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THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

FIFTIETH ANNUAL REPORT

1937

KNOXVILLE, TENNESSEE

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
KNOXVILLE

JAMES D. HOSKINS, President

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G. A. SHUEY, Associate Chemist
J. B. YOUNG, Asst. Soil Chemist
BROOKS ROBINSON, Asst. Soil Chemist
K. B. SANDERS, Asst. Soil Chemist
E. K. WEATHERS, Asst. Biochemist

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BENJ. D. RASKOPF, Asst. Agri. Econ.
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K. L. HERTEL, Physicist

PLANT PATHOLOGY

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J. O. ANDES, Assoc. Plant Pathologist
C. C. ALLISON, Assoc. Plant Path. (Tobacco Invest.)*
J. K. UNDERWOOD, Asst. Plant Path.
G. M. STONE, Asst. Plant Pathologist
E. S. BROWN, Asst. in Plant Pathology

SUBSTATIONS

BEN P. HAZLEWOOD, Supt., West Tennessee Experiment Station, Jackson
L. R. NEEL, Supt., Middle Tennessee Experiment Station, Columbia
F. S. CHANCE, Supt., Tobacco Experiment Station, Greeneville*
LESTER WEAKLEY, Asst., Mericourt Experiment Station, Clarksville

*Cooperative with U. S. Department of Agriculture.

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

Bulletins of this Station will be mailed free to any farmer in the State. Write Agricultural Experiment Station, University of Tennessee, Knoxville, Tennessee.

LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 1, 1938

To His Excellency, Gordon Browning, 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 1937. 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,

JAMES D. HOSKINS, President.

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
In account with
The United States Appropriations, 1936-1937

	Hatch Fund	Adams Fund	Purnell Fund	Bankhead-Jones Fund	Bankhead-Jones Offset Fund
Receipts					
U. S. Treasurer	$15,000.00	$15,000.00	$60,000.00	$37,291.94	
Other sources					$61,807.77
Disbursements					
Personal services	12,572.89	13,257.84	52,356.20	23,291.77	30,336.57
Supplies and materials	529.26	638.66	2,539.63	3,549.00	10,541.73
Communication service	288.02	1.25	25.84	60.48	613.85
Travel expenses	383.17	170.69	1,104.39	681.24	607.94
Transportation of things	25.45	28.07	285.22	330.25	775.61
Publications	618.54		331.32		493.89
Heat, light, water, power	10.00	52.64	213.21	362.36	1,157.23
Contingent expenses	.60		37.94	18.50	1,346.26
Equipment	560.53	827.61	2,172.33	1,554.21	5,317.29
Buildings and land	11.54	23.24	933.92	7,544.13	10,617.40
	$15,000.00	$15,000.00	$60,000.00	$37,391.94	$61,807.77

PUBLICATIONS

BULLETINS

Bulletin No. 160—Control of Tobacco Insects in Tennessee, by S. Marcovitch and W. W. Stanley. 14 pages. January, 1937. This bulletin includes discussion of the life-histories and habits and methods of control of the insects injurious to tobacco in Tennessee. Special consideration is given to experiments with cryolite, these experiments indicating that cryolite is a safe and efficient insecticide for the control of tobacco insects.

Bulletin No. 161—Frozen-Pack Fruit Markets, by Harry Carlton. 72 pages. June, 1937. The market survey of the frozen-pack industry was undertaken primarily for the purpose of locating additional markets for Tennessee strawberries, but other frozen fruits and certain vegetables were included. Frozen-pack fruits are now firmly established as raw material for processing into other forms of food products, principally preserves, ice cream, and pies. If Tennessee growers and packers will cooperate to put out a high-quality pack, they should be in a good position to meet the competition of the northwestern states in the markets for frozen fruits.

Bulletin No. 162—Cryolite Spray Residues and Human Health, by S. Marcovitch, G. A. Shuey, and W. W. Stanley. 48 pages. November, 1937. In the study reported in this bulletin, work at the Tennessee Experiment Station was supplemented by scientific data and information gathered from many other sources. The conclusion drawn from this study is that the spray residues on fruits and vegetables sprayed with cryolite have no deleterious or poisonous effect and are not injurious to health. The study indicates further that the present tolerance of .01 grain per pound of foodstuffs is not based on fact, but was applied arbitrarily, and should be raised.

OTHER PUBLICATIONS

MacIntire, W. H., Hardin, L. J., and Oldham, F. D. Calcium Metaphosphate Fertilizers—Chemical Composition and Properties. Ind. Eng. Chem., 29:224-234. 1937.

MacIntire, W. H., Hardin, L. J., Oldham, F. D., and Hammond, J. W. Development of P_2O_5 Insolubility in Phosphatic Mixtures—The Formation of Fluorapatite as Its Cause. Ind. Eng. Chem., 29:758-766. 1937.

Shaw, W. M., and MacIntire, W. H. The Relationship between Water-Soluble, Replaceable and Fixed Fractions of Potash Additions to Soils. Soil Science Society of America, 1:143-147. 1937.

Drain, Brooks D., and Fister, L. A. Some Strawberry Breeding Progeny Data. Proceedings, American Society for Horticultural Science, Vol. 35. 1937.

CHANGES IN STAFF

NEW MEMBERS

The following appointments to the Station staff were made during the year:

Benjamin D. Raskopf, Assistant Agricultural Economist, beginning March 16.

H. J. Bonser, Assistant Agricultural Economist, beginning July 16.

J. E. Wills, Associate Agricultural Economist, beginning September 1.

Dorothy E. Williams, Associate Home Economist, beginning November 16.

RESIGNATIONS

The following members resigned:

S. W. Atkins, Assistant Agricultural Economist, March 15.

P. B. Boyer, Assistant Agricultural Economist, February 14.

COOPERATION WITH THE TENNESSEE VALLEY AUTHORITY

Research of much value on a number of different problems has been made possible through funds provided by the Tennessee Valley Authority. All of the following projects have been carried out cooperatively:

FIELD EXPERIMENTS WITH PHOSPHATES

Comparative field trials of different phosphates have been made by the Station in cooperation with the TVA each year, beginning in 1934, to the present time. These trials have been made with various crops and on various types of soil found in the Valley area. The project was considered highly important because of the great need of phosphate by the soils of Tennessee and because of the variety of phosphates which are, or may become, commercially important.

The following phosphates have been included in the experiments:

16 percent superphosphate.
Nearly pure monocalcium phosphate.
Triple superphosphate.
Dicalcium phosphate.
Tricalcium phosphate.
Calcium metaphosphate.

The experimental results may be summarized as follows:

1. The 16 percent superphosphate is slightly superior to any of the others, ranking first, on the average, in all experiments with corn, potatoes, flax, and wheat.

2. Triple superphosphate—with which was averaged the data from monocalcium phosphate, a similar material—ranked a little above dicalcium phosphate, but both proved to be first-class sources of phosphoric acid for fertilizer use.

3. Tricalcium phosphate from two sources was tried—one being a fused phosphate produced at Wilson Dam. They behaved similarly and proved to be distinctly inferior to the preceding phosphates.

4. The experiments with metaphosphate were less extensive than those made with the foregoing, but in the majority of trials on wheat it gave yields as good as those from 16 percent superphosphate, or better.

Control Experiments with Various Phosphates in Rims

In addition to field trials, the various phosphates were tested in rims under controlled experimental conditions. The 133 rims used rested on subsoil and were filled with a uniformly mixed soil known to be deficient in phosphoric acid. Various crops, such as oats, millet, Sudan grass, and Austrian winter peas, were grown, and the weights of dry matter carefully noted. In some instances chemical analyses of the crops were made. The ranking of the different phosphates was nearly the same as that obtained in the field experiments, but the leading phosphates were practically on a parity. Only the fused or the tricalcium phosphate occupied a distinctly subordinate place.

Trials were made of calcium metaphosphate ground to 3 different degrees of fineness: (1) coarser than 10-mesh; (2) 10-50-mesh; and (3) finer than 50-mesh. The first two lots gave the largest increases in yield of millet hay, but the residual effect of the 10-50-mesh grinding far surpassed the 50-100-mesh grinding shown by the effects on Austrian winter peas which followed the millet crop—no additional application of phosphate being made in any case. The results indicated that metaphosphate may be in a superior class so far as after-effects are concerned.

Phosphates for Animal Nutrition

Soils very deficient in phosphoric acid cover large areas in the State. In extreme cases of this nature farm crops may not contain sufficient phosphate to nourish livestock properly. As a remedy, some form of calcium phosphate may be given to animals in their ration. A study of the comparative values of various phosphates which might be used in this way was begun in 1935, and has been continued up to the present time. The synthetic phosphates made by the TVA were found to be practically free from fluorine and consequently well adapted to the purpose. Dicalcium phosphate proved to be especially suitable.

Market Investigations

A market survey was begun in 1935 to find out the status of the frozen-pack industry and to throw light on its future development. Highly illuminating information was obtained, indicating a large and widely established business and a most promising future. The results of this survey were published in June, 1937, in Bulletin No. 161 of this Station.

Since that time, further studies showing the growth and trends of this business have been made.

A market study of sorghum sirup indicated that lack of a standardized product was a great handicap to the commercial handling of the product.

Standardized Sorghum Sirup

That sorghum sirup has not been standardized is due to the lack of uniformity in its manufacture, which is almost entirely a small-farm operation. Another drawback to this sirup is its strong taste, caused by impurities which the present methods of production do not eliminate. A project designed to overcome these objections has been actively pursued for the past 3 years, and has resulted in the partial solution of both problems.

Artificial Aid in Hay Curing

Under moist climatic conditions, such as prevail in Tennessee, the curing of hay according to usual practice often is difficult. Also rain on the cut crop in the field causes loss of some of the valuable constituents by leaching. Commercial hay driers have been developed, but their high cost and the extra expense involved has largely prevented their practical use.

A greatly simplified procedure was devised by TVA engineers and has been tried by the Station with promising results.

Tobacco Curing

Experiments have been conducted in the use of the electric current as a source of controlled heat in the curing of Burley tobacco. Favorable indications were obtained, but further investigation will be required before practical conclusions can be reached.

Sweet Potato Storage

Experimental trial of electric heating of a sweet potato house, with special regard to cost as well as efficiency, has been made, and the conclusion reached that the method has decided advantages over others in common use and is economically feasible.

Soil Survey

A soil survey is of far-reaching importance in its application to practical agriculture, and the Station has been happy to cooperate in the undertaking with the Bureau of Chemistry and Soils of the U. S. Department of Agriculture and the Tennessee Valley Authority. The number of acres surveyed since 1934 is 2,223,609, distributed as follows:

Jefferson County	200,409	complete
Humphreys County	335,184	complete
Roane County	243,200	complete
Lincoln County	364,851	complete
Hamilton County	350,870	complete
Cumberland County	423,975	complete
Bedford County	176,640	partial
Norris area	128,480	partial
Rhea County		begun

The scale of mapping is 1 inch to 2,000 feet. Details included in the mapping are the usual internal conditions, and such external conditions as—

Slope
Erosion
Stoniness
Depth of soil over rock
External natural drainage

With both external and internal conditions known and mapped, it is possible to group the soils into classes according to adaptation and to make more accurate recommendations than would otherwise be possible relating to crops, rotations, practices in management, and methods of protection against erosion.

The definite location of these external features makes it practicable to construct a number of maps clearly locating the more important problems of soil use and management.

At present, maps are being made for the use of the county agents, showing by different colors the class adaptation of all the soils. These maps, with accompanying simple legends, can be easily read and understood not only by the agricultural worker but by the land owner as well.

Samples of all important soils are being furnished the Agricultural Experiment Station for analysis as a guide in the recommendation of fertilizer for each separate soil. These samples are permanently preserved for later use and study.

Measuring Losses of Soil and Water Under Different Conditions of Soil Management

At the Greeneville and Knoxville Stations, studies are being made of the losses of water and soil suffered by land under different methods of management, including strip cropping, and as affected by different crops. The accurate measurement of these losses requires an expensive outfit, but the results should be well worth while and should give valuable suggestions in regard to more rational procedures in soil conservation. The work has not been long enough under way for results of special moment to be reported.

Rapid Methods for Determining the Fertilizer Requirements of a Soil

A number of rapid methods have been developed, both in this country and abroad, for determining the fertilizer requirements of a soil. Some are short chemical tests. Others require more time and are supposed to give more dependable results. Of the latter, the Neubauer and biological methods are prominent. In cooperation with the Tennessee Valley Authority and the Wisconsin Experiment Station, a comparative study was made of these two methods. The results were decidedly favorable to the biological methods, which proved more rapid and more dependable than the Neubauer method. The Station is making good use of the biological methods in connection with the soil survey.

HOME PRODUCTION OF FOOD SUPPLIES

J. J. Bird

At the beginning of the year, 5 substitutions were necessary in the 12 Homestead farms involved in the project on Home Production of Food Supplies. The new farms averaged 32 acres in size, 16.6 acres larger than the average size of the original group. The farms now average 24 acres, varying in size from 11.8 to 54.2 acres. Most of the Homestead farms fall within this acreage range. The adult equivalent per family also rose with the change in personnel. This was 3.78 in 1936, and increased to an average of 4.75 this year. The 5 new families had an average adult equivalent of 5.18. Soil maps of the new farms were made by Mr. E. Hubbard.

DIETARY

After data were obtained relative to uninfluenced diets during 1936, efforts were made to bring the family diets into conformity with those experimentally established. A definite change was effected. This was particularly noted in the amount of money spent per adult equivalent for food purchased. Under the uninfluenced diet the amount of money spent per adult was $44.27 in 1936. This was reduced approximately 50 percent in 1937. The purchased foods on which the principal reductions were effected are bread, corn meal, pork, lard, and sugar. A great variation in the ability of individual families to follow a prescribed diet was noted, and the food costs of the dietary groups were materially influenced by this variation. Detailed records were kept of approximately 30 food items consumed and whether bought or home-produced.

Assistance in food preparation was given the women by the home demonstration agent of the Cumberland Homesteads at intervals during the first half of the year. Most of this assistance was in the form of cooking demonstrations in a temporary kitchen set up for the purpose. Special supervision also was given by the demonstration agent to individuals in the homes. The foods that received particular attention at that time were edible soybeans, whole-wheat flour, and irish potatoes. The soybeans were used largely in the form of meal semi-roasted before grinding.

Records of child health were kept, as well as records of all family living costs.

SUBSISTENCE CROPS

The total acreage of subsistence crops grown was 95.6, averaging 7.97 acres per family. Yields averaged well for new land or semi-new land. Subsistence-crop yields per acre were as follows: Corn, 35.1 bushels; wheat, 15.2; potatoes, 65.0; sweet potatoes, 134; edible soybeans, 10 bushels; and soybean hay 2⅓ tons.

The leaf hopper seriously reduced potato yields, in spite of control measures that were better than average. The temperature was considerably above normal during May, June, and August. Precipitation was ¾ normal during June and almost twice normal dur-

ing August. Hopper injury prevented potatoes from taking advantage of the August rainfall. April, May, June, and July were below normal in rainfall. Detailed cost-of-production records were kept on all subsistence crops.

EXPERIMENTAL CROPS

A total of 53.35 acres were planted in plot experiments, as follows: Corn—19.03 acres, covering trials of fertilizer formula, fertilizer rate, fertilizer placement, rare elements, varieties, and topping and stripping; potatoes—14.53 acres in tests of fertilizer formula, fertilizer rate, fertilizer placement, dust versus granular fertilizer, rare elements, spray, date of planting, spacing, and varietal trials; tomato—10.72 acres in tests of fertilizer formula, fertilizer rate, fertilizer placement, rare elements, and acid versus alkaline fertilizer; snap beans—1.2 acres in a fertilizer formula test; beets—.9 acre in a fertilizer placement test; sorghum—6.97 acres in plot experiments, covering trials in fertilizer formula, seed rate, varieties, and lime versus no lime. The tomatoes, beans, and beets were grown for the Homesteads canning plant.

Besides the sorghum plot experimental acreage, 8.9 acres were field-planted to give a total of 15.9 acres for sorghum processing experiments under the supervision of Mr. G. A. Shuey. A total of 15 varieties were tested for cane yield and separately processed in the varietal trials.

The potato spray experiments were conducted in cooperation with Mr. J. O. Andes, Dr. S. Marcovitch, and Mr. W. W. Stanley, and the sorghum experiments in cooperation with Prof. O. W. Dynes and Mr. Shuey.

In connection with fertilizer experiments, 101 roughage and grain samples were saved for plant component analyses.

COVER CROPS

During the first half of August, 106.8 acres were seeded to crimson clover. Of this number, 47.4 acres were subsistence and 59.4 acres plot experimental land and part of the field sorghum area. Growth averaged better than that of the preceding season, but it appears that early July seeding will be more satisfactory under Plateau conditions.

MISCELLANEOUS SEEDINGS

Six acres were seeded to a permanent mixture in the spring on one farm. A light seeding of Korean lespedeza was made to thicken permanently seeded slopes covering 16 acres seeded in 1936. Permanent seedings in the fall on the slope land of the 5 new-land farms totaled 26 acres. Eight acres of Sudan grass were seeded on spring-cleared slope land preceding the permanent seeding on this land in the fall. It was less productive than in 1936 under similar land conditions.

LIVESTOCK

Dependence upon hiring horse or mule power for farm work proved unsatisfactory, at least in competition with wages paid for construction work. Whereas, last year 6 horses and mules were owned by the group, this year 14 were owned and a great deal more work was possible.

Range pasture was utilized only by the animals owned by the new men, since their pastures were not established in the fall of 1936. Some dicalcium phosphate was fed the cows to influence their appetite for roughage. After becoming accustomed to soybean hay, the cows made good use of it. Little disease affected the livestock, although there was some loss from hog cholera in the community.

BUILDINGS AND EQUIPMENT

Corn cribs were built on all farms during the year under a special arrangement with the Construction Division of the Homesteads. Rough cull lumber was furnished and the necessary mill work done by the farmer group. Enough crate material to make 25 standard 60-pound potato crates for each member was obtained in the same manner, this to facilitate field experimental work.

MISCELLANEOUS

All farms were signed up on the county soil conservation program. Three farms were entered in the "Farm to Prosper" contest sponsored in this area by a Chattanooga newspaper. An educational trip to the Tennessee Valley Agricultural and Industrial Fair at Knoxville was arranged for the 12 Homesteaders, and gave evidence of being very profitable.

SOIL SURVEY

W. O. Whittle

During the year 1937, final field sheets of Roane, Humphreys, Lincoln, and Hamilton Counties have reached this office, and tabulations of acreages in the different soil types have been prepared, showing also such features as best adaptation, slope, derivation, and texture. Other tabulation of data awaits final approval of field reports by the Bureau of Chemistry and Soils, in Washington.

From these counties we have samples of all important agricultural soils, with a complete description of the conditions under which each soil was developed. Samples have been procured from both cultivated and normal, or undisturbed, areas and are now ready for chemical analysis for such characteristics as lime, phosphate, and potash, all of which information, as well as the samples, will be permanently preserved at the Experiment Station, classified and tabulated for further information and study. This collection of soils should be of much importance and of great assistance in the further study of the various characteristics and requirements of

the soils of the State.

Field sheets are being colored, showing the uses to which the soils are best adapted, then matched and cut according to latitude and longitude and mounted to correspond with planimetric sheets available through the Tennessee Valley Authority. These sheets will be bound for convenient use of the county agents, who will receive also explanatory legends and a complete report from the chief of the field survey. A land-use map of Jefferson County, the only one completed, for the use of the county agent, has caused much favorable comment from Washington authorities and others. These maps should prove most helpful to the county agents and others interested in the characteristics and special adaptations of the various soils.

Field men have practically completed surveys of Cumberland and Bedford Counties and are making a good beginning in Union County. There are 9 men now in the field, 8 having financial support from the Tennessee Valley Authority. The salary of one of these men is paid by the Bureau of Chemistry and Soils, with subsistence and cost of transportation furnished by the Tennessee Valley Authority.

AGRONOMY

H. P. Ogden

WEATHER

The weather of 1937 was unusually good for most crops at Knoxville. All winter crops, especially clovers, were favored with ample moisture in the fall of 1936 and mild temperatures during the winter. There was more fall plowing than usual. January of 1937 was the warmest on record. There were no drouths during the year and fewer washing rains than usual. Freezing temperatures on April 12 were severe on unprotected lespedezas, but those seeded in winter grains or other cover escaped serious damage.

The late fall and early winter of 1937 was too wet to admit of the usual amount of plowing and seeding and too cold to give winter crops a good start. Two weeks in early December were especially cold, the temperature dropping to 9° above zero on the 7th.

SMALL GRAINS

Growing interest in small grains for soil conservation and the rapidly multiplying varieties of all the cereals coming from plant breeders of this and other experiment stations resulted in an increase in all varietal trials of these crops. In addition to tests for yielding capacity, more attention was directed toward milling tests, winter hardiness, disease resistance, and other desirable qualities. Samples of wheat grown at Knoxville and submitted to the Federal Soft Wheat Laboratory, at Wooster, Ohio, compared very favorably with samples of the same varieties grown at 15 other state experiment stations. In some respects the samples from Knoxville

rated highest in the test. The varieties used were the same as those submitted by the other stations.

Yields of winter oats were high, with Tennessee 1884, Tennessee 1945, and Tennessee 1922 considerably above such standard varieties as Lee and Turf. Other Tennessee selections known to be more winter-hardy than any of the standard varieties also yielded well. In the fall of 1937 a seeding was made late to test these new cold-resistant varieties. This seeding was made just one month before the extreme cold of December 7, which almost killed out the Lee and other standard varieties, while the Tennessee strains came through in good condition.

Of the new barleys tested, only Polder 3213 and Missouri Early Beardless equaled in yield Tennessee No. 52, which for a number of years has been our best-yielding variety.

SOYBEANS

New non-shattering varieties of soybeans produced by this Station continued to out-yield Tokio, which for many years has been the best standard variety. Five of these new varieties are late, like Tokio. One, however, is as early as Yokoten. Of the 91 vegetable-type varieties of soybeans on test at the Knoxville Station for 5 years, only 8 are considered worthy of further trial. F. P. I. No. 81043 has consistently rated best in quality when cooked, and is earliest, but lowest in yield. No. 84648 is the best-yielding and latest of the 8, but lowest in quality. Differences in quality, however, are not very great. The 8 varieties chosen for continued trial range from the earliest to the latest, since longer harvesting season of soybeans cannot be satisfactorily attained by succession plantings, but must be accomplished by planting varieties of different ripening dates.

Soybeans were again seeded on small grains and produced good yields of hay with the minimum of labor and soil erosion. The beans are simply drilled very shallow with a disc drill, late in March. The principal precaution taken to prevent injury to the small grains was to choose a time when the soil was dry enough and before the grain had grown too high. During the 7 years of the experiment, seeding dates of beans ranged from March 14 to April 16. The beans have not been hurt by freezing weather, which has occurred nearly every year after they were up. The only failure was in 1936, when seeding was too late, April 16, and an unprecedented drouth gripped this section from early April till July. The average yield from 167 plots seeded on small grains in the 6 successful years was 2.23 tons per acre of air-dry hay.

WINTER PEAS

The breeding of winter peas was continued with greater emphasis placed on the testing of breeding material. Work of previous years has shown that the winter-hardiness of Austrian winter peas can be combined with a number of types of both field and

garden peas. However, in all cases the progeny of these crosses are as highly susceptible to Ascochyta blight as the Austrian winter pea parent.

Nearly 200 strains of peas, *Pisum elatius*, and *Pisum sativum*, were tested for resistance to wilt and blight. These were grown on infested soil. None was found disease free. Certain strains, however, were apparently less badly affected by these diseases.

Seed of these strains was obtained from the Division of Plant Exploration and Introduction, U. S. D. A., from various state experiment stations, from the Southeastern Vegetable Breeding Station, and from foreign and commercial breeders and seedsmen.

While past experience in using strains susceptible to disease had been discouraging, other crosses were made between the more healthy strains and the Austrian winter peas or other winter-hardy hybrids.

CORN

The nature of cultural tests and varietal trials and the results from them were similar to those described in the 1936 Annual Report.

LESPEDEZAS

Varietal trials, including a new introduction, F. P. I. 81742, and a new late Korean, 19604, also *Lespedeza juncea* and *L. bicolor*, failed to reveal any better-yielding varieties than the annual or perennial varieties that have been grown here for several years. However, a new strain recently found in West Tennessee appears worthy of further trial.

Cultural trials, seeding experiments, dates of cutting for hay, and studies of factors affecting tannin content were continued.

Yields were obtained from the third year of fertility experiments in a wheat-lespedeza rotation. These experiments were made on plots which had been occupied continuously from 1905 with the cowpea-wheat rotation. In 1935, Korean lespedeza was substituted for cowpeas. The wheat crop and the fertilizer treatment were continued unchanged. The average yield of the 3 lespedeza crops was slightly more than from cowpeas during the preceding 3 years; but this could easily have been due to seasonal conditions. There is some indication that Korean lespedeza may be more sensitive to seasonal differences than cowpeas.

More time must elapse before the effects of the change from cowpeas to lespedeza can be definitely noted in the wheat. One of the two wheat crops following the change was decidedly above the average after peas, while the other was below it.

LEGUMES IN SOIL IMPROVEMENT AND CONSERVATION

Experiments begun in 1935 were continued through 1937 with the seeding of a number of species of legumes on representative soil types of East Tennessee. These experiments include not only the bringing in of new and untried species from foreign countries, but also the testing of new ways of growing the familiar species.

Seedings were made on various kinds of seedbeds. Some were well prepared, while others were made on stubbles of annual or perennial lespedezas, pastures of various kinds, and soils badly depleted by excessive cropping and erosion. Various treatments with dolomite and phosphates were made. Special consideration was given to effects of different soil types.

The species of legumes grown include alfalfa, red clover, alsike clover, crimson clover, a number of white clovers (among them, Ladino), two species of hop clover, English red suckling clover, Persian clover, cluster clover, black medic, sweet clover, several varieties of subterranean clover, seven kinds of bur clover, Austrian winter peas, wild winter peas, Tangier peas, chick peas, various vetches, also crown vetch (not a true vetch), several species of Astragalus, Wood's "clover", beggarweed, mung beans, rice beans, adsuki beans, sulla, sainfoin, and crotalaria.

ALFALFA UNIFORM NURSERY

A test of 40 strains of alfalfa in duplicate rod-rows was started and will be continued several years in cooperation with some 40 other states and the Bureau of Plant Industry, U. S. Department of Agriculture.

The seed used was obtained by selection, hybridization, and importation. It is hoped that through this test varieties of alfalfa may be found that are better adapted to Tennessee climate, more resistant to diseases and insect pests, and with greater longevity than those now grown.

FERTILIZER EXPERIMENTS

Experiments to test the efficiency of different phosphate carriers were conducted on the land of cooperating farmers located on representative East Tennessee soils. The Tennessee Valley Authority cooperated in these tests.

In spite of the inconvenience and other disadvantages of conducting such tests on private farms—using equipment that is not always adapted to the purpose and fitting into the farmers' cropping and labor schedule—this method has given a wealth of data on fertilizer responses on different soil types. With sufficient replication of treatments, the data apparently are reliable. By careful selection of farmers and locations, the loss from invasion by the farmers' livestock or by excessively variable soil was extremely low in 1937. As a result, good yield data were secured from 1792 cooperative plots.

The different phosphate carriers were used alone and in combinations with nitrogen, potash, dolomite, calcium silicate slag, and various "minor elements." In one set of tests the effect of size of particle of metaphosphate was studied.

In addition to these cooperative tests, the long-time experiments with various fertilizers and manures on rotations were continued as in the past.

CORN BREEDING

L. S. Mayer

The corn-improvement project is being continued along the lines outlined in previous reports. The growing season of 1937 was an almost ideal one for corn, and the results have been gratifying.

NEAL PAYMASTER INBRED LINES

As a result of the 3-year yield test of top-crossed inbred lines, many of the original 105 Paymaster lines have been discarded and 35 of the better ones retained for further use in single and double crossing. Ten of these appear to be decidedly superior and will be used for the single crossing in 1938. Twelve other lines that have not yet been used extensively in crosses also will be used in 1938 for that purpose. The lines of Paymaster which were included in the uniform top-cross test, in cooperation with the Division of Cereal Crops and Diseases of the U. S. Department of Agriculture throughout the Corn Belt and neighboring states, have aroused much interest among the station breeders, and many requests have been received for seed of these lines to be used in hybridizing work with their own inbreds.

PAYMASTER DOUBLE-CROSS YIELD TEST

A series of double crosses made in 1936 were tested for the first time this year. The test planting consisted of 2 x 25-hill plots, every fifth row a check, 4 replications. The direct and reciprocal double cross in nearly all cases constituted the 2-row plot. With a field check average yield of 55.25 bushels of dry shelled corn per acre, 23 of the double crosses out of 69 tested exceed that yield by 10 percent or more, 5 by 20 percent or more, and 2 were well over 30 percent above the average.

Several of these double crosses were sent to the Jackson and Columbia Stations to be included in their corn-yield tests. Those sent to Jackson, however, arrived too late to be included in the test. At Columbia, against the Neal Paymaster check average yield of 26.3 bushels, 2 of the 3 doubles tested gave excellent yields, one of 30.2 bushels and the other of 36.2 bushels—increases of 14 and 37 percent, respectively.

VARIETAL YIELD TEST

The varietal test was planted in 2 x 25-hill plots, 5 replications. The Russell strain of Neal Paymaster, used in all the yield test plots as the check, gave the highest yield of shelled corn of all the open-fertilized varieties, 60.08 bushels per acre. Jellicorse Twin Ear, from the West Tennessee Station, gave a yield of 58.98 bushels; and a prolific white dent, also from West Tennessee, known as Gordon White Dent, yielded 58.32 bushels. The short-season variety, Thompson Profific, yielded 53.28 bushels, and Yellow Neal, being developed by this Station, gave 56.05 bushels per acre. Not

any of the Jarvis strains yielded better than 52.37 bushels, while the 6 hybrids from the Corn Belt ranged from 51.52 to 36.84 bushels. The average yield of all the Paymaster strains was 56 bushels of shelled corn. Twelve double crosses from Kentucky gave good yields, but none was significantly better than the check Russell Neal Paymaster, the best yielding only 9 percent more. These results of out-of-state strains and hybrids give added proof that increase of yield through hybridization in this State must rest upon the production of successful hybrids from our own adapted varieties, such as Neal Paymaster. These we believe we already have; and plans are being formulated for the increased production of desirable double crosses for more widespread testing and study as to regional adaptability, and for commercial production.

CROP IMPROVEMENT

N. I. Hancock

COTTON

In the cotton varietal trials in 1937, a new strain, Coker's 100, gave promise of being worth while for plantings in this State. It is early-maturing—almost as early as Trice—has a 1 1/16″ full staple, and fairly large bolls. This strain is a selection of Stoneville 3. Stoneville 2B is an improvement in size of boll and quality of lint over the old Stoneville 2. There were no new introductions of the Delta and Pine Land cottons.

Seed treatments at Jackson show that it pays to treat the seed with 2 percent Ceresan, but the results at Knoxville, in cooperation with Mr. D. M. Simpson, of the U. S. Department of Agriculture, were not so significant.

For the past 4 years at Jackson, all the seed, both for the experimental plots and the large field, have been delinted with sulfuric acid. The method of delinting with acid is cumbersome, and unless the acid is thoroughly washed off the seeds, poor germination will result. By a new method worked out here, 2 bushels of seed can be delinted every 15 minutes. Time is saved by washing off only the excess acid, and then neutralizing that remaining by applying air-slacked lime at the rate of one pound per bushel of seed. A circular describing this method more fully will be published.

Studies on the growth rate of the cotton plants at Knoxville show that optimum gains are made during the period from July 5 to August 5. The peak of the gain in plant height precedes by 3 weeks the peak in the blooming rate. In 2 out of 3 years, a fairly good prediction of yield was obtained by using the optimum gain in plant height as the independent variable. The regression and correlation coefficients are as follows:

	1935	1936	1937
Regression coefficient	.0325X—.0083	.0605X—.5859	.0577X—.1362
Correlation coefficient	.5229	.7285	.4689

OATS

The winter of 1936-37 was a very favorable one for all grains. The Tennessee 1945 and Tennessee 1884 winter oat strains averaged from 8 to 10 bushels per acre above other varieties in the tests at Knoxville. More extensive plantings of these strains have been made over the State, and seed of them should be available for the fall of 1938. Four of these winter strains—Tennessee 1945, 1884, 1918, and 092—have been retained and the supply of seed is being increased. These oats are not resistant to smut and should be treated before planting. They have been bred especially for winter-hardiness and can be planted as late as October 20.

Further attempts to improve these strains are being made by hybridization, or crossing with other varieties.

BARLEY

Out of the 50 new smooth-awn barley strains, only 10 were retained for further trials. B3-56 and B5-33 were placed in the large field tests for comparison with other varieties. From the 3500 head-row selections planted the past fall, some desirable strains should be obtained.

Hooded barley is also being worked upon. Winter-hardy and later-maturing strains are being sought. Of 1000 head-row selections, 58 were retained for further observations.

SOIL CHEMISTRY

W. H. MacIntire and W. M. Shaw

SOILS AND FERTILIZERS

The several lysimeter studies as to the fate of additions of those components that enter into plant nutrition have been continued. The amounts of the several elements and their combinations that pass out in the leachings are used to indicate the changes induced in the soil by the incorporated materials. When definite indications are obtained, the soil itself is then available for laboratory study. The behavior and conservation of added fertilizers and soil amendments in a given soil are influenced by several factors, such as form, solubility, fineness, amount, manner and depth of incorporation, and distribution of rainfall. Variations in the specific properties and depth of a soil and its subsoil materially affect the fate of fertilizers and soil amendments. These several factors are recognized and considered in the conduct of the lysimeter experiments, the continuity of which affords cumulative data that bring out facts not developed in short-time studies.

COMPARATIVE BEHAVIOR OF VARIANT FORMS OF LIME AND MAGNESIA

The extent to which the several oxide and carbonate forms of calcium and magnesia enter into the soil system, and the function of the subsoil in preventing undue loss of calcium and magnesium, were studied further. In this experiment the behavior of the 7 dif-

ferent calcic and magnesic materials was accentuated by heavy rates of incorporation, which have demonstrated the divergence in the behavior of calcium and magnesium when either of these elements is present in dominant proportions, in contrast to the behavior of equivalent quantities of two elements in dolomitic proportion.

Particularly in evidence during the past year was the marked effect of a distribution of rainfall that diminished the proportions of rainwaters that passed through the soil. With a total rainfall substantially the same as that of the preceding year, the outgo of calcium for 1936-37 was only about two-thirds of that of the previous annual period. The amounts of the components carried from the soil over a 21-year period have been tabulated for publication. These results bring out forcibly the differences between the activities of the two bases calcium and magnesium within the soil and during their passage through the subsoil, which is still exerting a marked retardative effect upon the total outgo of calcium and magnesium, and upon interchange reactions.

At the conclusion of the 21-year period, the soils of 43 lysimeters were sampled and analyzed to determine the nature of the residual combinations. The results of these laboratory studies will be offered after the detailed report of the amounts of the several components that passed out in the rainwater leachings.

CONSERVATION OF LIME AND MAGNESIA FROM ECONOMIC ADDITIONS

The economy of liming with full initial treatments in comparison with duplicated, and also divided, or cumulative, additions of burnt lime, limestone, dolomite, and calcium silicate, has been studied during the period since the termination of the liming treatments, which were incorporated at economic rates in both the upper third and the full depth of the soil. This study is being conducted in parallel with an Onslow Sandy loam at the Virginia Station. During the past year, the outgo of calcium indicated a higher availability for the materials that had been incorporated in the divided, or cumulative, treatments. The underlying unlimed zone of soil continued to retain some of the compounds that were leached from the upper zone of treatment.

LIME-POTASH STUDIES

The effect of liming upon the availability of natural supplies of potassium is an important problem in this State. When the initially adequate native supplies of soil potash are cropped to exhaustion, the problem is extended to the effect of liming upon the availability of potash supplied by manurial treatments. Both phases of this problem have been considered in the current lysimeter studies.

At heavy rates, the several liming materials showed definite repressive effect upon the solubility of the potash in soil that had been depleted in its native supply of replaceable potassium. The effect of the residues from heavy additions of liming materials upon

the fixation of added potash also is definite, retentions of as much as 50 per cent of the annual additions having been established. During the past year of unusual distribution of rainfall, the acidic soil also registered a considerable retention of the added potassium salts.

The fixation of potassium also was investigated in a related laboratory study, following a build-up of the supply of potassium in a red clay subsoil and in a virgin soil of Chickamauga limestone origin and of a high degree of alkalinity attributable to calcium silicates. Both subsoil and soil fixed a large quantity of potassium. The potassium taken up by the subsoil was released under extended leaching, but the alkaline soil retained its fixed potassium in a non-exchangeable form. The results of this study were presented in *Proceedings, Soil Science Society of America*, I: 143-147.

The influence of liming upon retention of potassium was studied by continuation of annual additions to the slightly alkaline Jackson silt loam, to the acidic "Crossville" fine sandy loam, and to the acidic Cumberland silty clay loam. The Jackson soil retained about 25 per cent of the annual addition, but with little evidence of an effect from liming on the soil that was already slightly alkaline in character. The fixation of potassium in the two types, initially acidic, was materially enhanced by the liming treatments. In all cases, the fixation of potassium was accompanied by an exchange release of calcium and an increased outgo of that element.

The attempt to build up the potassium content of 4 soils and a red clay subsoil in outdoor lysimeters for subsequent use in liming treatments, was continued by the addition of potassium sulfate and the determination of the amounts of potassium retained by the soils. The Jackson soil retained 1,800 pounds of the 2,400-pound addition of K_2O; the Crossville and Cumberland soils retained 600-700 pounds from that addition; the clay subsoil retained 2,000 pounds; whereas, practically complete retention of the 2,400-pound addition was effected by the Chickamauga clay loam. Hence, although considerable quantities of potassic compounds still appear in the leachates from the 4 soils other than the Chickamauga, the rainwater leachates from that soil continue practically devoid of potassium.

CONSERVATION OF SOIL SULFUR

The advent and increasing usage of fertilizers of high concentration have revived the problem of the importance of nutrient sulfates, which constitute a substantial fraction of the standard types of fertilizers. It has been contended that the use of the phosphatic concentrates will necessitate supplemental treatments of sulfates. One effect of liming is to cause an increase in sulfate outgo, and this has been assumed to be attributable to increase in the quantity of sulfates engendered in the soil.

In those experiments in which the lime-potash relationships involved a build-up of potassium, all additions of that element were

made as the sulfate; and the fate of the sulfates derived therefrom, after incorporation in the soil, was studied. One series has been devoted to a study of the conservation of added sulfates, as affected by the residues of single economic incorporations of liming materials during the period beginning 12 years after the liming incorporations. During the past year, the residual effect of both calcic and magnesic residues was to accelerate the leaching of sulfates. In another experiment, sulfur conservation was studied by determination of the retentions from additions of the 3 sulfates, calcium, magnesium, and potassium, that are commonly used either separately or as components of fertilizers. The effects of supplements of limestone and of dolomite upon such sulfate retention were included as an objective of the experiment.

Computations of results show that complete recoveries of sulfates were obtained only from the magnesium sulfate. The recoveries from the other two sulfates ranged between 93 and 98 percent. A considerable fraction of the potassium sulfate addition was recovered as such, although the added potassium effected a definite replacement of the soil's content of calcium and magnesium. The supplements of both limestone and dolomite prevented any liberation of potassium by the additions of either calcium sulfate or magnesium sulfate.

MIGRATION OF PHOSPHATES

The comparative effects of limestone and dolomite upon mobility of phosphates was studied further by increasing the P_2O_5 content of 3 soils. Only the Jackson soil allowed a definite passage of the added phosphates. Evidence as to the divergence between the solubilities of added calcium phosphates and magnesium phosphates resultant from the magnesic additions, apparently await an adequate build-up of the phosphate contents of the several soils.

THE RELATION BETWEEN PHOSPHATES AND FLUORIDES IN THE SOIL

The extent of the reactions between additions of various types of orthophosphates and metaphosphates and calcium fluoride, which involves the precipitation of both P_2O_5 and fluorides through the formation of fluorapatite, was studied by the determination of the amounts of fluorine present in the rainwater leachates. The low concentrations of fluorides in the initial collections of leachates have been inadequate to warrant conclusions as to the respective behaviors of the several phosphates, and the differential effects of limestone and dolomite have not appeared.

NITROGEN CONSERVATION

The Agronomy-Chemistry studies as to outgo of nitrogen from 7 forms of nitrogenous fertilizers, applied during the winter, indicate that the limed Jackson soil yielded all of the N added as ammonium sulfate, urea, and "ammophos." The recoveries from the same materials in the unlimed Jackson soil were only about one-

half of the additions. The recoveries from cottonseed meal and from cyanamid were low for both limed and unlimed soils. Only partial recoveries were obtained from the additions to the Cumberland soil, the recoveries from the unlimed soil being slightly above those from the limed soil. The determinations of the occurrences of free ammonia, nitrates, and nitrites in the leachates show that the highest concentration of nitrites is concurrent with the maximal outgo of nitrates.

In a related study, the nitrogen losses from winter additions of 7 commercial ammoniacal materials, including ammonium hydroxide, were determined. During the current year, the highest recoveries from the Cumberland loam were approximately 80 percent for the chloride, sulfate, and nitrate additions, and about 30 percent for the added ammonium phosphates and hydroxide. The 6 ammonium salts gave recoveries of about 66 percent, against only 15 percent for the ammonium hydroxide additions to the Crossville soil. Similar recoveries were obtained from the Jackson soil. The predominant outgo of nitrogen was due to the nitrate content of the late-fall leachings. Only about 15-20 percent of the added ammonium component of the ammonium salts was leached by the rainwaters of the winter period, the outgo being due almost entirely to engendered nitrates.

In parallel with a previous 10-year study of the movement of a 960-pound increment of nitrogen through a 5-foot depth of clay subsoil, from additions of the nitrates of calcium, magnesium, and sodium, a corresponding series is being run with 3 ammonium salts—chloride, sulfate, and phosphate. The 1936-37 outgo of nitrates continued to be heavy, with cumulative leachings of 700-800 pounds of nitrogen. The nitrates leached have been accounted for by combinations with calcium, magnesium, and potassium. This is in contrast with the previous findings as to the failure of calcium, magnesium, and sodium nitrates to effect an exchange for potassium. It is noteworthy that the ammonium sulfate treatments have not caused an enhancement of the sulfate outgo.

COLLABORATIVE FERTILIZER EXPERIMENTS

The studies of the changes induced in mixtures of phosphatic and liming materials were pursued to determine further the rôle of component fluorides in causing a retrogradation of P_2O_5 availability. It was demonstrated that no retrogradation takes place except under conditions conducive to the formation of basic calcium phosphates in the presence of calcium fluoride, the "solid solution" of component fluorides being more avid than additions of the pulverulent type of calcium fluoride. Elevation of temperature to the extent induced by heat of reaction in large piles was found to accelerate the formation of fluorapatite. It was shown that complete disappearance of fluoride crystals was brought about by their contact with engendered and added tricalcium phosphate in both aqueous and carbonated water solutions. It was also demonstrated that some

formation of fluorapatite takes place during the "official" analytical technic.

The cumulative data as to the behavior of liming materials, in both straight and ammoniated phosphatic mixtures, served as the basis for the development of a new analytical procedure. In this procedure, a single, inherently acidic reagent—ammonium nitrate-ammonium citrate—was used to effect a more rapid and accurate analysis of all types of phosphatic fertilizers. A preliminary report of this procedure was discussed at the annual meeting of the A. O. A. C., and the detailed report of the study has been accepted for publication in the columns of *Industrial and Engineering Chemistry*.

Another study dealt with the chemical transitions that occur when phosphatic fertilizers are treated with selectively calcined dolomite, an activated and concentrated material composed of calcium carbonate and magnesium oxide. The material is compatible with phosphatic materials and affords a supply of readily available nutrient magnesium. The specific reactivities of the two components of this special calcine and the divergence caused by variation in proportions of water are set forth in a technical contribution that has been submitted for publication.

Chemical studies have been made of a number of experimental phosphatic products, including materials representative of pyro combinations. The pilot information was used in studies as to the response by plants and the influence of the fluorine content of calcium silicate slag and related problems, which have been conducted under the immediate charge of Doctor S. H. Winterberg.

W. M. Shaw has served as Associate Referee for Liming Materials for the Association of Official Agricultural Chemists. W. H. MacIntire has served that Association as General Referee for Soils and Liming Materials, and as its representative on the Board of Governors of the Crop Protection Institute.

GENERAL CHEMISTRY

G. A. Shuey

SORGHUM SIRUP

The field work on sorghum sirup was conducted at the Cumberland Homesteads, a Federal resettlement project, located near Crossville, Tennessee. A building and the processing equipment assembled by the Homesteads Cooperative in 1935 were leased by the Station, and minor repairs were made. Tanks and other equipment were rearranged to conform to our plan of processing. With the help of the Tennessee Valley Authority, a steam-heated evaporating pan of new design was installed. Water and electricity were provided by the Homesteads Cooperative at nominal rates. The Station provided fuel for steam-making; also necessary labor.

The arrangement was ideal in that the sorghum cane was grown on the Station's "Home Production of Food Supplies" farms,

at the Cumberland Homesteads. The growers were paid in part with sorghum sirup.

The cane, after being stripped of leaves and seed heads, was hauled to the processing plant, where it was weighed and passed through a 3-roller mill. The juice was conducted by gravity through a pipe line and delivered to wooden tanks, where it was measured, tested, and treated for clarification prior to evaporation to sirup. A uniform product was obtained by blending the finished sirup in a large tank. This was indeed a decided improvement over former attempts to make a uniform product. Yields of both cane and juice were obtained on 16 varieties of sorghum. Fertilizer experiments also were carried out on several varieties. Data are being compiled on the agronomic studies, processing operations, and chemical phases of the work. Marketing studies are receiving some attention.

Frost-damaged cane was processed during the last week of operations. Juice obtained from such cane gave yield data, but produced sirup of inferior quality. Plans are being made to plant the seed much earlier next year in order to allow plenty of time for maturing of cane before the normal season of frost.

During the last season a total of 82 tons of stripped sorghum cane, of all varieties, was experimentally processed. The weight of raw cane juice obtained was 41.35 tons, which represents an extraction of slightly better than 50 percent. The ratio of raw juice to sirup was 9.4 to 1; that is to say, 9.4 gallons of juice produced, by evaporation, 1 gallon of sirup. The total acreage of sorghum cane harvested was 16.4, thus averaging a yield of 5 tons of stripped cane per acre. The yield of sirup per acre was 62.2 gallons.

Plans are under way to continue the work during the 1938 season. Three of the most promising varieties are to be grown, and processing operations are to be carried out on a semi-commercial scale, in order that cost figures may be obtained and plant capacity determined.

STRAWBERRY JUICE

Studies were conducted to determine the effect of ripeness of strawberries on quality of juice.

Juices and semi-sirups were prepared from slightly underripe and from fully ripe strawberries of the Blakemore variety, the method of preparation being the same as outlined in Circular 48 and discussed in the Forty-Eighth Annual Report.

Juices and semi-sirups were packed in glass bottles and tin containers, pasteurized at 170° F. for 30 minutes, and sealed. They were kept at room temperature for 8 months, when the following observations were made. The fully ripened berries produced a rich, full-flavored juice and semi-sirup, which held up well in glass but deteriorated in tin containers. The underripe berries produced a light-colored juice and semi-sirup of very mild flavor, which did not hold up in either glass or tin containers.

Considerable service, in an advisory capacity, for the most part, has been rendered local fruit growers, canners, and processors of vinegar, in connection with their problems. Especial help has been given farmers in the manufacture, clarification, and preservation of apple juice, or cider.

SWEET POTATO VINEGAR

Lack of space and equipment prevented further work on the sweet potato vinegar project during the year. Laboratory experiments have demonstrated that excellent vinegar can be made of sweet potato culls. Plans are made for conducting this work on a much larger scale, as in barrels, and with air agitation, when space is available.

SWEET POTATO SIRUP

The sweet potato sirup project awaits additional space and equipment. Small-scale laboratory experiments have been successfully carried out. It is hoped that this project may be retained pending additional space and equipment.

FLUORINE SPRAY RESIDUE

Work on fluorine spray residue was conducted throughout the year as time permitted. Materials that were analyzed for fluorine content include whole wheat, wheat bran, polished rice, corn meal, commercial phosphates, bones of experimental animals, and cryolite residues of oranges and apples. In these analyses special attention was given to modifications of the method used, with the object of attaining accuracy. Fluorine can be isolated from phosphates and other inorganic substances by distillation as hydrofluosilicic acid, and subsequent titration with one of several reagents in the presence of an indicator. When organic and biological materials are being dealt with, however, the problem becomes somewhat complicated because of the necessity of ashing the samples and at the same time avoiding loss of fluorine.

Trials are being made in connection with the use of certain oxidizing agents which are incorporated with the sample to aid calcination at a lower temperature, to fix or retain the fluorine, and obtain the ash in such condition that subsequent isolation will be more accurate. This work is to be continued with the object of improving accuracy of method as applied to spray-residue problems.

MISCELLANEOUS WORK

Active cooperation has been rendered the Engineering Experiment Station during the year in connection with cottonseed processing. Analyses show the furfural yield from cottonseed hull bran to be from 18 to 20 percent on the water-free basis. In an effort to increase the yield of furfural, the hull bran is being treat-

ed by several chemical methods prior to distilling off the furfural. Tests were made to determine whether or not hydrolysis of hexose- and pentose-yielding substances was taking place during pressure-cooking of the cottonseed in the process of extracting the oil. Preliminary experiments indicate that reducing sugars are present or formed to the extent of 0.3 percent (calculated as dextrose) in the pressure-cooked meats before the oil is extracted. In the meal, after extraction of the oil, no reducing sugars were found. Thus, it would appear that the reducing sugars formed are carried through with the oil. This has not been proved experimentally.

Considerable analytical work has been done during the past year in connection with a study of astringent tannins in sericea and other legumes and in silage prepared from them. Data are being accumulated and the work as a whole will be reported more fully at a later date.

Analytical and consulting service on a wide variety of subjects has been rendered the other departments of the Station during the year.

At all times an interest is maintained in problems related to the utilization of agricultural products generally. In many instances the farms of Tennessee produce surpluses of main and seasonal crops. This is especially true of cotton, sweet potatoes, strawberries, vegetables, saccharine sorghum, and meats of various kinds. Adequate ways and means of utilizing crop surpluses would eliminate waste and result in profit to the farmer. All major farm crops have their by-products which have little or no salable value in Tennessee at present. Such by-products as cornstalks, corncobs, straw, sorghum cane bagasse, sweet potato culls, cotton stalks, cottonseed-hull bran, skim milk, and fruit and vegetable culls all require time, money, and soil fertility to produce, and yield but little to the farmer in return for his efforts. It is important that we look forward to expanding more and more in this phase of chemical research—the utilization of farm crops.

BIOCHEMISTRY

E. K. Weathers

The project on plant components has been continued. A manuscript entitled "Mineral and Nitrogen Contents of Lespedezas and Other Hay Crops in Tennessee" has been completed in preliminary draft and will soon be published.

During the year, samples of Korean lespedeza hay, soybean hay, corn leaves, and corn grain were obtained from the Cumberland Homesteads, located near Crossville, on the Cumberland Plateau. All of these crops were harvested from fields and plots which had received varying amounts of phosphate fertilizer. The Cumberland Plateau soil, known as Hartsells silt loam, is poorly supplied with lime and phosphate, and gives a marked response in

plant growth when these materials are supplied. Korean lespedeza from unlimed and unphosphated fields made practically no growth, while on the limed and phosphated fields a good yield was obtained. The lespedeza from fertilized fields averaged between 5 and 6 inches in height and gave an estimated yield of approximately one ton of hay per acre.

The chemical analysis of the Korean lespedeza hay, which was harvested in the full-bloom stage of growth, is shown in the accompanying table.

Chemical composition of Korean lespedeza hay from Cumberland Plateau—1937

Moisture-Free Basis

Fertilizer treatment	No. of samples	Moisture	Sand- and silica-free ash	CaO	MgO	K_2O	Fe_2O_3	Mn_3O_4	P_2O_5	N
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Phosphate and lime	14	8.80	3.99	1.34	.35	.91	.052	.017	.30	1.92
Untreated	2	9.19	3.10	1.10	.33	1.01	[1].161	.025	.38	2.24

[1]High iron oxide content probably due to clinging soil, since the plants were very sparse and grew horizontally rather than in an upright position.

ECONOMICS AND SOCIOLOGY

C. E. Allred

TYPES OF FARMING

The project on types of farming in Tennessee was continued, in cooperation with the Federal Bureau of Agricultural Economics. During the year a manuscript for a Station bulletin was completed in tentative form and submitted to the Bureau for approval. This involved the detailed checking of civil-district data on a large number of products.

A study of the factors determining the types of farming in the different sections of the State was begun.

Some work was done on trends in Tennessee agriculture, by types-of-farming areas.

Two preliminary publications were issued, as follows:

Organization of a Successful Small Farm in Central West Tennessee. Monograph 32. 38 pages.

Significant Changes in the Agriculture of Northeastern Highland Rim. Monograph 61. 43 pages.

AGRICULTURAL ADJUSTMENT

Studies of agricultural adjustment in Tennessee, begun in 1936 in cooperation with three divisions of the U. S. Department of Agriculture, were continued by the Station in 1937. Data secured by field work done during the previous year were analyzed.

Three preliminary publications, each relating to a different type of farming area, were issued during the year. They are as follows:

Soil Conservation Practices in Actual Use by Farmers, Eastern Highland Rim, 1932-36. Monograph 28. 38 pages.

Survey of Soil Conservation Practices in Central West Tennessee. Monograph 59. 55 pages.

How the Swiss Farmers Operate on the Cumberland Plateau. Monograph 33. 30 pages.

COTTON MARKETING

Work was continued on the cotton marketing project, in cooperation with the Federal Bureau of Agricultural Economics and 24 representative gins distributed in all sections of the cotton-producing area of the State.

The quality of Tennessee lint cotton, both as to grade and staple, was poorer in 1937 than in 1936. During the year, many one-variety communities were organized by the Agricultural Extension Service in an effort to improve the quality. There was also, at certain gins, an increase in the number of special days, on which only Delta and Pine Land cotton was handled, in order to keep the seed pure for planting.

Collection of data on selling cotton in the seed was continued, information being secured on the sale of 1800 bales at Newbern. Some of these bales were sold in the seed and some of them after ginning, which afforded opportunity to compare the results secured by the two methods of sale. The manuscript for a bulletin on this subject has been prepared and is being submitted to the U. S. Department of Agriculture for publication.

Cotton compresses constitute an important link in the marketing chain for Tennessee cotton. During the year, each of the 14 compresses located in Tennessee was visited and economic information obtained. For comparative purposes, similar data were secured on 82 compresses in other states. Analysis of the data is now in progress.

Two bulletins relating to this project were published in 1937:

Cotton Varieties Grown by Tennessee Farmers. Monograph 35. 39 pages.

Relation of Cotton Production to Consumption, by Areas, Tennessee. Monograph 58. 32 pages.

COOPERATIVE MARKETING

A study was made of the cooperative marketing of livestock in Tennessee, and a typewritten report of 154 pages prepared.

Considerable work was done in analyzing and interpreting data previously gathered on cooperation. The following publications were issued:

Cooperative Marketing of Sweet Potatoes in Tennessee. Monograph 34. 41 pages.

Marketing Strawberries Cooperatively in Tennessee. Monograph 43. 31 pages.

Marketing Livestock Cooperatively in Tennessee. Monograph 49. 37 pages.

Farmers' Mutual Fire Insurance in Tennessee. Part I, Development. Monograph 46. 21 pages.

Farmers' Mutual Fire Insurance in Tennessee. Part II, Organization and Management. Monograph 54. 48 pages.

Rural Cooperative Telephones in Tennessee. Monograph 45. 34 pages.

FARM TAXATION

The study of farm real estate taxation, which was under way at the end of 1936, in cooperation with the WPA and the Federal Bureau of Agricultural Economics, was carried over into 1937. Field work on the project covered a period of about one year. Two assistant supervisors, a secretary, and 112 field workers were employed. Work was done in 28 counties. A total of 97,000 hours were spent in securing the data, 177,000 schedules being filled out. Cost of the field work was $31,000, practically all of which was furnished by the WPA. The cost per schedule was 17.5 cents. After the schedules were filled out in the respective counties they were sent to a central tabulating office at Chicago in which the latest punch-card equipment was available. After being checked and tabulated, the original schedules were returned to the Station for further analysis and permanent filing.

Using the recently prepared detailed soil classification map of Jefferson County, a study was begun of the relation of assessments and tax delinquency to soil class.

EFFECT OF INDUSTRIAL DEVELOPMENT

A comparison was made of the use of land near and farther away from industrial centers, as illustrated by the situation in Jefferson County.

The extent and ramification of trade centers in the area of the proposed Gilbertsville Dam were studied.

Influence of industrial development at a distance and lack of it near home were brought out by a study of rural migration in Overton County.

SOUTHERN APPALACHIAN STUDY

Work on the Southern Appalachian project was mainly devoted to the analysis and interpretation of data previously gathered. Two publications in regard to the condition of farm homes were issued, as follows:

Farm Housing in Tennessee, with Regional Comparisons. Monograph 26. 46 pages.

Home Conveniences on Tennessee Farms with Regional Comparisons. Monograph 30. 44 pages.

Under the general title of "Human and Physical Resources of Tennessee," the following analytical publications were issued:

Geology, Topography and Soils. Monograph 38. 25 pages.

Climate. Monograph 40. 14 pages.

Flora and Wild Life. Monograph 42. 26 pages.

Minerals and Mining. Monograph 44. 20 pages.

Forests and Woodlands. Monograph 47. 16 pages.

Land Utilization and Land Drainage. Monograph 48. 21 pages.

Population. Monograph 50. 31 pages.

Agriculture. Monograph 53. 41 pages.

Plant Diseases, Animal Diseases, Insects, Microbes. Monograph 57. 23 pages.

Manufacturing and Trade. Monograph 62. 38 pages.

Transportation and Communication. Monograph 63. 45 pages.

Electrical Resources and Development. Monograph 64. 17 pages.

Storage Facilities. Monograph 65. 11 pages.

Financial Institutions and Insurance. Monograph 66. 29 pages.

OTHER RESEARCH

Prices of Farm Products.—For several years the Federal Division of Crop and Livestock Estimates has maintained its headquarters at The University of Tennessee, working in cooperation with this Department. During this time many data have been collected on farm prices in different sections of the State. Some of these data have been analyzed, and the following preliminary publications issued:

Regional Differences in the Farm Price of Corn, Tennessee and United States. Monograph 31. 38 pages.

Regional Differences in the Farm Price of Hogs, Tennessee and United States. Monograph 37. 44 pages.

Index Numbers of Prices Received by Tennessee Farmers, 1910-1936, with Regional Comparisons. Monograph 41. 40 pages.

Seasonal Prices of Farm Products in Tennessee, 1908-1936. Monograph 51. 48 pages.

Regional Variations in Farm Price of Small Grains, Tennessee and United States. Monograph 55. 37 pages.

Regional Differences in Farm Price of Irish Potatoes and Sweet Potatoes, Tennessee and United States. Monograph 56. 34 pages.

Suitable historical bases were worked out during the year for a continuous series of index numbers of farm prices, for the various farm products of Tennessee, and these index numbers will be published each month hereafter.

Farm Credit.—The study of the farm mortgage situation in Tennessee, begun in 1936, in cooperation with the WPA and the Federal Bureau of Agricultural Economics, was continued in 1937. A large number of schedules were secured in each of 28 representative counties in all sections of the State. These schedules have been deposited with the Station for permanent filing.

During the year, the schedules for seven of the above counties have been tabulated. This tabulation has shown the types of lending agency, extent of mortgage lending, number and types of foreclosures, and extent of corporate ownership of land in different parts of the State.

Field work on rural credit in an eastern Highland Rim county was mentioned in the 1936 annual report as having been done in cooperation with the Resettlement Administration. A typewritten report was prepared in 1937, summarizing the findings.

Farm Tenancy.—Research on farm tenancy was continued, in cooperation with the Resettlement Administration and the Bureau of Agricultural Economics.

Detailed schedules were secured on the social correlatives of farm tenancy in Crockett County. These schedules were edited and a set of punch cards prepared by the Bureau of Agricultural Economics, after which the schedules and cards were returned to the Station for further analysis. They will be permanently filed by the Station.

A typewritten manuscript of 197 pages was prepared on Farm Tenure, Inheritance, and Leases in Tennessee.

A study was begun of the methods of leasing land used by life insurance companies owning farms in Tennessee. Copies of their lease contracts were secured, together with a statement regarding methods of operation.

A preliminary publication was issued, entitled: What Is an Equitable Farm Lease? Monograph 52. 38 pages.

Educational Status of Farm Population.—Studies of the educational status of the farm population were continued, in cooperation with the U. S. Office of Education and the WPA. During the year, three publications were issued:

Education of Farm Owners and Tenants in Tennessee. Monograph 25. 40 pages.

Education of Farmers' Wives and Children in Four Counties of Tennessee. Monograph 27. 43 pages.

Relation of Education to the Social and Economic Status of Farmers in Tennessee. Monograph 29. 34 pages.

So far as known, this is the first time that information on the educational level of the adult rural population of this State has been made available. Such information should prove useful to agencies doing educational work with farmers and farmers' wives, by indicating the level on which material should be prepared.

Rural Relief Problems.—Research on rural relief problems, begun in 1934, in cooperation with the Division of Social Research

of the WPA, was continued. Field surveys were made in representative counties, data being secured from case records.

In Jefferson County a special study was begun in which all relief cases, and cases of old-age dependency were spotted on a detailed map showing land classes. It is expected that this study will throw light on the relation between sub-marginal land and the demand for Government assistance.

ENTOMOLOGY

S. Marcovitch

CRYOLITE SPRAY RESIDUES

For several years the Tennessee Agricultural Experiment Station has been at work developing the fluorine compounds as arsenical substitutes. Of the large number of compounds tested, cryolite, a sodium aluminum fluoride, proved to be the safest on foliage and most effective as an insecticide. In 1932 a report appeared from Arizona showing that mottled enamel of the teeth was caused in that state by fluorine dissolved in the water supplies when obtained from wells. The food and drug officials immediately imposed a tolerance on fluorine of .01 grain per pound of fruit, or 1.4 parts per million. Since the scope of knowledge was restricted, they believed that fluorine could not be more toxic than arsenic. Once again a chemical in solution was confused with a relatively insoluble material, such as cryolite.

The Tennessee Station for two years has been engaged in a study of the toxicity of fluorine as it occurs in drinking-water, with the toxicity of cryolite ingested in the quantities involved in the spray-residue problem. The details of this study are available in bulletin form, and only a few of the most significant findings will be mentioned here. When fluorine occurs in the water supply, more fluorine may be swallowed through the process of cooking than through drinking. Water is consumed in greater quantities than all other substances ingested, especially during the summer months. Assuming that 10 percent of our fruits and vegetables are sprayed, the consumption of water is 30 times as great as that of sprayed food. Teakettle scale from a mottled-enamel area was found to contain 8,072 parts per million of fluorine.

Marine foods, such as salmon, sardines, and baby foods prepared with bone meal (endorsed by the American Medical Association), contain up to 12 parts per million of fluorine; yet mottled enamel has been produced by no other means in the United States than the continued ingestion of water containing toxic amounts of dissolved fluorides during the period of calcification of the crowns of the permanent teeth—between birth and 8 years of age. The situation is aptly stated by Dean, of the Public Health Service, as follows: "In the light of present knowledge mottled enamel is a water-borne disease associated with the ingestion of toxic amounts

of fluoride present in the water used for drinking and cooking during the period of tooth calcification." The present tolerance on fluorine, therefore, is a standard for water supplies and has little or no relation to our spray-residue situation.

Another important advantage of cryolite is that it is incapable of causing fatalities, regardless of the dose consumed, and that it is a much safer material than lead arsenate, being less than one percent as toxic to human beings.

From our work as presented in Bulletin 162, we conclude that in cryolite we have a material that is reasonably safe to human health in the quantities used for spraying fruits and vegetables, harmless to foliage, and economical in price.

CONTROL OF TOMATO FRUIT WORM

The tomato fruit worm (*Heleothis obsoleta*) still remains the most important tomato pest in Tennessee. By boring into the fruits, it becomes less susceptible to poisons than would be desirable. Since this pest—also known as the corn ear worm—belongs to the cutworm family, poison baits were given a trial. Corn was also planted near-by as a trap crop. The final counts showed that corn was not only worthless but actually increased the number of worms in the tomatoes. The results of the poison baits and spraying are given in the accompanying table.

Effect of various treatments for the control of the tomato fruit worm.

Material	Clean fruit
	Percent
36 percent cryolite applied as dust	69
Derris-sulfur mixture applied as dust	37
Lead arsenate, 2 lbs. to 50 gals. water	76
Calcium arsenate, 1½ lbs. to 50 gals. water	74
Cryolite, 1½ lbs. to 50 gals. water	72
Cryolite, 2 lbs. to 50 gals. water	69
Cryolite, 3 lbs. to 50 gals. water	71
Corn meal, 50 parts to 2½ parts of sodium fluosilicate	73
Corn meal, 50 parts to 5 parts of cryolite	66
Cottonseed meal, 50 parts to 5 parts of cryolite	76

The sodium fluosilicate injured the leaves, while the calcium arsenate injured the fruit. The most economical material is the cottonseed meal bait with cryolite, as the cottonseed meal also acts as a fertilizer. Since the bait is broadcast, no equipment is necessary. For best results, a "pinch" of the bait should be applied to the fruit clusters when the first fruits are the size of peas. Once the worms gain entrance into the fruit, they are beyond the reach of the bait. Several applications should be made at weekly intervals.

MEXICAN BEAN BEETLE

Cryolite continues to give good control against the bean beetle. It seemed desirable to obtain yield records in comparison with other materials used for beetle control. In plot tests the following results were obtained:

Yield of string beans from plots sprayed with various poisons to control Mexican bean beetle.

Poison	Yield per acre
	Pounds
36 percent cryolite, 3 lbs. to 50 gals. water	1591
Copper oxyfluoride, 3 lbs. to 50 gals. water	1491
36 percent cryolite, 1½ lbs. to 50 gals. water	1238
Cryolite, 1½ lbs. to 50 gals. water	1231
Magnesium arsenate, 1½ lbs. to 50 gals. water	928
Check (not sprayed)	836
Calcium arsenate, 1½ lbs. to 50 gals. water; plus lime, 3 lbs. to 50 gals. water	794

The best yields were obtained in the cryolite plots. Although the arsenicals controlled the bean beetle, the bean plants were stunted and produced poor yields.

THE MORE IMPORTANT INSECT PESTS OF 1937

An increasing number of requests for information on the following insects have been received:

The New York weevil (*Ithycerus noveboracencis*).—This large, conspicuous weevil was found gnawing on new growth of apple twigs May 18, at Clinton, Tennessee.

Grasshoppers (*Melanoplus femur-rubrum*).—The worst grasshopper outbreak in 20 years occurred in Middle Tennessee. The principal species noted was the red-legged grasshopper. Tobacco, corn, cotton, and especially pastures, were attacked. Directions for the use of poisoned bait were circulated in June.

Blister beetle (*Epicauta lemniscata*).—This pest was reported from various parts of the State as injuring garden crops in June.

Tobacco flea beetle (*Epitrix parvula*).—Due to the wet weather prevailing during the season, the tobacco flea beetle did more than the usual amount of damage. In some sections newly set plants were destroyed.

HOME ECONOMICS

Florence L. MacLeod and Evelyn Utley

VITAMIN A VALUES

Porto Rico Sweet Potatoes

Investigations of the effect of cooking on the vitamin A value of the Porto Rico variety of sweet potato have been completed. The assays were made at the time of harvest and after storage for 4 and 8 months. Raw sweet potato was fed throughout the year,

to check the constancy of the variety with previous results, as well as to furnish a basis for measuring the effect of cooking. Reference cod liver oil, standardized by the United States Pharmacopoeia, was fed as a means of obtaining values for vitamin A in terms of the U. S. P. XI or International units.

At the time of harvest, it was found that the cooked sweet potato, per unit of weight, had a vitamin A potency twice as great as that of the raw sweet potato. When an allowance was made for the concentration of the potato due to baking, the improvement amounted to 36 percent.

After 4 months of storage, the increase in the vitamin A value of the raw potato due to storage was about 40 percent. The cooking of the stored potato increased the vitamin A value an additional 40 percent.

At the end of 8 months of storage, the same crop of Porto Rico sweet potatoes was tested again. The vitamin A value of the raw potato had increased another 40 percent between the fourth and the eighth month due to storage. The highest vitamin A potency for the series was obtained when the sweet potatoes, stored for 8 months, were cooked. The cooking at this time caused an improvement of about 20 percent.

The total improvement in the vitamin A value of the sweet potatoes from the time of harvest in the raw state to baking at the end of 8 months of storage was at least 100 percent. The increase in the vitamin A value of the raw sweet potato has been shown to be progressive throughout storage. It would appear to be caused by chemical changes which occur during storage. The increase in the vitamin A value due to cooking the sweet potato at any stage after harvest is not progressive. The reasons for the increased vitamin A value of the cooked sweet potato have not been determined at the present time.

Nancy Hall Sweet Potatoes

The Nancy Hall variety of sweet potato is being tested by the same method and with the same storage intervals as were used in testing the Porto Rico variety. Although the series of tests have not been completed, the results for the assay directly after harvesting showed that cooking the potatoes increased their vitamin A value at least 36 percent. At the present time the Nancy Hall sweet potatoes are being tested after 4 months of storage.

Yellow Turnips and Rutabagas

Yellow turnips and rutabagas were selected for the study of their vitamin A values in the fall of 1937 to add to the information concerning yellow-root vegetables. The Amber Globe variety of yellow turnip was found to be practically devoid of vitamin A value. The highest level of yellow turnip fed to rats in these tests was 6 grams daily, which proved to be insufficient. It was difficult to make the rats eat this amount, even by withholding the

basal diet. Provided they could have been made to eat a larger amount of the turnip, a higher level of feeding would have been undesirable, for too much of the basal diet would have been displaced by it.

The results obtained by cooking the turnips are questionable. It is difficult to say whether cooking increased the negligible amount of vitamin A present or whether the slight superiority of the cooked turnips was due to the fact that the animals ate the 6-gram portions more readily when cooked. The yellow turnips will be tested for their vitamin A value again after storage before final rejection.

The rutabagas being used in the tests for vitamin A values are of a deeper yellow color than the turnips. Although they do not compare favorably in vitamin A value with either carrots or sweet potatoes, the rutabagas are superior to yellow turnips as a source of vitamin A. Three grams of rutabagas when fed daily was sufficient for maintenance of weight in the rat, whereas 6 grams induced an average growth of 58 grams during the 8 weeks' experimental period. Cooking improved the vitamin A value of the rutabagas, so that the 3-gram level of feeding increased the average growth of the animals from mere maintenance to 24 grams during the 8 weeks' period.

The rutabagas will be investigated for the effect of storage on their vitamin A value at the same time as the yellow turnips are tested.

Carrots

The Chantenay variety of carrot was tested for its vitamin A content in the fall of 1936 and again after storage in the spring of 1937. At the time of harvest, the raw carrots were found to contain 40 Sherman units of vitamin A per gram. Cooking the carrots increased their vitamin A value to 66 Sherman units. An increase of approximately 40 percent, therefore, had taken place in the vitamin A value of the carrot due to cooking.

Storage did not increase the vitamin A value of the carrots. When tested in the spring, the carrots seemed less uniform and the response of the animals varied so widely that the work is being repeated with a larger number of animals.

The carrots, sweet potatoes, and turnips were obtained from the Horticultural Department of the Experiment Station.

Phosphate Studies

The availability for animal nutrition of the phosphorus in two different calcium metaphosphates was studied by methods used in previous work in this laboratory. Rats receiving either of the calcium metaphosphates as the only source of phosphorus in the diet showed somewhat poorer growths and lower percentages of phosphorus in their bodies than animals receiving the control diet, which contained phosphorus of known availability. The more soluble of

the two calcium metaphosphates gave slightly better results in growth and in deposition of phosphorus in the body.

A rock phosphate also was fed to rats as their sole source of phosphorus. Judging from the growth of the animals, the phosphorus must have been utilized to a considerable extent. Analyses for phosphorus in these animals have not been completed.

HORTICULTURE

Brooks D. Drain

RED RASPBERRY IMPROVEMENT

Propagation difficulties have delayed work on the red raspberry improvement project. Many superior seedlings from the earlier crosses have not been propagated by any known method except crown division. Two superior seedlings from this breeding work were hybridized in 1936 with *Rubus idaeus* L., the European red raspberry, and the resulting seedlings fruited in 1937. This combination gave splendid commercial quality and moderate disease resistance. Several very promising fall-bearing seedlings also were selected.

IMPROVED STRAINS OF PYRETHRUM

Plantings of the Station's improved strains of pyrethrum were made in about one-third of the counties of the State. Most of the plants have made a good growth during the past year. The next step will be for growers to propagate a sufficient number of plants to make plantings of profitable size. Crown-dividing plants more than two years old in March was the best method of propagating found in the Station's tests. Such crown divisions are set at once in the new planting.

FIRE BLIGHT-RESISTANT PEARS

Orchard heaters, burning waste crankcase oil from automobiles, were used to prevent cold injury to the pear orchard in the spring. Many emasculated and hand-pollinated blossoms set fruit, but most of them were parthenocarpic. A small seedling population now growing from these crosses will be set in nursery rows in the spring of 1938. Several hundred disease-resistant seedlings were top-budded into stock trees at the Mericourt Station. A few of the seedlings crossed in 1931 fruited in 1937.

LEAF SPOT-RESISTANT TOMATOES

This Department continued its efforts to secure the best possible leaf spot-resistant tomato stock. Forty-five foreign tomato importations were fruited and studied. The work on lines of breeding started by the late S. H. Essary was continued. A selection made at Newport, Tennessee, is the most promising strain secured up to the present time. Mr. Arthur Meyer took over a considerable part of the work of this project.

CROWN ROT-RESISTANT RHUBARB

A large number of seedlings from imported rhubarb seed were grown in crown rot-infected soil. Many died during the warmer period of the summer, but a part remained healthy and will be given further trial.

SWEET CORN

Sweet corn varietal trials over a period of years were summarized in Circular of Information No. 42. In brief, this circular recommended hybrid varieties of Golden Bantam, like Golden Cross Bantam and Tendergold, for trial in home plantings and local markets. Hybrid varieties of the Evergreen type were recommended for canners and truck growers.

SWEET POTATOES

Equipment for thermostatically controlled electric heat was installed in the Station's sweet potato storage house. Considerable power was consumed in curing, but only a moderate amount during storage. This method of storage requires a minimum of attention and maintains very uniform conditions. It is planned to conduct storage studies with this equipment. A comparison of manure and electric heat for growing sweet potato slips was started in 1937. In general, the electrically grown plants had a larger root system.

IRISH POTATOES

Home-grown Jersey Redskin irish potato seed held in cold storage until ten days or two weeks before planting gave as good yield for the late crop as the best obtainable certified seed shipped in. Warba continued to lead in yield of U. S. No. 1 tubers produced in the spring crop, and matures very early. Houma, a new variety from the U. S. Department of Agriculture breeding work, gave a large yield but ran high in culls and U. S. No. 2's. Some local-grown Cobbler seed from a high elevation compared very favorably with certified northern-grown seed, but ran somewhat higher in leaf roll. This emphasizes the importance of careful rogueing for diseases and control of leaf hoppers.

IRRIGATING VEGETABLES

The truck grower was favored by an unusually even distribution of rainfall in 1937. A few applications of irrigation water were made during dry periods, but the advantage was slight.

IMPORTED ORNAMENTALS

Promising new and imported flowering shrubs in the Station plots continued to attract the attention of farm women and garden-club members. Samples of a few of the more promising were distributed to most counties of the State through those attending the Farm Women's Short Course at Knoxville.

BOYSENBERRY

Boysenberry, a new variety of dewberry of the Youngberry type, fruited at this Station this year. It appears to be a strong competitor of the Youngberry and should be valuable for canning and processing for local markets and home use.

ROSES FOR ROADSIDE PLANTINGS

A planting of American Pillar, *Rubus multiflora*, and a Gardenia type of rose was made in 1932. The rooted plants were set in good soil at the top of a cut along the road and the new growth permitted to fall over the exposed subsoil. This planting has received no care. All three roses have good foliage and are free from diseases. The American Pillar has made a stronger growth than the Gardenia.

ASPARAGUS

This Department has conducted a series of experiments with asparagus, as it is not widely grown in Tennessee. Mary Washington appears to be the best strain. Relatively shallow plantings have made the best growth in two trials on clay soils. Two dustings of sulfur have controlled an unidentified leaf spot which is very common in these plantings. A furrow turned over the row just before harvest lengthens the shoots, smothers weeds, and improves the market quality of the crop. This is especially important on clay soils.

HARDY CHRYSANTHEMUMS

The common failing of many of the best varieties of hardy chrysanthemums is that they blossom so late in the fall that the flowers are damaged by freezing. The gardener or florist can control the time of flowering by proper manipulation of the light. To force late-blooming varieties into earlier production, the period of light was reduced to 9 or 10 hours per day, beginning about 6 or 8 weeks before the flowers were wanted. This can easily be accomplished by shading the plants with black cloth during part of the day. Under greenhouse conditions the blooming period was prolonged by supplementing daylight in the fall with electric lights. When the plants were removed from the additional light they bloomed very satisfactorily.

TREE FRUITS

Cold damage occurring late in the spring resulted in a small crop of plums and peaches. The apple orchard was loaned to the Department of Entomology for spray experiments. A device for scaring birds, called a carbide exploder, was used to reduce bird damage in the cherry plots. It was operated at a small cost and reduced the loss of ripening fruit over a considearble area. It must be operated on a tall pole.

PHYSICS

K. L. Hertel

TECHNICS FOR MEASURING FIBER PROPERTIES

Fibrograph.—Two fibrographs designed for greater flexibility were tested during the year and used to study the problem of sampling cotton. A new method of sampling was developed which required one-third the time of the old. The new sample gives a fibrogram representing fibers longer than 5/16 inch. The fibrogram is unreliable for shorter fibers. For well-mixed cottons a single fibrogram adequately represents the cotton lint, but for hand- or roller-ginned cotton several fibrograms are necessary. The present fibrograph will not accommodate larger samples, although samples five times as large have been prepared almost as easily and quickly as the present samples. A fibrograph accommodating the large samples is now being designed.

Fineness.—Experiments on a macroscopic method for quickly measuring "fineness" have been continued. Data on a number of cottons, as well as wool, rayon, and kapok, having a wide variety of sizes and shapes, have been obtained by the macroscopic method. These data are to be compared with more direct microscopic data to determine what physical property of the fiber is measured by the macroscopic method. The technics for obtaining reliable measurements of fiber cross-sectional areas and perimeters have been developed.

PLANT PATHOLOGY

C. D. Sherbakoff

Following is a brief statement of the progress made on each of the active projects of the Department of Plant Pathology during the year.

WHEAT

Head Blight and Root Rot

The work on head blight and root rot of wheat was concentrated on practical control through resistant varieties. Wheat selections and breeding for disease resistance, therefore, were continued, with special emphasis on (1) the selection of pure lines from different varieties of wheat; (2) the making of new crosses between pure lines to develop a variety resistant to all of the more important diseases, and at the same time satisfactory from an agronomic standpoint; and (3) the testing of the more promising selections in different parts of the State and on different types of soil.

During 1937, over 2700 pure-line selections were made from three sources—the older selections, the most promising standard

varieties, and the old crosses. These new selections were planted in October, in rod rows. A number of new crosses were made, and 65 crosses, of second and third generations, were multiplied for selection of the most desirable segregations in the future.

The test of the most promising old selections, in comparison with local varieties and with several of the best standard varieties, was carried on in quintuplet rod-row plots, in 13 localities, in different parts of the State. The results, in averages of 5 rod-row plots, calculated to bushels per acre, are shown in the accompanying table.

Wheat yields, in bushels per acre, calculated from the average of 5 rod-row plots, obtained in different localities, with standard varieties and selections, in 1937.

Locality	Check Farmer's wheat[1]	Tenn. 2 Hard	Tenn. 152	Leaps	Trumbull	Forward	Indiana Exp. Sta. Fultz	Indiana Exp. Sta. Mich. Amber	Tenn. 612	Tenn. 64	Average for the 10 varieties
Knoxville, Rt. 11	18.3	22.7	[2]**23.3**	19.8	18.8	17.7	20.2	15.9	21.4	20.4	19.8
Jonesboro after tobacco	26.1	28.5	30.8	28.9	31.2	33.1	34.6	27.8	**43.7**	33.7	[3]*31.8*
Jonesboro after corn	21.4	25.1	25.6	22.2	21.5	21.8	23.7	14.0	**26.8**	26.3	22.8
Union City	31.2	**36.6**	33.6	35.7	31.3	31.5	31.1	29.6	31.3	31.4	*32.3*
Martin	12.2	13.5	14.5	10.7	14.6	12.4	14.1	10.7	**14.7**	12.1	12.9
Knoxville, WPB	16.0	15.7	**17.3**	16.1	15.2	15.1	15.9	14.3	15.8	16.6	15.8
Phillips	14.6	14.7	16.5	16.8	16.9	15.0	16.8	14.5	18.0	**19.2**	16.3
Trenton	7.3	7.8	8.5	6.0	7.4	8.1	**10.7**	9.5	10.0	9.5	8.4
Clarksville	9.2	12.4	10.8	9.5	10.1	11.2	**12.5**	12.0	10.5	12.1	11.0
Kelly's bottom land	22.7	21.1	21.8	23.0	26.1	24.4	**29.6**	28.7	28.3	26.7	25.2
Kelly's hill land	19.3	25.4	25.6	22.4	21.1	23.2	**28.6**	16.5	22.4	27.3	23.1
Greeneville	13.5	16.9	16.8	15.1	14.9	12.4	**24.3**	15.9	17.6	19.0	16.6
Columbia	27.1	**40.1**	38.6	32.2	32.7	30.6	33.9	29.5	33.6	35.3	*33.3*
Average	18.3	21.6	21.8	19.8	20.1	19.7	22.7	18.3	22.6	22.3	20.7

[1]Except on the Station grounds at Knoxville, Greeneville, and Clarksville, where Tennessee 80 was used.

[2]The bold-face figures show highest yield, for the individual variety, in the particular locality.

[3]The italicized figures are those of the yields over 30 bushels per acre for all varieties in one locality.

The figures in the table seem to indicate that the 4 Tennessee selections and Fultz from Indiana are definitely better-yielding than the other 5. Of the latter, the wheats grown by the farmers on whose places the tests were conducted, the Tennessee 80, used as check on the plots at Knoxville, and the strain of Michigan Amber, were the lowest in yield. The results obtained in 1937, in the main, are similar to those obtained during preceding tests.

The averages of such tests, on soils ranging in fertility from extremely poor to very good, should not be expected, however, to show clearly the relative yielding capacities of different wheats. This will require a more detailed analysis of the data.

If examined in detail, the figures appear to show that Fultz from the Indiana Station was the best, or as good as any other, in most of the tests giving relatively poor yields for all varieties. If, however, the tests which produced over 30 bushels per acre for all varieties are considered, we find that Tennessee 2 was clearly best at Columbia and Union City, with yields of 40.1 and 36.6 bushels per acre, respectively; while Tennessee 612 was best at Jonesboro, where, after tobacco, its yield was 43.7 bushels per acre. The above figures indicate that the yielding capacity of any wheat should always be considered in connection with the soil-fertility levels, and that the tests should be conducted with this factor in mind.

Wheat breeding is further complicated by another extremely important factor, which should be considered before any new variety is recommended to our wheat growers; that is, the quality of wheat for milling purposes. This is being studied now in cooperation with our Agronomy Department, the Ohio Agricultural Experiment Station, and the U. S. Department of Agriculture.

Again this year the tests are located in different parts of the State, and to make them correspond more closely to the practical method of sowing wheat, the test units are in the form of regular drill plots. Our better selections are included also in the tests conducted by the Agronomy Department of this Station.

FUSARIUM WILT OF ECONOMIC CROPS

Cotton

The studies of cotton wilt, beginning July 1, 1936, are carried on in cooperation with the Division of Cotton and Other Fiber Crops and Diseases, U. S. Department of Agriculture. A large collection of cultures of Fusarium causing this disease was obtained in 1936, and studies of the cultures, especially with reference to their ability to produce disease in different varieties of cotton, are being conducted now in the laboratory and in the field. In connection with the latter studies, it should be stated that they were conducted in Tennessee this year, at Martin and Somerville, on the same basis and according to the same plan, in all details, as they were conducted in all other states cooperating in the studies, from Texas to North Carolina. The plans were worked out and the seed provided by the Division of Cotton and Other Fiber Crops & Diseases. This arrangement was accepted by the various agricultural experiment station workers participating in this study because all of them believe that only in this way can the necessary knowledge be obtained in a relatively short time. The varieties used in the field tests were selected primarily on the basis of their expected reaction to Fusarium wilt, and not on the basis of

comparative values of the varieties for local culture. This is the reason why such locally outstanding varieties as Stoneville 2 and Delta and Pine Land were not included in the tests.

The results of the tests show clearly that of the 12 varieties tested at both Martin and Somerville, only Half and Half and Coker 100 were greatly affected with the wilt. By the middle of September, Half and Half had 48.6 percent of wilted plants at Martin and 46 percent at Somerville; while Coker 100 had 27 percent of wilted plants at Martin and 18 percent at Somerville.

The addition of potash to cotton fertilizer at Martin materially decreased the wilt in the susceptible varieties and definitely increased the yield of cotton in practically all varieties. At Somerville, the beneficial effect of a potash application to cotton was not clearly evident. Of the 12 varieties, Sea Island 13B3 showed near immunity from the wilt, but, being an extremely late variety, it produced practically no cotton in any of the tests.

The varieties showed a marked difference in yield, some appearing clearly superior in this respect. Since no variety is especially desirable for culture in our State, none is recommended, although several of them, like Dixie Triumph 12, produced relatively very good yields, even in the field at Martin, which is heavily infested with wilt.

Tomatoes

The field studies and greenhouse work on tomatoes were confined to efforts to increase wilt resistance in the varieties generally considered resistant. At present these varieties have sufficient resistance only under conditions of relatively light attack. The method employed is the selection of certain lines and the making of certain crossings. With the assistance of the Plant Pathology Department of the Florida Experiment Station, a number of the more promising crossings were planted in November at Homestead Substation in Florida, to obtain an extra generation during this year. The wilt resistance of tomato material now available is believed to be sufficient to justify our proceeding with the improvement of tomatoes in other important characters, especially resistance to leaf spots. The studies on wilt and leaf-spot disease are carried on with the assistance of Mr. J. O. Andes.

STRAWBERRY BLACKROOT

The work with strawberry blackroot is done with the assistance of Mr. G. M. Stone. During 1937, it was confined to further crossings and selfings of the most promising selections and varieties. In all, there are now available about 5000 of the seedlings. The efforts at present are concentrated on breeding, with indications of improvement on the available material. No elaborate field test is being undertaken with seedlings now on hand. It is hoped that in

the near future the tests will be limited to a few outstanding new varieties.

RED CLOVER BREEDING

The primary object of the work with red clover is to produce strains resistant to the several diseases prevalent in the South. The method employed is that of brother-and-sister breeding, because the self-fertile lines are very few and cannot be depended upon in this work. However, the few self-fertile lines obtained are being carried alone. At present the progenies of some of the lines show definitely that they are in a condition of relative homozygosity. The work is done with the assistance of Mr. J. K. Underwood.

TOMATO LEAF-SPOT DISEASES

The breeding of tomatoes resistant to leaf-spot diseases is seriously hindered by the lack of truly resistant tomatoes among the known cultivated varieties. Some of the varieties and special selections, however, exhibit apparent resistance to these diseases, and are being utilized in this work.

APPLE BLACK ROOTROT

In the work on the apple black rootrot project considerable time was spent in the preparation of the material—primarily in getting a sufficient number of rootstocks produced under controlled conditions. Some time also was devoted to obtaining new isolations of the fungus and their study in the laboratory.

NEW FUNGICIDES

Field tests in cooperation with J. J. Bird, at Crosseville, again indicated that 5-5-50 bordeaux gave as good control of potato early blight as any other material used.

A certain amount of laboratory work, especially in connection with the effect of different fungicides on the fungus of bitter rot of apples, was done to pave the way for future studies.

MERICOURT EXPERIMENT STATION

AGRONOMY

H. P. Ogden

Varietal and Cultural Trials

Varietal trials of corn, soybeans, and lespedezas at the Mericourt Experiment Station, Clarksville, were conducted in the regular way. Each variety of corn was planted at 3 rates in order that each might be grown at the optimum rate.

Seedings of sericea at various dates, in wheat and on a prepared seedbed, were continued. Both scarified and unscarified seed were used.

Fertilizer Experiments

In addition to the regular fertilizer experiments with sweet potatoes, started some years ago, a test was made to determine the effect of granulation of fertilizer. This test was made with dark-fired tobacco. The comparison was between an ordinary 5-10-5 fertilizer and the same fertilizer made into small pellets about 1/16 inch in diameter and from 1/16 to 1/8 inch or more in length.

The results showed no significant difference between the ordinary pulverized and the granular form in yield, quality, or value per acre of tobacco.

In experiments with minor elements, the applications were too heavy and were toxic to crops.

Crop Rotations

One of the major experiments at Mericourt is the comparison of 5 different rotations with various fertilizer and lime treatments. All crops of all rotations are represented each year, requiring 200 plots. This experiment began in 1933, and has progressed satisfactorily. Decided differences already are beginning to be apparent. One of the interesting things is the excellent showing made by rotation No. 2, in which alfalfa is the sole legume. While the land is naturally acid and low in phosphate and potash, it produces good crops of alfalfa and red clover in these rotations when properly limed and fertilized.

HORTICULTURE AT MERICOURT

Brooks D. Drain

Fire Blight-Resistant Pears

Several hundred fire blight-resistant pear seedling selections from the Knoxville breeding work were top-budded into stock trees at Mericourt in the summer. This pear orchard is being managed in sericea with limited cultivation. The soil is very poor and tends to erode. Erosion has been reduced to a minimum and the trees are making an excellent growth. This method of orchard soil management is worthy of further trial and study. Mowing the sericea one or more times during the summer appears desirable in order to reduce moisture loss and limit seed production. All growth is allowed to remain in the orchard as a mulch.

Nut Trees

A Chinese pistachio (*Pistacia chinensis*) tree set out in 1933 is making a rapid growth, is free from cold injury, and healthy. It appears promising as an ornamental.

Blight-resistant chestnut trees set on soil of low fertility are showing some signs of malnutrition. A moderate application of a complete fertilizer (N. P. K.) will be applied in 1938.

Tomatoes

Newport 4, a selection from the tomato breeding work at Knoxville, gave the largest yield of U. S. No. 1 fruit in the canning-crop varietal trials. Supreme Marglobe, Certified Marglobe, and Certified Indiana Baltimore ranked next, in the order named. Early-set tomatoes gave much larger yields than those set out in June. This suggests that even canning-crop tomatoes should be set in the field as soon as danger of cold injury is past.

Improved Strains of Pyrethrum

Several thousand plants of the Station's high-test strains of pyrethrum were propagated by crown division and distributed to farmers in this vicinity. If this new crop grows well, the grower should allow it to stand for two seasons and then increase his planting to profitable size.

Asparagus on Loam Soils

Many farmers claim that asparagus cannot be grown successfully on clay and loam soils. The Mericourt planting on a moderately heavy loam soil produced over 3 tons of asparagus per acre in 1937 and graded over 90 percent U. S. No. 1. The rows were ridged with soil and bleached to meet local market preference.

Irish Potatoes

A July planting of the Jersey Redskin variety of irish potato gave a larger yield of U. S. No. 1 tubers than one made on June 20. Rainy weather delayed planting of the spring crop, and yields were small. Early-maturing varieties appear to have an advantage for such plantings.

Sweet Potatoes

Nancy Hall gave the largest yield of U. S. No. 1 roots in the varietal trials. Vineless, or Bunch, Porto Rico gave about the same yield per acre of U. S. No. 1 potatoes as the usual vining strain, but they graded out better. This vineless strain is also more convenient to grow.

Raspberries

St. Regis and King led in total yield in the red raspberry varietal trials. The former is early, small fruited, and of poor quality. The fruit of Latham rated high in commercial quality. The mulched plots yielded more than 6 times as much as those in cultivation.

Potomac, a new purple raspberry adapted to the South, has made a poorer showing at Mericourt than in other trials in Tennessee, but still yields nearly three times as much fruit as Cardinal, a purple variety commonly grown.

Acid Versus Alkaline Soils for Flowering Shrubs

A large list of flowering shrubs have been grown for 5 years on both acid and alkaline soils. Most of these plants appear to be tolerant to either acid or alkaline conditions.

Soil Management in Apple Orchards

From 1932 to 1937, inclusive, the apple orchard at Mericourt has been managed in lespedeza No. 76 with winter cultivation. The trees have made a good growth and there has been very little erosion, partly because of weed growth, and partly because the orchard is terraced. The lespedeza at the end of 6 seasons has failed to reseed itself.

MIDDLE TENNESSEE EXPERIMENT STATION

L. R. Neel, Superintendent

RECOVERY OF THE PASTURES

During 1937 the permanent pastures made a remarkable recovery from their condition in the fall of 1936. Then they were thin and short and crowded by growth of crabgrass, although a large part of this grass had been mowed and removed as hay. While not yet normal, the pastures made great progress toward recovery in the fall of 1937.

Holding down the growth of wild grass by grazing and mowing seems to have been a great help in re-establishing a sod. Doubtless the presence of an abundant supply of hop clover everywhere and white clover in many of the pastures has been most helpful in bringing back good bluegrass. In the past spring it was hop clover that furnished a large part of the pasturage and also of the hay when surplus growth needed to be removed. These little plants filled up the large and small gaps in the sod, and at the same time were storing nitrogen to help the spread of bluegrass as soon as the clover should disappear in June.

By fall, white clover in the pastures was more abundant than for many years. The hop clover also was there, filling every space not used by bluegrass or white clover. Both legumes are storing nitrogen in the soil to stimulate the growth of bluegrass next spring.

WHITE CLOVER MOVES IN SLOWLY

The assertion often is made that white clover will come into the pasture of its own accord, and need not be sown. If soil conditions are right, it will very slowly do this. It will do so rapidly if the pasture land is old, with sound white clover seed in the soil. In general, however, its natural spread should not be depended upon, and it should be a part of the pasture mixture. Pastures established at the Middle Tennessee Experiment Station without white clover in the mixture as much as 17 years ago still do not have in excess of 5 percent of this desirable legume; while a pasture started 3 years ago with white clover in the mixture and

with an application of somewhat less than 2 tons of ground limestone per acre, is now covered with white clover. A good crop of seed probably can be saved on it in 1938. A small area of a 14-year-old pasture was seeded with white clover and covered lightly with manure in the early spring of 1938. At the close of the year there is more white clover on this area than on an adjoining 10 acres where white clover was not sown and manure not used.

Lime helps white clover almost as much as it does alfalfa. Seeding white clover in the pasture mixtures or on old pasture land that does not contain this valuable little legume also is helpful. Furthermore, it is important that the right kind of seed be used in the pasture mixtures. Thus far the best source of white clover for our section is seed produced in Louisiana. Possibly when we save native white clover from very old pastures we shall have something better than the so-called Louisiana white. White clover seed has been saved from an old pasture and is being used in comparison with seed from Louisiana and other sources at the Middle Tennessee Experiment Station.

PASTURES ON EXPOSED GRAVELLY HILL LANDS

An analysis, made late in the year, of the pasture content of some of the gravelly hill land with southern exposure revealed the fact that 75 percent of the plants were hop clover and the remaining 25 percent were weeds and a sprinkling of bluegrass. This land has been manured twice and does hold some patches of bluegrass here and there, but never a sod. Hop clover furnishes excellent pasture from late March until near the middle of June. Then for a period of a month or more there is not much pasture available on this land. However, if rains come by the middle of July or a little later, crabgrass affords pasture and will do so until September or October. Light shade is being tried to help hold the bluegrass and clovers on these lands, and apparently the trees will do this when they are larger. Bermuda grass will serve the same purpose.

LARGE PART OF HAY FROM PASTURE LAND

As the pastures of the Middle Tennessee Experiment Station have become more luxuriant through the use of stable manure, the feeding of livestock on the land, and the encouraging of the growth of legumes, an increasing surplus needs to be made into hay. Now a considerable part of the annual hay supply comes from the pastures. During the spring and summer, more than 100 tons of good hay was put up from the pastures. It was bluegrass and hop clover, and crabgrass cut before maturing. White and hop clovers were helped by the removal of the tall surplus growth of other grasses to let light down to them and give them room for expansion.

ALFALFA ON BLUEGRASS SOD

It is easy to change from alfalfa to bluegrass. A pound or two of bluegrass can be seeded with the alfalfa, and the former will take the field in three or four years. Or a larger amount of blue-

grass may be seeded in alfalfa in September after light disking. To avoid the necessity for cultivation of rolling land that washes when exposed, it seems desirable to pass from bluegrass directly and speedily to alfalfa. Several years ago, therefore, plots of bluegrass sod were prepared by subsoiling and disking in late June or early July for seeding to alfalfa in late August or early September. The land was disked and harrowed to kill out the sod and make a fine, firm seedbed. Lime was used and inoculated seed was sown. Results on the plots have been satisfactory. In July this procedure was carried out on a larger scale, an acre of sod being used. The result was that as good a stand of alfalfa was secured there as on 20 acres of land prepared in the orthodox manner and seeded at the same time. It is believed that as this shift is made, erosion will be very slight, especially if a subsoil plow is run at approximately a right angle to the slope.

CRIMSON CLOVER ON UNPREPARED LAND

Seeding of crimson clover under all kinds of conditions on unprepared land was continued last fall. Hulled and unhulled seed were used. Austrian winter peas, winter vetch, and ryegrass were used under similar conditions.

BUTTON BUR CLOVER

Button bur clover got started on some rocky limestone lands near Lebanon, Tennessee, and has persisted there for a number of years. Seed was saved and some of this was furnished to the Middle Tennessee Experiment Station. Although this clover is said to be adapted to the region along the Gulf, and not farther up than the latitude of Montgomery, Alabama, seedings made last fall survived zero weather in December. But how valuable this plant will be, even if it proves hardy enough for Tennessee, remains to be determined.

WEST TENNESSEE EXPERIMENT STATION

Ben P. Hazlewood, Superintendent

WEATHER CONDITIONS

General weather conditions throughout the year at the West Tennessee Experiment Station were unusually favorable for field-crop production. The rainfall was above normal and well distributed, except in the month of January. The total for the year was 59.6 inches. The crop yields in several cases were the highest recorded since the Station was established, in 1909.

VISITATION

An unusually large number of farmers visited the Station during the year. The increase was due mainly to the attendance at the spring meeting for the study of winter crops and livestock experiments. The Farmers' Institute had the largest attendance it has had for a number of years.

CROP ROTATIONS

Ten experimental crop rotations are under way as a part of the field-crop plot experiments. They are designed to give results adapted to various types of farming. Studies also are made of the results from the use of lime, manure, phosphate, and potash. The most outstanding responses from these rotations have been from lime, manure, and potash. Rotations on white land gave the most marked responses from potash.

COTTON

Varieties.—The Deltapine and Stoneville strains of cotton continue to give the highest money-value returns per acre. Extensive trials have been conducted in cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture, and the Agronomy Department of the main Station. A more detailed report of the work on cotton varieties and strains at this Station may be found in the Crop Improvement section of this report.

Value of farm manure with and without lime and fertilizers.—The test reported in the following table was conducted on Calhoun soil, ranges A and B, plot 12, from 1911 to 1937, inclusive.

Results of annual fertilizer and manure applications to continuous cotton under limed and unlimed conditions.

Treatment per acre	Yield of seed cotton per acre Unlimed	Limed
No fertilizer	730 lbs.	899 lbs.
3 tons farm manure	1158 lbs.	1359 lbs.
200 lbs. superphosphate (16%) 50 lbs. muriate of potash	698 lbs.	893 lbs.
200 lbs. superphosphate (16%) 50 lbs. muriate of potash 3 tons farm manure	1243 lbs.	1415 lbs.

Effect of winter cover crops on yield of continuous cotton.—A test was begun to determine the effect on yield of continuous cotton when rye, ryegrass, crimson clover, bur clover, vetch, or Austrian winter peas, or a mixture of these crops, was seeded in cotton middles immediately following the first picking of cotton. Only one cotton crop has been harvested following these treatments, but some differences in yield were noted. The most interesting result observed was that a medium growth of a soil-improving crop made considerable difference in the yield of cotton. Rye and ryegrass both reduced the yield below that of no treatment. Soil erosion is a negligible factor on the area devoted to this test.

Time of applying nitrate of soda.—This test, conducted from 1929 to 1937, inclusive, was located on range X, plots 13-21, Lintonia soil of low fertility.

Results of annual applications of nitrate of soda on continuous cotton.

Treatment per acre	Yield of seed cotton per acre
No fertilizer	588 lbs.
100 lbs. nitrate of soda, first hoeing	1016 lbs.
200 lbs. nitrate of soda, planting time	1116 lbs.
100 lbs. nitrate of soda, planting time 100 lbs. nitrate of soda, first hoeing	1136 lbs.
200 lbs. nitrate of soda, first hoeing	1184 lbs.

Fertilizer responses.—Extensive fertilizer tests have been conducted, using nitrogen, phosphate, and potash, in different amounts. The principal response has come from the use of nitrogen, as is illustrated above. Phosphate has given practically no increase in yield under the various conditions in which it has been used as a cotton fertilizer at the Station. Potash has given a marked response on white land. The average increase in the yield of cotton from the use of 50 pounds of muriate of potash has been 600 pounds per acre. This increase resulted when cotton was grown in a 3-year rotation with corn, oats, and cowpeas, with and without lime. The need for potash as a cotton fertilizer has been more evident on the limed areas than on the unlimed areas.

CORN

Varieties.—Jellicorse gave the highest yield of corn on rich land and Neal Paymaster on poor land. Jarvis Golden Prolific gave the highest yield of all varieties of yellow corn. The yield of the early-maturing variety of white corn, Thompson Prolific, has been about equal to that of Jarvis Golden Prolific on both "rich" and "thin" land. The Thompson variety has been included in the trials for 9 years.

Comparative yields of grain for 4 varieties of corn for 1921 to 1937, inclusive.

Variety	Bushels of grain per acre	
	Thin land	Rich land
Jellicorse	25	59
Neal Paymaster	26	56
Jarvis Golden Prolific	23	50
Hickory King	20	39

Manure, lime, and fertilizers.—This test has been conducted on Lintonia and Olivia soils, range 4, plots 15, 16, and 21-24, from 1909 to 1937, inclusive.

Yields of continuous corn after the use of manure, lime, nitrogen, phosphate, and potash.

Plot	Treatment per acre	Bushels of corn per acre	
		Unlimed	Limed
15	200 lbs. superphosphate (16%) 50 lbs. muriate of potash 5 tons farm manure	33	35
16	200 lbs. superphosphate 50 lbs. muriate of potash (16%) 5 tons farm manure	34	(1)36
21	No fertilizer	13	14
22	200 lbs. superphosphate 50 lbs. muriate of potash	12	15
23	200 lbs. superphosphate 50 lbs. muriate of potash 100 lbs. nitrate of soda	24	28
24	100 lbs. nitrate of soda	27	30

[1]Burnt lime.

SEEDINGS ON SOD

Small grains.—Rye, oats, barley, and wheat were all seeded on dense Bermuda sod, October 18, 1936. Each of these grains made sufficient growth to be of some value as a winter pasture, but failed to mature grain sufficient to harvest. Considerable hop clover was present with the Bermuda grass.

Legumes.—Twelve legumes were seeded on dense Bermuda grass sod, October 18, 1936, by the use of either a grain drill or a clover-and-alfalfa drill. The plantings included vetch, Austrian winter peas, crimson clover, hop clover (procumbens), subterranean clover, white clover, black medic, alfalfa, red clover, alsike clover, sweet clover, and bur clover. Vetch, crimson clover, Austrian winter peas, and hop clover made very satisfactory growth. Only a scattered stand resulted from the seedings of the other crops named.

CLOVER AND GRASS GARDEN

An extensive planting of clovers and grasses has been maintained to determine the adaptability of various new varieties or selections. This planting now includes about 100 varieties.

LIVESTOCK

Purebred herds of Jersey cattle and Duroc hogs and a flock of Hampshire sheep are maintained. Beef cattle for feeding and pasture experiments are bought from West Tennessee farmers. All the work stock in use have been raised from purebred Percheron mares. The production of work stock has been discontinued in order that sufficient pasture might be available for other livestock projects.

Dairy Cattle

The dairy herd has been divided into two groups for the past 6 years. Group 1 was fed all-year pasture, alfalfa hay, and silage, and group 2 was fed the same pasture and roughage with the addition of 1 pound of grain to each 3 pounds of milk produced. The pasture consisted of crimson clover, from November first until May first, and permanent pasture the remainder of the year, supplemented with Sudan grass during July and August. The plan of this experiment was to have 12 cows complete 2 successive normal lactations in each group. To date, 6 cows have completed 2 successive normal lactations in each group, making a total of 24 lactations.

The total mature equivalent production of the cows fed no grain has been 85 percent of that of the grain-fed cows. There has been no noticeable difference in the physical condition of the two groups of cows. The no-grain-fed cows have maintained body weights equally as well as the grain-fed cows. Cows fed no grain produced as well as grain-fed cows during late April and early May. The low production of the no-grain group occurred during the months of September and October, and January and February, when it was 75 percent that of the grain-fed group.

Beef Cattle

Feeding experiments with beef cattle included methods of preparing corn for baby beeves, protein supplement for 2-year-old steers, and a comparison of field-cured and mow-cured hay.

Swine Feeding

A project was begun during the latter part of the year comparing crimson clover and a mixture of crimson clover and ryegrass as winter pasture in a ration for growing and finishing hogs. Each of these pastures was used in connection with barley-and-corn feeding.

HORTICULTURE AT WEST TENNESSEE STATION

Louis A. Fister and Brooks D. Drain

Strawberry Breeding

In the strawberry work in 1937, frozen-pack trials of strawberry selections attracted the most attention. Several hundred selections of the Station's past breeding were frozen in two ways; namely, 2 plus 1 sugar and an individual berry pack, or "dry pack." Out of the total number frozen there were two selections which, in the opinion of the Station staff, were outstanding in flavor, color, and texture. These two are also good producers and are rated high as fresh fruit.

About 3000 seedlings, consisting of high-rating selections crossed with standard varieties and also back-crossed, fruited for

the first time, and the most promising of these have been planted in the plots for further testing.

Blakemore out-yielded Klondike about 60 crates per acre in 1937.

Apples

Codling moth emergence was checked again and some spray tests were carried out for the purpose of comparing various substances with bordeaux and arsenate of lead on apples. Time of application has been shown in work at this Station to be very important in controlling diseases and insects.

Red Raspberries

Latham and Chief are the high-yielding varieties in the red raspberry varietal trials, and the quality of fruit is good. Latham produced 2900 quarts per acre, and Chief 2100 quarts. Because of insufficient time, the red raspberries were not given as many bordeaux sprays as in 1936, and consequently lost practically all leaves, due to leaf spot, before autumn.

Youngberry

A comparison of Lucretia dewberry with Youngberry proved to be a very interesting test. The latter produced 7500 quarts of fruit per acre, while the former yielded 4140 quarts. The Youngberry also outclassed the dewberry in size and flavor of individual berries.

Early Cabbage

The cabbage varieties were grown on ground that had been in sericea for 3 years previous to the planting. Copenhagen Market produced 11.3 tons per acre; Golden Acre, 10.6 tons; and Peerless, 14.4 tons. The Louisiana strain of Copenhagen yielded only 6.6 tons per acre, and the heads were exceptionally small.

Irish Potatoes

The early crop of irish potatoes, like the cabbage, was grown on ground which had been in sericea for 3 years previous to this planting. Warba was ready for harvest about two weeks earlier than Triumph or Irish Cobbler. Nittany Cobbler, a white cobbler from Pennsylvania, was the high-yielding variety, giving 207 bushels per acre, 151 of which were U. S. No. 1. Russet Burbank was the lowest-yielding variety, producing only 139 bushels per acre, 99 of which were U. S. No. 1.

An unusually fine crop of Jersey Redskin was produced on the late-crop plots. This was due to very favorable weather. As much as 200 bushels per acre was harvested from some plots, and 170 of these were U. S. No. 1. Treatment of seed after it is removed from cold storage is probably the main thing affecting a stand of plants later in the field. Good seed (green-sprouted be-

fore cutting) was the chief factor in obtaining a good stand. On the better soils, seed from New Jersey out-yielded home-grown seed from 11 to 26 bushels per acre of U. S. No. 1. But home-grown No. 2 seed, uncut, out-yielded the shipped-in seed by 36 bushels of U. S. No. 1 per acre.

Tomatoes

There was no appreciable difference in the yields of the varieties of tomatoes grown. The average of the varieties, which consisted of Marglobe, Glovel, Marhio, Rutgers, Newport, Indiana Baltimore, and Clark's "C", was 100 bushels per acre.

Sweet Potatoes

Bunch Porto Rico sweet potato yielded 221 bushels per acre of U. S. No. 1 and Nancy Hall 357 bushels. No fertilizer was applied to this planting, and the ground had been in peaches for 13 years previous to 1937. Mameyita gave 209 bushels per acre of U. S. No. 1, and Porto Morado, a selection from Louisiana, produced 254 bushels.

Lettuce

Eight strains of New York lettuce were tested along with Iceberg and Big Boston. Plants were set to the field in February and several freezes failed to hinder the plant growth. Imperial No. 847 was the best of the strains or varieties tried. Solid heads formed on all of the plants of this strain, but the centers rotted to some extent. Practically all of the other strains and Big Boston and Iceberg went to seed as soon as warm weather set in.

Irrigation

Even though the year was very favorable as far as moisture distribution was concerned, the irrigation of tomatoes and beans showed an increase over no irrigation. Irrigated Gulf State tomatoes gave an increase of 33 bushels per acre of marketable fruit over non-irrigated. Forty-one bushels per acre of marketable tomatoes was the gain from irrigating Marglobe. Irrigation gave a small increase in the production of Davis Stringless Wax beans.

TOBACCO EXPERIMENT STATION AT GREENEVILLE

Frank S. Chance, Superintendent

The work at the Greeneville Station is being conducted in cooperation with the United States Department of Agriculture.

TOBACCO

The fertilizer and varietal tests which have been under way for the past 6 years were continued. Many of the strains tested for quality and resistance to blackroot rot have been discontinued. The soil is so thoroughly infested with the organism causing black root-

rot that many of the more resistant strains are showing injury. Such varieties as Judy's Pride, Kelly, Lockwood, and Twistbud have been so badly affected for several years that they would not produce a profitable crop. Shipp's and Kentucky No. 5 are showing reduced yields. Tennessee Golden is only slightly affected, as are some of the more recent and unnamed strains. Two of the unnamed strains still are producing heavy poundage, and their quality is sufficiently good to justify a wider test of their value.

Fertilizer tests were started this year on the Nolichucky silt loam type of soil that is found at the Station. This makes 3 types of soil, common to Tennessee, that are being tested for fertilizer requirements for the production of quality tobacco.

In addition to these tests, a series was started on dolomite ridge soil to determine the effect of a high nitrogen application in producing quality tobacco. One set of these plots received an application of a 5-4-6 fertilizer at the following rates: Plot No. 1—4000 pounds; plot No. 2—2000 pounds; plot No. 3—1000 pounds; and plot No. 4—500 pounds per acre. Another set received the same amount of nitrogen and potash as plots 1 to 4, but double the amount of phosphate. The plots receiving the 8 percent phosphate were consistently better in quality than those receiving the 4 percent. All plots were replicated 3 times. The cost of the heavy fertilizer applications was more than paid back by the increase in the value of the tobacco produced.

This was the fourth year of the 21 tobacco crop-rotation tests. These are being conducted on soil that never grew tobacco before. Some differences are beginning to be evident, but conclusive results are not to be expected for 4 or 5 years.

PASTURE PROGRAM

Thirty-four grade Hereford calves that had been raised at the Station were pastured on crimson clover and ryegrass during the winter of 1936-37. These calves were on pasture all but 27 days during the winter. In addition to the pasture they received rough lespedeza and grass hay and an average of 2.9 pounds of shelled corn and .28 pound of cottonseed meal per head per day. The calves were taken away from their dams and weighed on December 1. After 181 days on the above ration, they had gained an average of 283 pounds per head. This is the first test in a winter-pasture experiment that is to be continued for many years. In the future, where grain is fed, barley will be substituted for corn in the ration. Barley is being used as the grain crop in the broadcast system of farming that is being conducted on the soil erosion project.

SOIL EROSION PROJECT

Enclosures and catch basins for 6 plots of 1/20 acre each were completed in the early part of the year. Records of water and soil loss were kept. Three of these plots are used for a 3-year rotation of corn, wheat, and lespedeza. One plot is used for a

rotation of crimson clover and barley. Two are grass-sod plots, one of which was treated with lime and a liberal application of nitrogen, phosphate, and potash. The other received the same amount of lime, nitrogen, and potash, but it did not receive any phosphate. These were both sown to a grass mixture in the early spring. These plots are on a Talbott silt loam soil that has a 10 percent slope. This is a long-time project, and it probably will be 4 or 5 years before the data accumulated are of much value.

BUILDINGS

A greenhouse 28½ by 58 feet, with a headhouse 30 by 30 feet, was built. This building is used in connection with the tobacco breeding work. The greenhouse makes it possible to get two seed crops per year. This doubles the speed of the work. It also makes possible controlled soil and temperature conditions for testing the various strains of tobacco for their resistance to black rootrot.

A livestock barn 38 by 110 feet, with two sheds 10 by 60 feet attached, was built during the year. This barn is for cattle-feeding tests that are being conducted.

The tenant houses on the farms purchased for the Station were not sufficient to take care of the labor needed and in most cases were so dilapidated that they were not worth repairing. Two 6-room brick houses and one brick duplex were built. This made 4 housing units of 5 rooms and a screened back porch each. The buildings are of solid brick and covered with metal. They are each equipped with complete bath and kitchen sink and are of plain but durable construction.

LIBRARY

Sarah C. Currell

A well-organized, workable, up-to-date library is indispensable to the growth and development of an experiment station. Quoting from one of our station men, "A library is an absolute necessity to a research worker." He further said that in one of his experiments still in progress the library references he had used far exceeded 100. Tennessee Experiment Station Bulletin 162, "Cryolite Spray Residues and Human Health," has a bibliography of 5 pages. These references were practically all obtained from the Station library. Seed-treatment experiments still in progress, which have called for 50 or more references, also demonstrate the importance of a library.

The Experiment Station men are able to keep abreast of the times through scientific and technical journals. The library in 1937 subscribed to 45. In addition to these, a large number are received through exchange. The publications from India are valuable to the men who are doing research work on cotton. These

publications are sent us in exchange for ours—and this is only one instance among many.

Publications are received from 47 other state experiment stations; the experiment stations located in Alaska, Guam, Hawaii, and the Virgin Islands; the state extension departments; foreign experiment stations; the United State Department of Agriculture, and the various state departments of agriculture.

The collections total 10,873 volumes, an increase of 242 over last year. This increase includes 132 volumes of bulletins and scientific journals which were bound and catalogued. It does not include the College of Agriculture collection, which is housed in the same room and is available to experiment station workers.

Accurate record is kept of material loaned. The libraries of the Experiment Station and the College of Agriculture circulated 1,508 books during the year.

The inter-library loan service is still being used by the Station staff. This affords them access to rare and valuable material not found in their own library. We in turn lend from our collection to other libraries.

The NYA appropriation has been continued. This enables the Station and College libraries to employ regularly a student for 50 hours per month. In addition to this, the Station and the College each employs a student from 12 to 15 hours per week to assist in the routine work of the library.

The Station library serves the staffs of the Experiment Station and the Agricultural Extension Service, and the faculty of the College of Agriculture. The agricultural students working in the College library are given the privilege of using books from the Station collection. The library is used by the Tennessee Valley Authority and by many workers other than those connected with the University, as well as extensively by members of the general faculty and the student body.