each one making a gain of 224 pounds from April 15th to October 15th, or a daily gain of 1.24 pounds. Each yearling made a gain of 219 pounds, or a daily gain of 1.22 pounds during the six months of summer. During the third period (24-30 months) a daily gain of 1.08 pounds was made, while in the fourth period (24-33 months) a daily gain of only .95 pounds per head was made. The cows

gained .65 of a pound per head per day, or a total gain of 116 pounds each during the summer.

During the winter months (October 15th-April 15th) each calf made a total gain of 52 pounds or a daily gain of .29 of a pound. The yearlings lost 16 pounds each in weight for the winter, the animals ranging from 24 to 30 months old lost 25 pounds each, and those which came in the fourth class (24-33 months) lost 35 pounds each for the same period. The cows lost 104 pounds each; this was largely due to the fact that many of them dropped calves during the winter time.



An average cow of the herd. Does not show compactness and sufficient depth of body for an ideal beef cow.

An average of the whole year shows that the calves made a daily gain of .77 pounds or a total gain of 276 pounds per head. The yearlings made a daily gain of .564 pounds per head, or a total of 203 pounds for the 12 months. A gain of 170 pounds per head, or a daily gain of .47 of a pound, was made by the cattle while they were increasing from 24 months to 30 months in age, while 136 pounds or .4 of a pound per head per day, was made by the ani-

mals while they were increasing in age from 24 to 33 months. The cows gained only 12 pounds for the year, showing that they were practically mature when they first dropped calves.

In short, the above table shows that, under the conditions of this experiment the daily gains were smaller as the animals increased in age. This was true in both the summer and winter work.

The gains were not as large as they should have been, due partly to the extremely dry weather from June to July 20, 1906, when the grass in the pastures became perfectly dry, and partly to the fact that one of the pastures used in 1907, was so wet in the early spring, that the grass did not grow satisfactorily during the whole summer. The fact has already been mentioned that the animals were also infested with the Texas tick.

Cost of Gains.

The cost of gains during the summer was based upon a rental of $2.50 per acre for all land used for pasture; calves under one year of age were charged one-half price. When the cost of keeping the dam was not charged against the calves, they made 100 pounds at a cost of 63 cents, but when the expense of the dam, as well as the pasture of the calf were charged against the calf, the cost of 100 pounds of gain was raised to $1.88. The cost of keeping the dam is the expense of keeping 1.39 cows, as only one calf was produced to every 1.39 cows. (See table 4). The yearlings made 100 pounds of gain during the summer at a cost of $1.28, the two and a half year old steers (24-30 months) at a cost of $1.43, and the gains of the steers in the fourth class (24-33 months) were made at a cost of $1.65 per 100 pounds.

TABLE 2. *Average Cost of Summer and Winter Gains.*

CLASS	Summer			Winter			Whole Year		
	Pounds gain	Cost of pasture	Cost of 100 pounds gain	Pounds gain	Cost of feed	Cost of 100 pounds gain	Pounds gain	Cost of pasture and feed	Cost of 100 pounds gain
Calves* 1–12 months	224	$1 40	$0.625	52	.....	.....	276	$1 40	$ 0 51
Calves** 1–12 months	224	4 20	1 88	52	$4 90	$9 42	276	9 10	3 30
Yearlings 12–24 months	219	2 80	1 28	—16	4 90	.....	203	7 70	3 79
2-yr. olds 24–30 months	195	2 80	1 43	—25	4 90	.....	170	7 70	4 53
2-yr. olds 24–33 months	170	2 80	1 65	—35	4 90	.....	136	7 70	5 66
Cows all ages	116	2 80	2 41	—104	4 90	.....	12	7 70	64 18

*Keep of dam not charged. **Keep of dam charged.

Feeds charged as follows: Cottonseed at $14.00 per ton; green sorghum at $1.50 per ton; mixed hay at $6.00 per ton; pasture charged at $2.50 per acre for season.

In the winter all cattle had access to the corn, cotton and pea-stubble fields of the plantation, and were fed some hay and a small amount of cottonseed to keep them in a reasonable condition of flesh. The average cost of wintering those animals that were more than twelve months of age was $4.90 per head (See table 3).

When the cost of wintering the dam was charged against the calf, the cost of 100 pounds of gain was $9.42. As all the other animals lost some in weight during this period, the cost of gain could not be determined.

The last column of Table 2 shows that when the cost of keeping the dam was not charged against the calf, 100 pounds of gain for the whole year cost 51 cents, but when the dam's yearly expense, as well as the pasture of the calf, were charged against the calf, the total cost to make 100 pounds of gain was $3.30. The cost of keeping an animal

from the time he was 12 months until he was 24 months old was $7.70; the amount of gain was 203 pounds, thus making 100 pounds of gain cost $3.79.

The two year old animals (24-30 months) gained 170 pounds at a cost of $7.70, or at a rate of $4.53 per 100 pounds for the year. The cost of gain on the long two year old cattle (24-33 months) was $5.66 per 100 pounds.

The last column of the table points out the fact that, as the animal advanced from the calf period to maturity, the cost of 100 pounds of gain increased, and all other conditions being equal, the younger the animal the cheaper were the gains.

Wintering Cattle.

Table 3, shows the total amount of feed consumed, the total cost to winter the whole herd, and the average cost to winter each animal for three consecutive winters.

Table 3. *Cost of Wintering Cattle**

YEAR	No. of cattle	Pounds of cotton seed consumed	Cost of cotton seed	Pounds of green sorghum consumed	Cost of sorghum	Pounds of hay consumed	Cost of hay	Total cost	Average cost per head
1905-'6..	45	27000	$189 00	.....	.....	35600	$106 80	$295 80	$6 57
1906-'7	65	12000	84 00	22000	$16 50	39600	118 80	219 30	3 37
1907-'8..	59	3132	21 92	.....	.....	86443	259 32	281 24	4 77
Average	....	14044	98 31	7333	5 50	53881	161 64	265 45	4 90

*Only animals above one year old were counted. The feed that the calves ate was charged against those animals which were more than one year old.

During the winter of 1905-'6 the herd consumed 27,000 pounds of cottonseed and 35,600 pounds of hay. That is, each animal that was more than 12 months old, consumed 600 pounds of cottonseed and 791 pounds of hay for the whole winter. The winter of 1905-'6 was a hard one on the cattle, as it was very wet and rainy. The winter range was not as good as usual, hence the large amount of feed consumed.

With cottonseed charged at $14.00 a ton, and hay at $6.00 a ton, each animal that was over twelve months old, con-

sumed $6.57 worth of feed. The cattle, as a herd, came through the winter in good condition.

The winter of 1906-'7 was very mild and the cattle did not eat as much feed per head as they ate the previous winter.

There were two very heavy frosts on the nights of October 13th and 14th, however, which killed all the lespedeza, so the cattle had to be fed some green sorghum from the middle of October until the fields became available as winter range.

Each animal consumed, during the whole winter, 338 pounds of green sorghum, 185 pounds of cottonseed, and 610 pounds of hay. The cost of wintering each animal above twelve months old was $3.37.

From October 15th to December 1st, of the winter 1907-'8, the cattle were fed hay and a small amount of cottonseed, as there was no green sorghum to be used. During this time they consumed 11 pounds of hay and 1.2 pounds of cottonseed per head per day. From December 1st to January 1st they were in the fields and canebrake and did not come up for feed. From January 1st to March 20th, 1908, the cattle came up to the barn each evening and were fed hay, but no grain.

For the whole winter each animal consumed 53 pounds of cottonseed and 1,465 pounds of hay. The cost of wintering the cattle was $4.77 per head.

The average for the three winters shows that it cost $4.90 to winter each animal over twelve months of age.

Area of Pasture Required per Animal.

A number of cattle, not in the experiment, were grazed in the pasture with the experimental cattle. Assuming that two calves would eat as much grass as an animal over twelve months old (and this assumption is followed out in rental charges), there would be the equivalent of 92 animals on 103 acres of land during the summer of 1906, or an average of 1.12 acres of pasture to each animal.

During the year of 1907 there were 90 animals on the 103 acres, giving an average of 1.14 acres to each animal. An average for the two years shows that 1.13 acres of land furnished pasture for one animal. This area, when charged at $2.50 per acre, gives a cost of $2.80 per season for the pasture of each animal over twelve months old.

This pasture was far better than the average Alabama pasture, as is shown by the fact that 1.13 acres supplied sufficient pasture for one animal. On an average, from 3 1-2 to 5 1-2 acres are required for each animal. When this piece of land was first put down to pasture it would not to keep as many animals as it does now; in fact, it was no better than the average pasture but by grazing, it has been raised to its present state of fertility.

Breeding Record.

Table 4. *The Per Cent of Calves Born.*

YEAR	No. of cows	No. of calves dropped	Per cent. of calves dropped	Record by quarters; number of calves dropped			
				Jan. 15 to April 15	April 15 to July 15	July 15 to Oct. 15	Oct. 15 to Jan. 15
1906..	24	17	70.8	5	4	5	3
1907.....	25	18	72	9	1	5	3
1908.....	25	14	56	14	..*	..	..

*The experiment closed on April 15th, so no record was obtained later than this date.

An animal that had dropped a calf was classified as a cow; the heifers were put in this class as soon as they calved. The number of calves born was very small, when compared to the number of cows that should have brought calves, especially during the year 1906. This low number was partly due, no doubt, to the fact that the bulls were kept away from the cows and the owner, owing to the pressure of other business, not being able to breed the cows when they should have been bred. The owner soon realized

the fact that too many of the cows went through the year without bringing calves, so in the spring of 1907 he turned the bulls with the cows and permitted them to run together the year round.

A complete record of the number of calves dropped was not secured for the year 1908—the year after the bulls were turned with the cows—as the test closed in April; but during the first quarter of the year 1908, fourteen calves were born, while during the same quarter of the years 1906 and 1907 only 5 and 9 calves, respectively, were born. No record was kept of the number of calves dropped after April, 1908, but when the last notes and weights were made it was seen that practically all of the cows were pregnant. Of course, it is a disputed point whether it is better to allow the bull to be with the cows or to keep him away from them all of the time. The farmer who has large pastures and has other business to look after, in addition to the cattle, cannot possibly obtain a high per cent of calves unless the bull is permitted to be with the cows. The busy farmer will not see the cows at the right time.

The breeder of registered animals should not allow the bull to run with the cows, for it is desirable that a record of the date of service be kept.

It is important that as many of the cows as possible produce calves each year; the idle cow is not only idle capital but she is a constant consumer of farm products. The idle cow has a very important part to play in the total expense of raising a calf, as the expense of keeping her must be charged against the calves which other cows produce (See financial statement, table 5-A). When there were 25 cows the owner had $750 invested in cattle (estimating each cow to be worth $30); of this amount only $540 was returning a profit when 72 per cent of the cows brought calves. In this case there were $210 invested in idle capital; this amount represents the equivalent of seven cows, and those seven cows consumed $51.80 worth of feed in a year.

FINANCIAL STATEMENTS.

Feed Expense to Raise a Beef Animal to Various Ages.

As a rule the farmer charges nothing against the cost of raising a calf but the feeds consumed. Looking at it from this standpoint the cost of raising a calf in this experiment, to various ages was as follows:

A. To 12 months:	
To winter feed of 1.39 cows the first winter	$ 6.81
To summer pasture, of 1.39 cows	3.89
To summer pasture of 1 calf	1.40
Total cost	$12.10
Cost per hundred weight	3.01
B. To 24 months:	
To cost of 12 months old calf	$12.10
To winter feed of animal (12-24 months)*	4.90
To summer pasture (12-24 months)	2.80
Total cost	$19.80
Cost per hundred weight	3.07
C. To 30 months:	
To cost of 24 months old steer	$19.80
To winter feed of animal (24-30 months)*	4.90
Total cost	$24.70
Cost per hundred weight	3.20
D. To 33 months:	
To cost of 30 months old steer	$24.70
To summer pasture for one-half summer	1.40
Total cost	$26.10
Cost per hundred weight	3.14

*Here again it is assumed that all animals over twelve months of age ate the same amount of feed, which assumption is, of course, not absolutely accurate. In rental practice, though, this assumption is carried out.

It should be remembered that the different classes of animals were not kept separate and fed in different lots; they all ran together, so the above statement is only a close approximation of the cost of raising the animals to the various ages. In the above statement it has been assumed that all animals which were over twelve months of age ate the same amount of feed and pasture; it was further assumed that the animal under twelve months of age used only one-half as much pasture as the animal which was over one year old. The last assumption is in keeping

A good cow of the herd. She dropped a calf every year.

with actual farm charges for pasture. It should be remembered that the cost to winter an animal was secured by dividing the total number of animals over one year old into the total cost of feed consumed during the winter months.

When placing the value upon the feeds, as shown on page 2, it cost $12.10 to raise a twelve months old calf, $19.80 if he was kept until he was twenty-four months of age, $24.70 to raise him to two and one-half years old, and

$26.10 to keep him until he was thirty-three months old. Or, it cost about three cents a pound to grow the animal to various ages, when nothing but the feed and pasture was charged against him.

This feed bill could be materially reduced by extending the pasture grazing season. The pasture season could be extended three months, almost anywhere in the South, by the use of "spotted" burr clover (Medicago maculata). Burr clover is a winter growing crop and occupies the ground in common with bermuda, which makes its growth during the summer months.

Feed Expense, Interest, Insurance, etc., to Produce a Beef Calf.

In estimating the cost of producing a beef animal, it is usual to charge nothing against the animal but the winter feed and the pasture used. But there are other items that should be charged against this animal, as interest on the money invested in the cattle, mortality, depreciation in value of the cows, etc. He should be credited with the manure produced. The following estimates charge the calf not only with the feeds used, but the other items mentioned above, and gives him credit for the approximate amount of manure produced:

A. To 12 months old:

To winter feed of 1.39 cows	$ 6.81
To summer pasture of 1.39 cows	3.89
To summer pasture of calf	1.40
To 7 per cent interest on 1.39 cows at $30 per head	2.92
To 7 per cent interest on 1-25 of a bull worth $150	.42
To annual depreciation in value of 1.39 cows at $1.50	2.09
To pro rata depreciation of herd bull	.80
To taxes, insurance, fencing and repairs	.86
To 4 per cent mortality	1.20
	$20.39

*By 3,600 pounds of calf manure at $1.25 a ton ..	$ 2.25
By 10,800 pounds of mother's manure at $1.25 a ton	6.75
Total expense of calf	$11.39
Cost per hundred weight	2.85

B. To 24 months old:

To cost at 12 months of age (manure not included)	$20.39
To winter feed	4.90
To summer pasture	2.80
To 7 per cent interest on yearling	1.45
To taxes, insurance, repairs, etc.	.86
To 4 per cent mortality	.83
	$31.23
By 23,400 pounds of manure for 24 mos. at $1.25 a ton,	14.63
Total expense of steer	$16.60
Cost per hundred weight	2.57

C. To 30 months old:

To cost at 24 months of age(manure not included)	$31.23
To winter feed	4.90
To 7 per cent interest on 2 year old animal for 6 mos.	1.10
To taxes, insurance, repairs, etc., for 6 months	.43
To 4 per cent mortality of 2 yr. old animals for 6 mos.	.63
	$38.29
By 28,800 pounds of manure for 30 mos. at $1.25 a ton,	18.00
Total expense of steer	$20.29
Cost per hundred weight	2.62

D. To 33 months old:

To cost at 24 months old (manure not included)	$31.23
To winter feed	4.90
To 3 months pasture	1.40
To 7 per cent interest on 2 yr. old animal for 9 mos.	1.65
To taxes, insurance, repairs, etc., for 9 months	.64
To 4 per cent mortality for 9 months	.94
	$40.76
By 31,500 pounds of manure for 33 mos. at $1.25 a ton,	19.69
Total cost per steer	$21.07
Cost per hundred weight	2.53

*In estimating the amount of manure produced it was assumed that the animal under one year of age produced 20 pounds per day for 180 days; that the yearling produced 25 pounds per day for a year; and that the two year old steer and the cow each produced 30 pounds per day. The price of manure, $1.25 a ton, is an assumed one, as there was no way to determine its exact value. But, judging from the many tests that have been made at Stations, the above value is a very conservative one. For instance, as quoted in the introduction, the Ohio experiments show raw manure to be worth $3.35 a ton when placed under the crops mentioned; when the manure was treated with a phosphorous carrier, its value was raised to $4.88 a ton. There was a difference, though, between the Ohio manure and the manure secured in the above tests; the Ohio manure was collected in the winter time when grains and hays were fed. It was a richer manure than that made during the summer months in this test, but probably no richer than the Alabama manures made during the winter months.

It is seen that when a calf is charged with everything that could be charged against him, and then credited with the manure produced, the cost of making 100 pounds of gain was somewhat smaller than the figures obtained when nothing but the feed and pasture were taken into consideration.

The labor employed to feed and look after the animals was not included in the above estimates, as it was a very small item. One winter the labor to feed and care for the cattle was $10.00 for the whole herd. Another winter the total labor item was only $7.50. The method used in the feeding and handling involved the use of but little labor; there was no feeding to be done but once a day, when the cottonseed and the hay were measured out to the cattle in a very few minutes.

When all of the expenses were charged against the animals and no credit was made for the manure, the expense of producing a steer varied from $4.84 to $5.07 per hundred pounds. The cost per hundred weight of raising a steer, when the manure produced received no credit, was as follows:

To 12 months of age	$5.07 per hundred weight
To 24 months of age	4.84 per hundred weight
To 30 months of age	4.95 per hundred weight
To 33 months of age	4.90 per hundred weight

These figures mean that if the above animals were sold for the above prices (The above prices can be realized for good cattle, as is shown by the fact that 60 steers, of about the same quality as those in this test, were fed by the Alabama Experiment Station and the Bureau of Animal Industry and sold February 28th, 1910, on the Louisville market for $5.75 per hundred weight) the feeds used were marketed at a good farm price; all deaths were deducted; seven per cent interest was received on the money invested in the animals; $2.50 an acre were secured for the summer pasture; and finally the manure was secured free.

Of course, in order that all these profits be realized, good cattle must be raised; it cannot be done with scrubs; the

scrub will not sell to advantage when he is offered to the butcher or packer, as his meat is of a poor quality and he dresses out a low per cent of salable meat.

The cattle upon this farm were not produced as cheaply as it is possible to raise them in the South. At least two farm practices can be introduced upon the average farm which will make it possible for steers to be raised much cheaper than were these animals. In this test no winter pastures were used, except the winter range. Through the use of a combination of burr clover and bermuda the pasture season can be extended at least two months in the year. The farmer who lives as far south as Greenville, Alabama, can have a grazing pasture the year through by the use of bermuda, burr clover and velvet beans. In the second place, the cattle were infested with the Texas tick, which reduced their average size no small amount. It is impossible to state just how much the tick retards the growth of a steer, but there were several severe cases of tick fever reported. Some of these cases died, and some of them lived, but when they did live they never attained anything near their normal size. Through the efforts of both the Southern States and the Federal Government the tick is now being exterminated; when the tick is eliminated, the farmer can expect to raise larger cattle than formerly, and, too, the death rate will be materially decreased.

BULLETIN No. 151 JUNE, 1910

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

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1. Wintering Steers in Alabama.
2. Fattening Cattle on Pasture in Alabama.

BY

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Professor of Animal Industry,

and

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*In co-operative beef work with Bureau of Animal Industry.

SUMMARY.

Part 1.

1. The cattle used in all of these tests were practically mature ones.

2. Winter rations used:

	1907-'08.	1908-'09.
Lot 1....	Range alone.	Range alone.
Lot 2....	Range plus half ration cottonseed meal and hulls.	Range plus half ration cottonseed meal and hulls.
Lot 3....	Range plus half ration peavine hay.	Range plus half ration cottonseed.
Lot 4....		Range plus half ration cheap hay.

3. In 1907-'08 each range steer (Lot 1) lost 97 pounds in weight. In 1908-'09 each range steer (Lot 1) lost 106 pounds in weight.

4. In 1907-'08 each steer in Lot 2 received 2.35 pounds of cottonseed meal and 8.5 pounds of hulls each day in addition to the range. During the winter of 1908-'09 each steer in Lot 2 received 2.41 pounds of cottonseed meal and 8.71 pounds of hulls daily. The first year each steer lost 6 pounds in weight; the second year each steer gained 3 pounds in weight.

5. In 1907-'08 each steer in Lot 3 was fed a daily ration of 8.5 pounds of good peavine hay in addition to the range; the loss in weight per steer for the winter was 9 pounds.

6. In 1908-'09 cottonseed was tried as a supplement to the range, 4.71 pounds being fed to each steer daily. The loss in weight per steer for the winter was 40 pounds.

7. In 1908-'09 cheap hay was used in Lot 4 to supplement the range, 11.8 pounds being fed to each steer daily. The winter loss per steer was 40 pounds.

8. The total cost to winter each steer in 1907-'08 was $4.70 and $3.57 in Lots 2 and 3 respectively. The total cost to winter each steer in 1908-'09 was $5.63, $3.23 and $2.06 in Lots 2, 3 and 4 respectively.

9. In 1907-'08 the fall buying price was $2.50 per hun-

dred weight. When the expense of wintering the steers was added to the fall price the spring prices were found to be $2.89, $3.17 and $3.03 per hundred weight in Lots 1, 2 and 3 respectively.

10. In 1908-'09 the fall buying price was $2.56 per hundred weight. When the expense of wintering the steers was added to the fall price, the spring prices were found to be $3.01, $3.34, $3.20 and $3.09 per hundred weight in Lots 1, 2, 3 and 4 respectively.

Part II.

1. The steers which were used in the above winter work were re-divided into lots and continued into the summer feeding work.

2. In 1908 the steers were fed for a period of 112 days on pasture. In 1909 they were fed for 154 days.

3. The summer rations were:

	1908.	1909.
Lot A	Pasture alone.	Pasture alone.
Lot B	Pasture plus cottonseed cake.	Pasture plus cottonseed cake.
Lot C	Pasture plus "Caddo" cake.	
Lot D	Pasture plus cottonseed cake.	
Lot E		Pasture plus cottonseed.

4. In 1908 the amount of feed used daily per steer, in addition to the pasture, was 3.31 pounds, 3.31 pounds and 2.76 pounds in Lots B, C and D respectively. In 1909 the daily amount of feed used per steer to supplement the pasture was 3.40 pounds and 4.49 pounds in Lots B and E respectively.

5. In 1908 the average daily gains were 1.51, 2.32, 1.84 and 1.62 pounds in Lots A, B, C and D respectively. In 1909 the average daily gains were 1.74, 1.88 and 2.06 pounds in Lots A, B and E respectively.

6. In 1908 the total cost to make one hundred pounds gain was $1.18, $2.56, $3.03 and $3.24 in Lots A, B, C and D respectively. In 1909 the total cost to make one hundred pounds of gain was $1.03, $3.21 and $2.39 in Lots A, B and E respectively.

7. In 1908 the net profits per steer were $2.86, $10.42, $6.62 and $0.43 in Lots A, B, C and D respectively. In 1909 the net profits per steer were $7.06, $6.99 and $8.39 in Lots A, B and E respectively.

8. In 1908 the steers dressed out (farm weights) 49.5 per cent, 53.8 per cent, 53.6 per cent and 52.7 per cent in Lots A, B, C and D respectively. In 1909 they dressed out (farm weights) 51.8 per cent, 54.2 per cent and 53.9 per cent in Lots A, B and E respectively.

9. These experiments are being continued at the present writing.

Some Alabama grass steers. In Experimental work in summer 1909.

1. Wintering Steers in Alabama.

2. Fattening Cattle on Pasture in Alabama.

By Dan T. Gray and W. F. Ward.

INTRODUCTION.

In Bulletin No. 150* are published the results of the information which was collected by the Alabama Experiment Station and the Bureau of Animal Industry at Washington in a three years' test to determine the cost of raising a beef calf. One point is brought out clearly in that work, namely, that if money is to be made upon beef operations, the steer must be properly finished for the market before he is offered for sale. If the steer is sold unfinished, the man who raised him is almost sure to lose money on the operation.

The question arises, then, How shall the steer, after he has been raised, or has reached the feed-lot period, be finished for the market to get the greatest possible profit out of him? The steer can be finished in one of two ways: he can be fattened during the winter months, or he can be

*Those interested in the subject of beef production can get the bulletin by writing to the Alabama Experiment Station at Auburn, or the Bureau of Animal Industry at Washington.

fattened during the summer months while the pastures are available. Since the co-operative beef work between the Alabama Experiment Station and the Bureau of Animal Industry began, some results have been published relative to winter fattening.** The present bulletin presents the results of two years' work in fattening cattle upon pasture during the summer months and selling the cattle at the end of the summer. It should be understood that this bulletin is only a report of the progress of the work, as the experiments are being continued.

DETAILS OF THE EXPERIMENTS.

Plan of the Work.

The cattle were bought in the fall, on account of the fact that they could be bought much cheaper in the fall than in the spring. In fact, they could hardly be bought at all in the spring. But they were not to be fattened until the following summer, so it became necessary to make a study of the cheapest and best methods of getting these mature steers through the winter months. So the work was divided into:

1. A study of methods of wintering mature steers,
2. Fattening these steers on pasture the following summer.

The cattle used in the winter's work were continued into the following summer's work.

Cattle Used.

The various pictures will show the kind of cattle which were used in these tests. Grade Aberdeen-Angus, Shorthorn, Hereford, and Red Polled were used. Many of them had a predominance of Jersey and scrub breeding. They were all bought of farmers in Sumter, Wilcox, Marengo, and neighboring counties, so they represented the average cattle of the western part of Alabama. They varied from two to four years in age. As will be seen later, the average weight at the beginning of the fall work was about 750 pounds each.

**See Bureau of Animal Industry Bulletin No. 103.

How the Work was Carried on.

Owing to the fact that pasture was not available upon the Experiment Station at Auburn, Alabama, the work was carried on upon the farms of Cobb and McMillian of Sumterville, Alabama, who kindly agreed to co-operate with the Alabama Experiment Station and Bureau of Animal Industry. The winter range and summer pastures were divided into lots suitable for the work. One of the authors of this bulletin, Mr. W. F. Ward, was stationed upon the farm and had personal supervision of all the experimental work.

At the end of each experiment the cattle were all shipped to the New Orleans market, where complete sale and slaughter records were secured.

Lot 1.—*End of winter* 1908. *Feed, range alone. Total winter gain of each steer,*—97 *pounds. Total cost to winter each steer,* (?).

The Winter Range.

The winter range consisted of the winter corn and cotton fields. The leaves had not been stripped from the corn stalks. Crab grass had grown up sufficiently between the rows of corn after the last cultivation, to be of some value to the cattle during the early weeks of the winter. No cane brakes were used. The cattle, except those in the range lots, were not given unlimited range; each lot was confined to a certain area. Of course, the man who has cane brakes

has an advantage in handling and feeding cattle in the winter time. Those animals which were confined in limited areas had about ten acres each upon which to graze. The outside cattle, or range lot, had an unlimited grazing area.

The winter range was available for use immediately after the cotton had all been picked.

Summer Pasture.

The summer pasture used in these experiments consisted of a mixture of sweet clover (Melilotus), Japan clover (Lespedeza), Johnson grass, crab grass, and some bermuda. The sweet clover became available for grazing about April 1, while the Japan clover was not ready until about June 15. In some sections of the country sweet clover is considered a pest, as stock will not eat it, but in the South, or at least in Alabama, all kinds of stock eat it with great relish: here they take to the sweet clover as readily as to alfalfa.

The pasture was divided into lots; the size of each lot depending upon the number of cattle grazed upon it, and as to whether the steers were to be fed a concentrated supplement or not. The object was to have an abundance of pasture for each bunch of cattle.

Method of Feeding and Handling the Cattle.

In both the winter and summer work the steers were fed but once a day. In the winter time movable feed troughs were placed out in the fields in which to feed the hulls, cottonseed meal and cottonseed, and movable hay racks were made in which to feed the hay. The racks and troughs were all made movable so that the manure would be distributed over the corn and cotton fields.

Movable feed troughs were also used during the summer feeding on pasture. No feeds were thrown upon the ground.

No shelter, except trees, was provided for the cattle in either the winter or summer time. They had no access to sheds. They did not suffer to any appreciable extent from the cold in the winter time or from the heat in the summer time. The summer pastures were well provided with good shade trees. When a summer shade is provided, cattle will

not suffer as much from heat in Alabama as they will in Illinois or Iowa.

While there were ticks in the pastures, the cattle were not permitted to become badly infested with them; a dipping vat was used to keep down heavy infestation. In the two years' work, during which time over 300 head of cattle were fattened, there were only four cases of Texas fever, and none of these cases was lost. In future work it is expected that the tick will be entirely eliminated.

The weight of each steer was secured at the beginning and end of each test. The total weight of each lot was secured every twenty-eight days.

When the steers were sold they had to be driven nine miles to a shipping point.

Lot 2.—*End of winter* 1908. *Feed, cottonseed hulls and cottonseed meal plus range. Total winter gain of each steer,* —6 *pounds. Total cost of wintering each steer,* $4.70.

Price of Feeds Used.

When the feeds were purchased upon the market, the market price plus the expense of hauling to the farm, was used in making up the financial statement. When the feed used was grown upon the farm an assumed market price was placed upon it. Local conditions determine to a large extent, the farm prices of feeds. Any prices that the authors might assume would not meet all conditions, but the following prices have been taken as a basis upon which to rest the financial estimates:

Cottonseed meal	$26.00 per ton
Cottonseed	14.00 per ton
"Caddo" cake	23.00 per ton
Cottonseed cake	25.00 per ton
Cottonseed hulls	6.00 per ton
Damaged hay	5.00 per ton
Cowpea hay	10.00 per ton
Pasture	.50 per month per steer

The above represents the prices of the purchased feeds laid down on the farm; the farm was fourteen miles from the railroad station. The cottonseed cake, which had been broken into nut size and sacked, was purchased from the Epes Cotton Oil Co. of Epes, Alabama. This cake can be purchased in the large cake size, just as it comes from the

Lot 3.—*End of winter* 1908. *Feed, peavine hay and range. Total winter gain of each steer,* —9 *pounds. Total cost of wintering each steer,* $3.57.

press, for about two dollars a ton cheaper than in the nut size. Some feeders find that it pays to break the cake on their own farms. The cake is the same thing as the cottonseed meal, except that it is not ground into a meal. There are several advantages in feeding cake in place of cottonseed meal—especially in summer feeding. A rain does not render the cake unpalatable; but it will often put the meal in such a condition that the cattle will not eat it. Again, no loss is incurred with the cake during windy days; cottonseed meal, when fed in the open pasture, is wasted on account of the winds. Furthermore the cake requires chewing before

being swallowed and therefore must be eaten very much slower than the meal, so when a number of steers are being fed together the greedy one has little chance to get enough cake to produce scours. In feeding cottonseed meal the greedy steer often scours on account of the fact that he can bolt the meal and get more than his share; this not only injures the steer but makes the bunch "feed out" unevenly.

The "Caddo" cake was purchased from the Caddo Cotton Oil Company of Shreveport, Louisiana. "Caddo" cake is the cake left after extracting the oil from the cottonseed by the cold process. That is, it is made up of both the cake and the hulls; or it consists of everything in the seed except the oil. These tests do not show it to be as valuable for feeding purposes as the ordinary cottonseed cake. The chemical, analysis of the "Caddo" cake fed, as reported by the State Chemist, Dr. B. B. Ross, of Auburn, was as follows:

Moisture	9.75 per cent.
Ash	4.70 per cent.
Fibre	21.18 per cent.
Protein	27.62 per cent.
Ether Extract (oil)	8.78 per cent.
Carbohydrates	27.97 per cent.

The mixed hay was a second or third class hay that could not be sold upon the market at all. It consisted of a mixture of Johnson grass, crab grass, and some alfalfa. The price placed upon it was all it was worth.

The cow pea hay was bright and of good quality.

PART I.

Wintering The Cattle.

As previously stated, the steers were bought in the fall of the year as they could then be secured cheaper than at any other date. In fact, in western Alabama where the work was done, the cattle could not be purchased in the spring at all. The object was to get these steers through the winter months as economically as possible and fatten them on pasture the following summer. Farmers are not agreed as to what is the best way to handle and feed mature steers during the winter months. Some farmers claim that the animals should be "roughed" through the winter upon a very small amount of feed in addition to the winter range; some hold that the range needs no supplementary feed at all; still others believe that the steer should be fed liberally so that he will be kept gaining all through the winter months.

The cattle used in the winter work were dehorned, tagged, and divided into lots (Three lots in the winter of 1907-'08, and four lots in the winter of 1908-'09) so that a study could be made of the amount of feed that should be fed during the winter time, and also to learn the value of some of the Southern feeds for carrying cattle through the cold months.

Gains during the Winter Months.

The winters of 1907-'08 and 1908-'09 were both mild ones. There was no weather cold enough to make the steers suffer, although, as before mentioned, there was no shelter at all, except a few trees. The following table shows the ration fed, total weights, and gains of each lot for the two winters:

TABLE 1. *Gains During Winter* 1907-'08—(84 *days.*)

Lot	No. of animals	RATION	Initial weight each steer Dec. 9	Final weight each steer March 3	Average total gain each steer	Average daily gain each steer
			Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
1	26	Range alone	722.	625.	—97.	—1 15
2	29	Range plus half ration cotton-seed meal and hulls	726.	720.	— 6.	— .07
3	24	Range plus half ration peavine hay	724.	715.	— 9.	— .11

Gains During Winter 1908-'09—(98 *days*).

			Dec. 4	Mch. 12		
1	25	Range alone	705.	599 0	-106.	-1.08
2	25	Range plus half ration cotton-seed meal and hulls	705.	708.	3.	.03
3	25	Range plus half ration cotton-seed	706.	666.	—40.	—.40
4*	25	Range plus half ration cheap hay	689.	649.	—40.	—.57

*This lot started in test January 1st, so fed only 70 days.

It was intended that the steers which received some feed in addition to the range should suffer no loss in weight during the winter months, but in some cases the loss was considerable during the latter part of the winter period when the range afforded very little grazing. The object was to give just enough feed, in addition to the range, to enable the cattle to hold their fall weight. No gains in live weight were desired. It should be remembered that these were all practically mature cattle, varying from two to four years in age.

During the first winter the experiment continued from December 9 to March 3, a period of 85 days. During this time the range cattle (Lot 1) lost 97 pounds each in live weight while the steers in Lots 2 and 3 practically held their fall weights. All of the cattle came through the winter in excellent health. While the cattle in the range

lot were thin at the end of the winter season, still they were in good condition for grazing; they evidently had not been weakened in any way. At the opening of the spring the steers in the peavine hay lot (Lot 3) seemed to be in better thrift than those in Lot 2, (the cottonseed meal and hulls lot), but they made practically the same gains in weight during the following summer. The hay used in 1907-'08 was of good quality.

During the winter of 1908-'09, the test continued from December 4th to March 12th—a period of 98 days. There were practically the same loses in live weight as the previous winter in Lots 1 and 2. In the range lot each steer lost 106

LOT 1.—*End of winter* 1909. *Feed, range alone. Total winter gain of each steer,* —106 *pounds. Total cost of wintering each steer,* (?).

pounds. The steers in Lots 3 and 4 lost rapidly in weight the last month of the test, due to the fact that the grazing on the range was not good at the end of the season; it was not intended that they should shrink in weight. Lot 4 was not started in the test until January 1, so the cattle in this lot were fed only seventy days. The hay used by Lot 4 was a very cheap hay; it was made up of a mixture of Johnson grass, crab grass, and some alfalfa, but had been damaged by rain to such an extent that it could not be sold at all.

Amount of Winter Feeds Used.

During the winter of 1907-'08 a comparson was made between feeding on the range alone and the same range when supplemented in one lot with a part ration of cottonseed meal and hulls, and in a third lot with a good quality of cow pea hay. The following winter (1908-'09) the same comparison was again made as regards Lots 1 and 2, while in a third lot cottonseed was used and in a fourth lot some damaged mixed hay was used to supplement the range.

Table 2. *Feeds used Winter* 1907-'08—(84 *days*).

Lot	No. of steers	RATION	Total amount consumed per steer		Daily amount feed consumed per steer	
			Concentrates	Roughage	Concentrates	Roughage
			Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
1	26	Range alone	None	None	None	No e
2	29	Range plus half ration cotton-seed meal and hulls	197	714	2.35	8.5
3	24	Range plus half ration cow pea hay	None	714	None	8.5

Feeds used Winter 1908-'09—(98 *days*).

1	25	Range alone	None	None	None	None
2	25	Range plus half ration cotton-seed meal and hulls	236	854	2.41	8.71
3	25	Range plus half ration cotton-seed	462	.....	4.71	.....
4*	25	Range plus mixed hay	.....	826	.....	11.8

*This lot was fed only 70 days—January 1st to March 12th.

There was no way to determine how much feed was secured from the range as far as pounds were concerned. Each steer had ten acres as winter range. The steers in Lot 1, the range lot, had to be turned out upon the general range each winter about a month before the end of the test, as their range of ten acres each had become exhausted

about thirty days earlier than was the case with those lots which were receiving supplementary feeds.

During the first winter each steer in Lot 2 consumed, in addition to the range, 197 pounds of cottonseed meal and 714 pounds of hulls, while each steer the second winter ate 236 pounds of cottonseed meal and 854 pounds of hulls. In 1908-'09 the animals were fed fourteen days longer than they were in the winter of 1907-'08. Each steer's daily ration was kept a little below 2.5 pounds of cottonseed meal and 8.5 to 8.71 pounds of hulls.

During the second winter the steers in Lot 3 were carried

LOT 2.—*End of winter* 1909. *Feed, cottonseed hulls and cottonseed meal plus range. Total winter gain of each steer,* 3 *pounds. Total cost of wintering each steer,* $5.63.

through the winter on cottonseed as a supplement to the range. It was learned that 4.71 pounds of cottonseed per steer per day was not quite sufficient to keep the animals from losing weight. Each steer lost 40 pounds in weight during the winter period of 98 days.

In the first winter's work it is seen that 8.5 pounds of good peavine hay, along with the range, afforded the steers sufficient daily feed to allow them to maintain a practically uniform weight. Or, when Lots 2 and 3 (1907-'08) are compared, it is seen that 714 pounds of cowpea hay were practically equal in feeding value to 197 pounds of cotton-

seed meal plus 714 pounds of cottonseed hulls. In other words, the cowpea hay was worth $13.02 per ton for wintering mature cattle compared with cottonseed meal and hulls, when the meal is valued at $26.00 a ton and the hulls at $6.00 a ton.

During the second winter (1908-'09) each steer in the cottonseed lot (Lot 3) lost about 42 pounds more in live weight than did the animals in the cottonseed meal and hulls lot (Lot 2); but still, when cottonseed is valued at $14.00 a ton it is probably cheaper than cottonseed meal and hulls for wintering steers.

The daily expense of feeding each steer on cottonseed meal and hulls was 5.7 cents, while the daily cost of the cottonseed per steer was only 3.3 cents. While not enough cottonseed was used to prevent loss in weight, still the amount fed daily to each steer (4.71 pounds) would probably not have to be increased very much to make the steers hold their fall weights. It would require 8.2 pounds of cottonseed, at $14.00 a ton, to cost as much as the 2.41 pounds of cottonseed meal plus the 8.71 pounds of hulls which were fed to each steer daily in Lot 2.

When this test was made cottonseed cost but $14.00 a ton. Since that time they have advanced about one hundred per cent in value, so that it would now be unwise to use cottonseed as a winter feed for steers.

It should be remembered that these were mature steers, and that such steers are capable of making use of the rough waste feeds during the winter months. Cattle of this age can use feeds that would be entirely unsuited to young growing animals. In handling and feeding mature steers during the winter months the object should be to make use of all the rough feeds and unsalable hays before any high priced feeds, as cottonseed meal, are used.

Winter Gains of Steers by Months.

Every farmer has old corn and cotton fields which afford some winter feeds for the cattle. As the winter advances the range usually affords a smaller and smaller amount of feed. The following table shows the gain of the various lots from month to month. From this the reader can gather

some idea of when the heavy losses usually occur, and regulate the amount of supplementary feeds accordingly.

TABLE 3. *Gains of Steers by Months* 1907-'08—(84 *days*).

Lot	RATION	Gains 1st month, Dec. 10 to Jan. 7th	Gains 2nd month, Jan. 7 to Feb. 4th	Gains 3rd month, Feb. 4 to March 3rd	Gains 4th month
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
1	Range alone	—4.	—38.	—55.	
2	Range plus half ration cottonseed meal and hulls	16.	—10.	—12.	
3	Range plus half ration peavine hay.	15.	—16.	— 8.	

1908-'09—(98 *days.*)

		Dec. 4 to Jan. 1st	Jan. 1 to Jan. 29	Jan. 29 to Feb. 26	Feb. 26 to Mch. 12
1	Range alone	—40.	—43.	— 7.	—16.
2	Range plus half ration cottonseed meal and hulls	18.	—12.	— 5.	2.
3	Range plus half ration cottonseed	0.	—16.	—46.	22.
4	Range plus half ration mixed hay	.....	—13.	—23.	— 4.

During each year's work those steers which received feed in addition to the range were started on a very small daily allowance. This amount was increased every few days for 28 days, when it was held uniform for the remainder of the winter. During the first winter's work the range cattle (Lot 1) practically held their initial weight during the first 28 days. As time went on and the range became shorter they lost more and more in weight. This is what should be expected. But the heaviest losses in 1908-'09 were experienced at the early part of the winter. However this winter was an unusual one. It was very rainy and muddy during the early months, so that the cattle were very uncomfortable and could not graze well. During the last of the winter very little rain fell, spring set in early

so as a matter of fact, the grasses put up early and the range cattle had some green feed during the last month in addition to the range.

As stated elsewhere, all of these cattle came through to spring in good grazing condition; they were strong and active, although the steers in the range lots (Lot 1) had fallen off in live weight about 100 pounds each.

LOR 3.—*End of winter* 1909. *Feed, cottonseed plus range. Total winter gain of each steer,* —40 *pounds. Total cost of wintering each steer,* $3.23.

FINANCIAL STATEMENT FOR WINTER WORK.

In the fall of 1907 the steers cost $2.50 per hundred weight, but the next fall, 1908, feeders had advanced some in price, making the fall price average $2.56 per hundred weight. The following spring cost was of course considerably greater than the fall price for two reasons. First, the cattle were not as heavy as they were the previous fall, and second, the cost of the winter feed had to be added to the fall price. The fall cost, plus the depreciation in live weight, plus the cost of winter feed made the steers cost around $3.00 per hundredweight in the spring. The following table, No. 4, shows the spring cost by lots. The average of these spring costs was taken as the initial cost of the steers in the summer feeding work which followed. The average cost of wintering each steer in the various lots,

together with the difference in value between fall and spring, are as follows:

TABLE 4. *Financial Statement.*

1907-'08.

Lot 1. Range alone:		
To 722 lbs. steer at $2.50 per hundred wt.	$18.05	
By value of same steer in spring, 625 lbs. at $2.89 per hundredweight		$18.05
	$18.05—	$18.05
Lot 2. Range plus cottonseed meal and hulls:		
To 726 lbs. steer at $2.50 per hundred wt.	$18.15	
To 714 lbs. cottonseed hulls at $6.00 per ton	2.14	
To 194 lbs. cottonseed meal at $26.00 per ton	2.56	
By value steer in spring 720.5 lbs. at $2.89 per hundred weight		$20.82
By required increase in value over range steer to break even, 28c per hundredweight		2.03
	$22.85—	$22.85
Lot 3. Range plus peavine hay:		
To 724 lbs. steer at $2.50 per hundred wt.	$18.10	
To 714 lbs. peavine hay at $10.00 per ton	3.57	
By value steer in spring, 715 lbs. at $2.89 per hundred weight		$20.65
By required increase in value over range steer to break even, 14c per hundredweight		1.02
	$21.67—	$21.67

1908-'09

Lot 1. Range alone:		
To 705 lbs. steer at $2.56 per hundred wt.	$18.05	
By value same steer in spring, 599 lbs. at $3.01 per hundredweight		$18.05
	$18.05—	$18.05
Lot 2. Range plus cottonseed meal and hulls:		
To 705 lbs. steer at $2.56 per hundred wt.	$18.05	
To 854 lbs. cottonseed hulls at $6.00 per ton	2.56	
To 236 lbs. cottonseed meal at $26.00 per ton	3.07	
By value steer in spring, 708 lbs. at $3.01 per hundredweight		$21.31
By required increase in value over range steer to break even, 33c per hundredweight		2.37
	$23.68—	$23.68

Lot 3. Range plus cottonseed:		
To 706 lbs. steer at $2.56 per hundred wt.	$18.08	
To 462 lbs. cottonseed at $14.00 per ton .	3.23	
By value steer in spring, 666 lbs. at $3.01 per hundredweight		$20.05
By required increase in value over range steer to break even, 19c per hundredweight		1.26
	$21.31	—$21.31
Lot 4. Range plus cheap hay:		
To 703 lbs. steer at $2.56 per hundred wt.	$18.00	
To 826 lbs. waste hay at $5.00 per ton ..	2.06	
By value steer in spring, 649 lbs. at $3.01 per hundredweight		$19.53
By required increase in value over range steer to break even, 8c per hundredweight		.53
	$20.06	—$20.06

Lot 4.—*End of winter* 1909. *Feed, coarse hay plus range. Total winter gain of each steer,* —40 *pounds. Total cost of wintering each steer,* $2.06.

The total cost to winter each steer in 1907-'08 was $4.70 and $3.57 in Lots 2 and 3 respectively. The range has no price placed upon it, although the results show that it has a very great value. The total cost to winter each steer in 1908-'09 was $5.63, $3.23 and $2.06 in Lots 2, 3 and 4 respectively.

After the cost of wintering the cattle and the winter shrinkage were added to the fall buying price the spring cost was obtained. The spring costs in Lots 1, 2, and 3 in

1907-'08 were $2.89, $3.17 and $3.03 per hundred weight respectively. In 1908-'09 the spring costs were $3.01, $3.34, $3.20, and $3.09 per hundred weight in Lots 1, 2, 3, and 4 respectively.

It is seen that the cheap coarse feeds produced about as good results as the high priced feeds, and at the same time the steers were carried through the winter much more economically with the cheap than with the expensive feeds. It will always pay to make use of the coarse or cheap winter feeds for the mature steers and save the high-priced feeds for the young animals of the farm.

It is well known that the effects of feeding mature cattle through the winter months continue throughout the following grazing season. Those mature cattle which make the most gain through the winter may be expected to make the smallest gains the following summer. This has been found to be true in this work, but a detailed presentation of this point will be found in later publications.

TABLE 5. *Total Summary of Winter Work.*

	1907-'08—84 days			1908-'09—98 days			
	Lot 1 Range alone	Lot 2 Range and cottonseed meal and hulls	Lot 3 Range and peavine hay	Lot 1 Range alone	Lot 2 Range and cottonseed meal and hulls	Lot 3 Range and cottonseed	Lot 4 Range and waste hay
Average weight of steers at beginning of test	722 lbs.	726 lbs.	724 lbs.	705 lbs.	705 lbs.	706 lbs	689 lbs
Total gain per steer for whole winter	—97. lbs	—6. lbs.	—9. lbs.	—106 lbs.	3. lbs.	—40. lbs	-40. lbs.
Average daily gain per steer	lbs. −1.15	lbs. −.07	lbs. —.11	lbs. −1.08	lbs. .03	lbs. —.4	lbs. —.57
Concentrates consumed per steer per day	.....	2.35 lbs.	.....	.....	2.41 lbs.	4.71 lbs.	.....
Roughage consumed per steer per day	.....	8.5 lbs	8.5 lbs.	.....	8.71 lbs.	. . . .	11.8 lbs
Average expense to winter each steer	.....	$4.70	$3.57	.....	$5.63	$3.23	$2.06
Initial, or fall cost of steers per cwt.	$2.50	$2.50	$2.50	$2.56	$2.56	$2.56	$2.56
Total cost steers per cwt in spring	$2.89	$3.17	$3.03	$3.01	$3.34	$3.20	$3.09

PART II.

Fattening Cattle on Pasture.

INTRODUCTION.

As a rule the ordinary permanent pasture in Alabama can be depended upon to furnish grazing from about April 1 to some time in October. The frosts usually kill the pastures in October. By making use of winter growing plants, such as burr clover, the grazing season can be opened about February 1 and sometimes even earlier.

A common mistake is to overstock the pastures. When this is done the grass often becomes short in August and September, and the cattle actually lose in weight instead of making a gain. The South often experiences a drought in August and September, therefore the farmer should have no more cattle on hand than can be well cared for during the grazing period.

The pastures used in this test, as stated before, were made up of several kinds of grasses. No one kind of plant was depended upon entirely. Johnson grass, Japan clover, and Melilotus were the most important grazing plants used. In addition to these some bermuda and crab grass were also found. If the pastures are to be improved each year, and the grazing season extended over as many months as possible, several plants must be made use of.

The cattle used in the summer feeding work were the same ones as had been used in the preceding winter's experimental work. When grass appeared in the spring the winter work was discontinued, the cattle redivided into lots, and the summer feeding work was begun immediately. Some steers, which had not been in the winter experiment, were added to the summer work. These extra steers had been fed nothing through the winter months except what they obtained on the open range. They were of the same quality as the steers which had been used in the winter tests.

All of these cattle had been dehorned the previous fall.

DETAILS OF THE EXPERIMENT.

Gains During the Summer Feeding.

The gains as recorded in the following table will show that the pastures used were good ones. It should be remembered, too, that as a result of feeding upon these pastures they are getting better and better as time goes on.

The following table sets forth, in a tabulated form, the total and daily gains of the steers for the summers of 1908 and 1909:

Table 6. *Total and Daily Gains During the Pasture Feeding Test.*

1908—(112 *days*).

Lot	No. of steers	RATION	Average initial weight per steer	Average final weight per steer	Total gain per steer	Average daily gain per steer
			Lbs.	Lbs.	Lbs.	Lbs.
A	26	Pasture alone	732	902	170	1.52
B	26	Pasture plus cottonseed cake	739	999	260	2.32
C	26	Pasture plus "Caddo" cake	738	944	206	1.84
D*	54	Pasture plus cottonseed cake	532	713	181	1.62

1909—(154 *days*).

A	40	Pasture alone	647	915	268	1.74
B	75	Pasture plus cottonseed cake	639	929	290	1 88
E	25	Pasture plus cottonseed	653	970	317	2.06

*The cattle in Lot D were not of the same grade as those in Lots A, B, and C, so really Lot D can not be compared with the other lots. Lot D was made up of a bunch of mixed cattle with no special breeding, and ranging from two to five years in age. The object in handling this bunch was to see if money could be made on such cattle. They had not been dehorned.

It is seen that, in every case, those cattle that received some supplementary feed gained more rapidly than those which received no feed but pasture. Of course, the more rapid a steer gains the quicker he can be gotten in shape for the market, and this is a very important point, as the

early fall steer does not come into competition with the fall stuff that is being brought into the market off grass.

As far as gains were concerned, the cattle did reasonably well both years. They were not grazed through the whole summer season, so the total gains, as represented in the sixth column, do not represent as great gains as can be made during a whole summer's grazing season. In 1908 they were grazed only 112 days, and in 1909 the test continued for 154 days. The best portion of the grazing season had been used however, as the cattle were sold from the first of August to the first of September.

In both years the cattle which received cottonseed cake in addition to the pasture gained more rapidly than did the

LOT A.—*End of summer* 1908. *Feed, pasture alone. Average daily gain of each steer,* 1.52 *pounds. Cost of* 100 *pounds of gain,* $1.18. *Total profit per steer,* $2.86.

pasture cattle. In 1908 the difference in favor of the cattle which had been fed was very marked, but in 1909 the difference between the two lots was not very pronounced. In 1909, Lot E the cottonseed lot, made the most satisfactory gains, it making an average daily gain of 2.08 pounds, while Lots B and A made average daily gains of 1.88 and 1.74 pounds respectively.

FEEDS CONSUMED.

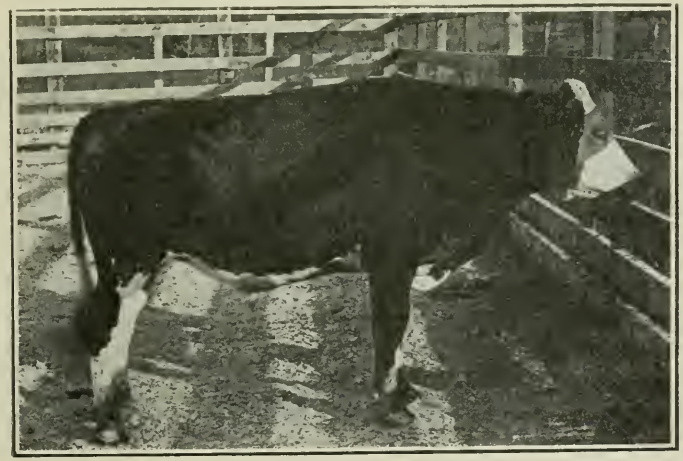
The cattle were fed but once a day; this was done each afternoon about sundown, or in the cool of the evening, in order that the steers would all come out to the feed troughs. The steers were started upon a small amount of feed, and

as they became accustomed to it the amount was gradually increased. The following tables will show that the concentrates were fed sparingly all through the tests.

The following table (table 7), shows the total amount of concentrates fed each steer for each year, the average daily feed, and the amount of concentrates required to make one hundred pounds of gain:

TABLE 7. *Feeds Consumed* 1908—(112 *days*).

Lot	Number cattle	RATION	Total amount feed consumed per steer	Amount feed eaten per day per steer	Pounds feed to make 100 pounds gain
			Lbs.	Lbs.	Lbs.
A	26	Pasture alone	.....	.....	.....
B	26	Pasture plus cottonseed cake ..	371	3.31	143.
C	26	Pasture plus "Caddo" cake ...	371	3.31	180.
D	54	Pasture plus cottonseed cake ..	309	2.76	171.
		1909—(154 *days*).			
A	80	Pasture alone.....	.....	.....	.....
B	75	Pasture plus cottonseed cake ..	524	3.40	181
E	25	Pasture plus cotton seed	691	4.49	218



STEER OF LOT B.—*End of summer* 1908. *Feed, cottonseed cake and pasture.*

Lot A received no feed in addition to the pasture as one object was to learn whether it would pay to supplement the pasture with a concentrate. During the summer of 1908 each steer in Lot B was given daily 3.31 pounds of cottonseed cake in addition to the pasture: in 1909 each steer in this lot was fed 3.4 pounds of the cake per day in addition to the pasture. In 1908 "Caddo" cake was used in one lot so that its value as a feed could be compared to cottonseed cake. The steers in Lot D in 1908 (these were a mixed bunch of steers and cannot be compared directly to the other three lots), on account of being smaller than the ones in the other lots, were fed only 2.76 pounds of cottonseed cake per head per day. In 1909 cottonseed was fed to Lot E.

When looking at the last column it is seen that the cot-

LOT B.—*End of summer* 1908. *Feed, cottonseed cake and pasture.*
Average daily gain of each steer 2.32 *pounds.*
Cost of 100 *pounds of gain* $2.56
Total profit per steer 10.42

tonseed cake was more efficient than the "Caddo" cake for making gains. In 1908 only 143 pounds of cottonseed cake were required to make one hundred pounds gain, while 180 pounds of the "Caddo" cake were required to make the same number of pounds gain. Lot D cannot be compared to Lots B and C. It is true that the "Caddo" cake did not cost as much as did the cottonseed cake, but it will be seen later, when the cost of the feeds are taken into consideration, that the cottonseed cake was the more economical feed to use. Under the conditions of this test one pound of cottonseed cake was equal, in feeding value, to 1.28 pounds of "Caddo" cake.

During the summer of 1909 a direct comparison was made between cottonseed cake and cottonseed as feeds to be used to supplement pastures. Under the conditions of this test one pound of cake proved to be equal to 1.21 pounds of the seed. The seed proved to have an exceedingly high feeding value when used as a feed to supplement the pastures.

The steers in Lot D were a bunch of mixed scrubs varying from one to five years in age. There was very little improved blood among these cattle. They were not dehorned so they were always restless at the feed trough, as the timid ones were afraid of the steers with long sharp horns. This lot was fed as a side issue to the main experiment to determine whether a profit could be made upon this class of cattle.

LOT C.—*Middle of summer* 1908. *Feed, "Caddo" cake and pasture.*
Average daily gain of each steer 1.84 *pounds.*
Cost of 100 *pounds of gain* $3.03
Total profit per steer 6.62

There was no way, of course, to determine just how much pasture grass was consumed, except as to the area measured off for each lot. But it is interesting to note that the amount of concentrated feeds required to make 100 pounds increase in live weight was exceedingly small. This was due to at least two factors. First, the steers had a green feed to go along with the concentrated feeds. Second, the amount of concentrated feeds fed daily was held down to only a few pounds, thus requiring the steers to obtain the major part of their feed from the pasture. Where lands are cheap pasture is cheaper than the too liberal use of concentrated feeds. It is impossible, at the present time, to say whether the amounts fed in these tests were the correct

ones or not. It is hoped that some light may be thrown upon this point during the progress of the work.

Cost of Summer Gains.

It is always unsatisfactory to discuss the cost of gains as it depends largely upon the cost of the feeds, the cost of which varies greatly under different conditions. In this discussion the price placed upon the feeds is the actual market quotations plus the expense of hauling them from the depot to the farm. The hauling distance was fourteen miles. Pasture is charged at fifty cents per month per steer; this is the prevailing price placed upon pasture throughout the western part of Alabama.

Table 8. *Cost to Make* 100 *Pounds of Gain.*

1908—(112 *days*).

Lot	RATION	Pounds feed to make 100 pounds gain	Cost 100 lbs. gain, pasture not charged	Cost 100 lbs. gain, pasture charged *
A	Pasture alone	.....	.....	$1.18
B	Pasture plus cottonseed cake	143	$1.79	2.56
C	Pasture plus "Caddo" cake	180	2.07	3.03
D	Pasture plus cottonseed cake	171	2.14	3.24

1909—(154 *days*).

A	Pasture alone	.....	.....	$1.03
B	Pasture plus cottonseed cake	181	$2.26	3.21
E	Pasture plus cottonseed	218	1.53	2.39

*Price of feeds: Cottonseed cake ..... $25.00 per ton
"Caddo" cake ..... 23.00 per ton
Cottonseed ..... 14.00 per ton
Pasture ..... .50 per month

In every case above, the cost to make one hundred pounds increase in live weight was very low. When steers are fattened during the winter time each pound of gain is put on at a loss, as each pound put on may be expected to cost from 8 to 12 cents; and the profit is dependent upon the enhancement of the value of the steer over and above the selling value of pounds of gain made. In these tests each pound put on during the fattening period was put on at a profit, a very unusual occurrence in fattening beef cattle. These cheap finishing gains made the feeding operations comparatively safe as far as profits were concerned. As stated before, these cheap gains were due to two factors: First, the cattle had a cheap and succulent roughage;—pas-

LOT D.—*End of summer* 1908. *Feed, cottonseed cake and pasture.*
Average daily gain of each steer 1.62 *pounds.*
Cost of 100 *pounds of gain* $3.24
Total profit per steer ..... .43

ture. Second, the amount of concentrated feeds used was kept down to a comparatively small figure: from 2.76 to 3.31 pounds of cottonseed cake and 4.48 pounds of cottonseed were fed to each steer daily. At the Missouri Station (Bulletin 76) the average of the summer trials show that 814 pounds of grain were required to produce one hundred pounds of gain, while in the Alabama test only 143 to 218 pounds of concentrate were required to make the same gains. At Missouri the steers were given an approximate daily feed of 20 pounds of grain in addition to the pasture.

While the Missouri cattle were fed a much heavier grain ration than the Alabama cattle, still the records of this test show the Alabama cattle to have made almost as large daily gains as did the Missouri steers.

When Lots B and C (1908) are compared it is seen that the cottonseed cake is superior to the "Caddo" cake, as one hundred pounds of increase in weight were made at a cost of $2.56 when the cottonseed cake was used, whereas when the "Caddo" cake was fed the same gain cost $3.03. When the cottonseed cake sells at $25.00 a ton the "Caddo" cake is not worth $23.00 a ton; when cottonseed cake sells at $25.00 a ton this test shows the "Caddo" cake to be worth only $20.54 a ton.

LOT A.—*End of summer* 1909. *Feed, pasture alone.*
Average daily gain of each steer 1.74 *pounds.*
Costs of 100 *pounds of gain* $1.03
Total profit per steer 7.06

The common or mixed bunch of cattle (LotD) make a very poor showing when compared with Lots B and C, although, as will be seen later, the steers in Lot D returned a small profit.

In comparing Lots B and E (1909) it is seen that the cottonseed produced gains more cheaply than did the cottonseed cake—that is, when the cottonseed is valued at

$14.00 a ton and the cake at $25.00 a ton. When cottonseed cake is valued at $25.00 a ton this test shows the cottonseed to be worth $20.73 a ton for fattening cattle on pasture. Cottonseed had this disadvantage however: during the latter part of the feeding period they were not relished as much as the cottonseed cake, and some trouble was experienced in keeping the steers "on feed." There was no trouble from scours when the seed were fed in the above amounts.

Financial Results of Summer Feeding.

Although those cattle which received pasture alone made cheaper gains than the ones which received some feeds in addition to the pasture, it must not be inferred that the grass cattle were the most profitable ones; the cost of the gains alone does not determine the final profits. While it is desirable to make the gains as cheaply as possible, still the selling price of the cattle at the end of the feeding period must also be taken into consideration before the final profit can be determind.

Table 9. *Financial Statment.*

1908.

Lot A. Pasture alone:		
To 26 steers, 19031 lbs. at $2.92 per cwt.	$555.71	
To pasture at 50c a month per steer ..	52.00	
To freight, commission, feed and yardage	94.12	
Total expenditures	$701.83	
By sale of 26 steers at $3.66 per cwt.		$776.29
Total profit on lot	$74.46	
Profit per steer	2.86	
Lot B. Pasture plus cottonseed cake:		
To 26 steers, 19199 lbs. at $2.92 per cwt.	$560.61	
To pasture at 50c a month per steer .	52.00	
To 9646 lbs. of cottonseed cake at $25.00 per ton	120.57	
To freight, commission, feed and yardage	94.12	
Total expenditures	$827.30	
By sale of 26 steers, 24245 lbs at $4.53 per cwt.		$1098.30
Total profits on lot	$271.00	
Profit per steer	10.42	

Lot C. Pasture plus "Caddo" cake:		
To 26 steers, 19176 lbs. at $2.92 per cwt.	$559.94	
To pasture at 50c a month per steer ..	52.00	
To 9646 lbs. of "Caddo" cake at $23.00 per ton	110.93	
To freight, commission, feed and yardage	94.12	
Total expenditures	$816.99	
By sale of 26 steers, 22740 lbs. at $4.35 per cwt.		$989.19
Total profit on lot	$172.20	
Profit per steer	6.62	
Lot D. Pasture plus cottonseed cake:		
To 54 steers, 28754 lbs. at $2.50 per cwt.	$718.85	
To pasture at 50c a month per steer ..	108.00	
To 16686 lbs. of cottonseed cake at $25.00 per ton	208.57	
To freight, commission, feed and yardage	195.48	
Total expenditures	$1230.90	
By sale of 54 steers, 36450 lbs. at $3.44 per cwt.		$1253.88
Total profit on lot	$22.98	
Profit per steer	.43	
1909.		
Lot A. Pasture alone:		
To 40 steers, 25879 lbs. at $2.95 per cwt.	$763.43	
To pasture at 50c a month per steer .	110.00	
To freight, commission, feed and yardage	144.80	
Total expenditures	$1018.23	
By sale of 40 steers, 34314 lbs. at $3.79 per cwt.		$1300.50
Total profit on lot	$282.27	
Profit per steer	7.06	
Lot B. Pasture plus cottonseed cake:		
To 75 steers, 47916 lbs. at $2.95 per cwt.	$1413.52	
To pasture at 50c a month per steer ..	206.25	
To 39025 lbs. of cottonseed cake at $25.00 per ton	491.56	
To freight, commission, feed and yardage	271.50	
Total expenditures	$2382.83	
By sale of 75 steers, 66514 lbs. at $4.37 per cwt.		$2906.66
Total profit on lot	$523.83	
Profit per steer	6.99	

Lot E. Pasture plus cottonseed:		
To 25 steers, 16328 lbs. at $2.95 per cwt.	$481.68	
To pasture at 50c a month per steer .	68.75	
To 17265 lbs. of cottonseed at $14.00 per ton	120.85	
To freight, commission, feed and yardage	90.50	
Total expenditures	$761.78	
By 25 steers, 22858 lbs. at$4.25 per cwt.		$971.46
Total profit on lot	$209.68	
Profit per steer	8.39	

It should be noted that the total profits shown above are based on estimates after pasture rent, freight, commissions, feed and yardage are taken from the total sales.

In 1908 it cost $3.85 per head to get the steers to the New Orleans market and in 1909 the expense was $3.62 per head. These cattle were shipped from western Alabama to New Orleans, a distance of about 500 miles; many farmers in the South are not required to ship their cattle this distance.

In 1908 the greatest profits were realized upon Lot B, the lot which received cottonseed cake in addition to the pasture; in this lot a net profit of $10.42 per steer was made. Lot C, the "Caddo" fed lot, returned a net profit of $6.62 per steer. The pasture lot, Lot A, made a profit of only $2.86 per steer. It paid to feed the cattle some feed in addition to the pasture, because when they were offered for sale those steers which had been fed the concentrated feeds were in much better condition than those that received pasture only, and consequently sold for more money per hundred weight. The grass cattle sold for $3.66 per hundred weight, the cottonseed cake cattle for $4.53 per hundred weight, and the "Caddo" cattle for $4.35 per hundred weight. The above represent the New Orleans prices. It cost about 60 cents per hundred weight, including shrinkage, to ship the steers to New Orleans.

In 1909 there was not such a marked difference in favor of the lots which received feed in addition to the pasture. In fact, the pasture lot, Lot A, and the cottonseed cake lot, Lot B, made practically the same profit, the former making a net profit of $7.06 per steer and the latter a net profit of $6.99 per steer. But the cottonseed fed lot, Lot E, was decidedly more profitable than either of the other lots, it making a net profit of $8.43 per steer. The profits in every case were exceedingly satisfactory.

In 1908 it proved to be exceedingly profitable to supplement the pasture with a concentrated feed. In 1909 no extra profit was made as a result of the use of the cotton-

LOT B.—*End of summer* 1909. *Feed, cottonseed cake and pasture.*
Average daily gain of each steer 1.88 *pounds.*
Cost of 100 *pounds of gain* $3.21
Total profit per steer 6.99

seed cake, but when cottonseed was fed along with the pasture the profits were greater than when pasture was used alone. The data so far collected warrant the statement that it pays to supplement our Southern pastures with a concentrated feed when cattle are being finished for the fall market. Additional experimental work will determine what concentrated feeds can be used to the greatest advantage.

Slaughter Results.

The cattle were shipped to New Orleans for sale and slaughtered, where complete individual slaughter records were secured. The authors have presented only a part of the slaughter records in the following table; the point will be discussed more fully in a subsequent publication.

Table 10. *Slaughter Data.*

1908.

Lot	RATION	Average farm weight each steer	Average New Orleans weight each steer	Average shrinkage in shipping per steer	Per cent. dressed out by farm weights
		Lbs.	Lbs.	Lbs.	Per ct.
A	Pasture alone	902	816	86	49.5
B	Pasture plus cottonseed cake	999	932	66	53.8
C	Pasture plus "Caddo" cake	944	874	70	53.6
D	Pasture plus cottonseed cake	724	686	38	52.7
	1909.				
A	Pasture alone	916	859	57	51.8
B	Pasture plus cottonseed cake	941	899	42	54.2
E	Pasture plus cottonseed	1001	946	55	53.9

It is seen by the above table that the steers which were given some feed in addition to the pasture suffered less loss in live weight in transit than did the ones which had nothing to eat but pasture. In 1908 each pasture steer (Lot A) lost 86 pounds in transit, while those which had been fed some concentrated feeds lost from 38 to 70 pounds each. The common cattle, Lot D, suffered a very small shrinkage which was due, in part, to their being smaller steers than the other cattle. The cattle did not shrink as much in

1909 as in 1908, but in 1909 the grass cattle lost considerably more weight in transit than did those that had been fed.

In both years the steers which had been fed the cottonseed products dressed out several per cent higher than the grass cattle. In 1908 the grass cattle dressed out 49.5 per cent; in 1909 a similar lot dressed out 51.8 per cent. The cattle which had been given some concentrated feeds along with the pasture dressed around 54 per cent. It should be noted that the last column is based on the farm weights of the cattle. If the New Orleans live weights were taken it would raise the figures in the last column from 2 to 2.5 points in each case.

LOT E.—*End of summer* 1909. *Feed, cottonseed and pasture.*
Average daily gain of each steer 2.06 *pounds.*
Cost of 100 *pounds of gain* $2.39
Total profit per steer 8.39

TABLE 11. *Complete Summary of Summer Feeding.*

	1907-'8				1908-'9		
	Lot A Pasture alone	Lot B Pasture plus cottonseed cake	Lot C Pasture plus "Caddo" cake	Lot D Pasture plus cottonseed cake	Lot A Pasture alone	Lot B Pasture plus cottonseed cake	Lot E Pasture plus cottonseed
Average weight each steer at beginning test	732	738	738	532	647	639	653
Average daily gain per steer	1.51	2.32	1.84	1 62	1.74	1.88	2.06
Average amount concentrates consumed per steer per day	.....	3 31	3.31	2.76	.....	3.40	4.49
Average amount concentrates to make 100 pounds gain .	.....	143	180	171	.....	181	218
Cost 100 pounds gain, pasture charged..	$1.18	$2.56	$3.03	$3.24	$1.03	$3.21	$2.39
Initial cost of steers per 100 pounds....	2.92	2.92	2.92	2.50	2.95	2.95	2.95
Selling price (N. O.) of steers per 100 pounds	3.66	4.53	4.35	3.44	3.79	4.37	4.25
Total profit per steer.	2.86	10.42	6.62	.43	7.06	6.99	8.39

TWENTY-THIRD ANNUAL REPORT

OF THE

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN, ALABAMA

1911

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ALABAMA POLYTECHNIC INSTITUTE.

Auburn, Ala., Jan. 31, 1911.

GOVERNOR EMMET O'NEAL,

Executive Department,

Montgomery, Ala.

SIR:—I have the honor herewith to transmit to you the Twenty-Third Annual Report of the Agricultural Experiment Station of this College.

The report of the Treasurer, herewith included, is for the fiscal year ending June 30, 1910.

This report is made in accordance with the provisions of the act of Congrest (approved March 2, 1887), establishing Agricultural Experiment Stations in the several States and Territories.

It contains the report of the Director, the Chemists, the Veterinarian, the Agriculturist, the Biologist, the Horticulturist, the Entomologist, and the Professor of Animal Industry, for the year ending December 31, 1910.

Respectfully,

CHAS. C. THACH,

President.

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R. B. Whitesell, D. V. M.....Assistant in Veterinary Science
E. R. Eudaly.....Assistant in Animal Industry

* Resigned.

REPORT OF HATCH AND ADAMS FUND FOR 1909-1910.

Receipts.

	Hatch	*Adams*
To Amount from U. S. Treasury	$14200.00	$12600.00

Disbursements.

By Salaries	$ 7503.73	$ 7837.57
By Labor	1293.23	805.75
By Publications	1274.96	
By Postage and Stationery	338.16	37.90
By Freight and Express	189.57	182.05
By Heat, Light, Water, and Power	604.03	28.60
By Chemical Supplies	309.88	118.77
By Seeds, Plants, and Sundry Supplies	457.97	761.49
By Fertilizers	507 67	84.27
By Feeding Stuffs		366.20
By Library	556.14	14.90
By Tools, Implements, and Machinery	145.98	90.27
By Furniture and Fixtures	19.80	103.65
By Scientific Apparatus	184.72	1156.31
By Live Stock	165.00	252.00
By Traveling Expenses	54.46	183.25
By Contingent Expenses	15.00	
By Buildings and Repairs	579.70	577.02
Total	$14200.00	$12600.00

STATE OF ALABAMA,

Lee County.

Personally appeared before me, Welborn Jones, a Notary Public in and for said county, M. A. Glenn, known to me as Treasurer of the Alabama Polytechnic Institute, who being duly sworn, deposes and says that the above and foregoing account is true and correct.

Witness my hand this 10th day of February, 1911.

WELBORN JONES,

(Seal) Notary Public.

This is to certify that I have compared the account with the ledger account of the Treasurer, and this is a correct transcript of the same.

C. C. THACH,

President A. P. Institute.

Circ. filed separately

REPORT OF DIRECTOR AND AGRICULTURIST.

J. F. Duggar.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

I respectfully submit the following report for the past year of the work under my charge as Director and Agriculturist of the Alabama Experiment Station.

Publications.

During the calendar year 1910 the publications of the Alabama Experiment Station consisted of the annual report, three bulletins, four circulars, and seven press bulletins. The titles and authors are given below:

Bulletin No. 149—Tests of Varieties of Cotton in 1909; by the Director and the Farm Superintendent.

Bulletin No. 150—Raising Beef Cattle in Alabama; by the Chief and Assistant in Animal Industry.

Bulletin No. 151.—Wintering Steers in Alabama. Fattening Cattle on Pasture in Alabama; by the Chief and Assistant in Animal Industry.

Circular No. 4—Information To Nurserymen in Regard to Fumigation of Nursery Stock; by the Horticulturist and Assistant Horticulturist.

Circular No. 5.—The Boll Weevil Advance in Alabama; by the Entomologist.

Circular No. 6.—Fighting the Boll Weevil; by the Entomologist.

Circular No. 7.—Destroying Boll Weevils by Clean Farming; by the Entomologist.

Press Bulletin No. 36.—Tests of Varieties of Cotton in 1909; by the Director and the Farm Superintendent.

Press Bulletin No. 37.—The Mexican Cotton Boll Weevil; by the Entomologist.

Press Bulletin No. 38.—Boll Weevil Enters Alabama; by the Entomologist.

Press Bulletin No. 39.—Falling of Cotton Squares and Small Bolls; by the Entomologist.

Press Bulletin No. 40.—Destroying Weevils in Corn; by the Entomologist.

Press Bulletin No. 41.—Tests of Varieties of Corn in 1910; by the Director and Farm Superintendent.

Press Bulletin No. 42.—Boll-Weevil Infested Area in the United States; by the Entomologist

As stated in each of my reports for the last two years, a large percentage of the bulletins of the Alabama Experiment Station are now out of print. There is urgent need that a number of the bulletins now out of print be reprinted. However, this cannot be done unless a special fund be appropriated for this purpose.

An increase in the printing fund is also needed in order that the mailing list of the Station be permitted to grow in proportion to the increased need for information shown by the farmers of Alabama. With an ample printing fund, much wider publicity could be given to the fact that these bulletins should be in the hands of every Alabama farmer, and these bulletins could be published in much larger editions and on a wider range of subjects than at present.

Staff.

The Experiment Station has been fortunate in the past year in having few changes in the Station staff. Mr. L. W. Shook was transferred from the position of Assistant in Animal Industry to work in Sumter county, conducted by this Station in co-operation with the Bureau of Animal Industry of the U. S. Department of Agriculture. He was succeeded by E. R. Eudaly, a graduate of the Texas Agricultural and Mechanical College. In the latter part of the year Mr. N. E. Bell, Assistant in Chemistry, resigned to enter the employ of the Bureau of Soils.

Agricultural Department.

In order to reach correct conclusions regarding agricultural practice, field experiments must be repeated through a series of years. Hence, most of the field experiments conducted on the Experiment Station farm at Auburn in 1910 were repetitions of earlier work.

The work which has required a large amount of the time and pains of the experimenting staff is that in breeding or improving cotton, corn, and oats. Satisfactory progress has been made in each of these lines in improving the plants under consideration, and a large mass of accurate data has been accumulated, which, when published, should afford a clearer insight into some of the problems of plant breeding,

and serve to formulate methods of procedure that can be followed by other plant breeders. In breeding cotton, more work has been bestowed on the Cook variety than on any other. However, much attention has been paid to the crossing of a number of varieties. The object, both in improving the Cook variety and in endeavoring to originate new varieties by hybridization, has been chiefly to evolve a variety better suited to boll weevil conditions than are any of the varieties now generally grown.

In the strains of Cook, which have been carefully bred up for four years, much improvement is noticeable in the form and productiveness of the plant and in certain strains progress has also been made in uniting earliness, fair size of boll, and in some strains increased length of lint, with the productiveness which has been sought in all work with this variety.

During the past year the systematic breeding of the Poulnot variety was undertaken with the hope of engrafting earliness on this variety, which is otherwise quite promising.

The special susceptibility of Cook cotton to the attack of boll rot has been an obstacle to its improvement. Beginning in 1910 a new method of handling the crop has been started and selections made with special reference to breeding a strain more nearly resistant than ordinary Cook to this serious disease. Elaborate records have also been made relative to the amount of boll rot on all of the different varieties of cotton grown on the Station farm.

The varieties of corn with which breeding work has been in progress for several years are Experiment Station Yellow, Henry Grady, and Mosby.

With oats the bulk of the breeding work has been done with the Red Rust Proof variety, though other varieties and various hybrids of our own making have received attention.

Except for Experiment Station Yellow corn, the improvement of which has now gone far enough to permit of its distribution to a limited number of farmers who will agree to grow it in careful tests in comparison with other kinds, the work of improvement will have to proceed for at least another year before it will be advisable to enter on any general distribution of seed.

In addition to plant breeding, some of the most important lines of experiments in progress during the year 1910

in the agricultural department are the following:

Cotton, relative fertilizing values of ground phosphate rock and acid phosphate.

Cotton, effects of planting heavy and light seed.

Cotton, continuation of the study of varieties.

Cotton, local fertilizer experiments.

Cotton, best time for applying nitrate of soda.

Corn, variety and culture experiments.

Oats, variety and culture experiments.

Crimson clover, variety and culture tests, and fertilizing value.

Cowpeas, variety tests.

Sorghum, variety tests.

Relative amounts of food produced by various crops suitable for hogs.

Soybeans, variety and culture experiments.

A study of numerous forage plants, including alfalfa, vetches, clovers, kudzu, and grasses.

Experiments in the manufacture on the farm of drain tile from cement and sand.

Rotation of crops.

Wheat, tests of varieties and mixtures.

Respectfully submitted,

J. F. DUGGAR,
Director and Agriculturist.

REPORT OF THE CHEMIST.

B. B. Ross.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

I herewith submit the following report with regard to the extent and character of the work of the Chemical Department of the Experiment Station for the past year:

The work of this department embraces investigations carried out under the provisions of the original Hatch act and of the Adams act, inspection work performed under police regulations which provide for the analysis of fertilizers, feed stuffs, illuminating oils, etc., while analyses are also made of many samples of miscellaneous materials sent in from all sections of the State.

The reports submitted by Dr. J. T. Anderson and Prof C. L. Hare furnish information with regard to the progress of the work that is being conducted by them under the provisions of the Adams and Hatch acts, while a considerable amount of analytical work has been done in connection with experiments and investigations conducted by other departments of the Experiment Station.

The investigations being carried out with a view to noting the effects of seed selection upon the quality of the cotton seed produced from season to season are of interest on account of the economic aspect of the subject, as cotton seed and cotton seed products at present constitute such an important proportion of the total value of the cotton crop. If results at all similar to those that have been secured elsewhere in corn breeding can be attained in the production of cotton seed particularly rich in oil or in protein, the possibility of still further increasing the value of the by-products of the cotton crop becomes apparent.

Additional work has been done in connection with investigations as to the availability of basic cinder or slag obtained as a by-product from the manufacture of steel by the basic open-hearth process, though as yet there is some lack of agreement between laboratory and field tests as to the availability of the phosphoric acid in this material.

Further work in the investigation of this question is contemplated during the present year.

The fertilizer work of the past season showed an increase of about 10 per cent over that of the preceding year, and although the feed stuff law enacted in 1909 was practically inoperative, owing to defects in the law, a considerable number of samples were analyzed during the past year, while many samples of food materials for human consumption were also subjected to analysis in this laboratory.

In addition to the analytical work above outlined, this laboratory has also made analyses of a large number of specimens of miscellaneous materials forwarded from various localities in the State, including soils, marls, phosphates, ores, waters, etc.

Very respectfully,

B. B. ROSS,
Chemist.

REPORT OF VETERINARIAN.

C. A. Cary.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

I respectfully submit a synopsis of the work of the Veterinary Department for 1910:

The influences of cotton seed meal on the health of the various organs of the body of pigs and horses, when fed cotton seed meal alone or in combination with other feeds, have been studied. This work requires time and repeated tests. It also requires numerous and tedious blood examinations, careful preparation of tissues for sections so that the pathological changes may be studied and recorded. While the toxic ingredient of cotton seed meal is said to have been determined, in so far as possible we aim to record all symptoms and microscopical changes in organs.

A study of the infections of cow's udders and the pathological changes is being continued. This requires numerous bacteriological analyses, and numerous sections and examinations of parts of a number of udders which are variously and differently diseased. The ways of infection, the influence of the morbid changes on milk secretion are considered. We had some opportunities to get records on the effects of peanuts, as a single ration, on hogs and pigs. This line of work is demanding attention on account of extensive use of the peanut as a hog feed and the rather common occurrence of a disease associated with, or caused by, the peanut. Observations on Osteo-porosis are made as cases are presented and chief aim is to find the cause of this obscure disease.

The sanitary question on farms, especially in dairies and dairy barns are studied. The infection of pens, soils, etc., by the careless handling of carcasses, manures and waste farm products is noted and studied. A study of the prevalence of animal parasites in domestic animals is made, and of necessity the work is slow because of lack of funds and workers who are able to push it.

The Farmers' Institutes during 1910 were not as numer-

ous as they were during 1909. But the sections of the state visited were somewhat more inaccessible, thus requiring more time and funds.

During 1910.

Farmers' Institutes held in Alabama	25
Number of counties visited	21
Number of Sessions	45
Average attendance at each session	71
Total Attendance	3186

The Round-Up Farmers' Institute and Summer School for Farmers was held at Auburn during the last week in July. There were 63 lectures and demonstrations given, beginning at 8 a. m. and ending at 10 p. m. every day. The enrollment for the Round-Up Institute was 835. For the second time the Institute had special lectures for women. These lectures were delivered by women on domestic art and science and on health and home life. These lectures were well attended and were attractive, interesting, and profitable.

C. A. CARY,
Veterinarian and Director of Farmers' Institutes.

REPORT OF CHEMIST OF SOILS AND CROP INVESTIGATION.

J. T. Anderson.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

The following report of the work done by this department during the year 1910 is respectfully submitted.

With the exception of about five months given, as usual, to the state fertilizer work, our attention was devoted entirely to the prosecution of the Adams Project, the determination of soil requirements by the analysis of the cotton plant.

The methods of investigation heretofore employed, with two or three important modifications, were continued, namely, the observation of the simultaneous effect of fertilization on the composition of the plant and on the crop yield. The latter effect was determined in all cases by cultivation in open plots; the former, the effect of fertilization on the composition of the young plant, by the analysis of plants drawn from the open plots, as well as of plants grown in the same soil in wire baskets, the soil in the latter case being subjected to the same system of fertilizer treatment as in the plots. Previous to 1910 our plot tests were conducted in co-operation with the agricultural department of the station, all the material for our use being obtained from selected correspondents of that department who were engaged in The Co-operative Soil Test Experiments. In 1910 some material changes in the methods of fertilization were made in these Co-operative Soil Test Experiments, which made it necessary for us to look elsewhere for our material. The services of some 8 or 10 independent co-operators in different parts of the State were secured for our work and instructions sent them as to the manner of conducting the experiments. Samples and data from these correspondents are now being worked up in the laboratory.

The sand culture experiments in clay cylinders imbedded in the ground for studying the effect of fertilization on the composition of the plant, were continued.

Another use for imbedded cylinders was found during

the season of 1910. Realizing the difficulty of securing reliable co-operation in conducting Plot Tests in many cases where co-operation was essential, it was thought that the soil to be tested might readily be transported and placed in imbedded cylinders for the tests, our experience having demonstrated that the cotton plant may be grown normally to maturity in such cylinders of suitable size. While the cylinder method as a substitute for the Plot Method has its disadvantages, its many advantages are obvious. Three types of soil were selected and a set of 12 cylinders for each type was provided. The foundation or subsoil was the same for the entire group of 36 cylinders. Each set of cylinders was then filled to a depth of 8 inches with its own type of soil. In the application of fertilizers to the individual cylinders of each set the same scheme was followed as has been employed in the plot tests. All other details observed in the plot method have been applied to the cylinder method, and the analytical results, thus far obtained, conform strikingly to those of the older method.

The assistant in this department, Mr. Bell, resigned in September and the vacancy thus created has not yet been filled. It is hoped that a suitable man may soon be found, that the work may go on again without interruption.

Respectfully submitted,

JAS. T. ANDERSON,
Chemist, Soils and Crop Investigation.

REPORT OF PHYSIOLOGICAL CHEMIST.

C. L. Hare.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

The work in this department during 1910 was, as in 1909, concerned with two main investigations.

1. The experiment of breeding cotton in an effort to increase the oil content of the seed was so far successful that some of the strains bred for three years showed a material gain in percentage of oil. These same strains, continued in 1910, suffered seriously during their growth from anthracnose which may necessitate the elimination of these high oil strains and the introduction of others which will in turn have to be bred up to the point attained by those originally used in the experiment. This is an illustration of the many problems that must be met and solved before a high oil cotton can be bred without sacrificing yield or quality.

2. During the year there was published a preliminary paper treating of the influence of feeds upon the properties of lard.

There have been obtained some striking results illustrating extremes of oiliness and hardness of lards produced from different feeds.

This investigation, with the scope enlarged, is being continued.

Respectfully submitted,
C. L. HARE.

REPORT OF ENTOMOLOGIST.

W. E. Hinds.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

The following report relates to the work of the Department of Entomology in the Experiment Station for the fiscal year 1910.

Work during the past year has continued mainly along the lines inaugurated during 1909. There has been no change in the working force. Mr. W. F. Turner, as Assistant, has given nearly all of his time to the routine station work, and especially to the Adams Fund investigation projects.

Correspondence.

Inquiries regarding the control of insect pests have increased during the past year, indicating that there is a general advance in agricultural and horticultural information along these lines. The entomologist has received and answered more than 1,500 letters during the past year.

Publications.

During the year 1910 the department of Entomology has issued the following publications in the Station Series: Circular No. 5, Boll Weevil Advances in Alabama. Circular No. 6, Fighting the Boll Weevil. Circular No. 7, Destroying the Boll Weevil by Clean Farming. Press bulletin No. 37, The Mexican Cotton Boll Weevil. Press Bulletin No. 38, Boll Weevil Enters Aabama. Press Buletin No. 39, The Falling of Cotton Squares. Press Bulletin No. 40, Destroying Rice Weevils in Corn. Press Bulletin No. 42, The Boll Weevil Area in the United States. This publication shows the area of 1910 infestation, and is the basis for applying quarantine regulations against the weevil.

Besides these regular station publications, two articles reporting results of the Adams Fund project work have been published in the Journal of Economic Entomology. One of these dealt with general results of fumigation work for the control of insects in stored grain, the other with

materials which may be, or are frequently used in the construction of fumigation outfits. Besides these, a third article dealing with the life history of the rice weevil in corn has been presented before the American Association of Economic Entomologists, and will shortly appear in the Journal of Economic Entomology. Several articles on economic entomological subjects have been printed in the Southern Farm Gazette, and the Southern Ruralist, besides a large number of newspaper articles in the daily and weekly press, giving information relative to the boll weevil advance, and advising the people as to the best way to meet the situation. Mr. W. F. Turner has published a paper on the Control of Cucumber and Cabbage Insects, appearing in the Report of the Alabama State Horticultural Society for 1910, issued by the State Department of Agriculture and Industry, Serial No. 36.

Public Addresses.

In order to supply the imperative demand for lectures on the cotton boll weevil, it has been necessary to refuse numerous requests for addresses at farmers' institutes. More than a dozen addresses dealing with the boll weevil, many of them illustrated with stereopticon views, have been given in Alabama during the past year, and one at Atlanta, Ga. The expense for these trips has been met by the State Department of Agriculture, or by the society making the request.

The Mexican Cotton Boll Weevil.

As had been expected the Mexican Cotton Boll Weevil, in its eastward advance, crossed the western boundary line of Alabama, in Mobile County toward the end of August, 1910. The first specimens of the pest to be found in this state were taken at Wilmer, Ala., by the writer, on Sept. 3d. During the following six weeks the advance of the pest continued until about the middle of October. The line was found to enter the County of Choctaw, slightly south of Meridian, Miss., and extending in a southeasterly direction, including also small parts of Clark and Monroe, and all of Washington, Mobile, and Baldwin Counties within the line of 1910 infestation. Fortunately, in many respects, killing frosts occurring during the closing days of October put an end to the weevil's advance.

The coming of the boll weevil has awakened an intense

interest among the cotton planters of the state, and they are now in a position to accept and adopt recommendations for improved methods, such as would not heretofore have appealed to them. Large numbers of insects, mistaken for the boll weevil, are being sent for identification, and information requested.

Fair Exhibit.

In connection with the exhibit placed by the Experiment Station with the Montgomery State Fair, the Department of Entomology showed particularly by specimens, photographs, charts, etc., the boll weevil and insects mistaken for it, the fundamental steps which should be adopted in fighting the weevil, formulae for insecticides, and similiar subjects.

Adams Fund Investigations.

Much time has been devoted to a pursuance of the investigation announced in our last report regarding the rice weevil. Much entirely new information as to facts in the life history has been gathered, and the more important of these facts reported as mentioned under publications. Further progress has been made also in the matter of fumigation. Owing to practical difficulties to be found in applying fumigaton for the control of the rice weevil in stored corn under ordinary farm conditions, we are testing other means of a control, and hope to find some practical method which may be readily applied under usual conditions with little expense.

Respectfully submitted,

W. E. HINDS,
Entomologist.

REPORT OF PLANT PHYSIOLOGIST.

F. E. Lloyd.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

I beg leave to submit the following annual report as Plant Physiologist of the Alabama Agricultural Experiment Station, being a report of the second complete year of my tenure of that office.

A year ago, I stated that the preparation of my monograph on the guayule, (Parthenium argentatum), a desert rubber plant of Northern Mexico, was completed. This will shortly appear as Publication 139 of the Carnegie Institution of Washington. As a logical continuation of this work, the guayule and several of its congeners are being studied continuously in their relation to soil and climatic conditions at Auburn, while, at the courtesy of the Carnegie Institution of Washington, two of the species, the guayule and the mariola, are under observation at the Desert Botanical Laboratory, Tucson, Ariz. The data accumulating will afford material for a study of acclimatization.

My study of the development of the fruit of the date (Phoenix dactylifera), begun as a portion of an Adams Fund project at the Arizona Agricultural Experiment Station, has been completed. One of the primary objects of this study was to gain light on the role of tannin, which in this fruit and in the persimmon is a predominant factor in its relation to the ripening process, but the behavior of other foods (starch, reserve cellulose, oil especially) were also studied, during the whole embryonic period. Among the results of major interest, it was found that, judging from their physiological relations, there are two kinds of tannin; one being used as a food material, probably for the building up of the reserve cellulose in the endosperm, thus affording support to the recently-published view of van Wisselingh based on **Spirogyra**; the other is not a plastic material, but is secreted within certain cells of the seed coats and carpel where it remains permanently, after the fashion of an excrete.

I have also found that there is no segregation of tannin during the ripening process, and this result was extended to the persimmon, (Diospyros), though the contrary view has been held. The work has been published under the title "The development and nutrition of embryo, seed and carpel in the date, Phoenix dactylifera, L." in the 21st Annual Report of the Missouri Botanical Garden, and reprinted for liminted circulation.

My work on the date naturally led me to a consideration of the persimmon, with particular reference to the behavior of the tannin-cells during ripening. As is well known, the great need of the persimmon grower is the ability to process persimmons after the fashion of the Japanese, and it was deemed that a more precise knowledge of the role of the tannin would contribute toward this end. I have found that the disappearance of astringency during ripening is due to the union of the tannin with a second colloid body, also secreted within the tannin-cell, to form an insoluble and imputrescible colloid-compound. It has also been shown that there remains a certain amount of soluble tannin and I have shown that this, under certain conditions, escapes from the tannin-cell and unites with a substance, probably pectose, which is derived by digestion of the middle lamella. These views harmonize with certain observations of Vinson on the heat relations of ripening in the date, and throw light on the data obtained by Bigelow, Gore and Howard, on the persimmon, thus enabling us to understand better the nature of the ripening process in these fruits. It may be added that the recently published work of Gore on the relation of carbon dioxid to ripening in the persimmon, following on Prinsen-Geerligs' results on the banana, will lead, I believe, to a solution of the method of processing fruit in a practical way. My own studies have in part appeared under the title, "The behavior of tannin in persimmons, with some notes on ripening," and are in part ready for the press in the form of two additional papers, (1) "The artificial ripening of persimmons," read at the last annual meeting of the Alabama Horticultural Society, and (2) "The nature of the tannin cell in the persimmon, Diospyros."

The Adams Fund project on transpiriation and allied phenomena in the cotton has progressed. It was found very difficult to get material to grow well in the Department greenhouse on account of the inadequate heating and

lack of suitable assistance, the fact being that the personnel of the department is not commensurate with the demands made on it. The present winter's experience has been no better in spite of an earnest endeavor to take advantage of our facilities as they stand. Field methods of studying transpiration and correlated phenomena have therefore received major attention, and for this purpose I spent a month, at my own charges, at the Desert Botanical Laboratory, getting data on the rate of transpiration, by comparative volumetric and gravimetric methods. It was found that the discrepancy between the results obtained by these methods is not fortuitous, but a regular one, the ratio between them reversing during night and day. The difference is believed to be due in part to the difference in the water content of the leaf. Some data, obtained during September and October on the cotton at Auburn, appear to align themselves with this conclusion. Synchronous observations on the atmometer (of Livingston), insolation-thermometer, anemometer, thermometer and plant pieces have also been made with the hope of elaborating field methods for the comparative study of transpiration. My results have been in part reported in a paper "The relation of transpiration to the water content of leaves," presented at the recent meeting of the Botanical Society of America. Mr. C. S. Ridgway has assisted me in this work.

Some progress has been made on methods for the study of the relations of fumigation to the physiological condition of the plant, with special reference to the condition of the stomata and to the water content, but the condition of the greenhouse has also interfered with this work.

The history of the pecan-scab in a single orchard, that of Mr. T. W. Oliver, Montgomery, Ala., has been followed with the co-operation of Mr. C. S. Ridgway, throughout the year. It has come to light that the unfruitful condition in this orchard is, to a large degree, not due to the pecan-scab organism. A brief bulletin of information treating of this organism has been published.

The following is a list of publications from the Department.

(1.) The development and nutrition of the embryo, seed and carpel in the date, Phoenix dactylifera L. Ann. Rep. Mo. Bot. Garden, vol. 21: pp. 103-164,4 plates. Dec. 22, 1910.

(2) Guayule (Parthenium argentatum Gray). A rubber

plant of the Chihuahuan Desert. Carnegie Institution of Washington, Publication 139. (In press).

(3) The behavior of tannin in persimmons with some notes on ripening. The Plant World, vol. 14: pp. 1-14. 1 plate. Jan. 1911.

(4) Some Alabama Plant Diseases, Bulletin No. 32, Ala. State Department of Agriculture. (With C. S. Ridgway and H. J. Chatterton). March 15, 1910. pp. 22.

(5) "El Guayule y su propagacion." (A Review.) Am. Rev. Trop. Agri. vol. 1: pp. 251-256. Aug.-Sept. 1910.

(6) Outline for the course in Botany, in a Manual for the County High Schools of Alabama. Montgomery, Ala. 1910.

(7) Plants and the Soil. 6th Ann. Rep. Ala. Soc. Ala. State Dept. Agri. Bull. 36. pp. 129-141. 1910.

(8) On the best method of teaching High School Botany. Proc. 29th. Ann. Session Ala. Ed. Assoc. pp. 244-251. 1910.

(9) Review of Spalding's Distribution and Movements of Desert Plants. Science n. s. 31: 863-866. June 3, 1910.

Respectfully submitted,

FRANCIS ERNEST LLOYD,

Plant Physiologist.

ANIMAL INDUSTRY DEPARTMENT.

D. T. Gray.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

Two bulletins have been issued from the Animal Industry Department the past year. Bulletin 150 has to do with the question of "Raising Beef Cattle in Alabama." In bulletin 151 is found a report of the progress of the co-operative beef feeding work in Sumter County.

The work of the Department has been enlarged some during the past year, but, in the main, the experimental work continues as was reported in the last annual report. The present work of the Department may be summarized as follows:

With Swine.

1. To study the results of finishing swine by dry lot methods as compared to the method of using green pasture crops. The last three years' work is now being prepared for publication.

2. To study the subject of hardening flesh and lard after it has been rendered soft as a result of the animals' having grazed green crops.

3. To note further the toxic effort of feeding cotton seed meal to hogs.

4. To learn the effect of some of the Southern swine feeds upon the frame work of the body.

5. To determine the most profitable amount of grain to feed with such green pastures as soy beans, peanuts and rape.

6. To study the question of home-curing of meats. A new smoke house has been erected for the work.

During the year an experimental hog farm has been established in Sumter County. This part of the hog work of the Department is being done in co-operation with the Burea of Animal Industry of Washington. At the present time about 200 hogs are being used in the work.

With Beef Cattle.

The co-operative beef work with the Bureau of Animal

Industry at Washington is going forward in an exceedingly satisfactory manner. Since the last report the work has been materially broadened. A second experimental farm has been established and a trained man, Mr. L. W. Shook, is on the farm and has immediate charge of all the experimental work. The main questions involved now are:

1. To study the methods of carrying mature beef steers through the winter months, when the object is to fatten them on pasture the following summer. 125 steers are being carried through the winter at the present time.

2. To determine the profits, if any, in supplementing the summer pastures with certain cotton seed by-products in finishing cattle for the summer and fall market. Almost 200 steers were used in the work last summer.

3. To study the question of fattening calves during the winter months on dry feeds. At the present time 150 calves are being used in these tests. They will be sold in March.

4. To determine the most profitable amount of cotton seed cake to feed steers while they are being finished on pasture.

5. To compare silage, cotton seed hulls and Johnson grass hay for finishing cattle in the winter time. The test was completed last March. 60 head of cattle were fed.

6. To determine the most profitable manner of making and saving barn yard manures when cattle are fed cotton seed meal and hulls. 60 steers are being used in the test.

7. To determine the cost of raising a beef calf in Alabama. A breeding herd of about 60 cows is being used in the test.

With Sheep.

The work with sheep continues about as reported in the last annual report. The most important points under consideration now are:

1. Early lamb production.

2. A comparison of Alabama feeds, including silage, for carrying the ewe through the winter months.

Very respectfully submitted,

DAN T. GRAY.

REPORT OF THE HORTICULTURIST

P. F. Williams.

Dr. C. C. Thach,
President Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

I respectfully submit the following report for the year ending December 31st, 1910.

Adams Investigation.

This work was continued the past year and considerable progress has been made. About 2,000 crosses of promising peach varieties were made and there were 763 set fruits resulting from these crosses. About 350 of these fruits produced perfect pits. These have been planted with a view of obtaining crosses or new varieties resistant to Brown Rot. Several varieties of peaches have been placed in the new greenhouse where the temperature may be controlled during the cross pollinating work.

Greenhouse.

A new greenhouse was added during the summer, this new house being 22 x 100 feet. Three sections of this have been given up to the Adams project. Seven sections will be devoted to miscellaneous vegetable work.

Citrange Investigations.

Mr. E. W. Lumpkin, a senior, has taken up this work and from a considerable number of crosses made with pollen from grape fruit, kumquat, ruby and common sweet orange on Citrus Trifoliate, 66 matured fruits were gathered and sent to Washington where the seeds from these crosses are being germinated in the forcing houses of the Bureau of Plant Industry. There is a growing interest in these hardy citrus fruits, and we shall continue this phase of the work another season.

Hatch Experiments.

The forcing of tomatoes under glass has been continued to check the result of the previous season and a few new varieties have been added. This work has been greatly

facilitated by the erection of the additional greenhouse.

Excellent results have been obtained with variety and fertilizer tests with cabbage, Irish potatoes, beans, kohlrabi, turnips, and lettuce. This work is being duplicated and increased with a view of publishing results during the coming year.

The crops of peaches, pears, and apples have been the finest recorded during the past year.

Valuable data have been obtained in connection with the combatting of insects and fruit diseases. A bulletin is in preparation dealing with **self boiled lime sulphur and its use.**

The department purchased a small canning outfit during the summer and demonstrations were conducted at the Farmers' Summer School and with students, showing the method of canning fruits and vegetables.

Library.

Prof. R. S. Mackintosh donated to the office a splendid collection of State Horticultural Society proceedings consisting of 137 volumes. The larger number of these reports are those of the Illinois, Iowa, Wisconsin, and Missouri Soceties.

Publications.

Last spring I wrote a bulletin on pecans, which appeared as Serial No. 34 of the State Department of Agriculture.

Nursery Inspection.

I have been ably assisted in carrying on the State Nursery inspection work the past summer by the Assistant Horticulturist, Mr. J. C. C. Price, and Mr. R. U. Blasingame. This work is crowding the regular station work, and now that the boll weevil has entered the State, it will be impossible to carry out the work covering both the nursery inspecton and boll weevil regulations without additional assistance and additional funds.

The list of State nurserymen and those of other States doing business in Alabama follows:

Certificates Issued 1910-11.

I. Alabama Nurserymen.

1. Chase Nursery Co., Huntsville and Chase.
2. Rolfe Nursery Co., Huntsville
3. Oak Lawn Nurseries, Huntsville.

4. Frasier Nursery Co., Huntsville.
5. Horsh, Sugg Nursery Co., Gladstone.
6. Huntsville Wholesale Nurseries, Huntsville and Gladstone
7. J. O. Kelly & Sons Nursery Co., Jeff.
8. Welch Nursery, Madison.
9. J. P. Jones, Nursery, Fabius.
10. Cullman Nurseries, C. S. Biggers, Cullman.
11. J. H. Parker & Sons, Vinemont.
12. R. W. Pullen Nursery, Blountsville.
13. Colmant Nurseries, Birmingham.
14. Carlos Reese, Birmingham.
15. Gravlee Nurseries, Newtonville.
16. W. L. Owen, Nursery, Ashland.
17. J. B. Earnest, Roanoke.
18. Rosemont Gardens, Montgomery.
19. C. Ravier & Sons, Mobile.
20. Irvington Nursery, A. H. Daves, Prop., Irvington.
21. J. S. Gaylord, Barnwell.
22. Eagle Pecan Co., Pittsview.
23. Industrial School Gardens, Mobile.
24. Little Gem Floral Garden, Mobile.
25. Orchard Hill Nursery Co., Cullman.
26. Deer Park Nursery, Deer Park.
27. L. Thublin, Mobile.
28. J. P. Brown, Carney.
29. Wakefield Nurseries, Wm. Wake, Flomaton.
30. Eufaula Pecan Co., Eufaula.
31. Lipp Nursery, Roanoke.
32. W. D. Summerfield, Birmingham.
33. Waverly Nursery, Paul Hoffman, Waverly.
34. Roseview Nurseries, F. E. Welch, Chunchula.
35. Cusseta Nurseries, W. L. Morris, LaFayette.
36. Glen Iris Nurseries, G. E. Luffman, Birmingham.
37. Mrs. C. R. Long, Montgomery.
38. Fernhill Greenhouse, H. L. Van Trott, Montgomery.
39. E. H. Williams, Montgomery.
40. H. W. Luther, Ensley.
41. Shadrick Stephinson, Russell.
42. Joseph W. Evertts, Decatur.
43. Birmingham Landscape & Nursery Co., Elyton.

II. Alabama Dealers.

1. C. H. Kennedy, Arley.
2. Colmant Nurseries, Birmingham.
3. J. M. Joiner, Wedowee.
4. John H. Draime, Citronelle.
5. J. J. Holmes, Montgomery.
6. R. L. McCarley, Scottsboro.
7. A. B. Webb, Scottsboro.
8. W. F. Propst, Oakman.
9. E. Day, Birmingham.
10. Geo. E. Luffman, Birmingham.
11. M. M. Dawson, Montgomery.
12. Homer N. Sneed, Pronto.
13. John B. Stroud, Pass Christian, Miss.

14. G. W. DeVaughn, Prichard.
15. A. Swift, Fairhope.
16. J. B. Adams, Pass Christian, Miss.
17. A. M. Troyer, Fairhope.

III. Nurserymen Outside The State.

1. The Stark Bros., Nursery & Orchard Co., Louisiana, Mo.
2. P. J. Berckmans Co., Augusta, Ga.
3. The Frank H. Wild Floral Co., Sarcoxie, Mo.
4. Southern Nursery Co., Winchester, Tenn.
5. Pike Co. Nurseries, McElveen & McLendon, Concord, Ga.
6. H. M. Simpson & Sons, Vincennes, Ind.
7. Bluhm Nursery Company, Smithville, No. 6, Tenn.
8. Mount Hope Nursery, Moss & Allen, Smithville, Tenn.
9. Griffing Brothers Company, Macclenny, Fla.
10. The Morris Nursery Co., Westchester, Penn.
11. Tennessee Wholesale Nurseries, Winchester, Tenn.
12. Center Grove Nursery, R. L. Cantrell, Smithville No. 5, Tenn.
13. Dreer Nurseries, Henry A. Dreer, Inc., Riverton, N. J.
14. Turkey Creek Nurseries, C. F. Barber, Propr., Macclenny, Fla.
15. Commercial Nursery Co., Winchester, Tenn.
16. Munson Nurseries, T. V. Munson, Mgr., Denison, Texas.
17. Rood Pecan Groves, Albany, Ga.
18. Continental Plant Co., Kittrell, N. C.
19. T. S. Hubbard Co., Fredonia, N. Y.
20. Wild Bros. Nursery Co., Sarcoxie, Mo.
21. Concord Nurseries, Smith Bros., Proprs., Concord, Ga.
22. Excelsior Nurseries, G. H. Miller & Son, Proprs. Rome, Ga.
23. Geo. S. Josselyn, Fredonia, N. Y.
24. Upson Nurseries, A. D. Williams, Propr., Yatesville, Ga.
25. Easterly Nursery Co., Cleveland, Tenn.
26. Lewis Roesch & Son, Fredonia, N. Y.
27. W. W. Thomas, Anna, Illinois.
28. Knoxville Nursery Co., Knoxville, Tenn.
29. Simpson Nursery Co., Simpson Bros., Props., Monticello, Fla.
30. The Storrs & Harrison Co., Painesville, Ohio.
31. Old Dominion Nurseries, W. T. Hood, Propr., Richmond, Va.
32. Ellwanger & Barry, Rochester, N. Y.
33. Cedar Hill Nursery Co., Winchester, Tenn.
34. Jackson & Perkins Co., Newark, N. Y.
35. J. Van Lindley Nur. Co., Pomona and Kernersville, N. C.
36. Thomas Meehan & Sons, Dresher, Penn.
37. Biltmore Nurseries, Biltmore, N. C.
38. Perry Nursery Company, Rochester, N. Y.
39. Union Nursery Co., Smithville, Tenn.
40. Bremen Nursery, J. T. Anderson, Propr., Bremen, Ga.
41. Mount Arbor Nurseries, E. S. Welch, Propr., Shenandoah, Ia.
42. Joe Shadow Nursery Co., Winchester, Tenn.
43. M. L. Spivey, Lynnville, Tenn.
44. W. N. Scarff, New Carlisle, Ohio.

45. J. G. Harrison & Sons, Berlin, Maryland,
46. J. L. Westbrook, Temple, Ga.
47. Fallriver Nursery, Fallriver, Tenn.
48. Valdesian Nurseries, Bostic, N. C.
49. Bobbink & Atkins Nurseries, Bobbink & Atkins, Rutherford, N. J.
50. Wagner Park Conservatories, Sidney, Ohio.
51. Miner & Miner, Sheriden, N. Y.
52. Glenn Cliff Nursery, Winchester, Tenn.
53. The Toomsuba Nurseries, Toomsuba, Miss.
54. Wm. Warner Harper, Chestnut Hill, Penn.
55. The Donaldson Co., Warsaw and Sparta, Ky.
56. Summit Nurseries, Miller & Gossard, Props., Monticello, Fla.
57. Monticello Nurseries, The Standard Pecan Co., Monticello, Fla.
58. Franklin Davis Nursery Co., Mullikin, Md.
59. Smithville Nursery Co., Smithville, Tenn.
60. Oakland Nurseries, Columbia, Tenn.
61. Keltonburg Nursery, C. A. Cantrell, Smithville No. 3, Tenn.
62. Thomas Meehan & Sons, Inc., Germantown, Penn.
63. Greensboro Nurseries, Greensboro, N. C.
64. The J. Steckler Seed Co., New Orleans, La.
65. Prosperity Nursery, Redman Bros., Smithville No. 3, Tenn.
66. The Wm. H. Moon Co., Morrisville, Penn.
67. Glen Saint Mary Nurseries Co., Glen Saint Mary, Fla.
68. Cureton Nurseries, Austell, Ga.
69. C. Forkert, Ocean Springs, Miss.
70. United States Nursery Co., Roseacres, Miss.
71. Tullahoma Nursery, Tullahoma, Tenn.
72. Chattanooga Nursery Co., Chattanooga, Tenn.
73. Arcadia Nurseries, J. H. Girardeau, Jr., Prop., Monticello, Fla
74. R. A. Eubank, Prospect Station, Tenn.
75. The Bechtel Pecan Nurseries, Ocean Springs, Miss.
76. G. M. Bacon Pecan Co., DeWitt, Ga.
77. Hartwell Pecan Nurseries, S. W. Peek, Propr., Hartwell, Ga.,
78. Forest Nursery & Seed Co., J. H. Boyd, Propr., McMinnville, Tenn.
79. Peter Henderson & Co., Proprietors, Jersey City, N. J.
80. The Shenandoah Nurseries, D. S. Lake, Prop., Shenandoah, Ia.
81. Schmidt & Botley, Springfield, Ohio.
82. Will F. Halladay, Decherd, Tenn.
83. The Sneed Wholesale & Retail Nur., J. F. Sneed, Mgr., Tyler, Texas.
84. Big Four Nursery Co., L. P. Potter & Sons, Smithville, No. 1, Tenn.
85. Foster & Griffith, Fredonia, N. Y.
86. Cumberland Nurseries, Winchester, Tenn.
87. The D. Hill Nursery, Co., Inc., Dundee, Ill.
88. Pecan Grove Farm Nursery, J. B. Wright, Propr., Cairo, Ga.

89. James Brodie, Biloxi, Miss.,
90. John B. Stroud, Pass Christian, Miss.
91. Southern Nut Tree Nursery, C. A. Rouzer, Mgr., Thomasville, Ga.
92. The Ramsey Pecan Co., Ocean Springs, Miss.
93. Hoopes Bros. and Thomas Co., Westchester, Penn.
94. R. L. Eaton, Monticello, Fla.
95. Jefferson Nursery Co., Proprietors, Monticello, Fla.
96. The Corinth Nurseries, Corinth, Miss.
97. The Newton Nurseries, Newton, Miss.
98. Fairview Nursery Co., Winchester, Tenn.
99. The Peachwood Nurseries, State Line, Miss.
100. The Alvin Japanese Nur., S. Arai, Mgr., Alvin, League City & Mykawa, Tex.
101. Eastern Nurseries, Holliston, Mass.
102. B. W. Stone & Co., Thomasville, Georgia.
103. J. W. Adams & Son, Springfield, Mass.
104. Chas. R. Fish & Co. Worcester and Auburn, Mass.
105. Stuart Pecan Co., Miss W. B. Stuart, Mgr., Beaumont, Texas.
106. John Lightfoot, East Chattanooga, Tenn.
107. Barnesville Nursery Co., Stafford & Howard, Barnesville, Ga.
108. Fairview Nurseries, J. E. Sweet, Naylor, Ga.
109. The Paper Shell Pecan Nursery, LaFayette, La.
110. Spring Hill Nurseries, Peter Bohlender & Son, Tippecanoe, O.
111. German Nurseries, Carl Sonderegger, Beatrice, Nebr.
112. The American Rose and Plant Co., Springfield, Ohio.
113. The American Crescent Nursery Co., Council Bluffs, Iowa.
114. Rich Land Nurseries, Rochester, N. Y.

Yours very truly,

P. F. WILLIAMS,
Horticulturist.

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