THIRTIETH ANNUAL REPORT

OF THE

Agricultural Experiment Station

OF THE

UNIVERSITY OF TENNESSEE

FOR 1917



COWPEAS IN CYLINDER EXPERIMENTS
Soils from various parts of the State

KNOXVILLE, TENNESSEE

The Agricultural Experiment Station
OF THE UNIVERSITY OF TENNESSEE

BROWN AYRES, President

EXPERIMENT STATION COMMITTEE

BROWN AYRES — I. B. TIGRETT
SAMUEL N. WARREN — J. E. HITE
H. CLAY EVANS

STATION OFFICERS

H. A. MORGAN, Director
S. M. BAIN, Botanist
C. A. MOOERS, Chemist and Agronomist
W. G. SHAW, Veterinarian
C. A. WILLSON, Animal Husbandman
MAURICE MULVANIA, Bacteriologist
W. H. MACINTIRE, Soil Chemist
O. M. WATSON, Horticulturist
G. M. BENTLEY, Associate Entomologist
S. H. ESSARY, Assistant Botanist and Mycologist
J. F. VOORHEES, Consulting Meteorologist
L. G. WILLIS, Assistant Chemist
H. R. WATTS, Assistant Entomologist
W. A. HOLDING, Assistant Chemist
W. A. CAMPBELL, Farm Foreman
S. M. SPANGLER, Assistant in Plot Work
S. A. ROBERT, Supt. West Tenn. Exp. Station, Jackson
J. E. CONVERSE, Assistant in Cooperative Experiments, Crossville
W. N. RUDD, Assistant in Cooperative Experiments, McMinnville
C. M. HUME, Assistant in Cooperative Experiments, Murfreesboro
ROY H. MILTON, Supt. Tobacco Exp. Sta., Clarksville
O. A. CAMPBELL, Assistant in Plot Work, Jackson
F. H. BROOME, Librarian and Secretary
MISS RUBY FRANKLIN, Assistant Librarian
MISS EFFIE M. KLOSS, Stenographer

The Experiment Station building, containing the offices and laboratories, and the plant house, are located on the University campus, 15 minutes' walk from the Custom House in Knoxville. The experiment farms, the barns, stables, dairy buildings, etc., are located one mile west of the University, on the Kingston Pike. The fruit farm is adjacent to the Industrial School, and is easily reached by the Lonsdale car line. Farmers are cordially invited to visit the buildings and experimental grounds.

Bulletins of this Station will be sent, upon application, free of charge, to any farmer in the State.

LETTER OF TRANSMITTAL

KNOXVILLE, TENN., January 1, 1918.

To His Excellency, Tom C. Rye, Governor of Tennessee.

Sir: I have the honor to transmit herewith, on behalf of the Board of Trustees of the University of Tennessee, a report of the work and expenditures of the Agricultural Experiment Station for the year 1917. This report is submitted in accordance with the law requiring that the Board having direction of the Experiment Station shall annually submit to the Governor of the State a report of its operations and expenses.

Very respectfully,

BROWN AYRES, *President.*

THE UNIVERSITY OF TENNESSEE AGRICULTURAL EXPERIMENT STATION

in account with

THE UNITED STATES APPROPRIATIONS, 1916-1917

	Hatch Fund	Adams Fund
To United States Treasury Draft	$15,000.00	$15,000.00
By Salaries	9,622.50	11,735.84
Labor	1,930.95	1,501.45
Publications	223.56	
Postage and Stationery	352.76	5.95
Freight and Express	224.81	58.46
Heat, Light, Water and Power	473.57	75.67
Chemicals and Laboratory Supplies	117.36	461.52
Seeds, Plants and Sundry Supplies	498.17	77.86
Fertilizers	1.20	
Feeding Stuffs	666.80	37.91
Library	235.59	87.02
Tools, Machinery and Appliances	390.35	167.53
Furniture and Fixtures	70.37	45.97
Scientific Apparatus and Specimens	.95	522.13
Traveling Expenses	45.75	180.50
Contingent Expenses	20.00	
Building and Land	125.31	42.19
	$15,000.00	$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the University of Tennessee Agricultural Experiment Station for the fiscal year ended June 30, 1917; that we have found the same well kept and classified as above; that no balances were brought forward from the preceding year on the Hatch and Adams Funds; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2, 1887, and $15,000.00 under the act of Congress of March 16, 1906, and the corresponding disbursements $15,000.00 and $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct.

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

Signed:

BROWN AYRES,
JAMES MAYNARD,
HU L. McCLUNG,
Auditors.

(SEAL)

Attest:

WILLIAM RULE,
Custodian.

THIRTIETH ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE FOR 1917

REPORT OF THE DIRECTOR

To President Brown Ayres:

MIDDLE TENNESSEE STATION

One of the acts of the Legislature of the spring of 1917 was to authorize the establishment of the Middle Tennessee Experiment Station, the location to be determined by a committee to be appointed by the Governor. (Public Acts of Tennessee, 1917, Chapter No. 35, Senate Bill No. 728.) The county receiving the Station was to provide the land. It is very gratifying to note the number of counties competing for the Station. Maury County offered, by option, a large number of tracts. After considerable investigation and survey, the committee approved a tract lying between the Hampshire and Mt. Pleasant Pikes, just west of Columbia. The area includes 652 acres, and cost the citizens and county of Maury approximately $100,000.00. The topography and location of the farm selected are excellent for experimental effort, and are very typical of a large area of the Great Basin of Midde Tennessee.

RECENT ACHIEVEMENT

A wilt disease of tomato has caused large losses to growers in West Tennessee. The possibility of controlling this disease appears to be assured by recent investigations of S. H. Essary, Assistant Botanist of the Station. Mr. Essary has been studying this disease for several seasons, and has succeeded in obtaining strains of tomatoes highly resistant to it; so much so that a successful crop can be grown on infested land where the plants commonly grown would perish before the fruit could ripen. The securing of these resistant strains is a noteworthy achievement, of which the Station is proud.

NEW PROJECT

A new project relating to soil sulphur was added this year. Little is known about losses of this element from the soil, or when it may be needed as a fertilizer element, along with phosphorus, nitrogen, and potash. Experiments will be conducted in which use will be made of drainage tanks, so that exact records can be obtained as to the income and outgo of sulphur in the soil.

PUBLICATIONS

Three bulletins were issued during the year.

No. 117 is a practical bulletin on the control of injurious insects and plant diseases—a subject of increasing importance to all farmers and gardeners.

No. 118 gives the results of a series of experiments bearing on soil nitrogen. Four representative soils from different parts of the State were brought to Knoxville and placed in cylinders sunk in the ground. All four soils were subjected to the same treatment and cropping.

A careful record was kept of the crop yields and their nitrogen content; also of changes in the nitrogen contents of the soil under various conditions of manuring, liming, and fertilizing.

No. 119 is a practical bulletin based on extensive experiments in liming on various soils throughout the State.

Other publications by members of the staff are as follows:

"Status of the Problem of Lime Requirement," by W. H. MacIntire. Jour. of Ass. of Off. Agr. Chem., Vol III, No. 1, pp. 144-149, May, 1917.

"The Divergent Effects of Lime and Magnesia upon the Conservation of Soil Sulfur," by W. H. MacIntire, L. G. Willis, and W. A. Holding. Soil Science, Vol. IV, No. 3, pp. 231-236, 1917.

"A Rapid Method for the Determination of Lime as Calcium Sulfate,' by L. G. Willis and W. H. MacIntire. Jour of Ind. and Eng. Chem., Vol. 9, No. 12, pp. 1114-1116, December, 1917.

Respectfully submitted,

H. A. MORGAN, *Director.*

REPORT OF THE ANIMAL HUSBANDMAN

Following is the report of the Animal Husbandman for the year 1917. Investigational work was conducted with horses, beef cattle, dairy cattle, and swine.

AT THE KNOXVILLE STATION—Horses: The Percheron Foundation stud is being used to demonstrate to the farmers the feasibility of producing horses of this type in Tennessee, and also the use of draft horses of this type for the production of mules. Experiments were also conducted on the feeding of velvet bean meal to determine the limitations of this feed for horses.

Beef Cattle: The experiments to determine the relation to the yield per acre of various crop rotations when fed to steers were completed during

the year. An experiment was also conducted with velvet bean meal as compared with cottonseed meal for finishing steers. The following rations were used:

Group I.	Velvet bean meal	9 lbs
	Soybean stover	5 lbs.
	Silage, ad libitum	
Group II.	Cottonseed meal	6 lbs.
	Soybean stover	5 lbs.
	Silage, ad libitum	

Sixteen steers were used with the first group and eight steers with the second group. The average daily gain with Group I was 1.89 pounds, and with Group II, 2.27 pounds. The average amount of velvet bean meal required to produce a pound of gain was 4.70 pounds, and the average amount of cottonseed meal was 2.67 pounds.

Dairy Cattle: Experiments were conducted in the feeding of velvet bean meal to dairy cattle. It was found that this could be successfully fed to dairy cattle if care were taken to mix the meal well with the silage at the time of feeding.

Hogs: Experiments were conducted in the feeding of velvet bean meal to hogs. As but little was known regarding its feeding value for this class of animals, the work done was more in the nature of an exploration. The conclusions were:

1. That it could not be fed to hogs alone, because it was unpalatable to them.

2. That with the hogs it could not well make up more than one-third of the grain ration.

3. That the hogs consumed it best when buttermilk was used with the velvet bean meal and ground corn.

At the West Tennessee Station—Horses: Progress can be reported on the Percheron Foundation stud and the work that is being done in the production of purebred Percherons and in the production of mules with Percheron mares.

Shorthorn Foundation Herd: In the winter of 1916-17, a cooperative breeding experiment was begun with the N., C. & St. L. Railway, looking to the establishment of a Shorthorn beef herd that should possess both the thick-set, blocky beef type and the milking qualities of the Milking Shorthorn. The Railway purchased eight females and one bull of the thick-set type, and the Experiment Station purchased a foundation herd of Milking Shorthorn families and type. Progress can be reported on this experiment.

Cooperative Steer-Feeding Experiments—During the winter of 1916-17, experiments were continued with a view to determining the best rations

for wintering stocker steers on the Plateau. The following rations were used:

Group I. Silage 15 lbs.; cottonseed meal 2 lbs.
Group II. Hay 10 lbs.
Group III. Silage 10 lbs.; cottonseed meal 1½ lbs.
Group IV. Silage 10 lbs.; cottonseed meal ¾ lb.

In these experiments, the groups on silage and 1 to 2 pounds of the meal made greater gains for the whole year than did the other groups.

Respectfully submitted,

C. A. WILLSON, *Animal Husbandman.*

REPORT OF THE BOTANIST

Pear Blight Experiments: As previously reported, the design in this project was to study the pear blight more carefully than has yet been done, and to select individual trees resistant to the disease, with a view to eventually obtaining a resistant variety or varieties of a quality suitable for commercial uses. Many more seedlings were obtained and inoculated with the disease organism. The seedlings showing resistance last year still appear to be resistant. A few of the new seedlings show the same resistance. This work is being carried on in cooperation with the Horticultural Department of the Station.

Clover Experimens: Further observations indicate that the anthracnose disease of red clover has become very rare in the State. The resistant variety of clover produced at the Station is being used extensively. Very little trouble from this disease in the future is anticipated.

Spirogyra Experiments: The continued illness of the Botanist during the year prevented further work on the Spirogyra experiments, and this project is being held in abeyance for the present.

The balance of this report concerns the work of Mr. S. H. Essary, Assistant Botanist.

Tomato Wilt Control: During 1917, two lines of work in connection with the control of tomato wilt disease were carried on.

1. Field Work. Furher tests were made, under field conditions, of the wilt-resistant strain previously reported. Seed were sent out to a number of sections where Fusarium wilt is especially bad. In every case from which report has been received the results have been very satisfactory. Seed from 20 plants, considered best in all respects in our 1916 plots, were

planted, in rows of 61 plants each, on the West Tennessee Experiment Station farm. From these, the best plants were again selected for next year. A large quantity of seed has been distributed already for the 1918 crop. The strain has been greatly improved by selection, as to earliness and other desirable qualities. The same line of work is to be pursued in 1918.

2. Greenhouse and Laboratory Work: A suitable cold-frame, which can be converted into a hothouse, has been built on the University grounds. In this, a number of strains of Fusarium, isolated from wilted tomato plants in different sections of the State, have been tested, as to pathogenicity, upon different susceptible varieties of tomatoes, grown in sterilized soil in pots. Each strain has been recovered in pure culture from plants showing typical symptoms of Fusarium wilt disease. These five strains, one each from Jackson, Gibson, and Nashville, and two from Knoxville, and many others obtained in pure culture from other plants, are being studied in the laboratory as to their morphological and cultural characters.

Sterile tomato seedlings, grown on agar, in flasks, have been inoculated with pure cultures of the five strains of Fusarium above mentioned. An effort is being made to determine the methods by which the parasite gains an entrance into the host plant. Further studies to determine differences between resistant and non-resistant strains, as to infection under like conditions, are being carried on at the close of the year.

Japan Clover Studies: During the season of 1917 further progress has been made in the study of several strains of *Lespedeza striata* found and previously reported. The various strains were again grown in rows and plots for comparison as to habits. The new upright strains again proved their superiority over the strains of flat growth. Where grown in plots, under field conditions, an upright strain produced a little over one-third more dry hay per acre than the best of flat strains. This was the most notable result of the season. A very early frost cut off seed production, so that no very definite results were obtained in this phase of the project. Enough seed was obtained to continue the work during 1918.

As previously reported, efforts to cross *L. striata* with other species of Lespedeza have not so far been successful. A few seedlings of crosses have been obtained, but they have failed to live. Further efforts at hybridizing will be made in 1918. Many native species of Lespedeza are being grown for this purpose. A study of the inoculation of the roots of the different species, and the organism connected with it, is to be one main feature of the work during 1918.

Respectfully submitted,

S. M. BAIN, *Botanist.*

AT KNOXVILLE STATION—Much the same lines of work have been followed the past year as in 1916. The seasons were, in general, favorable, but practically all the small grains in variety trials were lost as the result of exceptionally severe cold weather in February.

Some attention was given to the production of early-maturing velvet beans when planted with corn. Several varieties, such as Early Speckled and Georgia, have been found to mature readily here, but the question of their profitable production, as compared with soybeans, etc., is unsettled. Much more extensive trials were begun in 1917 than have been conducted here at any previous time.

About 20 new varieties of soybeans received from the U. S. Department of Agriculture were given a preliminary trial. None appeared of outstanding promise, but the best selections were reserved for trial the coming year.

The selection of rye for better fruiting strains was continued. Also further selections of tall oat grass were made. A small amount of select winter beardless barley was obtained, and its further increase will be pushed as rapidly as possible.

Grimm alfalfa has done nearly as well as common western seed, but appears to possess no advantage over it. In fact, the high price of Grimm seed is prohibitive. A considerable portion of Peruvian alfalfa has survived for two winters, the last one very severe. The possibility of seeding the crop in the spring, and so getting either a valuable crop for a single season or a good permanent stand, is being considered.

Several selections of lotus plants have been received from the U. S. Department of Agriculture, and have been transplanted both on the Station farms and elsewhere.

The cowpea-wheat, cowpea-corn, and five-year-rotation experiments have been continued for the twelfth season with satisfactory results.

Bulletin No. 119, entitled, "Ground limestone and prosperity on the farm," was published this year. It gives a summary of the results of field experiments conducted in various parts of the State, and contains some practical suggestions in regard to home-grinding, methods of application, etc. The general conclusion is reached that liming offers "more immediate and greater rewards to the Tennessee farmer than any other simple resource at his command."

AT WEST TENNESSEE STATION—The work at the West Tennessee Station has progressed satisfactorily, as in the past. Considerable attention has been given to variety trials, to methods of soil preparation, and cultivation for different crops, and to soil fertility questions. Under the last head are included a comparison of different crop rotations and the value of green-manure crops, lime, and fertilizer.

Cooperative Experiments—The cooperative field experiments, on the various farms operated by the N., C. & St. L. Railway, are being very satisfactorily carried out; much more so than is possible on privately owned farms.

Other lines of cooperative work with the farmers are being prosecuted much as in the past. In addition to a soil map of Rutherford County, completed last year, a good start has now been made in determining the special requirements of Rutherford County soils.

Work at the Tobacco Station, at Clarksville, continues to be well carried out under the energetic supervision of Mr. R. H. Milton, Superintendent.

Chemical Work—As in the past, a considerable number of samples of limestone have been examined, and the per cent of purity determined, for farmers desiring to grind the rock for fertilizer use. In this work, 68 counties of the State have been represented, and usually a number of samples have been received from each county.

Miscellaneous chemical work has been done as usual, such as analyses of feeding stuffs, soils, and fertilizers. Much of the chemical work is done under Adams Fund projects, and is under the supervision of the Soil Chemist, who is in charge of the laboratory.

Adams Fund Projects—Humus and Nitrogen Investigation: The lines of work outlined in previous reports of this Department, as related to humus and nitrogen studies, have been continued. Sixty-two rims have been added to our outdoor experimental series. Each rim is 1/10000 acre in surface area, and will hold about 200 pounds of soil. These additional rims are being used to supplement the original plans, and in particular to follow up certain problems relating to changes in the nitrogen content of the soil suggested by the results of the "cylinder" experiments begun in 1909.

Bulletin 118: The results of the first five years of "cylinder" experiments have been published in Bulletin 118, under the title, "A study of the nitrogen economy of certain Tennessee soils." The major conclusions reached may be summarized as follows:

1. The utilization of nitrogen from different manurial sources varies greatly with different soils.

2. The nitrogen content of crops grown on different soils may be appreciably influenced by the kind of soil.

3. Increased crop production results in appreciable conservation of soil nitrogen, a conservation much greater than can be accounted for by the increase in crop residues.

4. Manurial treatments result in changes in soil nitrogen, due in some instances to the effect of the material applied *per se,* as in the case of lime, which, under bare fallow, results in an increased loss of nitrogen, and in others to the conservation brought about by the crop increase. The latter

factor may, as in these experiments, more than offset the loss of nitrogen induced *per se* by liming, nitrating, etc.

5. Only one soil of the four investigated appeared to get appreciable quantities of nitrogen from the atmosphere, the soil supply showing little diminution in the five-year period under continuous cropping in non-legumes.

REPORT OF THE SOIL CHEMIST

The work in soil chemistry during the past year has been in large part directed toward the development of the several phases of the lime and magnesia assimilation, transformation, and leaching studies, and their influences upon the more important soil components. Particular attention has been given to the absorption of lime and magnesia and the carbonation of these materials. The atmospheric condition of the lysimeters has also been studied to some extent.

A study of the differential effects of different forms of lime and magnesia upon the outgo of sulphur in the tanks installed in 1914 has led to the addition of 22 lysimeters, to be used in a more comprehensive experiment, directed particularly toward an investigation of the sulphur problem, in so far as it is influenced by the several forms of the earthy alkalis. This has necessitated a periodic examination of the abnormal sulphur contents of the local rainfall.

Considerable work was also directed to the development of an accurate method for the determination of lime, which would be adapted to both rapid and accurate determination of the heavy amounts and wide variations encountered in the lysimeter leachings. This method was published in the Journal of Industrial and Engineering Chemistry, Vol. 9, No. 12, p. 1114. A preliminary report as to the divergent effects of lime and magnesia upon loss of sulphur as sulphates appeared in Soil Science for September, Vol IV, No. 3.

Considerable work was also done by Mr. F. W. Bouson, a graduate assistant, upon the problem of dolomite absorption by soils. The work was necessarily discontinued for the time being, owing to the departure of Mr. Bouson, but valuable preliminary data were obtained, and it is hoped that the problem may later be carried to completion.

In addition to the foregoing, the Soil Chemist has served during the past year as Referee for "Lime Requirement" for the Association of Official Agricultural Chemists. Considerable work was done in this connection in collaboration with the Michigan Station, the University of California, the Bureau of Plant Industry, and the Leather and Paper Laboratory of the Bureau of Chemistry, Department of Agriculture, in studies of the fundamentals of lime absorption, particular attention being directed toward the consideration of the effect of controlled conditions upon the speed of reaction and extent of absorption and the influence thus exerted upon

soap solutions, and tobacco extracts. Nicotine sulphate, 40 per cent, with the addition of soap as a sticker, afer the following formula, has proved most successful: One ounce nicotine sulphate, 40 per cent; 8 gallons water; and ½ pound soap.

Sprayers and Accessories: Upon the appearance of new types or modifications of spray mechanics, equipment has been secured and thoroughly tested, and the principle of operation and the material used in construction have been investigated.

The Honey Bee: A line of experiments has been conducted with the three-banded Italian honey bees in the Station apiary, with particular attention to a comparison of weak and strong colonies in the prevention of robbing, and the keeping out of ants, roaches, and the bee moth.

Publication: Bulletin No. 117, "Suggestions for the control of injurious insects and plant diseases," was issued by this Department during the year.

Respectfully submitted,

G. M. BENTLEY, *Associate Entomologist.*

REPORT OF THE ASSISTANT LIBRARIAN

Bound volumes	5,483
Accessions during the year	147
Purchased	27
Obtained by exchange and gift	48
Bound by the Station	72
Volumes complete, ready for binding	98
Journals subscribed for	43
Agricultural papers received in exchange for bulletins	91

Respectfully submitted,

RUBY FRANKLIN, *Assistant Librarian.*