

THIRTY-THIRD ANNUAL REPORT  
OF THE  
Agricultural Experiment Station  
OF THE  
UNIVERSITY OF TENNESSEE  
FOR 1920

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SWEET CLOVER ON A POOR, ROCKY HILLSIDE ON THE CUMBERLAND PLATEAU  
The soil was limed and phosphated and the seed were inoculated.

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KNOXVILLE, TENNESSEE

# Agricultural Experiment Station

## UNIVERSITY OF TENNESSEE

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H. A. MORGAN, President

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### EXPERIMENT STATION COMMITTEE

W. S. SHIELDS

W. P. COOPER

T. W. HUNTER

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### STATION OFFICERS

H. A. MORGAN, Director  
C. A. MOOERS, Vice-Director, Agronomist  
C. A. WILLSON, Animal Husbandman  
W. H. MACINTIRE, Soil Chemist  
G. M. BENTLEY, Associate Entomologist  
S. H. ESSARY, Botanist  
C. E. ALLRED, Agricultural Economist  
C. D. SHERBAKOFF, Plant Pathologist  
S. MARCOVITCH, Assistant Entomologist  
W. M. SHAW, Assistant Chemist  
J. B. YOUNG, Assistant Chemist  
S. M. SPANGLER, Assistant in Plot Work  
S. A. ROBERT, Supt. West Tenn. Exp. Station, Jackson  
C. M. HUME, Actg. Supt. Middle Tenn. Exp. Station, Columbia  
J. E. CONVERSE, Assistant in Cooperative Experiments, Crossville  
H. W. JONES, Assistant Tobacco Exp. Station, Clarksville  
H. P. OGDEN, Assistant in Cooperative Experiments, Murfreesboro  
R. L. LONG, Assistant in Plot Work, Jackson  
F. H. BROOME, Secretary  
MISS RUBY FRANKLIN, Assistant Librarian  
MISS CARRIE M. MONDAY, Stenographer

The Agricultural Building, containing the offices and laboratories of the Experiment Station, the College class rooms, and the headquarters of the Division of Extension, is located at the University farm, on Kingston Pike, about one mile west of the University. Farmers are cordially invited to visit the building and experimental grounds.

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

# LETTER OF TRANSMITTAL

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KNOXVILLE, TENN., January 1, 1921.

*To His Excellency, A. H. Roberts, 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 1920. 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,

H. A. MORGAN, *President.*

# THE UNIVERSITY OF TENNESSEE AGRICULTURAL EXPERIMENT STATION

in account with

## THE UNITED STATES APPROPRIATIONS, 1919-1920

|                                          | Hatch Fund  | Adams Fund  |
|------------------------------------------|-------------|-------------|
| To United States Treasury Draft .....    | \$15,000.00 | \$15,000.00 |
| By Salaries .....                        | 9,896.73    | 11,739.54   |
| Labor .....                              | 1,004.56    | 647.10      |
| Publications .....                       | 88.29       |             |
| Postage and Stationery .....             | 423.46      | 45.35       |
| Freight and Express .....                | 97.88       | 120.23      |
| Heat, Light, Water and Power .....       | 591.64      | 323.26      |
| Chemicals and Laboratory Supplies .....  | 10.80       | 960.70      |
| Seeds, Plants and Sundry Supplies .....  | 556.63      | 129.46      |
| Fertilizers .....                        | 30.00       |             |
| Feeding Stuffs .....                     | 81.08       |             |
| Library .....                            | 315.95      | 114.07      |
| Tools, Machinery and Appliances .....    | 733.25      | 118.25      |
| Furniture and Fixtures .....             | 494.40      | 60.10       |
| Scientific Apparatus and Specimens ..... |             | 404.43      |
| Traveling Expenses .....                 | 110.19      | 127.13      |
| Building and Land .....                  | 565.14      | 210.38      |
| Totals .....                             | \$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, 1920; 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:

W. S. SHIELDS,  
T. A. WRIGHT,  
H. A. MORGAN,

*Auditors.*

(SEAL)

Attest:

THOS. D. MORRIS,  
*Custodian.*

# THIRTY-THIRD ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE FOR 1920

## REPORT OF THE VICE-DIRECTOR

*To President H. A. Morgan:*

### CHANGE IN STATION ORGANIZATION

Since the establishment of the Agricultural Experiment Station at the University of Tennessee, there have always been members of the Station staff who taught in the regular University courses. There were certain advantages to the University in this arrangement, especially in the earlier years, when the only members of the faculty who were fitted to teach purely agricultural subjects were on the Station staff. With the increase in funds the University became able to employ teachers of agricultural subjects. Beginning July 1 of this year, practically every member of the Station staff was employed to devote full time to Station work. This change is expected to be of material benefit to the experimental and investigational work.

Under the present arrangement the number of departments in the Station was necessarily reduced. Those which were considered to be best organized, or essential at this time, were retained. They are as follows:

1. Agronomy.
2. Soil Chemistry.
3. Botany and Plant Pathology.
4. Entomology.
5. Agricultural Economics.

It is hoped to strengthen the weaker departments and to add new ones, especially in animal husbandry and horticulture, as soon as increased funds will permit.

### NEW DEPARTMENT

Attention is called to the Department of Agricultural Economics, which has recently been added to the Station, and which is expected to furnish accurate and much-needed information in regard to agricultural conditions in the State. The Agricultural Economist, Prof. C. E. Alfred, is well prepared by training and experience for work of this kind. His report summarizes the conditions and objects in view, as well as the beginning that he has made.

## INCREASED FACILITIES

The purpose of the Experiment Station is to investigate, and as far as possible solve, agricultural problems peculiar to the State. One of our great problems is that of soil fertility. For that reason the Station has always given it much attention, as may be seen from the articles and bulletins published. The special requirements for the various large soil areas have been learned from field experiments. In addition, the investigations made possible through the chemical laboratory have been actively carried on. This Station in 1909 began soil work in a special manner by the use both of cylinders sunk in the ground and of lysimeters. These lysimeters, or tanks, in which soil can be placed and crops grown, and which are provided with outlets and receptacles for retaining all the water that leaches through, were designed to permit a more thorough study of soils and subsoils than anything of the kind, either in this country or abroad. The chief difference between these and other lysimeters lies in their variation of one to six feet in depth, thus allowing of fractional studies, so to speak, of the changes that take place in the movement of water and of the more soluble elements of plant food in the soil, in particular the elements nitrogen and lime. Since Dr. W. H. MacIntire became a member of the staff as Soil Chemist, in 1912, the investigation of lime problems has received increased attention, and decided progress has been made in understanding the chemical changes that take place in both lime and magnesia when applied in burnt form; also their effect on the outgo of potassium and sulphur.

Recognizing the value of this work, the National Lime Association arranged with the Station to extend further the lime investigations under Dr. MacIntire, and agreed to donate approximately \$10,000.00 over a five-year period, beginning in 1920. The amount received this year was \$1,800.00. The Southern Agricultural Limestone Association supplemented the project with a gift of \$1,500.00, which was used in installing a new set of lysimeters. The interest thus expressed by these Associations is highly appreciated.

## NEW PROJECTS

Diseases affecting farm and garden crops are becoming more and more important. A common belief among station men is that it is only a matter of time when all the plant diseases now found scattered throughout the world will be transported to the United States, and that all those adapted to our climatic conditions will have to be reckoned with. This Station has in the past given attention to plant diseases, especially while Prof. S. M. Bain was Botanist. For some years the low yield of wheat in this State has been a matter of much concern to both the farmers and the millers. The Station has studied the subject from the point of view of soil fertility, varieties, and cultural methods, but the role of plant diseases has not been investigated sufficiently.

## CHANGES IN THE STAFF

This year the Station was fortunate in getting the services of Dr. C. D. Sherbakoff, for several years the efficient Associate Plant Pathologist of the Florida Station. Dr. Sherbakoff has exceptionally high standing in his specialty, and is expected to be a valuable addition to the Station staff. He has both a B. S. and a Ph. D. degree from Cornell University. One of his projects will relate to the diseases of wheat and the other to Fusarial diseases in general, with special reference to this State.

Mr. S. Marcovitch, Assistant Entomologist, comes to us by transfer from the office of Prof. G. M. Bentley, State Entomologist. Mr. Marcovitch is a graduate of Cornell University, 1914, with the Degree of B. S., and of the University of Minnesota, 1916, with the degree of M. S. He was Assistant Entomologist in Minnesota until 1917. From 1917 to 1919 he was in charge of biology at the National Farm School, Philadelphia. He came to Prof. Bentley's office in 1919.

Mr. W. M. Shaw comes from the University of Minnesota, where he obtained a B. S. Degree in 1916 and an M. S. degree in 1917. He made an excellent record as Assistant in Soils at the Minnesota Station.

Resignations: Mr. H. R. Watts, Assistant Entomologist, June 30, and Mr. F. J. Gray, Assistant Chemist, April 1. Both men resigned to go into commercial work. The Station is sorry to lose their services, both being well trained and efficient in their respective lines.

Transferred to full time in another department of the University: Dr. L. R. Hesler, Prof. M. Mulvania, Prof. O. M. Watson.

Added to the staff: Dr. C. D. Sherbakoff, Plant Pathologist, from September 1; S. Marcovitch, Assistant Entomologist, from October 1; W. M. Shaw, Assistant Chemist, from August 1; H. P. Ogden, Assistant in Cooperative Experiments, at Middle Tennessee State Normal School, Murfreesboro, from July 1; S. M. Spangler, Plot Assistant, from Jan. 1; C. A. Mooers made Vice-Director and Agronomist July 1.

## PUBLICATIONS

No regular bulletins were issued this year, but the following publications appeared from members of the staff:

Report on the Lime Requirement of Soils, by W. H. MacIntire. Jour. of the Asso. of Off. Agr. Chem., Vol. IV, No. 1, pp. 108-123, August 15, 1920.

Planting Rates and Spacing for Corn Under Southern Conditions, by C. A. Mooers. Jour. of the Am. Soc. of Agron., Vol. 12, No. 1, pp. 1-22, January, 1920.

The reports of the various departments follow, and give a somewhat detailed outline of their activities.

Respectfully,

C. A. MOOERS, *Vice-Director and Agronomist.*

## REPORT OF THE AGRICULTURAL ECONOMIST

The Department of Agricultural Economics, of the Agricultural Experiment Station, and of the College of Agriculture, of the University of Tennessee, was organized September 1, 1919. Previous to that time no investigational work in agricultural economics had been done by the Tennessee Station, and practically no work of that nature had been done in this State by the U. S. Department of Agriculture, though it had done considerable work in surrounding states which were in position to cooperate.

### 1. ORGANIZATION AND PRELIMINARY STUDIES

The last part of 1919 and the first part of 1920 were spent in organizing the Department, and making plans for its development.

1. A complete outline was made of the work being done in agricultural economics in every state in the Union, and this tabulated for study.

2. An analysis was made of the subject matter of agricultural economics, its boundaries defined, and its larger problems silhouetted against the background.

3. Plans were made for the investigational work to be done by the Department during the coming year.

4. At about this time the Office of Farm Management and Farm Economics of the U. S. Department of Agriculture called a conference to outline the work which it could best carry on, in the various states, in land economic problems. A careful study was made of the land problem in Tennessee; so far as possible with the data and time available, the most important problems were outlined and taken to Washington and presented at the conference.

5. The Committee on Agriculture, of the Tennessee State Bankers' Association, asked for help, and to assist them three things were done:

(a) A study was made of the work which has been done by similar committees in all of the other states, and these activities tabulated.

(b) Suggestions were made as to the lines of work which the Committee might find it desirable to undertake in Tennessee.

(c) A blank was prepared for the use of member banks in collecting certain data on farm tenancy which the Committee desired to secure, these data to be tabulated and interpreted by this Department.

6. The National Child Welfare Association desired to make a survey in Tennessee, one section of the survey to be devoted to rural conditions. It was pointed out to the man in charge of that section that to be of real value the study must be based on a survey of actual rural conditions in the State. The Division of Extension agreeing to bear half of the expenses, a brief economic and social survey was made of thirteen representative communities in the State. Assistance was rendered by this Department in planning the study, preparing the blank, and making out the list



of tabulations to be made. This material has been tabulated and is now on file in this Department, and a summary of it will be published by the Association.

7. When the Department was established there was no adequate reference library on agricultural economics either in the Experiment Station or University library, and apparently but a very small fund was available with which to secure one. Without such a library, however, it is impossible to do the best work. Considerable attention has, therefore, been devoted to developing such a library and to classifying it for reference purposes. To date about three hundred reference books and about fifteen thousand bulletins have been received, and about twelve thousand of the bulletins indexed. Files of economic journals, and monographs, are also being accumulated and classified. About \$350.00 of personal funds have been expended in this way.

## II. MAIN LINES OF RESEARCH

1. In cooperation with the Office of Farm Management and Farm Economics of the U. S. Department of Agriculture, an economic and social survey was planned of land ownership and tenancy in a typical county in the Central Basin. Williamson County was chosen, a very complete schedule containing over three hundred questions was worked out, and the field work completed early last fall. The data are now being tabulated at Washington.

2. A study similar to that made in Williamson County was planned for a typical county in West Tennessee. Madison County was chosen, and the field work has been completed. This study was also made in cooperation with the Office of Farm Management and Farm Economics, and the schedules are now being tabulated by that Office.

3. A study of the relation of tenancy to kind and character of farming was undertaken in cooperation with the Committee on Agriculture of the Tennessee Bankers' Association. That Committee failing to secure the cooperation which it had expected from member banks, the burden of securing the data, and of tabulating it, fell on this Department. Over 230 reliable schedules were obtained, and the work of tabulating the material is well advanced.

4. To determine the possibilities, means, and methods of acquiring ownership of a farm in Tennessee, a special study was undertaken. Records on over 600 typical farms were secured, and the work of tabulating the data is now almost completed.

5. A study of farms for sale has been made. This includes the location, topography, character of soil, character of buildings, distance to town, church and school, reasons for selling, etc. About 235 records were secured in this study and tabulation of the data has been completed.

6. Using the Census figures as a basis, a careful study has been begun of tenancy in relation to various factors in different parts of the State. The Census reports, as published, are raw material for the agri-

cultural economist, and to be of any value to farmers must be carefully analyzed and interpreted. This mass of material is a mine of valuable information, and after the 1920 Census is published it is planned to develop this study further.

### III. MISCELLANEOUS ACTIVITIES

1. For the President of the University a thorough study was made of the available statistical information on the resources of Tennessee. This included a statement of these resources, a comparison of agriculture with other industries, agricultural possibilities of the State, and an estimate of what it would mean to the State if these resources were well developed. This has been completed.

2. Another study undertaken at the request of the President of the University was of the production and exportation of each kind of mineral from the State. To secure this, a careful tabulation was made of all available statistics gathered from various sources, and these supplemented by the latest information obtainable from the various Bureaus concerned, at Washington. Completed.

3. To assist Dr. Jarvis, of the U. S. Bureau of Education, who was making a study of the needs of the University, we were called upon to gather certain data. These included the total wealth of the State, distribution of this wealth, taxes collected, the number of physicians, dentists, pharmacists, veterinarians, and nurses in the State, and annual number needed to keep up the supply, etc. Completed.

4. In cooperation with the Division of Extension of the University a study was made of the marketing problems, as regards dairy products, in one of the inaccessible counties of Middle Tennessee. Several days were spent there studying the situation, and as a result the Division of Extension is now endeavoring to establish cooperative cheese factories in two communities in that county.

5. Considerable correspondence has been necessary in order to clear up certain points in the records being studied, secure specimens of farm leases being used in the State, perfect and carry out cooperative arrangements, and reply to inquiries sent in by farmers.

### IV. NEEDS AND PROSPECTS

1. Further studies of tenancy in other sections of the State. The hope has been expressed that we may soon make studies in (a) the Clarksville tobacco section, (b) the Highland Rim, (c) East Tennessee. The Office of Farm Economics has offered further cooperation in making (a) other studies of farm tenancy and (b) a study of land utilization on the Cumberland Plateau.

2. Farm management surveys should be made at once in various sections of the State to learn the principles and factors which control profits in farming in each section.

3. There is a need, and a demand on the part of farmers, for in-

formation on cost of production in this State. Efficiency and the lowering of farm costs become extremely important if profits are to be made when the prices are low for farm products.

4. At present only half of the time of one man is available for investigational work. The gathering of reliable data, tabulating it, and interpreting it properly, take a great deal of time. We have only one-sixteenth as many men in the Department as are to be found in a similar department in another state. The addition of one more man, either full-time or half-time, would be a great help in serving the needs of the State.

5. Clerical and stenographic help is badly needed. In tabulating data, much of the work requires time rather than technical knowledge, and a competent clerk is needed to do work of this kind, none at present being available. In attending to correspondence it has been found expedient during the past year, also, to write the letters in long hand in order to get them off quickly, the one available stenographer being overloaded and frequently far behind with her work.

6. Tabulating machines, filing cabinets, and office equipment are far from adequate. If up-to-date equipment of this kind could be secured the efficiency of the Department would be considerably increased.

Respectfully submitted,

C. E. ALLRED, *Agricultural Economist.*

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## REPORT OF THE AGRONOMIST

### HATCH FUND PROJECTS

The general projects in Agronomy, under the Hatch Fund, do not change materially from year to year. They include fertility and liming experiments, varietal trials of farm crops, plant improvement by selection and breeding, and the study of cultural methods. Much of the preliminary experimental work of this character is done at the University farm, and the findings of possible value are then tried out in other parts of the State. The specific projects now in force may be summarized as follows:

1. Varietal trials with various farm crops, such as corn, wheat, oats, soybeans, and vetch.
2. Green-manuring experiments, with cowpeas in particular.
3. Liming and fertilizer experiments, including a comparison of different phosphates.
4. Tillage experiments with corn: (a) soil preparation; (b) methods of cultivation.
5. Date of-planting trials with various crops, corn in particular.
6. Rate-of-planting experiments with both corn and soybeans.
7. Improvement of certain crops by selection.

8. Improvement of wheat by hybridization and selection—in cooperation with the Bureau of Plant Industry, Cereal Investigations.

9. The effect of the cowpea crop on soil fertility, with special regard to (a) wheat crop following, and (b) corn crop following. A study of the nitrogen content of the soils used is included.

10. Sweet clover versus red clover as a legume for pasture purposes—a cooperative pasture experiment with the Bureau of Plant Industry, Forage Crop Investigations.

11. Influence on stand and yield of both time and height of cutting of sweet clover.

12. Experiments to determine the best place for the application of farmyard manure in a standard five-year crop rotation.

13. A study of the comparative returns from manure applied immediately prior to (a) the seeding of wheat and (b) the seeding of cowpeas, in a cowpea-wheat rotation.

14. The changes in the nitrogen content of the soil under various conditions, such as limed, unlimed, fallow, and with and without green-manure crops.

15. Fertility experiments in a five-year rotation.

16. Trials of new legumes for hay and pasture, such as Hubam sweet clover, Ladino white clover, and lotus.

Many data have been obtained, and it is hoped to publish at an early date such conclusions as appear justifiable.

A variety of soybeans known as "Easy Cook", sent us, along with others, by the U. S. Department of Agriculture, has recently been tried, and appears to have considerable possible value as a food plant to take the place of our common navy beans. The latter yield poorly in our climate, and only under exceptional conditions can be considered really profitable. The varieties of soybeans commonly grown are cooked with difficulty and are not especially palatable. The Easy Cook variety, on the other hand, cooks quickly and is of excellent quality for table use. It seems to be a good yielder of both seed and hay, certainly far ahead of any kind of navy bean.

#### MIDDLE TENNESSEE COOPERATIVE EXPERIMENTS

The Middle Tennessee Cooperative Experiments are being continued at three main points; Murfreesboro, in cooperation with the State Normal School; Clarksville, in cooperation with the U. S. Department of Agriculture, Office of Tobacco Investigations; and Crossville, on the farm of Jas. Smith. Each place has its representative types of soil and its peculiar problems. The projects in force may be summarized as follows:

1. A comparative study of various crop rotations.
2. A field comparison of various forms of lime, also rate-of-liming experiments.
3. Effect of various systems of cropping on the yield and quality of

dark-leaf tobacco—cooperative with the Bureau of Plant Industry, U. S. Department of Agriculture.

4. Fertility experiments with tobacco—cooperative with the Bureau of Plant Industry, Tobacco Investigations: Object, to determine the effects of various fertilizers, used singly and in combination, on the yield and quality of tobacco.

5. Study of the fertilizer and lime requirements of Rutherford County soils.

6. Varietal trials of various farm crops.

7. Time-of-application experiments with nitrate of soda, for (a) corn and (b) cotton.

8. Date-of-planting experiments with the small grains—wheat, oats, and barley.

9. The comparative values of different phosphates, as determined by field experiments.

10. The soil need of (a) sulphur and (b) magnesia.

11. The most profitable amount of phosphate for use on general farm crops.

12. The comparative pasture value of certain new legumes—Ladino white clover, lotus, sweet clover.

#### WEST TENNESSEE STATION

The field plot work in soils and crops at the West Tennessee Station is more extensive than that done at any other one point in the State. The land lies well for experimental purposes and the types of soil are representative of large areas of West Tennessee.

Following is an enumeration of the more important projects in force:

1. A comparative study of various crop rotations.

2. A field comparison of various forms of lime; also rate-of-liming experiments.

3. Effects of various crops as soil improvers, such as cowpeas, lespedeza, alfalfa, sweet clover, red clover, tame grasses.

4. Tillage experiments with corn and cotton to determine best depths of plowing and cultivation.

5. Varietal trials of various farm crops.

6. Date-of-planting experiments with corn, cotton, and the different small grains.

7. Time-of-application experiments with nitrate of soda on (a) corn and (b) cotton.

8. Rate-of-planting with both corn and cotton.

9. Thinning experiments with cotton.

10. Effect of corn stalks turned under on a following wheat crop.

11. Experiments in growing cotton without hand-hoeing.

12. The improvement of lespedeza by selection.
13. The value of farmyard manure in a crop rotation both with and without lime and commercial fertilizers.

### ADAMS FUND PROJECTS

Three Adams Fund projects in Agronomy are in active operation:

1. Humus investigation.
2. A study of the nitrogen economy of the soil.
3. The abnormality of soils in lysimeter experiments.

All these projects have been approved by the Office of Experiment Stations, as required in the administration of these funds. The first two were undertaken because of the rapid loss of nitrogen and humus from Tennessee soils and the difficulty with which they can be profitably replaced in farm practice. They have been in force for several years. A bulletin on the subject of the second project was published in 1917. Other experiments have been conducted in cylinders for the past five years to determine the comparative effects of various forms of lime on the soil content of humus and nitrogen. The results obtained, both with and without the production of crops, are being compiled for publication. The most striking result is the conservation, or saving up, of soil nitrogen where a crop (in this case tall oat grass) covers the ground the year round. The losses of soil nitrogen under all other conditions, including those where cowpeas were grown in the summer, but with no crop in the winter, were very large. Another important result was the marked increase in loss of nitrogen under liming, in particular where burnt lime was used. Ground limestone was found practically to equal the burnt lime, so far as crop increase was concerned, but without bringing about the serious loss of soil nitrogen induced by the various forms of burnt lime.

In addition to cylinders without bottoms, lysimeters, or cylinders provided with bottoms and outlet tubes so that the drainage water can be collected, have been used here since 1909. One of the distinctive features of these lysimeters is their variation in depth, which ranges from 1 to 6 feet. In the 1-foot lysimeter, for example, there is placed only surface soil to form a layer about 6 inches in depth. In the 2-foot lysimeter is placed a layer of subsoil 1 foot in depth and on top is placed the same amount of surface soil as used for the 1-foot depth. The object of these variations is to study the effect of subsoil of various depths on crop growth, the conservation of moisture, and losses of both soil and applied nitrogen and other elements from the soil. The results obtained show conclusively that lysimeters of different depths are required in order to get an accurate record of what is taking place. For example, the subsoil was found either to absorb or to set free the nitrogen leaching through it, so that only a fraction of the amount lost in that way from the surface soil was recovered in the drainage. On the other hand, the recovery in the drainage from the shallow lysimeters containing no subsoil was apparently complete. Certain peculiarities in the results, and the importance attached

to these projects, suggested the third project, to make the conclusions as reliable and as applicable to farm practice as possible.

### PUBLICATIONS

As the result of experimental work done in this Department, an article on planting rates and spacing of corn under southern conditions was published in the Journal of the American Society of Agronomy, Vol. XIII, No. 1, January, 1920. This article places the subject on a simple mathematical basis. A popular form, adapted for practical use, may be published as a Station bulletin.

Respectfully submitted,

C. A. MOOERS, *Agronomist*.

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### REPORT OF THE BOTANIST

Tomato Disease Work: The wilt-disease-resistant variety of tomato previously reported was again grown during the season of 1920. It showed that it had lost none of its resistant qualities, and had been greatly improved by further selection for earliness and production. A good quantity of seed was saved for growing in 1921. This variety is now being grown in different sections where wilt is prevalent. Owing to the fact that it was for a number of years somewhat later in developing and ripening fruit than the common varieties, it has been grown only in limited quantities. This difficulty having been overcome, it is now believed that this variety will take its place among tomato growers, and will help in solving the wilt trouble. Crop rotation and sanitary measures recommended to tomato growers have been of great help to them in reducing the losses formerly sustained from wilt.

The wilt-resistant variety was grown at the West Tennessee Experiment Station in comparison with one of the best standard varieties commonly used by farmers in that section, and it proved to be equal to it in all particulars.

A large number of cultures of the wilt organisms were isolated from diseased tomatoes in Tennessee, and others were obtained from other states where wilt had been a problem. These cultures were tested upon a common susceptible variety of tomato. The results show that there are differences in these strains of wilt organisms. Some proved to be very virulent upon this variety of tomato, while others proved to be very ineffective. In a second experiment, these same cultures were tested upon a number of varieties of tomatoes, including five so-called wilt-resistant varieties. The same cultures which proved the most virulent in the previous experiments were again the most virulent. The so-called wilt-resistant varieties of tomatoes all showed considerable resistance, but finally developed the symptoms of the wilt in a large per cent of the plants. The common varieties of toma-

foes died from wilt early in the experiment. This shows that resistant varieties, while not free from the disease, may survive long enough to ripen the principal part of the crop before they succumb.

Two very promising crosses of our resistant variety with Bonny Best and Chalk's Early Jewel, two very early commercial varieties, were made some years ago by workers in the Wisconsin College of Agriculture. We have obtained these crosses, and they were grown in our plots in 1920. They show great promise in the third generation. They will be compared with other varieties in 1921 for disease-resistance and desirable characters.

Japan Clover Work: The work with improved varieties of Japan clover was continued during the year along the lines indicated in the last report. Selections made for larger and more upright varieties were grown again on a larger scale than previously—large enough to determine their value in a commercial way. The seed from the best variety will be grown in 1921 for the use of the Tennessee farmers. A plan has been formed to introduce this seed generally. The variety has remained true to type, and is free from contamination with other kinds. It is so much better than any other variety for the needs of Tennessee farmers that it will eventually, we believe, take the place of the commonly grown kinds from seed imported into the State. Besides this tall variety, others have been selected which are adapted for uses other than hay production. One of these is a very early-maturing variety, which matures seed nearly a month earlier than any others tried. It is rather small in size and will not compete with the tall variety or the common variety now grown generally, except in high and cool situations. The plant from which this variety was derived was found in the mountains of East Tennessee, at an elevation of about 4500 feet. This variety ought to prove of value as a pasture plant and as a soil improver where the season is short. Another selection matures very late in the season, is very leafy, and of a bunchy habit of growth. It seems peculiarly adapted for a pasture plant. It is somewhat resistant to frost, remaining green until the hard freezes of early winter. When sown thick, it makes a fair yield of hay, of a fine-stemmed and leafy nature.

Plant Disease Survey Work: The work of making a plant-disease survey of the State, in cooperation with the U. S. Department of Agriculture, was continued during the 1920 season. It was found that the losses from plant diseases were somewhat reduced from the previous season, except in case of fruit crops. The work of controlling these diseases has been greatly advanced in the State. Many measures for control have been put into effect, with the advice and help of the Station workers. Many projects are under way which if carried out will very materially reduce the enormous losses which the farmers have experienced in the past. This work in the future will be carried on principally by the Professor of Botany in the College and the Plant Pathologist in the Experiment Station.

Respectfully submitted,

S. H. ESSARY, *Botanist.*



## REPORT OF THE PLANT PATHOLOGIST

The work of the Plant Pathologist was commenced in September. After a preliminary survey of the State's needs in phytopathological research, and after consultation with the other workers of the University interested in the subject, it was decided to conduct the work under the two following projects:

1. Wheat Deterioration: This project includes studies of the cause, or causes, of low yields and of poor quality of wheat obtained by the farmers of the State during recent years. At present it appears that neither low soil fertility nor poor methods of cultivation can be held entirely responsible for this generally observed deterioration of wheat. The work done during the period covered by this report consisted primarily of a determination of wheat seed contamination by various micro-organisms detrimental to the plant, and of some preliminary field experiments, located in five different sections of the State, to determine the effect of certain standard wheat seed treatments upon the yield and quality of the crop. The work shows that the wheat seed commonly used by the farmers is very generally and severely contaminated by several fungi; namely, by an *Alternaria*, a *Helminthosporium* and a *Fusarium* (probably a conidial stage of *Gibberella Saubinetii*), all of which have been found, according to the studies of plant pathologists of North Dakota, Ohio, and some other states, to cause damage to wheat. It is too early yet to report anything on the field experiments.

2. Fusaria Causing Wilt of Economic Plants in Tennessee: The name "Fusarium" is applied to a genus of fungi, among which are species causing wilt of important cultivated plants, such as tomato, Irish and sweet potato, watermelon, cotton, garden bean, and peppers. Some of these fungi are responsible for certain very important diseases of small grains and of corn, causing root-rot, scab, stalk-rot and ear-rot. Many Fusaria, while very common in soil and on all kinds of decaying vegetable matter, are probably harmless saprophytes. The work on this project had been started by the accumulation of a considerable number of fungi, in pure cultures, for their comparative study. The collection at present includes Fusaria isolated by Professor Essary from wilted tomato plants, by Mr. Kurtzweil from corn plant, by the writer mainly from corn and wheat, and by some other plant pathologists from various plants in several other states.

Respectfully submitted,

C. D. SHERBAKOFF, *Plant Pathologist.*

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## DEPARTMENT OF SOIL CHEMISTRY

The work of the Department of Soil Chemistry for the year has been directed toward the further development of the lysimeter and parallel studies relative to the effect of the several forms and varying amounts of lime and magnesia upon chemically and biologically induced changes, as

measured by the leaching of soluble salts from the soil. The influence of the physical form and variations in amounts of applied lime- and magnesia-carrying materials in the tendency toward more permanent fixation in the soil has been one of the main objects in view. Such studies are of great interest and importance in Tennessee, where lime is extensively needed, and where its use is becoming widespread.

The academic problem of the scientific factors involved in the reaction between acid soils and lime was further studied by the Soil Chemist in collaborative work with the Association of Official Agricultural Chemists and several other experiment stations.

Additional data were also secured upon the transformation of sulfurous materials into forms available to growing plants. Collection and analysis of rainwater from different parts of the State have also furnished valuable information as to this source of sulfur for the soils of the State.

A contribution was made to the symposium on lime, conducted under the auspices of the American Society of Agronomy, at Springfield, Massachusetts. This contribution was entitled "The Nature of Soil Acidity with Regard to Its Quantitative Determination." A contribution, offered jointly with the Vice-Director, was also submitted on the same occasion.

The work relative to the oxidation of elemental sulfur in quartz media, as affected by lime and magnesia, was considerably amplified, and the results secured are indicative of valuable information.

The Soil Chemist devoted considerable time toward the development of a suitable method for the determination of total sulfur in soils, such a method being essential to our investigations.

One publication appeared from the Department during the year: namely, "Report on Lime Requirement of Soils," in the Journal of the Association of Official Agricultural Chemists, Vol. 4, No. 1.

The personnel of the Department was strengthened during the year by the coming of Mr. W. M. Shaw, a graduate and post-graduate of the University of Minnesota. Mr. Shaw succeeded Mr. Gray, who resigned April 1, 1920.

The members of the staff desire the privilege of recording their appreciation of the cordial support and inspiring sympathy of the Vice-Director, whose support has done much to maintain their zeal in the problems before them.

Respectfully submitted,

W. H. MACINTIRE, *Soil Chemist.*