

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

FIFTY-FIRST ANNUAL REPORT
1938



KNOXVILLE, TENNESSEE

LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 2, 1939

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 1938. 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, 1937-1938

Receipts					
	Hatch Fund	Adams Fund	Purnell Fund	Bankhead- Jones Fund	Bankhead- Jones Offset Fund
U. S. Treasurer	\$15,000.00	\$15,000.00	\$60,000.00	\$56,087.91	
Other sources					\$56,087.91
Disbursements					
Personal services	12,387.68	14,019.24	53,216.60	33,148.28	33,185.79
Supplies and materials	348.98	468.93	2,281.71	1,847.48	5,207.87
Communication service	320.52	2.21	27.04	63.80	699.84
Travel expenses	111.41	54.05	999.27	673.10	936.78
Transportation of things	76.13	19.37	143.62	186.35	382.29
Publications	1,129.17		80.99		1,026.70
Heat, light, water, power	23.50	16.59	514.55	230.97	2,162.73
Contingent expenses	5.65	1.50	30.40	204.38	663.24
Equipment	586.09	280.69	2,143.86	5,724.06	7,745.03
Buildings and land	10.87	137.42	561.96	14,009.49	4,077.64
	\$15,000.00	\$15,000.00	\$60,000.00	\$56,087.91	\$56,087.91

FIFTY-FIRST ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE, FOR 1938

JACK-STOCK AND MULE-PRODUCTION PROJECT

Reference is made in the report of the Animal Husbandry Department to the jack and jennet breeding studies. This project, which had its beginning in 1936, has been developed as rapidly as the circumstances would allow. It necessarily is an expensive project, requiring land, buildings, and special equipment, as well as breeding stock. The project was located on a farm adjoining the Middle Tennessee Station property in Maury County. Nearly 130 acres of land was purchased in 1936 at a cost of \$40.00 per acre. Since there were no worth-while improvements on the place, suitable barns and other buildings had to be constructed, the total expenditure being nearly \$12,000.00.

The location selected is in the Central Basin, a section of the State which has long been recognized as especially well adapted to livestock and which has more interest in mule production than any other area of similar size in the State.

A project of this kind would be expected to require several years to furnish dependable basic information. It is hoped that such information will standardize the industry on a higher level than has been reached up to the present time.

SOIL SURVEY

During the year 1938 completed field sheets for Bedford and Cumberland Counties have been received and tabulations made showing the extent of the various soil series and types.

Field sheets, after being colored to show land-use classification, are matched, mounted, and bound in convenient form for use and reference. During the year these maps have been prepared for use of the county agents of Humphreys, Roane, Lincoln, and Hamilton Counties; also four copies for the Tennessee Valley Authority, one for the Experiment Station, and one for the United States Bureau of Chemistry and Soils. Thirteen field men, giving full time, supported by the Tennessee Valley Authority, were in the employ of the Experiment Station at the end of the year. Four men from the Bureau at Washington also were engaged in the work.

During the year approximately 740,227 acres have been surveyed in areas affected by, or in close proximity to, the dams at Gilbertsville,

Norris, Watts Bar, and Coulter Shoals. Much work has been done in Decatur, Rhea, and Knox Counties, and work has commenced in Grainger County. Samples of soils from all completed counties have been received, and those from Jefferson, Hamilton, Humphreys, Lincoln, and Roane Counties have been analyzed for lime, phosphorus, and potash. These soil samples and analytical data are being preserved in convenient form for reference, and should be most helpful to persons interested in the characteristics of the soils and the development of better agricultural practices.

LEGUME SILAGE AS A FEED FOR POULTRY

P. W. Allen and M. Jacob¹

While the practice of ensiling legumes as feed for cattle is widespread and has great promise, legume silage as a feed for poultry has not yet been suggested, so far as the writers know, although it is especially suitable for poultry.

In a series of experiments having to do with poultry sanitation at the Tennessee Experiment Station during the last few years, it has been found that the severity of the action of intestinal parasites on infected fowls depends to some extent upon the diet. A diet of sour milk reduced the severity of attacks by pullorum organisms, coccidia, ascaridia, cecal worms, tapeworms, and other pests. It was assumed that this beneficial effect was due, at least in part, to the lactic acid in sour milk, and that other foods containing considerable amounts of lactic acid might well be considered in the feeding of poultry, as all poultry have more or less intestinal infection. Accordingly, sauerkraut has been tried as an addition to the diet of poultry and has been found to be beneficial. Sauerkraut, however, has little nutritive value and its use cannot be expected to reduce the amount of other feed required.

In the summer of 1937, some especially fermented legume silage was fed to white leghorn cockerels. They ate this silage so eagerly that in the spring of this year 4,000 pounds of legume silage was made, in barrels holding about 500 pounds each, to be fed experimentally to poultry. This silage was made by the addition of 70 pounds of blackstrap molasses to one ton of cut green legume. Sericea, alfalfa, and red clover were made into silage.

It had been discovered in the course of these experiments that there are two different fermentations which may take place in the making of legume silage: one in which the cut legume remains bright and green, develops a high lactic-acid content, and is a true form of pickling; and the other in which the cut legume becomes dark in color, with the top half drying out considerably and tending toward putrefaction and molding. Especial care was taken, in making the legume silage for this ex-

¹N. O. Sjolander, J. A. McBee, and I. H. Smiley gave valuable assistance in this work.

periment, to see that the bright-green color and the lactic-acid fermentation were obtained. A study of this type of fermentation is partly completed and will be reported later.



Fig. 1—Typical cockerels of groups A, B, and C at end of experiment.

The fowls used for this legume-silage experiment were 45 white leg-horn cockerels about 6 weeks of age. All were from the same flock, and averaged a little less than one pound. They were divided into 3 groups, as follows:

Group A consisted of 18 cockerels, which were given a standard poultry mash, and in addition as much legume silage, consisting of a mixture of alfalfa, red clover, and sericea, as they would eat. The mash and silage were mixed together, and the average cockerel ate 4 ounces of mash and 4 ounces of silage per day.

Group B consisted of 9 cockerels, which were given a standard poultry mash, and in addition as much sour milk as they would eat. The average cockerel ate 4 ounces of mash and 4 ounces of sour milk. Excess mash was accessible at all times.

Group C consisted of 18 cockerels, which were given a standard poultry mash and no other food. The average cockerel ate 4 ounces of mash. Excess mash was accessible.

Every factor which it was possible to control was controlled. Each cockerel was kept in a separate cage. All had the same kind of cage, the same temperature and air movement, the same amount of sunshine, the same mash, and the same care. The glass roof of the poultry house is made of "vita glass," allowing 90 percent of the active rays of the sun to enter. All birds were found free from pullorum infection, by blood testing, at the beginning of the experiment.

While it is appreciated that a food advantage should be demonstrated on a basis of 10 to 20 thousand fowls before final conclusions are drawn, initial experiments on 45 fowls, in which all factors are carefully controlled, strongly indicate directions, which cannot be ignored.



Fig. 2—Poultry house where experiment was carried on.

TABLE 1—*Postmortem data concerning foxels in groups A, B, and C*

Group	Percentage showing medium to heavy infestation with—				
	Tapeworm	Ascaridia	Coccidia	Cecal worms	Gizzard worms
A	18	0	0	0	5
B	20	0	10	37	0
C	14	10	25	25	0

TABLE 2—*Data concerning legume silage*

Crop	Percent of acidity as lactic acid	Plate count	
		Bacteria	Fungi
Sericea	1.8	170,000,000	1,000,000
Alfalfa	2.1	4,500,000	100,000
Red clover	2.0	3,500,000	300,000

The data given in tables 1-3 show initial results, but were obtained under such carefully controlled conditions that the chance for error was not large. Taking all facts into consideration, there are some important conclusions which can be drawn from this experimentation. When, in addition to a basic ration, poultry are fed a "lactic acid fermented bright green legume silage," made from red clover, alfalfa, or sericea, and have become accustomed to it in their diet, they show the following favorable results from the silage feeding:

1. Greater zest in eating and larger quantities of food consumed per day.

2. A remarkable increase in weight over poultry not receiving such silage in addition to a basic ration.

3. A physical condition, as determined by appearance and action of living birds and by post-mortem examination, which is definitely better than that of poultry not fed legume silage in addition to a basic ration.

TABLE 3—*Percentage gains made by cockerels from the seventh to the sixteenth week, inclusive.*

GROUP A									
No. of cockerel	1187	1191	1181	1154	1131	1144	1173	1177	1187
Percentage gain	171	177	207	207	264	162	186	180	133
No. of cockerel	1161	1118	1178	1147	1116	1124	1122	1163	1168
Percentage gain	260	236	169	192	200	400	357	173	183

Average percentage gain for group A, 214.

GROUP B									
No. of cockerel	1160	1172	1149	1158	1140	1156	1157	1145	1192
Percentage gain	176	166	244	161	178	245	300	218	255

Average percentage gain for group B, 215.

GROUP C									
No. of cockerel	1138	1121	1151	1186	1169	1152	1164	1167	1155
Percentage gain	153	157	150	190	190	150	87	185	137
No. of cockerel	1165	1125	1175	1171	1159	1130	1189	1170	1190
Percentage gain	209	191	160	157	154	172	191	230	133

Average percentage gain for group C, 166.

REPORTS BY DEPARTMENTS

AGRONOMY

H. P. Ogden

WEATHER CONDITIONS

The weather in 1938 was characterized by mild temperatures and excessive moisture during the first half of the year and a serious drouth from the middle of September through early November. Such a season was favorable at first for all winter crops, but growth was too rank in February and March. Freezing weather April 3, 4, and 10 caused considerable injury, especially to early-blooming varieties of barley. Warm, damp weather through May and June was responsible for a severe attack of stem rust of wheat, resulting in low yields and poor quality.

Pastures and hay crops were exceptionally good, but the weather was unfavorable for saving hay. Korean lespedeza was better than usual and not as badly infested with dodder as it often is.

Corn and other intertilled crops were good on the Station farm, but on many farms were weedy.

Early fall seedlings germinated well, but later ones either failed entirely or were destroyed after germination by severe drouth. Others failed to come up till the November rains and were not able to make enough growth before the very cold weather at Thanksgiving. Heaving was worse than usual during December, 1938.

SMALL GRAINS

Varietal trials of wheat, oats, and barley were conducted along the usual lines. Wheat yields were low in this locality, but were fair on the Station farm, although the quality was very poor and weights per bushel were low, due to stem rust, which rarely attacks wheat here, but was rather bad in 1937 and much worse in 1938.

Late varieties suffered worst. Gasta, the earliest variety, made excellent yields, leading all varieties in 1938. This variety often yields remarkably well, but the kernels are small and not attractive in appearance.

The milling quality of a variety of wheat is important in determining its desirability. Tests were conducted, and will be continued over a period of years, in cooperation with the Federal Soft Wheat Laboratory at Wooster, Ohio, to obtain data on the quality of certain varieties of wheat when grown in Tennessee and when grown in other parts of the country.

Yields of barley were below the average, due to freezing weather in April. The very early varieties, such as Missouri Early Beardless and Tennessee No. 5, were in bloom when the freeze occurred, and suffered worst. Polders C. I. 3213 had not headed, and escaped injury. Such experiences as this indicate the importance of continuing varietal trials over a period of years. For example, the yield of Missouri Early Beardless was highest of all in the test in 1937, but in 1938, due to the freeze, it was lowest.

Varietal trials with oats have revealed two very valuable varieties produced in the crop-improvement work carried out by N. I. Hancock. These are Fulwin and Tennex, formerly known, respectively, as Tennessee 1945 and Tennessee 1884. The origin of these new varieties is given in the Crop Improvement report.

These varieties are exceptionally winter-hardy. Their ability to endure low temperatures is shown in table 4.

Other Tennessee selections were included in these tests. They ranked as the first 5 in the 1933 test. In the 1937 test the Tennessee selections held the first 4 places and the 6th and 7th. However, these other

Tennessee varieties, while perhaps more cold resistant, have failed to yield as well as Fulwin and Tennex.

The remarkable winter hardiness of these two varieties is shown in

TABLE 4—*Percentage survival of oats in cold-chamber tests*¹

Variety	1933		1935	
	Percent	Rank	Percent	Rank
Fulwin (Tennessee 1945)	75.0	6	73.1	3
Tennex (Tennessee 1884)	74.2	7	68.3	7
Hairy Culberson			68.2	8
Winter Turf			60.0	11
Winter Fulghum 699-2011			53.1	20
Cokers 32-1			57.8	13

¹These tests were conducted by Dr. H. C. Murphy, of the U. S. Division of Cereal Crops and Diseases, in cooperation with the Iowa Experiment Station.

TABLE 5—*Percentage survival and rank of oats in winter-hardiness test*

Variety	1936-37		1937-38	
	Percent	Rank	Percent	Rank
Fulwin (Tennessee 1945)	92.8	1	76.1	1
Tennex (Tennessee 1884)	91.9	2	75.6	2
Hairy Culberson	90.3	4	71.3	7
Winter Turf	86.6	12	67.6	14
Winter Fulghum 699-2011	88.4	9	71.4	6
Cokers 32-1	87.9	10	70.1	11

TABLE 6—*Yields of grain of Fulwin and Tennex at Knoxville, Jackson, and Columbia, in mean bushels per acre.*

KNOXVILLE						
Variety	1933-1934	1934-1935	1935-1936	1936-1937	1937-1938	
					Seeded Sept. 16	Seeded Oct. 30
Fulwin (Tennessee 1945)	Bushels 51.2	Bushels 43.1	Bushels 19.1	Bushels 87.0	Bushels 46.0	Bushels 38.3
Tennex (Tennessee 1884)	48.6	42.2	16.5	86.0	48.5	40.7
Winter Fulghum 699-2011	39.6	37.1	7.4	61.5		
Virginia Gray Turf	33.8	22.6	2.8	54.8	36.1	
Lee		28.8	6.3	75.1	48.3	11.4
Cokers 32-1		24.7	2.5	62.9	41.7	34.5

Variety	JACKSON		COLUMBIA
	1936-37	1937-38	Late seeding, Oct. 16, 1937
Fulwin	Bushels 82.5	Bushels 75.8	Bushels 25.0
Tennex	78.3	81.7	34.4
Winter Turf	47.4	43.3	17.2
Lee		61.7	
Cokers 32-1	70.1	57.5	13.3

tables 4 and 5, giving the percentage survival and rank in a uniform winter-hardiness nursery test conducted by the U. S. Division of Cereal Crops and Diseases, cooperating with the Tennessee and 27 other state experiment stations.

They also have out-yielded other good varieties grown in the State, as shown in table 6.

The extremely low yields at Knoxville in 1935-36 were due in part to plant lice in the fall of 1935, but more particularly to cold injury during the winter. The table also indicates the possibility of seeding these new winter-hardy strains later in the fall than is safe for other varieties.

They are comparatively early and are bred for considerable straw so as to attain a fair height on less fertile land (figures 3 and 4). On very rich land they are likely to lodge.



Fig. 3—Fulwin oats (Tennessee 1945) on the left and Virginia Gray Turf on the right. May 21, 1937.

Note especially the difference in earliness.

While these varieties are not resistant to smut or rust, they mature early and thus escape serious rust injury in Tennessee; and since smut is easily and completely controlled with New Improved Ceresan dust, it is not a serious matter. These varieties are not recommended for states farther south, where rust is often more serious.

On the whole, these two new varieties of winter oats are a distinct improvement over any other winter oats tested by this Station. Limited amounts of seed are expected to be available in the summer of 1939.



Fig. 4—Fulwin oats (Tennessee 1945) on the left and Tennessee 1922, a dwarfy strain, on the right. May 21, 1937.

WINTER PEA IMPROVEMENT

The principal activity on the winter pea improvement project was the testing of breeding material supplied by the Division of Plant Exploration and Production, U. S. Department of Agriculture, in the attempt to find a strain resistant to ascochyta blight. None was found, but crosses were made with those strains that showed some tolerance to the disease. All strains, however, were badly infected, and most of them died before ripening seed.

OVERWINTERING OF SUGAR BEETS FOR SEED PRODUCTION

An experiment was begun in the fall of 1935, in cooperation with the Division of Sugar Crop Investigations, U. S. Department of Agriculture, to test the possibilities of seed production in this region. Seeding is done in the early fall, and the small beets are allowed to remain over winter where first seeded instead of being dug, stored, and replanted.

Various dates of seeding and cultural methods were included in the experiments. A wide range of results were secured during the 3 years of the test. More work will be needed before a thoroughly dependable method can be announced.

WINTER LEGUMES SEEDED ON SOD

This was the second year of the experiment with winter legumes seeded on sod. A number of winter annual clovers and other legumes were seeded on lespedeza stubble, Bermuda grass closely mowed, and Bermuda grass burned off.

Seedings of crimson clover either hulled or unhulled, Austrian winter peas, and vetch gave fair to good stands in almost all cases. Austrian winter peas, however, were very much better when worked into the ground, even though just enough to cover them, while crimson clover generally gave good results even when left on the surface. While in some cases better stands of crimson clover were secured by sowing unhulled seed, this was not always the case.

Hop, cluster, Persian, and white clovers were successful only where the sod was thin and short or where it had been burned. This was true also of black medic and sweet clover. Bur clover seeded in the bur in September failed to make enough growth to endure the winter. The only successful seedings were from hulled seed sown in September or unhulled seed sown in August. Only the hop clovers were successful on poor and unlimed land, and even these failed where the soil was bare.

A smooth, or "button," bur clover, *Medicago orbicularis*, found growing wild in the "cedar glades" at Lebanon, Tennessee, made a good showing in these tests, especially when sown on a good seedbed and properly inoculated. It is a much later variety than the other bur clovers.

These tests were made on the Experiment Station farm and also with cooperating farmers.

ALFALFA NURSERY

Nursery rows of over 40 strains of alfalfa were seeded in 1937 in the hope of finding a strain resistant to leaf spot and leafhoppers and also fully winter-hardy. This test will be continued to determine something of the length of life of the different strains.

One very interesting strain known as "creeping" alfalfa was added in 1938. It is said to spread by underground stems as well as seed, in India, and is therefore of interest as a possible pasture plant. While the plants grew well, there were no underground stems the first year, although many of the stems are of a trailing habit of growth.

SOYBEANS

The usual varietal trials and culture tests of soybeans were made; also a test of shattering. The shattering test was made by harvesting only one row of each variety when the seed was ripe and leaving another row to harvest in January.

There were 59 varieties in the test. Interesting differences were found in the percent of shattering and also in the quality or soundness of the unshattered beans. Some had "popped out" 100 percent; others not at all. Seed of the non-shattering type ranged from perfectly sound to completely rotten inside the pod.

Five non-shattering varieties developed by the Experiment Station were grown in acreage in Middle and West Tennessee in order that their behavior under farm conditions might be observed and the supply of seed increased. Limited amounts of seed of 3 of these strains will

be available for seed increase, and will be distributed by the Tennessee Crop Improvement Association. In habit of growth they resemble Tokio, being erect and branching, having dark-green foliage, with gray pubescence, or fuzz, on leaves and stems. They are like Tokio also in being late.

For 10 years the Experiment Station has tested seedlings of soybeans in late March on fall-sown small grain. Laredo soybeans seeded shallow with a grain drill in March have made good yields of hay with the minimum of labor and apparently with no injury to the wheat. In 1938, tests were made on the wheat fields of 9 cooperating farmers in addition to the test on the main Station farm. In 8 of the fields the yields of wheat were slightly greater on the plots where soybeans were seeded.

GREEN-VEGETABLE SOYBEANS

In 1933, 80 varieties of green-vegetable soybeans were received and put on test for yield, earliness, and cooking quality. The less desirable varieties were quickly eliminated. In 1938, only 8 of the original lot were still in the test. These included the better-yielding and better-quality varieties, ripening early, midseason, and late. While yielding ability is determined fairly accurately, differences in quality were not easily obtained, due to the personal tastes of the judges. As a matter of fact, many judges found the differences between varieties too slight to detect; even the differences between field varieties and "vegetable" varieties were not great.

CORN

Effects of thinning and replanting on stands and yields of corn were continued, as were trials on the residual effects of sodium chlorate used the previous year to kill Johnson grass.

In the varietal trials, Yolo corn, grown for the first time at this Station, proved to be unadapted to conditions here.

ANNUAL LESPEDEZAS

In varietal trials of annual lespedezas, the recently introduced variety F. P. I. 81742 does not seem to have a place in this State except possibly in the more northern sections of the Cumberland Plateau, where its earliness may be of advantage. It resembles Tennessee No. 76 in its upright habit of growth and fine stems. It is about 3 weeks earlier than Korean. It made poor yields of hay but good yields of seed when compared with Korean, Kobe, and Tennessee No. 76.

PERENNIAL LESPEDEZAS

Seeding experiments with sericea were continued.

The problem of improving the feeding value of sericea was attacked from a number of angles. The effects of frequency of cutting on yield and quality of hay, and on the vigor of the plants, were studied.

The study of factors affecting tannin content of sericea was continued.

An effort was made to find companion crops that might serve to reduce the percentage of tannin in the mixed hay. The results were not encouraging, except in the combination of sericea and Johnson grass. Sericea was seeded in Johnson grass in 1932. Both have done well. The proportions of grass and sericea apparently have remained about the same.

Lespedeza bicolor, seeded in 2½-foot rows in 1936, was cut for silage and also for hay. The green material was mixed with molasses and packed in small containers. It made silage of excellent quality. The hay was very coarse, but seemed to be fully as palatable as sericea hay, or more so, when fed to mules. High yields were obtained from small plots.

Seedlings made on galled areas in 1936 produced a fair stand. In 1938 these plants ranged up to 6 feet in height where phosphate and limestone were used, while annual lespedezas, beggerweed, and many other soil-improving crops failed entirely.

Bicolor is a very vigorous bush-type perennial lespedeza, with promise of being valuable in soil conservation and possibly as a forage



Fig. 5—Timothy and red clover in the thirty-third year of a 5-year rotation.

Plot on left received an average of 4½ tons of manure per acre; plot on right, none. Both plots have received 600 pounds of superphosphate and 100 pounds of muriate of potash per acre every 5 years since the rotation was started in 1905.

crop. The seed was obtained originally from Manchuria and has produced plants of widely differing types.

Further work in seeding and utilization of bicolor is planned.

FERTILIZER EXPERIMENTS

Fertilizer experiments in connection with crop rotations were continued.

The hay crops shown in figure 5 illustrate the great importance of manure even on land of naturally high fertility, despite the fact that 600 pounds of superphosphate and 100 pounds of muriate of potash have been applied during each 5-year cycle of the rotation. Both plots have been fertilized in this way every 5 years since 1905. The plot on the left received in addition 22½ tons of manure during each 5 years, while the plot on the right received no manure.

In addition to these tests on the Experiment Station farm, there were trials of different phosphate carriers on hundreds of plots, on 8 different soil types, representing the principal crop land of East Tennessee and the Cumberland Plateau. Figure 6 shows the effect of 3 tons of dolomite per acre on one of these soil types (Montevallo silt loam). Standard superphosphate was tried in comparison with triple superphosphate, metaphosphate and fused phosphate. These were used alone and in combinations with nitrogen, potash, and dolomite.

This is the fifth year of these experiments, which are conducted in cooperation with the Tennessee Valley Authority.



Fig. 6—Red clover and timothy seeded in wheat on Dandridge silt loam.

The wheat on both plots with stakes received 200 pounds of superphosphate per acre. The plot on the right received in addition 3 tons of ground dolomite.

CORN BREEDING

Cooperative with U. S. Dept. of Agr.

L. S. Mayer

SEASONAL WEATHER CONDITIONS

The growing season in 1938 was generally favorable to the corn crop, though not so good as in 1937. The early part of the season was very favorable, with abundant and well-distributed rainfall through May, June, and July. Prolonged periods of hot, dry weather in mid-August and in September tended to reduce corn yields materially.

CORN HYBRID PRODUCTION

The production of double-cross hybrids of Neal Paymaster inbred lines was considerably enlarged this year. Through the cooperation of 25 farmers in Williamson County, 5 in Obion, 3 in Hamblen, and 1 in Giles, and 28 students of vocational agriculture in 10 other counties, approximately 20 acres in $\frac{1}{4}$ -acre plots were planted with single crosses of Neal Paymaster lines, at the ratio of 2 females to 1 male. All of these plots were inspected and passed for certification by the Tennessee Crop Improvement Association, through whose agency also the double-cross seed was put on the market. Approximately 400 bushels of hybrid seed corn was obtained. The various recombinations permitted the making of 16 different hybrids, which have been designated serially—Tennessee hybrid No. 1 to 16. These hybrids will be tested for yield in uniform test plots at Jackson and Martin, in West Tennessee; Columbia and Clarksville, in Middle Tennessee; and Knoxville and Greeneville, in East Tennessee. The results of this first effort at commercial production of Tennessee hybrids are most gratifying. At the time of making up this report all available double-cross seed has been disposed of to farmers. This seed was put up in peck bags, tagged and sealed by the Crop Improvement Association, and priced at \$1.60 per peck, of which the grower receives \$1.50. The 10-cent differential covers the cost of the bag, tag, and seal, which are furnished by the Association. Upon this price base it is estimated that the Williamson County cooperators stand to gross \$200.00 per acre.

YIELD TEST OF DOUBLE CROSSES

The Neal Paymaster double crosses made in 1936 were tested again this year. The crosses were planted in 2 x 15-hill plots, 4 replications, and randomized.

In the first group of 10 doubles having the female parent (83S x 85A), 5 are better than the open-fertilized Neal Paymaster by 16 to 33 percent. In the second group having the female parent (83S x 104B), 7 are better by 12 to 28 percent. In the sixth group there are 7 double crosses better by 16 to 25 percent. Of these double crosses, 5 were tested by the Experiment Station of North Carolina, at Rocky Mount, Clayton,

and Swannanoa, in that State. Dr. Paul H. Harvey writes, "Of all the hybrids we had in test yours [the Tenn. Neal Paymaster hybrids] showed the most promise. All were prolific and had good husk protection."

Of the 68 crosses tested for the two years 1937 and 1938, 15 were better than the parent variety by 10 percent or more. Several of the inbred lines involved in some of these double crosses have been dropped because of their poor performance in the 3-year top-cross test. Others that did not enter into the double crosses this year will be so used in 1939.

VARIETAL YIELD TEST

The yield test of varieties included again this year the standard Tennessee varieties and strains, Corn-Belt hybrids from commercial growers, and other hybrids from the U.S.D.A. and elsewhere. The plantings were randomized 2 x 15-hill plots, 4 replications. The high-yielding Russell strain of Neal Paymaster again ranked first, making 48 bushels, with U. S. 177 a close second. The Kentucky Station hybrids, which gave good results last year, though not significantly better than the Russell Paymaster, fell considerably below Paymaster this year. The out-of-state hybrids in general were again much below the standard Tennessee Neal Paymaster. Among the yellow varieties and hybrids, the new Tennessee Yellow Paymaster gave a top yield of 46 bushels, only 2 bushels under the white Neal Paymaster and much superior to any other yellow variety tested.

TWO NEW VARIETIES

Two new varieties were produced this year for introduction in 1939. These have been officially named by the Station, "Tennessee Yellow Paymaster" and "Tennessee Early Yellow." The former has given excellent yields in the preliminary tests, is of the same seasonal period as Neal Paymaster, and is the only yellow yet available that is apparently able to compete with Neal Paymaster. The Early Yellow has not yet been tested for yield. It is a short-season variety and will be useful as a yellow corn on the Cumberland Plateau and other high elevations, or where the corn crop precedes fall grains. The available seed of these two new varieties will be placed out for increased seed production in 1939.

SWEET-CORN HYBRID

The sweet-corn hybrid developed by the writer a few years ago is now being grown commercially in Knox County and is increasing in favor. One commercial cannery has become interested and is planning to make canning tests during the coming season.

STATION POLICY ON HYBRID PRODUCTION

The increasing interest in hybrid seed corn and the enlarging program of commercial production of Tennessee Paymaster hybrids have necessitated the following policy by the State Experiment Station: (1) No inbred

lines developed in the cooperative project will be released, except to other station or Department breeders; (2) single crosses will be released to the hybrid-seed producers at cost through the Tennessee Crop Improvement Association; (3) the maintenance of inbred lines and single crosses will be undertaken by the Station through the leasing of isolated plots within a short radius of the Station at Knoxville.

CROP IMPROVEMENT

N. I. Hancock

COTTON

Within the past 10 years, considerable improvement has been made in the staple length of cotton in Tennessee. The table¹ below shows that longer cotton is being grown.

Staple length Inches	1928 Percent	1938 Percent
Below $1\frac{5}{16}$	62.4	14.2
$1\frac{5}{16}$ to $1\frac{1}{32}$	34.1	66.4
Above $1\frac{1}{32}$	3.5	19.4

This change has come about as a result of increased interest on the part of the farmers in growing better and fewer varieties, and from the fact that in most instances the planting seed were obtained from the breeder. This improvement will continue as long as the premiums for the longer cottons remain within reasonable limits, such as those of the past year, or as long as the farmers make an effort to retain the purity of their seed stocks.

Experiment Station trials demonstrate that staple length is a constant character. Neither the classer at Memphis nor the fibrograph (an instrument for measuring staple length) gave any large differences on the same varieties grown at the three places. This is shown in the table below, where averages of 50 samples are given in 32ds of an inch.

	Knoxville 32ds inch	Jackson 32ds inch	Tiptonville 32ds inch
Classer	33.7	33.9	34.2
Fibrograph	34.0	33.6	34.0

Circular No. 61, "A New Method of Delinting Cottonseed with Sulfuric Acid," was published in June. In this circular a method is described which the small farmer may use. Though the grower may not care to take the trouble to delint the seed, he will find it profitable to dust them with Ceresan, especially if the seed have become infected with disease.

Strains of the Stoneville variety, and of Deltapine 11A continue to lead in the trials and are recommended for this State.

¹These data were taken from grade and staple estimates of the Economics Department of this Station, cooperating with the U. S. Division of Cotton Marketing, as of December 1 each year.

OATS

Of the winter-oat selections, 4 were tried under field conditions the past year. Two of them were found to be promising and their records, for introduction, are given in the Agronomy section of this Report. They have been named "Fulwin" for Tennessee 1945, and "Tennex" for Tennessee 1884.

Both Fulwin and Tennex are straight-line selections out of Winter Fulghum 699-2011¹. In 1930 this variety was observed to be very winter-hardy, but it contained many off-type plants. One thousand heads, or panicles, were selected and planted; and again in 1931, 2000 selections were planted. At the same time a number of the county agents sent in panicle selections, but practically all of these proved to be out of Winter Turf or of the spring type. Thus Fulwin came from the 945th head-row selection planted in 1931 and Tennex came from the 884th row.



Fig. 7—First generation of oat crosses, or hybrids, growing in the greenhouse.

It will be seen that they grow very tall and must be staked.

Tennessee 1922, a dwarfy strain, and Tennessee 092, a strain of more compact panicles, have not been named yet, and are being tried further at the stations as well as under field conditions.

BARLEY

Eight fairly promising strains of the smooth-awn barley cross, Lion X No. 52, have been chosen and placed in the regular barley varietal trials. There were 2500 head rows planted in 1937, and 400 of these were selected and repeated 3 times in rod rows for the 1938 plantings.

¹Fulghum 699-2011 is a strain originated by T. R. Stanton, who is at the head of the U. S. oat investigations.

Out of the 1500 head rows of hooded barley, 100 selections were saved and are repeated 4 times in rod rows.

IMPROVEMENT OF GRASSES FOR PASTURAGE

J. K. Underwood

The conversion of unproductive and eroded lands into productive grasslands, and the improvement of our present grasslands, are obvious needs. These objectives finally have been adopted as part of the national agricultural program. The United States is far behind other countries in this phase of agriculture. Hence, there is pressing demand for improved grasses for the various types of soil, climate, and exposure.

Most species of grass are composed of many strains, which vary greatly in date of maturity, vigor, leafiness, seed production, palatability, nutritional value, and other characters too numerous to mention. A pasture is the sum of the individual plants in it. The improvement of a pasture, therefore, depends upon the isolation of as many strains as possible, by work with individual plants, just as is the case with practically every other farm crop.

A project on the improvement of grasses for pastures has been organized by the Tennessee Agricultural Experiment Station, through which it is hoped to isolate strains from the native or naturalized grasses that show promise. This pasture project is broad enough to include the following phases for selection and breeding: (1) Regulation of aggressiveness; (2) tolerance to various types of soil and exposure; (3) increase in vigor and quick renewal of growth after grazing or cutting; (4) increase in longevity; (5) increase in yield and viability of seed; (6) increase in tonnage per acre; (7) increase in palatability and nutritional value; (8) increase in resistance to freezing temperatures, and winter-hardiness; (9) increase in drouth-resistance; (10) adaptability to soil-erosion control; (11) resistance to diseases.

A large number of seed samples were secured during the summer of 1938. These came from all parts of the country. In addition, seed were collected from grasses native to this State and from acclimated naturalized species; and progeny rows will be maintained and selections made according to the objectives.

Special attention is being given to the improvement of the English and Italian ryegrasses, Kentucky bluegrass, tall oatgrass, timothy, rescue grass, and Dallis grass.

A number of intergeneric and interspecific crosses are planned. It is hoped by this means to secure a greater number of variations, from which desirable strains may be isolated.

EFFECT OF PHOSPHATING ON LOSS OF SOIL BY EROSIONCooperative with TVA¹

K. B. Sanders

In the spring of 1936, on the farm of Mr. Roy French, Knox County, it was noted that the wheat crop on Montevallo silt loam soil had made much greater growth on an area which had been fertilized with phosphate and nitrate of soda than on an adjacent area which had been fertilized with only nitrate of soda. The question arose as to whether the phosphated area with its heavier crop cover would hold the soil the better against loss by erosion.

In April of that year, 2 small plots for an erosion study were established, one on the phosphated area and the other on the unphosphated area. Each plot was separated from the rest of the field by strips of sheet metal placed at the upper end and at the sides. This scheme prevented any runoff water from other parts of the field from getting into the plot; and any rainfall on the plot itself, if not absorbed by the soil, would have to run off the plot at its lower end, where arrangement was made to catch it in large metal cans.

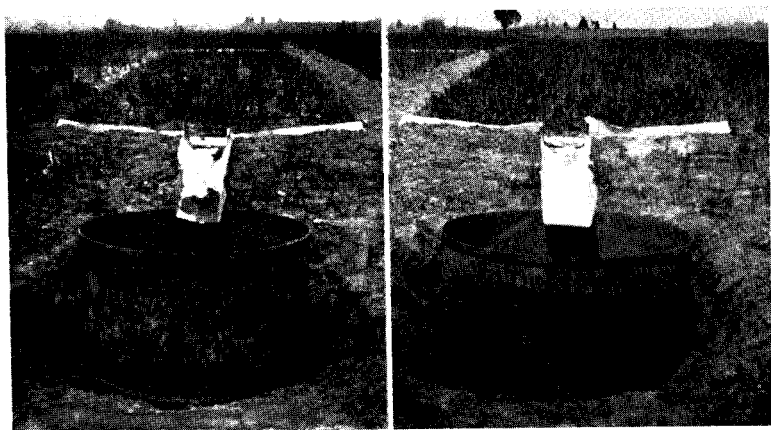


Fig. 8—The runoff from the plots was caught in large metal cans.

The unphosphated plot is shown on the left, and the phosphated plot on the right.

Periodically, from April to November, inclusive, the quantity of runoff from the plots was measured and the soil content of the runoff ascertained. The crop cover and soil losses during this period are shown in table 7.

¹Mr. A. L. Kennedy, Agricultural Engineer, cooperated in the installation of the runoff-measurement equipment and in other ways.

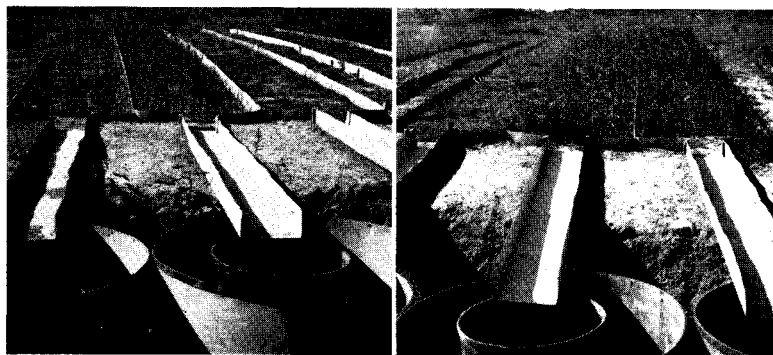
TABLE 7—*Soil losses per acre from Montevallo silt loam of 6 percent slope, for 7 months, April-November, 1936.*

Plot No.	Crop cover and fertilizer treatment	Soil losses
3	Wheat followed by lespedeza. Nitrate of soda, 150 pounds per acre, applied to wheat	Tons 7.99
4	Same as plot 3, except that the equivalent of 200 pounds per acre of 16 percent superphosphate was applied to wheat, in addition to the nitrate of soda.	4.88

These data show that during this 7-months period soil was washed off the unphosphated plot at the rate of 7.99 tons per acre, but off the phosphated plot at the rate of only 4.88 tons per acre. The greater protection against erosion afforded by the phosphated plot, was due, apparently, to the increased crop growth, resulting from the phosphate fertilization.

In November, 1936, 4 additional plots were established and planted to small grain, to be followed by lespedeza. Two of these plots were on the original phosphated area, one being planted to small grain in 8-inch rows on a seedbed, and the other to small grain in 16-inch contour furrows in lespedeza stubble. Two similar plots were established on the original unphosphated area. The 2 plots used in the first study were continued in lespedeza, making a total of 6 plots. Phosphate as well as nitrate of soda was applied to the 3 plots on the original phosphated area, while only nitrate of soda was applied to the other 3 plots.

Subsequently, crop growth on the phosphated plots was decidedly greater than that on the unphosphated, or check, plots, as shown in figure 9.



Check plots
Nos. 1, 2, 3 (left to right)

Phosphated plots
Nos. 4, 5, 6 (left to right)

Fig. 9—Crop cover of small grain and lespedeza.

The annual erosion losses from these 6 plots are shown in table 8.

TABLE 8—*Soil losses per acre from Montevallo silt loam of 6 percent slope for one year, November 7, 1936, to November 6, 1937, inclusive.*

Plot No.	Crop cover and fertilizer treatment ¹	Soil losses
3	Lespedeza stubble followed by lespedeza	Tons
4	Same as plot 3, except phosphated	3.27
		1.23
1	Small grain in contour furrows in lespedeza stubble, followed by lespedeza	7.47
6	Same as plot 1, except phosphated	1.53
2	Small grain on seedbed followed by lespedeza	17.43
5	Same as plot 2, except phosphated	6.23

¹Nitrate of soda at 150 pounds per acre was top-dressed on all 6 plots. On plots 4, 5, and 6 the equivalent of 200 pounds per acre of 16 percent superphosphate was applied. The phosphate was applied in the drill for the small grain, and top-dressed on the lespedeza.

The data in table 8 show that (a) with each of the 3 cropping practices the phosphated plot lost much less soil than the corresponding unphosphated plot; and that (b) when the 3 cropping practices are compared, either with or without phoshate fertilization, the lespedeza plot lost the least soil during the year, the plot with small grain in contour furrows lost considerably more soil, and the plot with small grain on seedbed lost the most soil.

The greater protection against erosion afforded by the phosphated plots was again apparently due to the increased crop growth resulting from the phosphate fertilization.

The following question now arises: Are these results, obtained with Montevallo silt loam, applicable to other soil types? Obviously the amount of increase in crop growth resulting from phosphate fertilization depends jointly on the kind of soil and the kind of crop. If it is known that the use of a particular kind of fertilizer on a given crop, on a given soil type, will cause an increase in crop growth, it seems reasonable to assume, from our data and from data of other experiment stations, that the use of the particular fertilizer probably will result in smaller erosion losses. Some information on the question may be gained by a study of existing data on fertilizer trials with different crops and soils. It appears, however, that before general conclusions can be safely drawn, actual erosion measurements from phosphated and unphosphated, or fertilized and unfertilized, areas of other major Tennessee soil types should be made.

Measurements of erosion losses from differently cropped plots on Talbott silt loam at the Greeneville Station and from strip-cropped plots at the Knoxville Station are now being made.

STRIP-CROPPING PROJECT

Cooperative with TVA

N. D. Peacock

SITE

During the spring of 1937, a slope was selected for the soil-erosion project. It faced to the southwest and was comparatively uniform, with approximately a 10 percent grade. The area had been in chicken ranges for several years, without cropping, and the surface soil, therefore, was in better than average condition. Over a period of years, however, there had been a decided movement of soil to the bottom of the slope, so that the depth of top soil ranged from 6 or 8 inches in the thinnest area near the top to 18 or 20 inches along the bottom of the slope. The soil is a Cumberland loam with more than an average supply of organic matter.

PREPARATION OF THE SITE

In order to secure a uniform minimum depth of top soil and a uniform 10 percent grade, the entire surface of the area was worked by hand with WPA labor. A concrete wall was constructed at the top and at the bottom of the slope, allowing 120 feet as the length of the slope to be considered. Between these walls the top soil was removed and piled. The subsoil then was graded to a uniform sub-grade 6 to 8 inches below the surface, and the surface soil was replaced, leaving a uniform 10 percent slope from top to bottom, with a minimum surface-soil depth of 6 inches. The area then was divided into six 1/20-acre plots. These were separated with a 1 x 8 cypress board placed on edge and half buried, leaving approximately 4 inches above the surface of the ground. Each of the 6 plots, therefore, was 18½ x 120 feet in size. Below these plots, concentration troughs were constructed of concrete in such a way as to carry all runoff of soil and water through the sampling apparatus.

PLAN OF COMPARISON

To determine the influence of strip cropping on soil and water loss was accepted as the purpose of the experiment. Sod strips and cultivated strips of varying widths were alternated in 3 of the test sections. These alternating strips were 20, 30, and 60 feet wide, in sections 1, 2, and 3, respectively. Section 4 was put entirely in sod, and sections 5 and 6 were entirely in cultivation. In section 5 the soil was plowed and smoothed in the fall, while in section 6 it was plowed and left rough.

Irish potatoes were used in all cropping areas. An early crop of Irish Cobbler, followed by a late crop of Jersey Redskin, was grown during 1938.

ESTABLISHMENT OF SOD STRIPS

The soil for the sod strips was prepared uniformly and an application of 600 pounds per acre of 3-9-6 fertilizer, prepared from ammonium sulphate, muriate of potash, and triple superphosphate, was broad-

cast during the soil preparation, and an application of 120 pounds per acre of nitrate of soda was made as a top-dressing. A mixture of tall oatgrass, 10 pounds per acre; orchard grass, 7 pounds; and red clover, 10 pounds, was seeded September 10. A volunteer seeding of ryegrass came irregularly in the sod areas, and for that reason the entire area which had been seeded was reworked to remove all the grass. The area was plowed with a 3-foot plow, smoothed, and reseeded October 14. The seed mixture was varied to suit the season, the following being used: rye, 70 pounds per acre; timothy, 8 pounds; and red clover, 10 pounds. Following this seeding, a comparatively uniform stand of sod was secured in all plots. During the summer the grass on all sod plots was cut and removed at sufficiently frequent intervals to prevent lodging and to encourage the formation of a close sod.

CROP MANAGEMENT

The Irish potatoes for the first crop were planted March 14, approximately 1½-ounce seed pieces being spaced 15 inches apart in the row, with the rows 3 feet apart. Certified Irish Cobbler seed, cut with two eyes per piece, was used. Under these potatoes, 600 pounds per acre of 6-9-6 fertilizer was used. The rows were marked with a wheel hoe, the furrow was opened with a bulltongue, the fertilizer was distributed and mixed with a wheel hoe. The seed was dropped, carefully spaced, and covered by hand. The middles then were worked with a 4-shovel cultivator. A splendid stand of potatoes resulted. They were given normal cultivation through the growing season. The first crop of Irish Cobblers was harvested July 5. The yield record is given in table 10.

After harvest, the big weeds were pulled by hand, and the soil was worked with a double-shovel, followed by a 3-shovel cultivator. The areas were cultivated after each rain to put the soil into good condition; and the second crop, the Jersey Redskin variety, was planted August 6. The same fertilizer application, planting method, and plan were followed as reported for the first crop. A uniform stand was secured; it was given normal cultivation and was harvested November 15. The yield record is shown in table 10.

Following the second harvest, all crop areas were plowed and left rough except in section 5, where the area was harrowed, leaving a comparatively smooth surface.

SOIL MOVEMENT

At the end of the first year it is plain that there has been a considerable movement of soil away from the lower edge of the sod strips and an accumulation at the upper edge. The increased soil movement on section 5, where the soil was smoothed in the fall, has been clearly evident. Data showing both water and soil losses for the year 1938 are reported by K. B. Sanders in table 9.

PLAN OF STRIP-CROPPING SECTIONS

1938 and 1939

Sec. 1	Sec. 2	Sec. 3	Sec. 4	Sec. 5	Sec. 6
SOD	SOD	SOD	SOD	CROP	CROP
CROP	CROP			SMOOTHED	LEFT
SOD	SOD	CROP	GRASS	AFTER	ROUGH
CROP	CROP			FALL	AFTER
SOD	CROP			PLOWING	FALL
CROP					PLOWING

1940 and 1941

CROP	CROP	CROP	CROP	SOD	SPRING-
SOD	SOD		LEFT		PLOWED
CROP	CROP	SOD	ROUGH	GRASS	NOT
SOD	CROP		AFTER		PLOWED
CROP	SOD		FALL		AFTER
SOD			PLOWING		HARVEST

1942 and 1943

SOD	SOD	SOD	SPRING-	CROP	SOD
	CROP	CROP			
CROP	SOD	SOD	NOT	LEFT	GRASS
	CROP	CROP	PLOWED	ROUGH	
	SOD	CROP	AFTER	AFTER	
	CROP	CROP	HARVEST	FALL	
				PLOWING	

TABLE 9—*Total water and soil losses for the year 1938.*

Cumberland Loam, 10 percent slope, Knoxville Station
 Plots 120 ft. x 18.15 ft. = 1/20 acre¹. Data obtained by K. B. Saunders.

Section	Soil conditions	Water losses ¹				Soil losses per acre	
		Runoff		Runoff			
		Inches		Percent		Tons	
			Average		Average		Average
1	Six 20-ft. strips—alternate cultivated and grass	5.72		10.9		15.68	
2	Four 30-ft. strips—alternate cultivated and grass	4.92	5.05	9.3	9.6	20.33	17.5
3	Two 60-ft. strips—alternate cultivated and grass	4.51		8.6		16.38	
4	All grass	3.92		7.4		0.81	
5	All cultivated	8.61	7.43	16.3	14.1	50.65	45.6
6	All cultivated	6.25		11.9		40.54	

¹52.68 inches total rainfall.

 TABLE 10—*Yields of potatoes, per acre.*

Section and plot		1¾ inches & over		1½ to 1¾ inches		Less than 1½ inches	
		Spring crop	Fall crop	Spring crop	Fall crop	Spring crop	Fall ¹ crop
		Bushels	Bushels	Bushels	Bushels	Bushels	Bushels
Sec. 1	Plot 2	160.00	17.70	21.00	13.80	6.00	3.70
	Plot 4	86.00	16.04	20.00	12.60	9.00	18.70
	Plot 6	117.00	48.80	21.00	21.30	10.00	23.58
Sec. 2	Plot 2	98.67	6.67	22.67	9.52	6.67	19.13
	Plot 4	127.33	59.67	24.00	24.83	11.33	31.93
Sec. 3	Plot 2	184.33	76.11	28.00	21.95	12.00	26.87
Sec. 5		134.83	59.81	28.33	23.67	12.67	29.62
Sec. 6		141.00	70.10	28.50	22.33	13.67	28.07

¹The late planting and the long period with lack of rainfall, followed by favorable conditions late in the season, resulted in large numbers of newly formed potatoes about the size of marbles at digging. These are not included in the weights.

HOME PRODUCTION OF FOOD SUPPLIES

Crossville

J. J. Bird

The 12 Homestead farms which completed the 1938 dietary and farm study averaged 36.7 acres, an increase of 12.7 acres over the 1937 average. Seven changes were made in the personnel of the cooperating farm families at the beginning of the year, which resulted in the increased acreage. The farms averaged 18 acres of cleared land and ranged in size from 20 to 59 acres. Prior to 1938, one unit had been farmed 2 years, 9 had been farmed one year, and 2 were new-land farms.

At the beginning of the year the original set-up of 6 diets in duplicate was changed to 4 diets, carried through in triplicate, the principal food-quantity allotments being established on a high-low variation instead of the high-medium-low variation of the 1936 and 1937 schedule.

The adult equivalent established for each family on the basis of calorie consumption by ages averaged 4.48, ranging from 2.6 to 7.2. At the end of the year, food consumption averages were based on an adjusted family adult equivalent to compensate for extra meals served throughout the year.

DIETARY

The chief food variables, and variations in percentage of calories furnished by the major food types, were established as follows: Cereal 34-20 percent; irish potato 14-3 percent; soybeans 10-0 percent; meat 30-20 percent; garden 4-2 percent; sweetpotato and milk remaining constant, at 3 percent and 20 percent respectively. Detailed records of food consumed were kept on 5 uninfluenced check families. Dietary No. 1 was low cereal, high potato, high soybean, low meat, and low garden; dietary No. 2, high cereal, low potato, no soybean, high meat, and low garden; dietary No. 3, low cereal, high potato, no soybean, high meat, and high garden; dietary No. 4, high cereal, low potato, high soybean, low meat, and high garden. The No. 1 dietary contrasted sharply with the typical dietary of the region and varied as much in its healthfulness. Dietary No. 2 was somewhat typical of that prevailing on the Plateau. Detailed records of food consumed here during 1936 and 1937 indicated that many families obtained between 50 and 60 percent of the calorie intake from cereals and pork. In this type of diet, lard consumption at the rate of 78 pounds per adult equivalent was recorded in the case of one check family.

All groups conformed closely to the cereal allotments, the 34 percent group obtaining 34.5 percent of the calorie intake from cereals, the 20 percent group averaging 26 percent. One family in a low-cereal group reached the low of 22 percent without great difficulty or ill effects.

The low 3 percent diet of irish potato approximated the average consumption of this commodity throughout the region and required the consumption of 2 bushels per adult equivalent. The relatively wide range of 3 to 14 percent was determined on the dietary value of the irish potato in a subsistence diet and its adaptation to local growing conditions. The 6 families on the 3 percent potato diet averaged 3.5 percent. The 14 percent group averaged 10.5 percent, an extreme variation as a group. The high family in this regard consumed 7.2 bushels per adult equivalent.

Milk consumption was higher than the standard 20 percent allotted in all diets. The high meat families consumed less milk, a variation due largely to differences in production of the individual cows.

Meat consumption was irregular, due in part to the new families having irregular amounts of meat for use. Little difficulty was experienced in getting the families adjusted to the low meat diet.

The soybean was the great unknown to all families working with it for the first time. Four of the 6 soybean diets were given to 4 new families. As a whole, the 1938 families were better adapted to giving the soybean the necessary trial than the previous groups. Some very interesting reactions were observed throughout the year. Once the families overcame their blind objection to the dietary use of the soybean, through special preparation of the bean and observation of experimental methods of making it attractive under the supervision of Miss Kemmer, Experiment Station Home Economist, its desirability was generally acclaimed. One family whose dietary did not include soybean insisted on adding it. At the request of a group of Homestead women, assistance was given in a demonstration of soybean food preparation. An average consumption of 19 pounds per adult equivalent was attained by the new families, while an average of 32.5 pounds was consumed by the 2 families having had previous experience with soybeans.

The consumption of garden vegetables was relatively uniform, although 6 gardens were twice as large as the other 6. Three groups averaged 3 percent and one 4 percent. The irregular amounts of canned vegetables on hand in the case of the new families had some bearing on this. The low garden allotment of 2 percent corresponded to the size of garden generally recommended for the average farm family. The efficiency of utilization of products from the 2 garden sizes was indicated by the production per adult equivalent of 219 pounds on the 2 percent garden and 370 pounds on the 4 percent. From the small garden, 93 pounds per adult equivalent was canned, and from the large garden 237 pounds.

FOOD CONSUMPTION AND COSTS

The cash value of total food consumed and food purchased per adult equivalent varied little among the dietary groups. The average value of food consumed at present prices per adult equivalent was \$109.06

for the controlled families and \$123.08 for the 5 check families. The average cost of food purchases per adult equivalent per year was \$28.57 and \$80.20 respectively, the latter based on the records of 8 uninfluenced diets. In 2 of the controlled families the cost of food purchased was less than \$15.00 per adult equivalent per year. The families under controlled diets consumed 25 percent less cereal, 19 percent more irish potato, 33 percent more vegetable, 11 percent less milk, 40 percent less lard, 66 percent less poultry meat, 27 percent less eggs, and a little less sugar than did the check families. The calorie consumption of the check families was 14 percent higher than that for the 12 controlled-diet families and higher than that recommended for health. The extra calories were obtained largely from cereals and lard.

The cash cost of the home-produced foods varied from \$8.64 to \$33.56, making a total average food cost of \$47.83 per adult equivalent. The lowest total cost recorded during the year was \$32.67. This corresponded to a yearly cost of foods produced and purchased of approximately \$130.00 for an average family of 3 children. Further progress toward practical subsistence off the land may be expected in 1939, when the new families will be fully adjusted.

The average cost of clothing, medical attention, education, and all foods purchased or home-produced was \$71.08 per adult equivalent. Car ownership cost \$30.56 per adult equivalent in the 9 families having cars.

HEALTH

Monthly weight-gain records were obtained on 37 children. Of these, 32 were 16 years of age or under and were fairly well divided in dietary groups, numbering 8, 9, 7, 8 in groups 1, 2, 3, 4, respectively. There were 11 children in the check families in the same age group. The average yearly gains per child in the 4 groups and check families were as follows:

1. Low cereal, high potato, high soybean, low meat, low garden	8.61 pounds
2. High cereal, low potato, no soybean, high meat, low garden	3.72 "
3. Low cereal, high potato, no soybean, high meat, high garden	7.21 "
4. High cereal, low potato, high soybean, low meat, high garden	8.94 "
Check families	4.30 "

Since there were 2 groups high and 2 low in each principal food schedule, the children may be further grouped accordingly, and gains indicated as follows:

	High	Low
Cereal	6.32 pounds	7.91 pounds
Potato	7.92 "	6.33 "
Soybean	8.78 "	5.47 "
Meat	5.47 "	8.78 "

SUBSISTENCE CROPS AND LIVESTOCK

A total of 75.8 acres were planted to subsistence crops, an average of 6.3 acres per farm. Irish potato and sweetpotato yields were higher than the expectancy, while corn and wheat averaged lower. Milk production per cow ranged from 3200 to 5000 pounds. Few cows produced 5000 pounds. Several family cows in the group showed marked symptoms of depraved appetite, similar to that caused by phosphorus deficiency. All cows were furnished a phosphorus supplement in the form of dicalcium phosphate. An extreme example of this condition was indicated by a high-producing Jersey consuming 25 pounds of dicalcium phosphate overnight. She suffered no serious ill effects. This cow had been eating all available paper and cardboard boxes.

Twenty-three acres of clover and grass were seeded in August, largely on the new-land farms. All subsistence corn land was seeded to crimson clover. Approximately $1\frac{1}{2}$ acres of sericea were seeded in June on steep land on each of 9 farms, with a view to the future ensiling of this legume.

EXPERIMENTAL CROPS

With the average subsistence area cut to 6.3 acres per farm, the largest part of the No. 1 land was available for plot experiments. A total of 63.4 acres was planted in this manner. Corn experimental acreage was 30.8; potato, 17.4; tomato, 7.6; sorghum, 3.3, besides 7 acres grown for studies in commercial processing of sorghum conducted by Mr. G. A. Shuey; snap beans, 2; and beets, 2.3 acres.

Two of the new farms were not in condition to be utilized fully, due to late spring breaking of new land. The experimental acreage corresponding to the eventual cash-crop land will be increased to the full capacity of each farm in 1939.

CORN

The use of nitrate of soda had a decided effect on yield of corn on land 3 years broken. Rates of 0, 80, and 160 pounds per acre resulted in acre yields of 32, 39.5, and 46 bushels respectively, under 4 replications on each of 2 farms. A similar treatment on 4 farms 1 and 2 years broken had no effect on yield. The phosphate-rate tests resulted in appreciable gains over checks only, 35 pounds of triple superphosphate proving the most economical under the season's growing conditions. Potash failed to affect the yield. The rare elements tried were zinc, manganese, copper, and boron. All except boron seemed to have a slightly depressing effect on yield. Boron did not increase the yield. In the corn varietal trials the yield ranged from 31.8 bushels for Neal Paymaster to 38.4 bushels for Hickory King. Corn topping is a general practice in this region. On 2 farms corn was topped in the hard dough stage, resulting in an average yield reduction of 9 percent. In one case the reduction was 13.7 percent.

SORGHUM

Sorghum cane yield on new land was influenced materially by the application of nitrate. Applications of 80 and 160 pounds of nitrate of soda increased the yield 31 and 65 percent respectively. Where muriate of potash was applied at the rate of 40 pounds per acre there was an increase in the yield of cane. Higher applications of potash resulted in an increase of the sugar content of the juice.

POTATO

Standard superphosphate (16 percent), dicalcium phosphate, triple superphosphate, and calcium metaphosphate applications were made on potatoes on 2 farms during 1936, 1937, and 1938. No significant differences in yield resulted over this period. Nitrate application on potatoes on 6 farms produced a yield increase of 52 percent up to 300 pounds per acre of ammonium sulphate. Returns from nitrate application increased as the rate of phosphate was increased. Economical yields of potatoes under general insect- and disease-control conditions were not obtained from applications above 500 pounds of 16 percent equivalent superphosphate. The 500-pound rate increased the yield 52 percent over a 100-pound application on 2 farms. Muriate of potash at the rate of 25 pounds per acre increased the yield 16 percent. No gain resulted from higher applications.

Placement of ammonium sulfate up to 400 pounds per acre had no effect on potato stand or yield. Methods of application were simplified to suit hand planting. In lieu of hand application, fertilizer materials were applied in the row and bulltongue-mixed once, otherwise row-top-dressed. Muriate of potash up to 96 pounds per acre in the row did not affect the stand.

Potato response to rate of application of a 4-10-4 fertilizer was tested on 2 farms. On one the top rate was 1600 pounds per acre, which produced an increased yield of 120 percent over a 400-pound application. On the other farm, where the rate went to 2500 pounds per acre, economical gains were obtained up to 2000 pounds, increasing the yield from 122 bushels under a 500-pound application to 260 bushels under the 2000-pound rate. The rare elements produced no effect on yield.

Much concern was shown over extreme yellowing of potato plants in this area during July, a condition commonly thought to be caused by disease. A hill-spacing yield test with Irish Cobblers served to demonstrate the physiological cause of this condition through plant competition, a likely condition on this type of land when new. Plants were spaced 12, 16, 20, 24, and 28 inches apart in 3-foot rows. Extreme yellowing was evident on all 12-inch plots, diminishing regularly to complete absence on the 28-inch plots. The acre yield increased with each reduction in spacing from 177 to 258 bushels per acre. The U. S. No. 1 yield increased accordingly, being highest on the closest-spaced and yellowest plots.

The erratic appearance of potato-scab disease led to special observations of its occurrence. There seemed to be little relation between scab appearance and soil pH. Unmarketable crops due to scab were produced on new-land soils having received no lime and where scab-free seed was planted. Also no scab was found on several crops from fields which had received 2 tons of ground limestone per acre one and two years before. The relation between date of planting and scab occurrence appeared significant. The liming of Plateau soils is highly desirable for general crop production and to determine the effect of rate of lime application on miscellaneous crops and scab occurrence. Experiments were started on 2 farms in which finely ground limestone was applied at the rates of 0, 1, 2, 3, and 4 tons per acre in March. Irish Cobblers subject to scab were planted on these plots in early April. Neither field had received lime earlier. No scab appeared on one set of plots, while all plots produced scab approximately equal to the no-lime check, 28 percent, on the other. Scab-free seed was planted. The effect of lime on scab appearance may be more significant in 1939 and later.

Leaf-roll was the most prevalent virus found in all potato fields, ranging from 3 to 10 percent. Certified seed was planted on all farms. Three fields planted to "selected" seed from a region heavily infected with yellow dwarf contained 65 percent of the disease. Two fields planted to seed home-grown for several years contained 15 percent rugose mosaic besides a higher percentage of milder forms of mosaic. All late-spring plantings of potatoes were damaged seriously by late blight.

The usual prevalence of hopperburn seriously limited yields on all plots, in many cases shortening the life of plants 4 to 6 weeks. Early blight also was more severe than usual. The hand sprayer proved inadequate even on small acreages. An attempt to correct this deficiency will be made in 1939 through the use of a cooperative spray ring. Potato yields produced under bordeaux spray were 17 percent higher than those produced under certain commercial copper sprays. Pyrethrum sulfur dust for leafhopper control was ineffective alone, due to the prevalence of early and late blight.

The extreme amount of rain at potato-planting time brought out varietal differences in susceptibility to seed-piece rot. The Chippewa was notably subject to rot in cut seed, and also at harvest, as a result of mechanical injury. Several seedlings were similar in this respect. The Bliss Triumph, Irish Cobbler, and certain other seedlings were relatively resistant. Varietal yields were somewhat impaired by this condition.

The potato crop produced the greatest labor income per acre, averaging \$26.10 on practically new land. One acre returned \$72.00 labor income.

TOMATOES, BEANS, BEETS

Tomato yields were largely unmarketable, due to cracking. Whether this trouble can be controlled under the high average rainfall of July

and August is to be determined. Varying the planting dates, from April 15 to June 9, had no effect upon this condition. Varying the quantities of nitrogen and potash had little effect on yield. Increasing rates of phosphate application affected yields markedly. The rate of application of a complete fertilizer, 4-10-4, had the most pronounced influence on yield. Rates of 1000 and 1600 pounds increased the yield of tomatoes 34 and 97 percent respectively over an application of 600 pounds per acre. Snap-bean yields responded to an increasing rate of a 4-10-4 fertilizer up to 1000 pounds per acre. Sodium nitrate up to 75 pounds per acre increased yields 50 percent over the plots receiving no nitrate. Heavy rates of nitrate application produced profitable yields on canning beets. Varying the rates of phosphate and potash had no effect. Varying the methods of fertilizer placement had no effect on yield. Beet yields were not affected by any of the rare elements. Crimson clover was seeded on 60 acres of the experimental crop land.

PRECIPITATION

Rainfall was heavier than usual during the months of May, June, July, and August. October this year was the driest on record. Excessive rain and cool weather hindered corn and sorghum growth, but was favorable for potato production. The high precipitation was conducive to the development of early and late blight.

Advantage was taken of ravine areas on certain farms for the construction of 5 dams to insure sufficient water supply for high-pressure spraying of the maximum acreage of potatoes on each farm in 1939.

ANIMAL HUSBANDRY

M. Jacob

BEEF CATTLE FEEDING EXPERIMENTS

The beef cattle feeding experiment, begun at the Knoxville Station in 1935, comparing cottonseed meal, cottonseed meal and tankage, peanut-oil meal, and soybean-oil meal, fed with corn silage for fattening 2-year-old steers, was completed in March, 1938. A detailed report covering this experiment was published and is available as Tennessee Experiment Station Bulletin No. 167.

In November, 1938, a beef cattle feeding experiment was begun at the Knoxville Station with 2-year-old steers to compare—

1. Acre yield of beef from corn harvested in various forms and combinations.

2. Costs and profitableness of acre-beef yields from corn fed in various forms and combinations.

In this, the first year of the experiment, 28 native steers were used which graded good to choice. They were divided into 4 uniform lots of 7 steers each, and fed a finishing ration for 150 days. Lot 1 was fed corn silage and an average of 4.97 pounds of cottonseed meal per steer per day. Lot 2 was fed corn silage and enough cottonseed meal to

balance the ration, which was 1.65 pounds per steer per day. Lot 3 was fed corn silage, legume (lespedeza) hay, and cottonseed meal in the same amount as lot 2. Lot 4 was fed corn stover, and crushed corn-cob-shuck meal in the same amount as stover. This lot also received cottonseed meal and legume (lespedeza) hay in the same proportion as lot 3.

Accurate cost accounts were kept on every phase of this experiment, which showed returns per acre of corn, less cost of processing for feeding, of \$137.15 for lot 1, \$120.73 for lot 2, \$129.43 for lot 3, and \$76.56 for lot 4.

This experiment will be continued for at least two years more in order to justify definite conclusions.

STEER FEEDING AND GRAZING EXPERIMENT

The steer feeding and grazing experiment at the Middle Tennessee Station, begun in 1929, to determine the amount of grain necessary to feed 2-year-old steers being finished on grass, following winter feeding on a uniform ration, and reported in the 1936 Station Report, was continued another year with practically the same results.

On November 30, 1937, an experiment was begun at the Middle Tennessee Station to determine the most satisfactory ration for wintering yearling steers that are to be finished on grass the following summer. In this experiment, 30 yearling steers of good grade were selected and divided into 3 uniform lots of 10 steers each. Lot 1 was fed a winter ration consisting of 20 pounds of silage and 8 pounds of stover or low-grade hay per steer per day. Lot 2 was fed a ration of 1½ pounds of cottonseed meal per steer per day, with silage and stover or low-grade hay in the same amounts as lot 1. Lot 3 was fed a ration of 1 pound of cottonseed meal and 4 pounds of corn-cob-shuck meal per steer per day, with stover or low-grade hay in the same amounts as lots 2 and 3.

On April 5, 1938, following a winter feeding period of 126 days, when ready to be turned on pasture, 5 average steers out of each winter lot were placed together for summer grazing and designated as lot 1. The 15 remaining steers out of winter lots 1, 2, and 3 were placed together and designated as lot 2. Lot 1 was grazed and finished on grass without grain. Lot 2 also was grazed and finished on grass, but in addition was fed 5 pounds of corn-cob-shuck meal per steer per day. The cattle were sold on August 18, 1938, after a grazing period of 135 days.

The rates of gains for the first year are shown in table 11.

These feeding and grazing trials will be continued for at least two more years.

TABLE 11—*Rates of gains of steers in feeding and grazing experiment, 1937-38*

	Pasture and no grain			Pasture and 5 pounds corn-cob-shuck meal		
	Lot 1 Wintered on no grain	Lot 2 Wintered on cot- tonseed meal	Lot 3 Wintered on c.s.m. and corn- cob-shuck meal	Lot 1 Wintered on no grain	Lot 2 Wintered on cot- tonseed meal	Lot 3 Wintered on c.s.m. and corn- cob-shuck meal
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Ave. daily gain, winter.....	.913	1.214	1.698	.954	.995	1.535
Ave. daily gain, summer.....	1.343	1.204	1.224	1.568	1.412	1.196
Ave. daily gain, winter and summer.....	1.135	1.209	1.453	1.272	1.210	1.359

BEEF CATTLE COST OF PRODUCTION EXPERIMENT

The final test of feeding baby beefs, as a part of the beef cattle cost of production experiment at the Middle Tennessee Station, was carried out during the winter of 1936-37. The object was to determine—

1. The comparative values of shelled corn, ground shelled corn, and corn-cob-shuck meal in winter-finishing baby beefs.

2. Whether winter-finishing baby beefs is profitable under Tennessee conditions.

Table 12 gives some of the information covering the results for this year.

TABLE 12—*Data on baby beef feeding experiment*

	Lot 1 Shelled corn and cotton- seed meal	Lot 2 Ground shell- ed corn and cottonseed meal	Lot 3 Crushed corn- cob-shuck meal and cottonseed meal
Number of calves	5	5	5
Number of days on feed	209	209	209
Average initial weight (lbs.)	402.4	404.4	403.6
Average final weight (lbs.)	706	715.2	672.2
Average gain per calf (lbs.)	303	310.8	268.6
Average daily gain per calf (lbs.)	1.452	1.486	1.284
Cost per cwt. gain	\$11.95	\$12.07	\$11.93
Average selling price per cwt.	\$10.20	\$10.20	\$10.10
Net profit per calf	\$11.47	\$11.24	\$12.04

These results were in agreement with those of 1934-35 to the extent that all lots showed substantial profit. However, during that year lot 1 made the most profit, lot 2 was second, and lot 3 made the least. This year, lot 3 made the most profit, lot 1 was second, and lot 2 made the least. In the test carried out in 1935-36 all lots were fed at a financial loss. But as the calves were fed at a substantial profit in 2 out of

3 years, it may be assumed that finishing baby beeves is practical under conditions as they exist at the Middle Tennessee Station.

While the foregoing experiment was under way, a similar test was being conducted at the West Tennessee Station. In that experiment the calves were a little older and the initial weights somewhat heavier. Pigs were used with each lot, and credit was given for pork produced. The latter, which is a very practical procedure, especially when whole shelled corn is fed to cattle, was responsible for the results, which were in favor of lot 1, fed whole shelled corn.

BEEF CATTLE FEEDING EXPERIMENT

In December, 1937, a steer feeding experiment was begun at the Middle Tennessee Station to determine the comparative values of silage and alfalfa hay in a finishing ration for yearling steers. Twenty-six yearling steers of good grade were selected and divided into 2 uniform lots of 13 steers each. Lot 1 was fed corn-cob-shuck meal and alfalfa hay. Lot 2 was fed a grain mixture of 1 part, by weight, of cottonseed meal and 2 parts, by weight, of corn-cob-shuck meal and silage. Both lots were marketed at the end of 148 days, with all cattle in the experiment bringing the same price.

The steers in lot 1 made an average daily gain of 1.6 pounds, and a net profit of \$2.84 per head; the steers in lot 2 made an average daily gain of 1.53 pounds, and a net profit of \$1.90 per head.

This experiment will be continued for at least two years in order to justify definite conclusions.

STEER FEEDING EXPERIMENT

In November, 1936, a steer feeding experiment was begun at the West Tennessee Station to determine the comparative feeding value of cottonseed meal alone, a mixture of equal parts of cottonseed meal and soybean meal, and a mixture of equal parts of cottonseed meal, soybean meal, and high-grade (60%) tankage, when fed with corn and sorghum silage as a winter fattening ration for 2-year-old steers. The rations for the different lots were as follows:

Lot 1—Cottonseed meal and silage

Lot 2—Cottonseed meal, soybean meal, and silage

Lot 3—Cottonseed meal, soybean meal, tankage, and silage

TABLE 13—*Cost of feeds and average daily rations of steers on experiment*

Feed	Cost per ton	Lot 1	Lot 2	Lot 3
		Pounds	Pounds	Pounds
Silage	\$ 5.50	44.4	44.4	44.4
Cottonseed meal	30.00	5	2.5	1.66
Soybean meal	40.00		2.5	1.66
Tankage (60 percent)	60.00			1.66

TABLE 14—*Weights, gains, and cost of gains of steers*

	Lot 1	Lot 2	Lot 3
Number of steers	8	8	8
Number of days in experiment	150	150	150
Average initial weight (lbs.)	818.4	830.6	830.1
Average weight at end of 150 days (lbs.)	1118.2	1130.9	1127.9
Average gain per steer (lbs.)	299.8	300.3	297.8
Average daily gain per steer (lbs.)	1.999	2.002	1.985
Cost per 100 pounds gain	\$9.86	\$10.47	\$11.61

TABLE 15—*Financial statement, steer feeding experiment*

	Lot 1	Lot 2	Lot 3
Initial cost per steer at \$6.00			
per cwt.	\$49.10	\$49.83	\$49.80
Feed cost per steer	29.58	31.45	34.58
Total cost (initial and feed) per steer	78.68	81.28	84.38
Necessary selling price per cwt. with 3% shrink to break even	7.25	7.41	7.71
Necessary margin	1.25	1.41	1.71

In this trial, 3 uniform lots of 8 steers each were used. The steers were native cattle of good grade, with a predominance of Hereford breeding. This experiment must be continued for at least one and possibly two years more before definite conclusions can be drawn. Tables 13, 14, and 15 give detailed information covering this year's trial.

LAMB STUDIES

The third and final year of an experiment conducted at the Middle Tennessee Station in cooperation with the U. S. Bureau of Animal Industry, to determine the value of feeding grain to breeding ewes in the production of early spring lambs, was completed in June, 1937. Each year the ewes and their lambs were divided into 4 uniform lots, and the lambs were kept with their mothers until shipped to the U. S. Experiment Farm, Beltsville, Maryland, which was early in June, for slaughter and carcass grading. The experiment was carried out as follows:

Lot 1.—The ewes in this lot and their lambs were grazed without grain during the entire experimental period, until the lambs acquired desirable market weights in the spring of 1935.

Lot 2.—The ewes in this lot were handled and grazed without grain, similarly to those in lot 1, but the lambs were fed grain in creeps until the end of the experimental period. The grain mixture consisted of 3 parts, by weight, of cracked shelled corn, 2 of oats, and 1 of bran, which was fed ad libitum.

Lot 3.—The ewes in this lot were fed $\frac{1}{2}$ pound of a similar grain mixture per ewe per day from November 1, 1934, until 3 days after the lambs were born, when the grain ration was increased to 1 pound per

ewe per day, being continued at this rate until the end of the experimental period. The lambs in this lot did not receive grain.

Lot 4.—The ewes in this lot were fed grain the same as in lot 3, but the lambs also were fed grain in creeps, as were those in lot 2. All lots had access to uniform pasture, consisting of permanent pasture of bluegrass and orchard grass for the late summer and fall, rye and crimson clover or barley during the winter, and bluegrass and white and hop clover during the spring and early summer. The 4 lots were rotated every 2 weeks.

During the 3 years of this experiment, a total of 281 lambs were shipped to Beltsville for grading. Of these, there were 68 lambs in lot 1, 71 in lot 2, 70 in lot 3, and 72 in lot 4. There were no appreciable variations in the average grading of the 4 lots for the 3 years. The grade on foot, just before slaughter, was "good" and the carcass grade was "high good" for all lots. From the results obtained, there appeared to be no advantage, from the standpoint of grade, in feeding grain in the production of these early spring lambs under conditions as they existed at the Middle Tennessee Station.

PIG FEEDING EXPERIMENT

A pig feeding experiment, which is to be repeated several years, was begun at the West Tennessee Station in December, 1937, to determine the comparative value of crimson-clover pasture, and crimson-clover and ryegrass pasture, in a fattening ration for pigs when they are full-fed a ration of corn and protein supplement, and barley and protein supplement. The rations for the different lots were as follows:

Lot 1—Shelled corn and a mixture of 2 parts, by weight, of high-grade tankage and 1 part, by weight, of cottonseed meal, free choice, and crimson-clover pasture.

Lot 2—Shelled corn and a mixture of 2 parts, by weight, of high-grade tankage and 1 part, by weight, of cottonseed meal, free choice, and crimson-clover and ryegrass pasture.

Lot 3—Barley and a mixture of 2 parts, by weight, of high-grade tankage and 1 part, by weight, of cottonseed meal, free choice, and crimson-clover pasture.

Lot 4—Barley and a mixture of 2 parts, by weight, of high-grade tankage and 1 part, by weight, of cottonseed meal, free choice, and crimson-clover and ryegrass pasture.

Tables 16 and 17 give detailed information on this experiment for a period of 120 days (December 1, 1937, to March 31, 1938).

TABLE 16—Average daily ration of pigs

Feed	Lot 1	Lot 2	Lot 3	Lot 4
	Pounds	Pounds	Pounds	Pounds
Shelled corn	6.2	5.8	5.5	5.5
Ground barley			.5	.52
Protein supplement	.53	.5		

Average feed prices: Shelled corn, \$20.00 per ton; barley, \$20.00 per ton; protein supplement, \$40.00 per ton; pasture, \$4.00 per acre.

TABLE 17—*Weights, gains, and other items in pig feeding experiment*

	Lot 1	Lot 2	Lot 3	Lot 4
Number of hogs	5	5	5	5
Number of days in experiment	120	120	120	120
Average initial weight (lbs.)	45	44	45	43
Average weight at end of 120 days (lbs.)	260	249	226	217
Average gain per hog (lbs.)	215	205	181	174
Average daily gain per hog (lbs.)	1.79	1.7	1.51	1.45
Initial cost per hog at \$8.00 per cwt.	\$3.60	\$3.52	\$3.60	\$3.44
Feed cost per hog	\$8.82	\$8.19	\$7.86	\$7.81
Total cost (hog & feed) end of 120 days ..	\$12.42	\$11.71	\$11.46	\$11.25
Cost per 100 lbs. gain	\$4.10	\$4.00	\$4.34	\$4.49
Feed for 100 lbs. gain:				
Corn (lbs.)	337	340		
Barley (lbs.)			365	379
Protein supplement (lbs.)	33	29	34	36
Necessary selling price per 100 lbs.	\$4.78	\$4.70	\$5.07	\$5.18

JACK-STOCK AND MULE-PRODUCTION STUDIES

In November, 1936, an area of approximately 130 acres of land immediately adjacent to the Middle Tennessee Station was purchased as a suitable location to conduct jack and jennet breeding studies in co-operation with two other states and the U. S. Bureau of Animal Industry. Since then, this farm has been equipped with a house, barns, paddocks, and other general farm improvements essential for a study of this kind.

During 1937 and 1938, a foundation breeding herd was assembled, consisting of 1 jack and 11 jennets, all of breeding age. These animals were selected on the basis of type and breeding, and were of the best that could be found in Tennessee.

A project of this kind is of necessity a long-time study, and will involve many related problems, which must be approached and interpreted from a regional point of view. Among the objects of this experiment are the following:

1. To aid in improving the type and quality of jacks and jennets.
 2. To determine the most practical and economical methods of growing and managing jacks and jennets.
 3. To determine the type of jack most desirable for jack-stock and mule production.
 4. To determine the type of mare most desirable for mule production.
 5. To study the influence of soil and pasture improvement on growth and development of jack-stock and mules.
 6. To make further studies on the physiology of reproduction.
- Mares and additional jacks will be added as facilities permit.

DAIRY CATTLE FEEDING AND GRAZING EXPERIMENT

Additional observations on the experiment begun at the West Tennessee Station in 1932 to determine the amount of grain necessary for most economical milk production when cows have access to all-year pasture, are being reported in the section of the annual report devoted to the West Tennessee Station.

The experiment with the dairy herd, begun at the Middle Tennessee Station, comparing cows on full-grain ration with those on limited-grain ration, with all-year pasture, has been continued, and results have been reported in Tennessee Experiment Station Bulletin No. 163.

BANG'S-DISEASE CONTROL

The work of controlling Bang's disease in the breeding herds of cattle at the Middle and West Tennessee Stations is still under way. The agglutination test by both the Huddleson and tube methods is conducted every 90 days. Neither herd, consisting, on an average, of 100 head at the Middle Tennessee Station and 35 head at the West Tennessee Station, has had any reactor during the past 2 years.

Mr. L. R. Neel, Superintendent of the Middle Tennessee Station; Mr. Ben P. Hazlewood, Superintendent of the West Tennessee Station; and Professor H. R. Duncan, of the Knoxville Station, have given their usual willing and valued assistance, and have made it possible to carry out the large amount of work involved in the animal husbandry research program at the Tennessee Stations.

PHOSPHATE NUTRITION STUDIES

Cooperative with TVA

Dorothy E. Williams and Elise Morrell

Experiments have been under way during the past year dealing with the availability of phosphorus in feeds. The feeds so far studied have been samples of *Lepedeza sericea* and alfalfa. Similar experiments with soybean have recently been initiated.

In the study of sericea, the availability of the phosphorus of the hay to the white rat was compared (1) between stems and leaves, and (2) between sericea of a low phosphorus content and sericea of a high phosphorus content. A triplicate feeding experiment was set up in which animals on a control diet were compared with animals on a diet containing sericea stems low in phosphorus content and with animals on a diet containing sericea leaves low in phosphorus content. All conditions were kept as nearly identical as possible as to amounts and kinds of nutrients and roughage, except that in the case of the control animals the source of phosphorus was entirely from Osborne and Mendel salt mixture; in the case of each of the diets containing sericea stems and leaves respectively one-half the phosphorus was from salt mixture and one-half from the hay. In each group of 3 animals, food consumptions

were kept the same by the food intake being limited to the quantity eaten by the animal which consumed the least. The amount of phosphorus in all diets was reduced to what was considered to be the minimum or slightly below the minimum for normal growth and bone development under usual dietary procedures.

Experiments were similarly set up in comparing control animals and those fed diets containing sericea stems high in phosphorus and those fed diets containing sericea leaves high in phosphorus.

Supplementary experiments were set up designed to demonstrate the effects on rate of growth and phosphorus retention of (1) food consumption; (2) different ratios of calcium to phosphorus in the diets; and (3) varying amounts of phosphorus supplied in the diet as a whole.

RESULTS

Under the conditions of the experiments, it seemed reasonable to suppose that any differences in rate of growth and phosphorus retention were due to differences in availability of phosphorus in the diets under discussion.

In a comparison of sericea leaves and stems, some evidence appears for the greater availability of the phosphorus in the stems than of that in the leaves.

In the case of the diets containing low-phosphorus or high-phosphorus sericea, the results seem to indicate that the phosphorus in the former was only slightly available to the animals, whereas that in the latter was entirely or in considerable part available. It was hypothecated that the difference in availability was due to lack of assimilation in the case of the diet containing the low-phosphorus sericea. In this diet, in order to make the amount of phosphorus the same as in the other diets, a larger amount of the sericea of low phosphorus content was necessarily included. This, for some reason, caused an increased elimination of feces, as determined by the collection and weighing of the feces for all animals. In other words, the animal feeding on the diet containing the low-phosphorus sericea not only was receiving hay with a smaller amount of phosphorus per unit weight, but was unable to make much use of what was there.

Similar experiments, using alfalfa in place of sericea, and in about the same amounts as were used of sericea, indicate that when an alfalfa hay relatively low in phosphorus was compared with one high in phosphorus, the phosphorus of the low-phosphorus alfalfa was not so available to the animal as that of the high-phosphorus alfalfa.

Experiments have been begun to determine whether or not an analogous result will be obtained from a comparison of two samples of soybean hay of fairly divergent phosphorus content.

GENERAL CHEMISTRY

G. A. Shuey

LEGUME SILAGE

The practicability of utilizing a wide variety of plants, including legumes and grasses, in the making of silage, has been demonstrated repeatedly by agricultural experiment stations and by farmers during comparatively recent years.

In Tennessee, many leguminous crops—among them *Lcspedeza sericea*, *L. bicolor*, hairy vetch, and crimson clover—grow luxuriantly, and produce a large total yield. Early-season rainfall often is heavy, so that early cuttings cannot be utilized readily as hay. Even if weather conditions should permit the curing of these crops for hay, there are peculiar problems connected with sericea and crimson clover which put them at a slight disadvantage as compared with other hay crops. Lespedezas, particularly sericea, contain astringent tannins that apparently render them somewhat distasteful to livestock. Crimson clover does not readily yield its water, and therefore is difficult to cure even under the best of weather conditions.

A series of experiments were carried out which had as their object a study of the ensiling qualities of legumes, especially crimson clover, sericea, bicolor, and hairy vetch. Molasses, orthophosphoric acid, and hydrochloric acid were applied in accordance with recommended practices. Monocalcium phosphate, and skim milk, except in bicolor, also were used.

The addition of molasses, or other form of sugar, provides material necessary to the formation of acetic and lactic acids in the process of fermentation. The addition of mineral acids in sufficient amounts to provide a degree of active acidity equal to a pH of 4.0, or slightly lower, is supposed to preserve the carotene by preventing excessive and undesirable types of fermentation. The use of phosphoric acid is advocated now, the argument being that besides controlling fermentation it adds phosphorus to the ration.

The crops were cut fine ($\frac{1}{4}$ - to 1-inch size) and ensiled with a total moisture content of approximately 70 percent, except in the case of hairy vetch, which had a somewhat higher content of moisture. Substances used for treating the green crops prior to ensiling were diluted with a small amount of water and thoroughly hand-mixed with the cut plant materials. This, of course, reduced the dry-matter content to slightly less than 30 percent. Special treatments were applied at the following rates per ton of ensiled crop: Molasses, 60 pounds; phosphoric acid, 24 pounds of 78 percent acid; monocalcium phosphate, 26 pounds; hydrochloric acid, 90 liters of twice normal; skim milk, 300 pounds, this amount being purely arbitrary. Crops thus prepared were packed tightly in gallon-size containers, sealed, and allowed to stand for 5 weeks at approximately 75° F.

Crimson clover ensiled with molasses and phosphoric acid produced silage of good odor, taste, and color. Silage treated with phosphoric acid was somewhat lighter in color than molasses-treated silage of this crop.

Proximate analyses show that the composition of silage made from sericea and bicolor by the several treatments is similar with respect to feeding value. Silage made from hairy vetch is much higher in ash, somewhat lower in protein, and lower in nitrogen-free extract than silage made from sericea and bicolor by the several treatments. The ash content is considerably increased by the addition of phosphoric acid and monocalcium phosphate, as would be expected. In a general way, analyses indicate that there is practically no loss of feed nutrients in the process of making silage from these crops. The extent to which carotene, the mother-substance of vitamin A, is retained in silage made from sericea, bicolor, and hairy vetch has not been determined by us. Plans are being made to include carotene studies next year.

The amount of soluble tannin contained in sericea and bicolor is reduced by the process of ensiling. The largest amount of soluble tannin appears to parallel the stronger acid materials used in treating the silage. With each of the crops studied it was found that molasses, skim milk, and no treatment show considerable reduction in the amount of tannin contained in the silage. This is an interesting fact, as an extremely low result for tannin was obtained when skim milk was used in preparing the silage. Skim milk being a protein substance, it reacts to lower the tannin content. This may lend support to the postulation that lowering

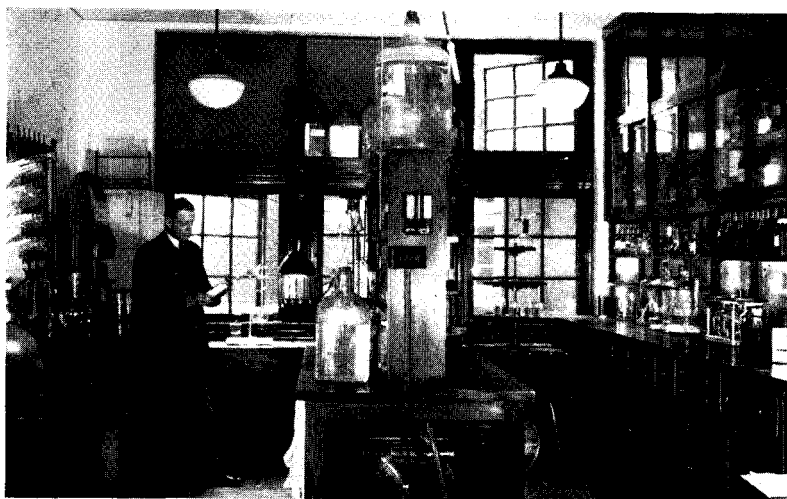


Fig. 10—Chemical laboratory for the study of sorghum sirup, cottonseed, and other farm products.

of astringent tannins in silage made from sericea and other tannin-bearing crops is due to the formation of an insoluble protein-tannate type of substance. Furthermore, it appears that mineral acids, phosphoric and hydrochloric, exert a solvent action on the tannin of sericea and bi-color silage. Silage treated with the recommended amounts of mineral acids show relatively low pH values and a correspondingly high content of soluble tannin.

The foregoing presentation merely touches on some chemical phases of this work—it is only the beginning. The subject of silage-making from lespedezas and other legumes, singly and mixed with the small grains, corn, sorghums, and other crops, under different conditions and varying chemical treatments, presents an important problem, in which there is a growing interest in Tennessee. Future studies should be conducted on a more extensive and practical scale. Large quantities of the various crop materials should be ensiled with appropriate substances that have been found to enhance quality. Chemical analyses should be made of the crops and of the silage produced from them, as a means of evaluating the products. Livestock feeding experiments should be conducted in order that something may be learned about the relative nutritive values of silage thus produced, and probable effects, if any, of mineral acids and phosphorus on the general well-being of animals.

Three crops—crimson clover, sericea, and alfalfa—have been ensiled in gallon containers with a mixture of molasses and phosphoric acid, and excellent results obtained. Molasses was used at the rate of 60 pounds per ton of green crop and phosphoric acid at the rate of 10 pounds per ton. Molasses was diluted with an equal volume of water; the acid was then added, and the whole thoroughly mixed. The value of this mixture in large-scale silage production remains to be proved.

PROCESSING OF COTTONSEED AND COTTONSEED PRODUCTS

The processing work on cottonseed has been conducted in an improved commercial-size experimental cottonseed-oil mill, which is installed in Estabrook Hall, on the University campus. Chemical phases of the work are being carried out in laboratories of the Agricultural Experiment Station and the Engineering Experiment Station. To date approximately 53 tons of delinted cottonseed have been processed in the cottonseed processing laboratory.

A study for the adaptation of cottonseed humidifying equipment to commercial oil-mill operations has been made. Equipment has been designed and built to specifications that were developed in our research. The study disclosed the need and desirability for storing humidified seed for 2 or 3 hours to permit absorption of surface moisture by the cottonseed kernel. This is opposed to present methods, which contemplate the aerating of humidified cottonseed to dissipate surface moisture.

A study was made of control methods employed in the cooking of cottonseed and the proper processing of cottonseed prior to cooking. Optimum conditions for processing were established. In addition, a principle of cooking control was developed whereby the degree of superheat in cooking under steam pressure may be used to (a) produce optimum cooking conditions with respect to heat, (b) control the quantity of moisture remaining in the processed material, and (c) indicate the optimum point for terminating the process. Heretofore elapsed time was used as a guide in cooking and governed the duration of the process. Cottonseed is a commodity that varies widely in moisture, oil, and protein composition. Time control of the cooking operation is generally unsatisfactory.

We have designed and reduced to blueprints, in detail, a new-type cottonseed pressure cooker, embodying principles developed in the research. The new-type cooker should be capable of more efficient performance, and should admit of simplified construction that would make it sell at a price approximately 35 percent below the selling price of the present type of cooker.

Experiments have been carried out in hydraulic plate press operations to determine what factors contribute to efficiency in the expressing operation. Studies are being made on the rate of pressure application to the press, time of drainage, and details of plate and box construction in respect to drainage area. Results to date, while encouraging, are inconclusive.

In accordance with objectives outlined in the project, work of a preliminary nature is being conducted on possible ways of utilizing cottonseed hulls. The cottonseed hulls are ground in a hammer mill and then are known as "cottonseed-hull bran." Rather extensive surveys of literature have been made on the general subjects of production and uses of furfural and lignin and their application in plastics. A number of samples of cottonseed-hull bran have been analyzed for both the furfural and lignin contents, the object being to gain some knowledge of the amounts of furfural-yielding substance (pentozans) and lignin contained in hulls. Thus far, results indicate that furfural is recoverable to the extent of 14 to 16 percent, based on the weight of moisture-free hulls. In an effort to increase the yield of furfural, the hull bran is being treated by several chemical methods prior to distilling off the furfural. This work is now in progress. Attempts are being made to separate pentozans by lixiviating, with dilute acids and rotain, without changing the form of the lignin, which occurs in the hulls to the extent of 43 percent. This phase of the work will require considerable experimentation. Should these attempts be successful, greater commercial possibilities in the utilization of hulls may be expected. Proximate analyses of cottonseed-hull bran have been made with the object in view of learning something concerning its feeding value.

SORGHUM SIRUP

Field and laboratory work on sorghum sirup was continued during the past year. The field work was conducted at the Cumberland Homesteads, near Crossville. A building and processing equipment belonging to the Homesteads Cooperative were used for the processing operations. One additional blending tank of 500-gallons capacity and one open-style coil evaporator were installed by the Station. Otherwise, the equipment was about as reported last year. Water and electricity were provided by the Homesteads Cooperative at nominal rates. The Station provided fuel and labor for making the steam.



Fig. 11—Sorghum cane field.

Sorghum cane was grown on the farms operated by the Station in connection with the study of home production of food supplies. The process used was the same as reported last year. The object of this year's operations was to gather some knowledge as to plant capacity and cost of operations.

Over a period of several years, 15 varieties of sorghum cane have been grown and processed into sirup in this plant. Of this group, the Sugar Drip variety has given the highest yields of cane and juice. Unfavorable weather conditions at planting time in the years 1937 and 1938 resulted in poor stands of cane, and yields were below normal. The average yield of stripped cane was $5\frac{1}{2}$ tons per acre. Sirup was produced from this cane at the average rate of 13.4 gallons per ton, or 73.7 gallons per acre. A total of 54.8 tons of stripped cane was processed. It was found that the cost of making sirup from cane laid down at the plant was 33.89 cents per gallon. This includes cost of



Fig. 12—Interior view of testing laboratory in experimental sorghum sirup plant.

labor, fuel, containers, lubricating oil, electric power for grinding, and miscellaneous items.

With the addition of one sirup evaporator, costing approximately \$70.00, the plant will have a capacity of about 10 tons of cane per day, with a production of from 130 to 150 gallons of sirup. Careful planning and good management of plant operations are important if this sort of undertaking is to be successful. The marketing end of the project has received some attention. The sirup produced in this plant during the past two years has been received with a good deal of favor.

Considerable analytical work on sorghum juice and sirup has been done in the laboratory. It is proposed to give more emphasis to this phase of the work during the coming year.

UTILIZATION OF FRUITS

Some attention has been given during the past year to the utilization of fruits. Several attempts were made to prepare a concentrated strawberry juice by freezing out the water. Results of this work are inconclusive. Interest was maintained in the quick freezing of strawberries and other fruits that are being studied cooperatively by the University and the TVA.

MISCELLANEOUS

Considerable analytical and consulting service on a wide variety of subjects has been rendered the Station departments during the year. Numerous samples of hay and other feeds have been analyzed. Twenty samples of soybeans have been analyzed for oil content. Service has

been rendered the Department of Agronomy in connection with experimental germination of cotton pollen.

At all times an interest is maintained in problems related to the utilization of agricultural products generally. This phase of agricultural research is timely and important.

PLANT COMPONENTS

E. K. Weathers

The project on plant components was continued during the year 1938. The data collected from the beginning of the project in 1932 up to and including a part of the 1937 data, were published as Station Bulletin No. 166, entitled "Mineral and Nitrogen Content of Lespedeza and Other Hay Crops in Tennessee."

Chemical analyses during the year 1938 included the following crops: (1) from the Knoxville Station—Austrian peas, *Lespedeza bicolor*, crimson clover, Louisiana white clover, and Crown vetch; (2) from the Cumberland Plateau—crimson clover, soybeans, corn leaves, and corn grain.

CHEMICAL COMPOSITION OF CROPS ANALYZED

Crimson Clover

Crimson clover was collected from the Knoxville Station and the Cumberland Plateau when it was in the bloom stage. The plants were separated into leaves and stems and a separate analysis made of each part. The analytical data are given in table 18.

TABLE 18—Average percentage composition of crimson-clover leaves, stems, and whole plant from Knoxville Station and Cumberland Plateau, 1938

Moisture-free basis

Place grown		Ash	CaO	MgO	K ₂ O	Fe ₂ O ₃	Mn ₂ O ₄	P ₂ O ₅	Crude protein N x 6.25	Crude fat	Crude fiber	N-free extract	Leaves & stems
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Knox-ville Station	L	10.69	2.69	.52	2.74	.064	.614	.93	20.47	1.85	27.77	39.23	50.51
	S	7.75	1.21	.33	3.15	.026	.005	.59	10.97	.95	43.28	37.06	49.49
	W	9.24	1.95	.42	2.94	.047	.010	.76	15.76	1.41	35.44	38.15	
Cumberland Plateau	L	9.11	2.80	.41	1.88	.026	.009	.49	20.26	2.36	24.08	44.20	59.62
	S	7.62	1.08	.30	1.87	.013	.003	.27	10.53	1.09	34.97	45.80	43.38
	W	8.41	2.09	.36	1.86	.020	.006	.40	16.28	1.85	28.56	44.91	

L=leaves,

S=stems,

W=whole plant.

A comparison of the analyses of the samples of crimson clover from the two sources, using the Cumberland Plateau samples as controls,

showed that the Knoxville samples, on the whole-plant basis, contained 9.87 percent more ash, 1.67 percent more magnesia, 58 percent more potash, 135 percent more iron oxide, 67 percent more manganese oxide, 90 percent more phosphoric acid, 24 percent more crude fiber, 6.7 percent less lime, 3.2 percent less crude protein, 24 percent less fat, and 15 percent less nitrogen-free extract.

The leaf percentage of the crimson clover from the Knoxville Station was 50.5; from the Cumberland Plateau, 59.6.

Corn Leaves and Corn Grain

Table 19 gives analyses of corn leaves and corn grain grown on the Cumberland Plateau. The corn was grown on 1/70-acre plots and each fertilizer treatment was used on 4 plots. A sample of the leaves and of the grain was taken from each plot, and then the samples from the 4 plots of the same treatment were combined to make up the sample for chemical analysis. Thus, each analysis in the table represents the average of 2 samples, or the composite of material from 8 plots. The 2 farms on which the plots were located received lime—in one instance in 1935, in the other in 1936. The phosphate treatment is given in pounds equivalent to 16 percent superphosphate and the applications ranged from 0 to 360 pounds per acre.

Table 19 indicates that the quality of corn leaves or of corn grain is not improved appreciably by the application of phosphate. However, it does show that 180 pounds of phosphate per acre gave a yield of 38 bushels of corn grain, or an increase of 36 percent over the untreated plots; and that 360 pounds of phosphate per acre gave a yield of 39 bushels, or an increase of 39 percent over the untreated plots, which produced an average of 28 bushels per acre.

TABLE 19—*Average percentage composition of corn leaves and grain fertilized with varying rates of phosphate, 1937*

Moisture-free basis									
Phos- phate per acre	Yield per acre	Ash	CaO	MgO	K ₂ O	Fe ₂ O ₃	Mn ₂ O ₃	P ₂ O ₅	N
Leaves									
Pounds	Bushels	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
0	Not determined	11.52	1.09	.43	1.83	.055	.027	.23	1.40
180	" "	9.91	1.19	.37	1.52	.053	.028	.22	1.01
360	" "	9.79	1.21	.40	1.47	.059	.028	.21	.88
Grain									
0	28	1.38	0.17	.26	.58	.008	.002	.58	1.55
180	38	1.38	0.14	.25	.56	.016	.002	.65	1.44
360	39	1.33	0.14	.27	.56	.007	.002	.61	1.36

Soybeans

The soybeans were grown on Hartsells soil, Cumberland Plateau. Two samples were obtained from fields which received 200 pounds of phosphate in 1936, and two samples from fields which received 200 pounds of phosphate in 1936 and 200 pounds in 1937. The average figures are shown in table 20.

TABLE 20—Average percentage composition of soybean hay from Cumberland Plateau grown on fields phosphated one year and fields phosphated two years.

Moisture-free basis

Date cut 1937	No. of years phosphated	Ash	CaO	MgO	K ₂ O	Fe ₂ O ₃	Mn ₂ O ₄	P ₂ O ₅	N
Sept. 16	1	P. ct. 8.95	P. ct. 2.15	P. ct. .71	P. ct. 1.39	P. ct. .065	P. ct. .027	P. ct. .31	P. ct. 1.65
Sept. 16	2	8.15	1.96	.60	1.74	.040	.020	.35	2.47

This table indicates that the content of potash and nitrogen was increased appreciably after 2 applications of phosphate in consecutive years, while the phosphoric acid content was only slightly improved.

In several crops analyzed from Hartsells soil, where phosphate treatments were made, there has been no appreciable increase in the phosphoric acid content in the plants. The problem of how to increase the phosphoric acid content in plants grown on Hartsells soil of the Cumberland Plateau region is one of considerable importance and probably will receive some attention in the coming year.

Other Crops from Knoxville Station

Samples were taken of 4 additional hay crops from the Knoxville Station. The chemical analyses of these crops are given in table 21.

TABLE 21—Composition of *Lespedeza bicolor*, Austrian peas, Crown vetch, and Louisiana white clover, Knoxville Station, 1938

Moisture-free basis

Crop	Date cut	Wt.	Stage	Ash	CaO	MgO	K ₂ O	Fe ₂ O ₃	Mn ₂ O ₄	P ₂ O ₅	N
Bicolor	May 23	Inches 28	Pre-bloom	P. ct. 6.17	P. ct. 1.53	P. ct. .30	P. ct. 1.78	P. ct. .037	P. ct. .030	P. ct. .55	P. ct. 3.01
Austrian peas	May 26		Bloom	7.51	1.33	.43	2.62	.029	.009	.91	3.34
Crown vetch	May 24	44	Bloom	8.15	1.43	.36	3.04	.040	.011	.64	3.43
La. white clover	May 24	5	Late-bloom	13.25	2.34	.67	3.33	.166	.027	.72	3.89

Tobacco

Tobacco samples numbering 133 were collected from a rim experiment. Dandridge and Hartsells soils were used, and various fertilizer treatments were made on each soil.

In addition, 10 samples were taken for analysis from 2 long-time fertility plots. The samples from each plot included stalks, first priming leaves, second priming leaves, leaves, suckers, and tops, making a total of 5 samples from each plot.

These samples have all been prepared for analysis and the work, which will be concerned mainly with the potash content, is under way.

CHEMISTRY

SOILS AND FERTILIZERS

W. H. MacIntire and W. M. Shaw

Efforts in the soil chemistry laboratories during the year were devoted to investigations of the fundamental principles that govern the availability and conservation of soil fertility elements. Much of the work involved chemical analysis of the rainwater percolates from soils obtained from different sections of the State and treated with various fertilizers and different calcic, magnesian, and dolomitic liming materials. Outdoor lysimeters of varying depths admitted of the use of columns of soil and soil-subsoil. Progress was made in a study of the capacity of the soil to absorb bases and in the development of a procedure for the determination of the nature and degree of lime saturation.

LIME CONSERVATION STUDIES

The experiment as to the variant behavior of 7 liming materials, and their effects upon other plant nutrients of the soil, was continued. The losses of calcium, magnesium, potassium, sulfur, and nitrogen from soil and from subsoil have been determined and compiled as a contribution to the science and the practice of soil liming. The difference between the amounts of calcium and magnesium from rainwaters and the amounts present in the soil percolates has given the amounts of these two bases actually derived from each soil.

It is important to determine how long the beneficial effects of added liming materials will continue. The behavior of the economic additions of 4 types of liming materials incorporated in single full quantities and in divided annual treatments in the upper third of the soil were continued in collaboration with the Virginia Experiment Station. The availability of calcium, magnesium, and other nutrients was favored by the annual repetitions of the fractions of the full treatments. The study of the availability of residues of liming materials after such materials had become assimilated by the soil, and the effect of the residues upon other soil constituents, likewise was continued.

In conjunction with the general liming problem, a study was made of laboratory methods to determine the reactivities of limestones of divergent type and of different degrees of fineness. A method is being proposed to measure the speed of the reactivity of any sample of ground limestone in relation to its total neutralizing value. This laboratory test can be made within a few minutes, and registers the combined effects of quality and degree of fineness of the particular ground rock. The method was undertaken as a collaborative effort for the Association of Official Agricultural Chemists. Extensive experiments have shown that representative dolomitic limestones are characterized by distinct and determinable differences in the chemical reactivity. The data and conclusions from these studies will be presented for publication in the near future.

LIME-POTASH EXPERIMENTS

In its tendency to undergo fixation in the soil, potassium occupies an intermediate position among the common fertilizer elements. A considerable proportion of incorporated soluble potassium salts becomes fixed in the soil. The fixed potassium resists leaching by the rainwater, and in some instances it is not removed by relatively active solvents.

The extent to which the applied potash will continue unfixed and readily leached is governed by the nature of the soil. The relationship between total quantity of potassium absorbed and the fraction that will be in the more available state is determined only by more specific knowledge of the individual soil. The potash problem arises as a corollary of liming. Through the lysimeter studies at this Station it was first established that liming tends to conserve potash, both native and applied. This effect of lime upon availability of soil potassium has been observed also in field studies in various parts of the country.

In one lime-potash experiment with 3 Tennessee soils, with and without lime, it appears that liming conserved the added potassium in soils that were acidic at the beginning of the experiment. On the contrary, a soil inherently and slightly alkaline at the beginning of the experiment did not demonstrate a fixation of potassium as an effect of liming. Periodicity of rainfall influences the alternate drying and wetting of the soil and is a factor in the behavior registered by the additive potassic treatments.

In another phase of the lime-potash experiment a build-up of potash has been attempted in 5 Tennessee soils, which have received annual additions of 800 pounds of K_2O as a preliminary step to later liming. The soils have shown a marked difference in their capacity to fix added potassium, and correspondingly great differences in the release of the absorbed potash to the drainage waters. The soils that had shown the low-absorption capacity for potash continue to yield the absorbed potash readily to their drainage waters. The lysimeter findings as to fixation of potash in variable form and degree are in full harmony with

the behaviors registered in related laboratory experiments with the same soils.

The original studies to determine the capacity of the soil to transform solid forms of sulfur into sulfates that can be utilized by plants, as measured by sulfate outgo in rainwater leachings, has been supplemented by studies to show the effect of limestone and dolomite on the conservation of added calcium, magnesium, and potassium sulfates. Thus far the results show that practically all of the sulfate radical of each of the sulfates was leached from the limed soils, but only in the case of magnesium sulfate was there a complete recovery of the added sulfate. In some of the unlimed soils, however, there appeared to be a slight retention, or build-up, of the sulfur supplied by the sulfate addition to the acidic soil. The sulfur requirement of some plants is as great as the phosphorus requirement, or even greater, and the supply of nutrient sulfur is an important fertility consideration.

MIGRATION OF PHOSPHATE

Different phosphates have markedly different degrees of solubility and behave differently toward soils before and after the addition of liming materials. The effect of limestone and of dolomite upon the mobility of soluble phosphates and their ultimate degree of availability in 3 Tennessee soils was studied by means of lysimeters. An annual incorporation of 600 pounds of 16 percent superphosphate has been made for 8 years. The Cumberland loam and Ford clay loam have suffered only meager losses of phosphates. In contrast, there was a definite loss of the soluble phosphate that had been incorporated with the Jackson silt loam. The cumulative loss of P_2O_5 from the Jackson soil was as much as 12 pounds per acre for the 8-year period. Information as to nature of the phosphates retained by the several soils will be obtained after the lysimeter phase of the problem has been completed, and the residual soils can be utilized in laboratory studies.

FLUORINE-PHOSPHATE RELATIONSHIP

The potency of fluoride to effect "reversion," or decreased solubility, of processed phosphatic fertilizers has been proved by experiments conducted in these laboratories. The capacity of the fluorine content of the soil, of fluorides brought by rainwaters, and of those added in fertilizers, to effect reversion of the basic types of phosphates into fluorophosphate in the soil is not known. A lysimeter experiment to throw light on this point was begun in 1936. The study includes various types of standard phosphatic materials and also those developed recently. Analyses of the leachates for the past two years shows some increases in the fluorine content of the drainage waters from the experiments in which fluorides were added. The relation of type of phosphate and the influence of variable liming supplements upon fluorine outgo have not been registered by capacity of the phosphates to tie

up with the fluorides in the soil. Because of the meager solubility of the phosphates in the leachings, no attempt has been made to correlate the phosphate and fluorine content in the drainage waters. The availability of the accumulated phosphates in the soil will be studied by chemical analyses, or by plant response, after completion of the lysimeter phase of the experiment.

NITROGEN CONSERVATION

Additional data were obtained in the agronomy-chemistry study of the economy of different nitrogenous fertilizers. Two Tennessee soils, with and without supplements of limestone, were utilized in this study. Several of the nitrogen carriers are not initially soluble, and undergo oxidation in the soil before engendered nitrates appear in the leachings. Nitrogen from those organics, therefore, is stored up in the soils, and in some favorable seasons may yield an outgo of nitrogen in excess of the annual application. Most of the leached nitrogen is accounted for by nitrates, but at times appreciable quantities of nitrites and some ammonium compounds occur in the leachings. Although the ammoniacal salts are readily soluble, their nitrogen is fixed chemically in the soil in forms from which nitrogen subsequently is released through oxidation to the readily leached nitrates. A single year's results, therefore, cannot be taken as an index of the behavior and the actual character of the properties of a nitrogenous fertilizer without due consideration of the cumulative effects during seasons when the soil flora is dormant, in contrast to the biological activities during warm periods. Some striking features may be noted in the findings for the period from January, 1937, to January, 1938. Uniformity in the nitrate releases from the control soils indicates that the initial effect of the single liming at the beginning of the experiment has been spent, although the larger part of the added calcium remains in the soil. The unusually low nitrate recoveries from the sodium nitrate additions of the limed experiment are in marked contrast to the much higher recovery from the same treatments, without supplemental liming. This is interesting in connection with field observations as to response from nitrate of soda and liming treatments in comparison with ammoniacal salts and supplemental liming.

The conservation of ammoniacal forms of nitrogen has been studied with 3 Tennessee soils, to which have been applied 6 different ammonium compounds in annual winter additions of 33 pounds of nitrogen. In general, the nitrogen recoveries are lowest from the Jackson soil, but the highest recoveries from the Cumberland and the Crossville soils were only about 60 percent of the annual additions. The ammonium phosphates gave the lowest nitrogen recoveries. This was especially true of the diammonium salt. Apparently, the ammonium part of the phosphatic salts is held tenaciously by the soils in forms resistant to the action of bacterial flora during the periods when leaching occurs.

Capacity of subsoil strata to prevent losses of the basic and acidic radicals of ammonium salts by leaching has been studied. In this experiment the effect of 5-foot clay subsoil on the outgo of nitrogen from 3 ammonium salts was observed for the fifth year. This experiment is in parallel to a study in which the outgo of nitrogen from the same addition of nitrogen as nitrates of sodium, calcium, and magnesium was determined over a 10-year period. The 1937-38 results show considerable diminution in nitrogen outgo from the heavy treatments of phosphate, chloride, and sulfate of ammonium. The total outgo of nitrogen for the past year dropped from the 400-pound outgo of the previous year to about 100 pounds. The amounts of calcium, magnesium, and potassium in the rainwater leachings decreased also, and in corresponding proportions. The cumulative results from this experiment demonstrate divergence in the behavior of the ammonium radical of the different carriers toward soil bases. The amounts of calcium and of magnesium forced out of the 6-foot columns of soil-subsoil by the additions of ammonium phosphate were only about one-half as much as those displaced by the equivalent amounts of ammonium carried by the added ammonium chloride. This relationship indicates that the radical of the ammonium phosphate induced no migration of bases. Practically all of the sulfate part of the ammonium sulfate additions has been retained by the soil and subsoil. From an addition of 3430 pounds of sulfate, in terms of CaCO_3 -equivalence, the ammonium sulfate treatment induced an outgo of only 200 pounds above that from the 6-foot control soil-subsoil over a period of 4 years. The nature of the sulfate retention is still problematical. In contradistinction, the chlorine of the ammonium chloride addition was leached rapidly and completely. This divergence in behavior of the chloride and sulfate of ammonium may have a definite practical bearing in fertilizer usage, since the chlorine ion is liable to be toxic, whereas the sulfate ion is not.

COOPERATIVE FERTILIZER STUDIES

In studies of the composition and properties of new types of fertilizer material, it is essential to assure adequacy of analytical technic. Methods admissible for established materials may require modification and adaptation for the analysis of new products, or it may be necessary to evolve new procedures. The original methods for the analysis of phosphatic materials were of German origin and were intended for acidic products. The processing of fertilizers, by ammoniation and by inclusion of liming materials, has resulted in materials that cannot be evaluated fairly from analyses made by the original methods. Previous studies had shown the need for a dependable and simplified method for the analysis of all types of phosphatic fertilizers. As a result of many trials and much study, a single solvent was proposed and a rapid technic was evolved for the analysis of all types of phosphatic materials. This method has been presented in both briefed and amplified form and

is now being studied by the Association of Official Agricultural Chemists. Its adoption would prove a definite economy to state control officials, to station chemists, and to laboratories of the fertilizer industry.

Because of its ready reactivity with water-soluble phosphates and the high availability of its P_2O_5 content, the recently developed calcine of rock phosphate would be expected to be preferable to raw rock as a corrective P_2O_5 addition to superphosphates. Beeson and Jacob found, however, an unexpected development of citrate-insolubility in mixtures of the calcine with superphosphate. The same undesirable result was obtained in these laboratories when triple superphosphate was similarly used. It was brought out that the tricalcium phosphate of the defluorinated rock phosphate calcine reacted with the fluorides of the superphosphates with resultant formation of a very insoluble phosphate-fluoride compound similar to the one that is present in the raw rock. Essentially, the diminution in phosphate availability represents a return of a considerable portion of the calcine to its original raw-rock condition.

In studies as to the fate of added phosphates and fluoride compounds in the soil, it was necessary to develop analytical procedures to assure full recovery of the fluoride residues. It was found that a pre-ignition of soil with calcium peroxide afforded a complete release of fluorine in subsequent distillation, whereas a corresponding pre-ignition with magnesium peroxide caused an unrecoverable fixation of the fluorine. In the preparation of plant ash for fluorine distillation it was found, however, that the magnesium peroxide was preferable to the peroxide of calcium, which reacted too violently with organics. In both cases, it was found that the distillation and fluorine recovery were greatly expedited by passage of a current of steam through the boiling perchloric acid digestion, instead of the ordinary boiling and replacement of water removed as distillate.

In the cooperative work, the experimental products and by-product materials from Wilson Dam have been studied in the laboratory and in pot cultures. Information so obtained is primarily of pilot nature for "semi-works" operations, rather than of general interest. Included in these studies is an attempt to segregate the components of the calcium silicate slag that has proved to be a beneficial liming material, equal or even superior to limestone on the basis of equivalent CaO content.

During the past year W. M. Shaw and W. H. MacIntire have served collaboratively as Associate Referee for Liming Materials and as General Referee for Soils and Liming Materials respectively for the Association of Official Agricultural Chemists.

ECONOMICS AND SOCIOLOGY

C. E. Allred

FARM TAXATION

The study of the relation of assessments and tax delinquency to soil class in Jefferson County was completed and analyzed, and the follow-

ing preliminary publication issued: "Economic and Social Factors Associated with Land Class in Jefferson County, Tennessee." Monograph 76. 75 pages.

Using data collected by the Tennessee Agricultural Experiment Station under two cooperative projects with the Federal Bureau of Agricultural Economics, FCWA, and WPA, a preliminary analysis was made of 7 Tennessee counties, and a publication issued: "Acquisition of Farm Land by Credit Corporations in Tennessee." Monograph 77. 49 pages.

AGRICULTURAL ADJUSTMENT

In cooperation with three divisions of the United States Department of Agriculture, studies of agricultural adjustment in the State were continued. Surveys are under way in representative counties to determine the relationship existing between the quality of soil and the status of farm families living on the various soil classes. Analysis of one county, so far made, indicates that the quality of the soil influences tax delinquency, farm bankruptcies, farm mortgage financing, farm income, property insurance, and rural relief. This study should be of value in agricultural planning and land-use classification. A preliminary publication of results secured in Jefferson County was issued.

Analysis was made of some other aspects of the data secured in Crockett County, and a publication issued: "Land Use Problems in Crockett County, Tennessee." Monograph 72. 43 pages.

During the year a study was published entitled, "Economic Strategy of the Tennessee Location as Shown by Statistical Studies"—a part of the report prepared by The University of Tennessee on "The Qualifications of Tennessee as the Proper Location for a Federal Regional Farm Products Laboratory." This report covers the permanence of types of agriculture in Tennessee, types of farming areas in the State with major farm crops and livestock, the manufacturing and transportation facilities of the State, and other factors useful in agricultural planning.

TYPES OF FARMING

The study of types of farming in Tennessee was continued, and preliminary publications were issued:

"Factors Determining Types of Farming." Monograph 79. 37 pages.

"Types of Tenant Areas in Tennessee." Monograph 73. 46 pages.

A bulletin on "Types of Farming in Tennessee" has been completed in cooperation with the Federal Bureau of Agricultural Economics and is now being edited for publication.

An analysis is being made of the place of livestock in cotton farming areas of Tennessee.

A 325-page typewritten report on a farm-management survey of Overton County has been completed. This study covers the farm organization in type-of-farming area 11.

A 216-page typewritten report on "Farm Management in Relation to Land Use, Soil Conservation, and Soil Type, Crockett County, Tennessee,"

see," was completed. This manuscript covers, for type-of-farming area 3, the characteristics of present farming conditions, land use and its problems, fertilizers, recommended soil conservation practices, land-use recommendations, farm organizations in relation to farm tenure, relation of various factors to farm income, and profitable farming combinations.

COOPERATIVE MARKETING

In cooperation with the Division of Cooperative Research, Tennessee Valley Authority, a survey is being planned on farmers cooperative associations in Tennessee.

COTTON MARKETING

In cooperation with the Federal Division of Cotton Marketing, work was continued on cotton projects. During the past season, 25 ginners in Tennessee cooperated by furnishing samples used as a basis for the semi-monthly cotton grade and staple reports issued by the Bureau of Agricultural Economics in cooperation with the Tennessee Agricultural Experiment Station. Cotton classification cards, indicating the quality of cotton grown by individual farmers, were sent to growers having their cotton ginned at these cooperating gins. Semi-monthly reports for this season indicate an improvement in cotton staple over the previous season.

A report was issued on "Cotton Compressing in Tennessee and United States." Monograph 71. 41 pages. Significant findings of this study indicate the number and growth of cotton compresses in Tennessee and the United States, compress operation and ownership, shipping destination, compressing facilities and costs, and services rendered by the 14 plants in the State.

During the season, data were gathered on ginning equipment and machinery in the State.

Cooperation with the Federal Bureau of Agricultural Economics was continued on the study of selling cotton in the seed, and a publication prepared on "Cotton Sold in the Seed in the United States." This bulletin was published during the year by the Bureau. Additional data on cotton sold in the seed and other cotton-price data were gathered at Newbern, Tennessee.

Some work was done with 9 one-variety-cotton communities in West Tennessee during the season. These communities were organized under the Smith-Doxey Act, which provides classification and market news service to groups of cotton producers organized to promote cotton improvement.

SOUTHERN APPALACHIAN STUDY

The Southern Appalachian project was continued, the following publications being issued under the general title, "Human and Physical Resources of Tennessee":

"Construction, Hotels, Tourist Homes, and Conventions." Monograph 69. 22 pages.

"Homes." Monograph 70. 24 pages.

"Organizations, Recreation, and Culture." Monograph 74. 35 pages.

"Churches and Church Auxiliaries." Monograph 78. 27 pages.

"Education: Public and Private; and Illiteracy, Reading Habits and Libraries." Monograph 81. 41 pages.

"Health and Health Facilities; and Welfare Work: Public and Private." Monograph 83. 44 pages.

"State Government and Federal Activities." Monograph 84. 36 pages.

"County and Municipal Government." Monograph 86. 35 pages.

A study of Knoxville as a regional market for farm products has been initiated, including an analysis of the Knoxville produce markets.

OTHER RESEARCH

Prices of Farm Products.—In cooperation with the Federal Division of Crop and Livestock Estimates, which maintains Tennessee headquarters at The University of Tennessee, this Department has published a monthly index of prices received by Tennessee farmers, and price indexes for various farm products in the State. These publications were begun last year.

Additional data were tabulated and analyzed on farm prices in various sections of the State, the following studies being published:

"Regional Differences in Farm Price of Horses and Mules, Tennessee and United States." Monograph 67. 18 pages.

"Regional Differences in Farm Price of Milk Cows and Dairy Products, Tennessee and United States." Monograph 68. 41 pages.

"Price Areas of Farm Products in Tennessee." Monograph 75. 31 pages.

"Factors Affecting Farm Prices." Monograph 80. 33 pages.

Significant findings of these price studies indicate that prices received by farmers in Tennessee, in general, average higher than prices in the United States; that during the periods studied, prices received by farmers in the State varied widely between regions. Corn, for example, varied 12.6 cents per bushel between regions, wheat varied 25 cents per bushel, rye 6 cents per bushel, and barley 17 cents per bushel.

In cooperation with the Federal Division of Crop and Livestock Estimates, an analysis is now in progress of regional variations in prices paid by farmers in Tennessee. Monthly data are obtained from business establishments to furnish information concerning prices paid by farmers in different areas.

Farm Credit.—Some previous data relating to farm credit were analyzed and published in a preliminary report: "Rural Credit in Tennessee." Monograph 82. 42 pages.

This Department cooperated with the Production Credit Corporation of Louisville in making a survey of the use of farm credit by 200

farms in Williamson and Marshall Counties. Findings of this survey are being summarized and analyzed for publication.

Data secured in a study of the farm mortgage situation in 7 representative counties, begun in 1937, in cooperation with the WPA, FCWA, and Federal Bureau of Agricultural Economics, were analyzed, and a typewritten manuscript of 177 pages was prepared on the "Acquisition, Operation, and Sale of Tennessee Farm Land by Credit Corporations in Tennessee." One section of this report has been published.

Rural credit corporations, including commercial banks and trust companies, held 8 farms in 1922 and 297 in 1936, in these 7 counties. Insurance companies and commercial banks have consistently held over one-half of the total corporate-owned land; the Federal Land Bank and trust companies, one-third; while mortgage companies, joint stock land banks, and merchant credit corporations have held comparatively little land.

Rural Relief Problems.—Research on rural relief problems, started in cooperation with the WPA in 1934, was continued. Analysis of public relief received by rural families on various qualities of soil in Jefferson County shows that work relief, old-age assistance, and aid for dependent children are three times as great on the poorest as on the best soils. Work has been started on similar studies in other counties.

Several of the monographs issued under the general heading of "Human and Physical Resources of Tennessee" have a bearing on different phases of rural relief.

Standard of Living.—In cooperation with the State Land Planning Specialist, Federal Bureau of Agricultural Economics, family schedules were secured on 136 farm families in Overton County. These schedules were analyzed, and a 208-page typewritten report, "Standard of Living and Migration of 136 Farm Families in Overton County," was prepared. This report covers composition and characteristics of families, housing conditions, home surroundings, household conveniences, cultural facilities, value of living from the farm, standard of living, migration of sons and daughters, and mobility of farm operators.

Farm Tenancy.—A survey of renting and cropping arrangements was made in 9 cotton counties of the State, in cooperation with the Agricultural Adjustment Administration. Data from this survey are being analyzed for publication.

Three publications relating to farm tenure were issued:

"Types of Tenant Areas in Tennessee." Monograph 73. 46 pages.

"Tenure by Type-of-Farming Areas and Color in Tennessee." Monograph 85. 21 pages.

"Business Cycles and Age of Operators as Factors in the Progress of Tennessee Farmers." Monograph 87. 30 pages.

ENTOMOLOGY

S. Marcovitch

PLUM CURCULIO

The plum curculio is a native American insect attacking the plum, peach, and other stone fruits. One of the first control measures advocated was paris green. This was used as a spray as early as 1870. Since the appearance of lead arsenate, in 1893, the latter material has come into general use because it is much safer on foliage. Even lead arsenate, however, will defoliate peach trees in many orchards of Tennessee when 3 or more applications are made.

During the past several seasons, cryolite sprays have been tried and found safe on foliage, even to the extent of 7 applications. They have given good control of the curculio, being on a par with lead arsenate. In 1936 the cryolite sprays on the Machado variety, in the Wallace orchard, near Knoxville, caused a tip-end injury on the fruits. Some of the peaches had a concave surface at one end instead of the normal convex tip. This particular type of injury was not observed on other varieties or in other years.

In former trials it was found that magnesium oxide acts as a corrective for fluorine injury. An attempt was made to prevent this tip-end injury by the use of a combination of 1 pound of cryolite and 1 pound of magnesium oxide to 50 gallons of water. Unfortunately, the past season's peach crop in the experimental orchard was destroyed by frost, so that it was not possible to carry out these tests. For the present it seems that 2 early sprays of lead arsenate followed by 2 sprays of cryolite should control the curculio with the least possible effect on the foliage or the fruit. A split schedule of lead arsenate and cryolite is used now by many apple-growers in Washington State for the control of the codling moth. Finishing the spray schedule with cryolite will prevent objectionable lead residues where late spraying is practiced. Where a fungicide is necessary, flotation sulfur or a wettable sulfur will be found compatible with cryolite, but a lime fungicide will not. In years of curculio abundance, or brown rot in rainy seasons, additional sprays of cryolite and sulfur could be used to advantage against the second brood in July without danger of defoliation.

MAGNESIUM OXIDE AS A CORRECTIVE FOR CRYOLITE INJURY OF FRUIT

The work of the United States Public Health Service showed that magnesium oxide is an excellent material for the removal of fluorine from water supplies.

With this as a clue, a few tests have been carried out to determine how the magnesium oxide would work with cryolite and barium fluosilicate on smartweed, which is highly susceptible to fluorine injury. Cryolite could not be tested directly in this way, since it does not injure smartweed; hence, Dutox, or barium fluosilicate, which does injure

smartweed, was substituted. When a dust of 50 percent Dutox and 50 percent magnesium oxide was applied, practically no injury was obtained.

Since lime is not compatible with cryolite, it follows that neither lime-sulfur nor bordeaux are compatible with cryolite. In many instances lime-sulfur is being replaced by wettable sulfur, which is compatible with cryolite. In the Station's work with bordeaux on apples, a modified form was used which was found to work well with cryolite. This modified form consisted of—

Copper sulfate -----	4 pounds
Hydrated lime -----	1¼ "
Magnesium oxide -----	6 "
Cryolite -----	4 "
Water -----	100 gallons

Chemically speaking, only 1¼ pounds of lime is necessary to precipitate all the copper in 4 pounds of copper sulfate. Any excess above 1¼ pounds merely helps to reduce copper injury. The above combination with magnesium oxide was found to reduce copper injury and to be compatible with cryolite.

CONTROL OF THE TOBACCO HORNWORM

The application of lead arsenate on tobacco for control of the hornworm often leaves objectionable residues of lead and arsenic. For this reason, the extensive use of lead arsenate is not being recommended.

Tests with cryolite show that this material will control not only the hornworm but also the tobacco flea beetle, and leave no objectionable residues. The cryolite dusts do not kill the hornworm as rapidly, however, as the lead arsenate. An attempt was made to determine, as accurately as possible, the comparative toxicity of several standard insecticides. The comparison was based on the median lethal dose which kills 50 percent of the worms and is expressed as the M. L. D. in milligrams per grain of body weight. Known quantities of chemicals were fed to the worms and the M.L.D. was found to be as follows at the end of 96 hours:

Material	M. L. D.
Paris green	.015 mg. per gram of body weight
Lead arsenate	.085 " " " " " "
Alorco cryolite	.110 " " " " " "
Calcium arsenate	1.350 " " " " " "

INSECT CONDITIONS IN 1938

The army worm (*Cirphis unipuncta*) appeared, in outbreak proportions, at Knoxville and Dandridge, in rye and wheat. The variegated cutworm (*Lycophotia margaritosa*) was also present.

The corn earworm (*Heliothis obsoleta*) was less abundant than usual in tomatoes, due probably to the extremely wet weather prevailing at the time of oviposition.

The bean beetle (*Epilachna varivestis*), which thrives in cool, wet weather, was more than normally abundant and destructive.

HOME ECONOMICS

Florence L. MacLeod and Evelyn Utley

VITAMIN A VALUES

Experiments dealing with the effects of cooking and storage on the vitamin A values of Porto Rico sweetpotatoes, Chantenay carrots, Amber Globe turnips, and rutabagas have been completed.

The vitamin A value of Porto Rico sweetpotatoes increases upon storage over a period of 8 months. The raw potato at harvest had a value of about 40 U.S.P. XI units per gram; after 4 months of storage, 55; and after 8 months, about 95. At harvest the cooked potato had a vitamin A value of approximately 90 U.S.P. XI units per gram; after 4 months of storage, 140; and after 8 months, at least 185. Cooking, therefore, at all periods of storage studied, increased the vitamin A value.

The Chantenay variety of carrots decreased in vitamin A value upon storage. At harvest the raw carrot had a value of somewhat less than 80 U.S.P. XI units per gram. After 5 months of storage the value was at least 28. Cooking at harvest increased very slightly the vitamin A value of the carrot, while after storage there was a decrease of approximately 34 percent due to cooking.

Amber Globe turnips were shown to have a low vitamin A value. Storage for 5 months, or cooking either at harvest or after 5 months, produced little change in this value.

Rutabagas at harvest, whether raw or cooked, had a vitamin A value of at least 0.5 of a U.S.P. XI unit per gram. Cooking at this time had only a very slight effect on the vitamin A value of the rutabagas. After 5 months of storage the raw rutabaga had a value of approximately 0.4 of a unit per gram, indicating a decrease of about 25 percent. Cooking increased the value of the stored rutabaga about 15 percent.

Nancy Hall sweetpotatoes also were studied during the year. Contrary to previous findings, the vitamin A value remained unchanged after storage. Cooking increased the A value. Since these potatoes were exposed to an unseasonably low temperature before they were dug, it is possible that some change took place in them due to the cold. The Nancy Hall variety will be further investigated next year. Potatoes exposed to a low temperature and others held under normal temperature conditions are being assayed for their A value.

In the course of this work, U.S.P. reference cod-liver oil has been used as a standard. It has been found that the growth responses of rats to the same number of U.S.P. XI units of cod-liver oil fed at different seasons are not always the same. Such results indicate that it is impossible to establish one factor for the conversion of U.S.P. or International units into Sherman growth units as has frequently been attempted.

HORTICULTURE

Brooks D. Drain

GARDEN BEAN IMPROVEMENT

A study of inheritance in garden beans was started July 1. This includes resistance to insect injury, diseases, and nematodes, as well as southern adaptation and commercial quality. Certain strains of *Phaseolus* (figure 13) imported from India were used as parents to secure seedlings resistant to Mexican bean beetle injury. Mr. A. B. Strand is the leader of this project.



Fig. 13—Common garden beans in the middle foreground, showing severe Mexican bean-beetle damage. Asiatic beans on each side have almost no injury.

By crossing these two kinds of beans, it is hoped to secure varieties for this State that will escape bean-beetle injury.

RED RASPBERRY IMPROVEMENT

A number of the Station's best red raspberry seedlings were successfully propagated by root cuttings. These plants were grown in a nursery row during the summer and sent out for grower-tests in November. The reports from the selected growers will aid us in choosing the best varieties to introduce. The usual population of hybrid seedlings were set out and fruited. Figure 14 shows how well these new varieties grow under Tennessee conditions compared with those formerly available.

FIRE BLIGHT-RESISTANT PEARS

Late freezes and frosts again destroyed the larger part of the pear crop in the Station orchard, but orchard heaters enabled us to save many of our crosses, and a few of the hybrid seedlings fruited. None of these fruits were superior to Kieffer, but some approached it in quality. About 2000 hybrid seeds were saved and now are growing in plant beds.

More than 100 seedlings that had failed to develop fire blight in previous years developed the disease this year and were destroyed. Pear leaf spot was unusually destructive, as is shown in figure 15.

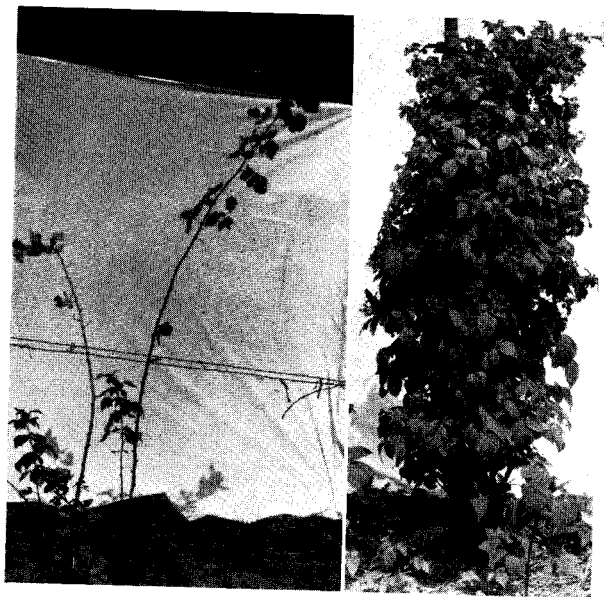


Fig. 14—Left: A typical plant of a more northern variety of red raspberry (Taylor). Right: A seedling from the Station's breeding work.

Note the loss of foliage in late summer on the northern variety, as compared with the apparent health, vigor, and productive capacity of the seedling. New varieties such as the latter retain their foliage until late autumn and seem to be adapted to Tennessee soil and climate.

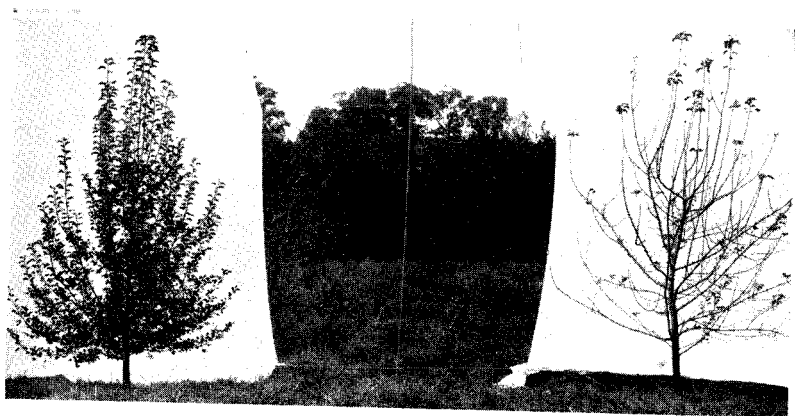


Fig. 15—Left: One of the new pear varieties developed in the Station's breeding work. Right: A tree representative of surrounding varieties. The tree of the new variety is two years old, and is free from leaf spot and fire blight. Trees of surrounding varieties lost their leaves in late August.

LEAF SPOT-RESISTANT TOMATOES

About 232 imported tomatoes fruited in the Station's planting and 32 failed to fruit under field conditions. Several selections were made for breeding work, as shown in figure 16.

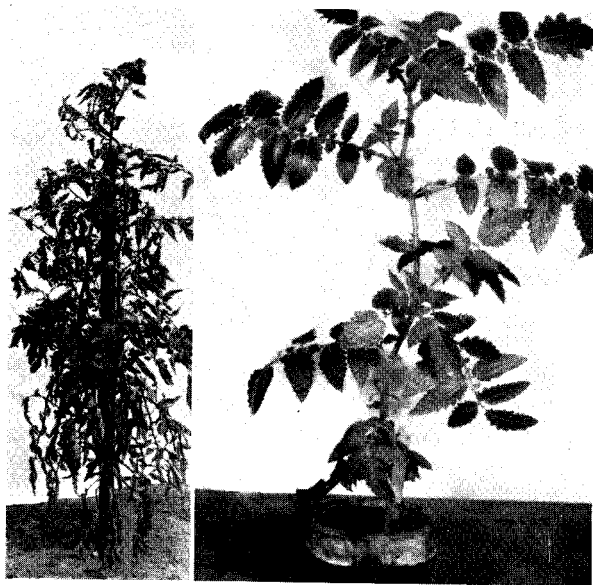


Fig. 16—Left: Marglobe, the leading variety of tomato in Tennessee. Right: An imported tomato from Peru.

Note that the lower leaves of Marglobe are dying, while the imported variety shows health and vigor. This variety, however, is poorly adapted to Tennessee climate. Tennessee growers need varieties that are free from defoliation and will thrive in our climate.

IMPROVED STRAINS OF PYRETHRUM

A survey of growers who made trial plantings of the Station's chemically selected strains in 1937 showed that in many cases their plantings had grown successfully. Some indicated a desire to expand their planting to profitable size.

IMPORTED ORNAMENTALS

The Station's collection of flowering plants imported from foreign countries continued to attract attention. A considerable number appear well adapted to Tennessee soil and climate. Samples of the following were propagated and distributed at the Farm Women's Short Course: *Dianthus winteri* (two varieties), *Caryopteris tangutica*, *Nepeta grandiflora*, *Hypericum patulum henryi*, *Indigofera kirilowii*, *Salix matsudana*, and an unidentified white-flowering species of jasmine. A survey of results

secured by persons receiving samples in past years indicated a high percentage of success.

BOYSENBERRY

Plantings of Boysenberry at this Station and Youngberry in West Tennessee continued to thrive and give large yields. This type of dewberry promises to find a prominent place as a home fruit and for local markets, but the fruit is too soft for distant shipping.

IRISH POTATOES

An application of 20 tons of sawdust per acre decreased irish potato yields for two seasons, even when accompanied by an application of 720 pounds per acre of a 5-10-5 fertilizer. Chippewa continued to give about the same yield as Cobbler. Michigan certified seed did exceptionally well in the source-of-seed trial.

Further work with the Jersey Redskin fall-crop irish potato was carried on to determine the most suitable period for planting. Indications are that the period from July 1 to July 10 is favorable for the Knoxville area. Plantings later than July 20 are subject to early frost damage.

A study was made of fertilizer placements. Results of the past season do not show differences in yields whether the fertilizer was placed beneath the seed piece or on both sides of the seed. The important thing is to have the fertilizer mixed well with the soil and not have the seed piece in direct contact with fertilizer.

SWEETPOTATOES

A bunch, or bush, strain of Porto Rico sweetpotato continued to give somewhat larger yields than the vining type and is more convenient to grow. This Department has tried out Yellow Jersey, both bunch and vining strains, for many years. Satisfactory yields usually can be secured on fertile soil. The comparison of manure and electric heat for growing sweetpotato slips was continued. It should be carried on for several years before an attempt is made to draw conclusions. Two electrically heated sweetpotato storage houses were operated, one at Knoxville and one at Clarksville. The electrical method of heating gives very uniform temperatures when the equipment includes a good thermostat.

SWEET CORN

A number of varieties of white and yellow sweet corn were tested. The white hybrid varieties, such as Hybrid Country Gentleman, Top-Cross Country Gentleman, and Stowell Hybrid, were more productive than Country Gentleman and Stowell Evergreen.

Results of a questionnaire show that 86 percent of the patrons of the University cafeteria preferred white hybrid sweet corn to the white field corn. Bloomsdale Golden and Golden Cross Bantam, two yellow varieties, yielded as many ears as the white sweet corn, but the total weight was less.

TREE FRUITS

Cold damage late in the spring resulted in a small crop of fruit except where the trees were protected by orchard heaters. The apple and peach orchards were loaned to the Department of Entomology for spray experiments. The plum crop was a complete failure.

ASPARAGUS

Shallow plantings of asparagus, 3 inches and 6 inches deep, gave larger yields than plantings set 12 inches deep, but at the end of 7 years all plots were yielding approximately the same. These plots have a clay soil.

TURNIPS AND RUTABAGAS

Ten varieties of turnips and one variety of rutabaga, or Swede turnip, were planted in August. Records and tests indicate that Purple Top White Globe, Shogoin, and Amber Globe turnips are more desirable than White Egg and Purple Top Strap Leaf turnips and American Purple Top rutabaga. Preliminary results show that Amber Globe turnip, which is a yellow-fleshed variety, is preferred to the American Purple Top rutabaga, which has an orange-flesh-colored root.

WEED ERADICATION IN LAWNS

Weed control, with an oil or fatty trade compound, was tried the past season. The area treated was a Bermuda lawn that was heavily infested with crabgrass. Ten days after the application, practically all of the crabgrass was killed and Bermuda grass and lespedeza had taken its place. Some of the material was sprayed on bluegrass without any ill effects. Further study should be made as to its desirability for bluegrass lawns. The material is specific for dandelions, crabgrass, and plantain.

WAX COVERING FOR VEGETABLES

Tomatoes and squash were dipped in a wax emulsion and allowed to dry, and then were stored for varying periods of time. Tomatoes so treated appeared to keep better than tomatoes that were not treated. Care must be taken not to allow drops of the material to collect on the fruit, as they will cause brown spots. Squash that was treated kept better than squash that was not treated. Rotting occurred around the stem where the wax did not penetrate.

AFRICAN SQUASH

A new and very promising squash was grown this summer. This squash averages about the size of the small sugar-pie pumpkin. It is a bright golden-yellow color when ripe. The flesh is very thick and sweet, and would seem to be well suited for pies. It is a little soft for cooking. The fruits appear to be very resistant to pickle-worm damage and may be stored for a long period of time.

COOPERATION WITH TVA

Sweetpotato Storage

Two sweetpotato storage houses were operated with electric heat. Records of electric current consumed, temperature, and humidity were

taken. Circular No. 63 gives a more detailed discussion of the work on this project.

HORTICULTURE AT MERICOURT EXPERIMENT STATION

Brooks D. Drain

Tomatoes

Newport 4, and Certified Marglobe tomatoes continued to lead in yield and quality of the crop produced for canning. A summary of the date-of-planting data for the past two seasons with Certified Marglobe is given in table 22.

TABLE 22—Yield of *U. S. Nos. 1 and 2 combined, per acre*

Date of setting in the field	1937	1938
	Tons	Tons
April 30	18.77	18.77
May 14-15	16.24	16.87
June 1	12.48	8.20
June 16	2.19	3.46

These records indicate that early planting of tomatoes is very important under Tennessee conditions.

Sweetpotatoes

This Station has been trying out various strains of Yellow Jersey sweetpotatoes for a number of years. The vineless, or bunch, strain is more convenient to grow and has given as good yields as the usual



Fig. 17—The Station's bunch, or bush, strain of Porto Rico sweetpotato.

The internodes of the vines are very short. Note that such growth habits are very convenient in digging and cultivating.

vining strain, or somewhat better. In general, Yellow Jersey strains have been failures on poor soils, but often equal Nancy Hall both in quantity and quality on fertile sites. Maryland Golden, a golden-colored sport strain of Yellow Jersey, has been discarded because it has not kept well in storage.

Figure 17 shows a plot of the Station's bunch strain of Porto Rico sweetpotato. This strain is being tried out by certain growers and appears to be superior to the usual vining strain.

Fire Blight-Resistant Pears

A block of *Pyrus calleryana* seedling-stock trees were planted in *Lespedeza sericea* sod land in the winter of 1935-36. This sod was plowed in 1936, and since then has been cultivated each spring. A good stand of sericea remains. Growth of the sericea has been controlled by cutting.



Fig. 18—Two-year-old pear trees grown under sericea culture.

This picture was taken in midsummer, just before a cutting was made to check moisture loss. Cultivations are made during the dormant period. All sericea hay is left as a mulch.

Growth of the pear trees has been very satisfactory, as illustrated in figure 18. Hybrid varieties from the pear breeding work at Knoxville have been top-budded into these trees. It is hoped that a high-quality and disease-resistant variety will be found among these hybrid selections.

Irish Potatoes

A trial of various dates for planting late irish potatoes indicates that the first week in July probably is best for the Jersey Redskin variety at this Station.

Apple Orchard

The soil-management plans for the apple orchard were changed to a comparison of Korean and sericea lespedeza. Most of the cultivation will be given during the dormant period. Sericea and weed growth will be controlled by cutting. By autumn there was a good stand on all plots.

Boysenberry and Red Raspberries

A planting of red raspberry selections from the Knoxville breeding work was set out in the spring of 1938. A small plot of Boysenberry also was started. Only a medium stand was secured. Boysenberry has been fruited at Knoxville and appears very promising for home use and local markets.

Rhubarb

Crown rot, a soil disease, is very destructive in rhubarb plantings in this State. The Station's planting has been managed under mulch for many years. Crown rot has been present, but spreads slowly under these conditions.

Pyrethrum

This Station distributed plants of high-test, chemically selected strains of pyrethrum in the spring of 1937. Since that time some parent stock has been maintained at Mericourt.

Asparagus

Shallow plantings of asparagus, 3 to 4 inches deep, have made a much better growth than deeper plantings on clay and loam soils. Mounding the soil over the rows for producing white asparagus smothers winter weeds and gives a good-length shoot. It has been the practice of the Station to mound some soil over the rows to lengthen the shoots when cutting green asparagus.

HORTICULTURE AT WEST TENNESSEE STATION

Louis A. Fister and Brooks D. Drain

Strawberry Improvement

A large number of the more promising strawberry selections at the West Tennessee Experiment Station have been given careful trials for shipping, freezing, yields, quality of fruit, and health and vigor of the plants. Six of the highest-rating seedlings have been selected for further trial by the best strawberry growers in various parts of the State. Varieties favorably reported by these growers will be named and released for general planting.

The 3 outstanding varieties in the strawberry varietal trials are Culver, Catskill, and Blakemore. The first 2 have large, rough, and highly flavored fruits. The yields of these 3 varieties were: Catskill, 290 crates per acre; Culver, 270; Blakemore, 215.

Peaches

Oriole is a remarkably high-flavored peach among the many new varieties fruiting at this Station. The fruits of this variety ripen early, have yellow flesh, and are freestones. The yield from Oriole has been disappointingly low. Golden Jubilee matures its fruit about one month before Elberta. This peach has very good flavor, is of large size, but bruises easily in shipping and handling. South Haven and Eclipse are two of the best midseason varieties in this planting. Both are yellow freestones with high quality and flavor, but the latter does not size up well. They ripen about 2 weeks before Elberta. Georgia Belle, an old standard white-fleshed variety, leads in yield and is well liked for local markets.

Red Raspberries

Latham and Chief again showed that they are the best varieties tested here for earliness, yield, size of fruit, and flavor. Chief ripened a few days ahead of Latham, but is not quite as large as the latter. Latham produced at the rate of 3150 pints per acre without any spraying the previous year, and Chief 3100 pints. A small planting of the more promising seedlings from the breeding work at Knoxville was made.

Irish Potatoes

The early part of the season of 1938 was unusually favorable for Irish potatoes. White Warba, Chippewa, and Cobbler all produced slightly over 200 bushels of U. S. No. 1 per acre, and Triumph 160 bushels. The seed of Red Warba was shriveled and in poor condition, but yielded 131 bushels of No. 1 per acre. This new strain of Warba is attracting attention for the early crop. All of the above varieties were planted March 14 and dug June 6.

A good stand of Jersey Redskin was obtained with a July 16 planting, green-sprouted, cold-stored seed being used. The month of October was very dry, and yields were disappointingly low.

Cucumbers

Imperator led in yield in the varietal trials with cucumbers. The soil was of a gray type.

Irrigation For Vegetables

The autumn of 1938 was dry and favorable for irrigation. Black Valentine snap beans were planted August 9, and harvesting began October 3. The equivalent of about 9.2 inches of water was applied by irrigation. The irrigated beans yielded 293 bushels per acre, non-irrigated 162 bushels. In a similar trial with Asgrow Stringless Green-pod the yields were: irrigated, 188 bushels; non-irrigated, 136. Snap beans at that time were selling at an average price of \$1.00 per bushel.

Sweetpotatoes

The Station's strain of Bunch Porto Rico sweetpotato yielded 250 bushels of U. S. No. 1 per acre. These roots were of nice, marketable size. Mameyita is an attractive variety of the Porto Rico type, but in several years' trials has given disappointingly low yields. Nancy Hall has outyielded Porto Rico and all the newer varieties for a number of years.

MARKETS

Harry Carlton

A comprehensive survey of the entire frozen-foods industry, started in 1937, was completed in 1938. All the important food processing and distributing centers in the country were visited, and growers, processors, experiment station workers, cold-storage warehouse operators, and food brokers, distributors, and retailers were interviewed. The information collected covers buying methods and prices paid to growers, packing and freezing methods, standards, sales methods and policies, storage and transportation, distribution, retailers' and consumers' reactions, prices and profit margins, general growth and progress of the industry, normal packing seasons, suitable varieties for freezing, and freezer-locker storage for farm and garden products.

The data and opinions obtained have been coordinated and studied and are being assembled into a detailed report, which will cover the general progress of the frozen-food industry since its beginning and a detailed study of the operations, methods, and equipment of the industry for the past two years. The report is to be condensed into a Station publication that will make the information available to all persons interested in the subject. During the preparation of this report the subject matter is being kept up to date by correspondence, attendance at trade conventions, and short investigation trips into nearby marketing and processing areas.

Special attention is being given to the "quick-frozen" fruit and vegetable situation. Although at the present prevailing prices it is rated a luxury food in many localities, this type of pack has increased in volume at the rate of approximately 60 percent a year throughout a period of poor business conditions and low buying power. The growth of this business since the 1935-36 survey, covered by Bulletin No. 161, indicates that the estimated future division of fruit and vegetables sales— $\frac{1}{3}$ fresh, $\frac{1}{3}$ frozen, and $\frac{1}{3}$ canned—may prove correct. Frozen fruits and vegetables grown in New York, Maine, New Jersey, Oregon, Texas, and other states are now being sold in Tennessee the year round in competition with Tennessee fresh produce. With the exception of strawberries and a few Youngberries, practically no Tennessee products are being quick-frozen commercially.

Based on our marketing studies, the following estimates were made of the production volume of quick-frozen foods in 1937:

Fruits	25,000,000	pounds
Vegetables	70,000,000	"
Seafoods	35,000,000	"
Poultry	10,000,000	"
Meats	5,500,000	"
Total	145,500,000	"

Approximately 5000 of the 600,000 retail food stores in the country were equipped to sell quick-frozen food in 1937.

The appearance of quick-frozen poultry in this tabulation and its growing popularity suggest a threat to the Tennessee poultry business unless plans are made to meet the competition by marketing part of our poultry in this form.

The survey paid special attention to methods of contracting, grading, and paying for agricultural products for processing. Processor trade associations and growers' cooperatives were visited and interviewed regarding their organization, contract forms, and marketing methods. A separate report is being prepared on this subject.

Freezer-locker installations were visited and studied in the Northwest, which claims to have originated the freezer-locker idea, and in other sections of the country. Operated by farmer cooperatives and by private owners, they enable farm and town families to quick-freeze and store, for their own use, home-grown fruits and vegetables, as well as meats, fish, and poultry. By this means fresh food becomes available the year round at slightly above the home-production costs. When properly constructed and operated, they have proved successful and their use has spread rapidly throughout the country. Several have been built in Tennessee and more are contemplated.

Tennessee Agricultural Experiment Station Bulletin No. 168, "Home-Preparation of Fruits and Vegetables for the Freezer-Locker," has been compiled and will be published early in 1939. This bulletin, based on our survey of the frozen-food industry, gives general and detailed instructions for the proper selection and preparation of fruits and vegetables for freezing and storing in the freezer-locker.

A paper, "Some Commercial Aspects of the Frozen Food Industry," was presented at the Food Preservation Conference held in Knoxville, October 21, 1938, and was published in *Refrigerating Engineering*, November, 1938. This paper summarized the status of the sale and distribution of frozen food, based on our 1937-38 survey.

Advantage was taken, during the survey, of opportunities to secure information on other subjects, such as flax production for seed and for fiber; the production and use of starch made from sweetpotatoes; and dry ice, especially in connection with its use in the food industry.

The survey included a check on consumer reaction to the experimental pack of quick-frozen Tennessee Blakemore strawberries, Youngberries,

and peaches made by the Tennessee Engineering Experiment Station in cooperation with the Tennessee Valley Authority. Distributors and users of the product generally considered it of excellent quality, and the indications are that the public would give a similar pack ready acceptance.

PHYSICS

K. L. Hertel

MEASUREMENT OF FIBER PROPERTIES

Fibrograph.—This instrument has been tested under actual laboratory conditions and has been compared with other instruments. Two operators working with one instrument make at least 100 analyses per day. Each analysis consists of sampling the raw cotton, preparing the sample, tracing the length-distribution curve, measuring the curve, and recording the mean length and the upper-half mean length. The upper-half mean length has been found to be very nearly equal to the staple length. The standard deviation of the measurements has remained constantly below 1/32 inch.

One fibrograph has been used continuously on a cooperative project with the Bureau of Plant Industry of the United States Department of Agriculture. Most of the samples analyzed were from the regional variety test. Another has been used intermittently on Experiment Station projects; 200 samples from Jackson, Tiptonville, and Knoxville having been analyzed with the fibrograph and by an expert classer. The upper-half mean length of the fibrograph was found to be approximately the same as the classer's staple length. The instrument was used also to analyze 4,000 samples from open-pollinated and inbred plants. A fibrograph to analyze a sample consisting of about 150,000 fibers has been completed and is ready for routine tests.

Fineness.—The investigation on the macroscopic method for measuring fiber fineness, based upon hydrodynamic principles, has been continued. Plans are under way for building a laboratory instrument based on the results of this investigation. The method also gives the density of the fiber, which may be a significant property, and appears to be applicable to the determination of the size of other particles than fibers.

PLANT PATHOLOGY

C. D. Sherbakoff

WHEAT

Practical control of head blight (scab) and root rot of wheat, under our conditions, evidently can be attained only by the use of resistant varieties. Hence, the breeding of such varieties has been continued this year, with special emphasis on the selection of promising segregates from our old and new hybrids. In June, just before harvest, about 2000 heads were selected from the hybrids. Only 806 were finally saved. These were planted in 4-foot head rows late in October.

Uniform yield tests of the most promising selections—T2, T64, and T612—and of some of the best standard varieties—Fultz, Trumbull, Forward, and Fulcaster—grown in different parts of the State have been continued. The results are similar to those of former years—the selections giving better yields than the best standard varieties. However, owing to the general occurrence of stem rust, which caused considerable damage the past season, the difference in yield between the selections and the standard varieties was comparatively small—the selections for all plots in all of the 6 locations giving an average of 23.76 bushels per acre, and the standard varieties, 23.01 bushels per acre. While the yield differences in favor of the new selections during previous years were considerably higher than during the past season, it was found that some of the selections are rather low in milling quality, especially when grown on comparatively poor soil. Of the selections, T2 seems to be doing especially well, on good soil, from Knoxville westward, and T612 in the northeast corner of the State. The two selections are being increased by a few acres in the two respective sections.

Yield tests of the standard wheats and of the Station's selections during the past 14 years show definitely that no material progress in wheat improvement can be made by simple selection. Such improvement seems to depend entirely on selections from sufficiently segregated populations of hybrids made by the crossing of wheats which carry desirable characters supplementary to each other. Such crosses have been made during the past 9 years. From these crosses some very promising segregates are now being obtained. Other hybrids have been made recently, and will be made during the next few seasons, by crossing the available lines with the new varieties which appear to be immune from or highly resistant to different stem and leaf rusts, covered smut, and scab. These new wheats were obtained through the cooperation of workers in the U. S. Department of Agriculture and in several state experiment stations. The wheats are excellent breeding material, but are not suitable for local culture.

FUSARIUM WILT OF ECONOMIC CROPS

Cotton Wilt

During 1938, field tests of Fusarium wilt of cotton, in cooperation with the U. S. Department of Agriculture, Division of Cotton and Other Fiber Crops and Diseases, were made at Martin and Tiptonville. The results obtained are about the same as those of 1937: on land where wilt practically destroys cotton of very susceptible varieties, such as Half and Half, a normal crop is obtained with the more resistant varieties, such as Dixie Triumph 12. The yield of all varieties tested seems to be definitely improved by the use of a fertilizer containing enough potash.

Considerable attention has been given to the breeding of wilt-resistant varieties of cotton adapted to local culture. This phase of the work was initiated in 1937.

The studies of the existence of specialized forms of the fungus causing cotton wilt, *Fusarium vasinfectum*, involved a large amount of cultural work in the laboratory. In addition, certain greenhouse-infection experiments with 7 pure lines of the fungus were conducted, which indicate that the pure lines apparently differ in their ability to penetrate and cause injury to the host. This work also is carried on in cooperation with the Division of Cotton and Other Fiber Crops and Diseases.

Tomato Wilt

The more promising segregates of wilt-resistant tomatoes were tested for other characters, especially for their resistance to the leaf-spot diseases. None of the tomatoes were found to be sufficiently resistant, and efforts are therefore being made to increase the resistance by crossing the selections that appear to be more resistant to leaf-spot diseases.

Tobacco Wilt

A small-scale test was made of the burley strain of wilt-resistant tobacco furnished by Dr. W. D. Valleau, of the Kentucky Agricultural Experiment Station. The indications are that the strain possesses considerable resistance to *Fusarium* wilt and should form excellent material for further studies.

STRAWBERRY BLACK ROOT

The work with strawberries has been confined to the growing of different hybrids and segregates obtained during recent years. There were 80 small lots of crosses of 1936, and 59 lots of crosses and 17 selfed seedlings of 1937. All these are grown at the Knoxville Station. At Portland, a number of older hybrids and segregates, which proved to be more promising, are being compared with several of the best standard varieties. All the material is being developed primarily from the point of view of its resistance to black root.

RED-CLOVER BREEDING

The primary aim of the red-clover project is to produce strains resistant to several diseases prevalent in the South. The method employed is that of "brother-and-sister" breeding. At present the progenies of some of the lines appear to be very promising, especially as regards their resistance to anthracnose and powdery mildew. For next year's test, 259 hand-crossed lines have been obtained.

ROOT-KNOT NEMATODES

The matter of host specialization unquestionably is of great importance in the problem of control of root-knot nemas. The project at present is concerned with the question whether the specialization is due to a gradually acquired ability of the nemas to locate and feed on the

host, as some investigators believe, or wholly or largely to the segregation and survival of favored genetic races, as suggested by others.

An opportunity was sought for starting work that might contribute to a solution of the question. Last year an experimental tomato plot, about 100 x 120 feet, at the Knoxville Station, had to be abandoned because of extremely heavy infestation with root-knot nemas. It was decided, therefore, to use this lot for cotton breeding, since previous observations indicated that common nematodes on tomatoes probably would not be injurious to cotton. A number of cotton varieties and crosses were grown on the plot in 1938. None of the cotton plants showed any above-ground symptoms of root-knot injury. Late in the fall, all cotton plants were pulled up and the roots examined for the galls. None were found. Tomatoes had been grown on this plot every year except one since 1924.

This is clear evidence that the nema population which severely injured tomato plants was not able to affect any of the varieties of cotton grown, even though the nemas were being starved. No cotton had been grown previously either on or near the plot, so far as could be learned. The cotton nematode is present in Tennessee, however, in places where the soil is favorable and where cotton has been grown for a long time. It was found in a severe form in the plot which last year was selected for the Station's regional cotton-wilt variety studies, at Tiptonville. The soil is sandy, and cotton had been grown there continuously for many years.

The two locations are extremely interesting from the point of view of host specialization of the nemas and will be used in this study. Other cases where the root-knot injury is conspicuous, and where one crop has been grown continuously for a number of years, should likewise be utilized.

The investigations under the New Fungicides, Tomato Leaf-Spot Diseases, and Apple Black Root Rot projects were supervised by J. O. Andes, Associate Plant Pathologist.

NEW FUNGICIDES

During this year there was an opportunity to test several new fungicides. These were the so-called "insoluble" copper compounds. To determine their effectiveness, tests were made with apples, cherries, grapes, raspberries, and tomatoes. The principal constituent of the materials used was basic copper sulfate. With these materials foliage injury was obtained only in the case of cherries, despite the fact that the season was extremely favorable for bordeaux injury.

It appears that cherry leaf spot and raspberry leaf spot were controlled by these "insoluble" compounds, as well as by bordeaux of the same copper content.

The apple experiment included blocks of the Black Ben and Golden Delicious. These varieties are very susceptible to bitter rot, and the

weather was unusually favorable for the development of the disease. Practically no control of bitter rot was obtained with any of the fungicides tested except bordeaux mixture 4-6-50, which gave an average of 88 percent disease-free fruit. The addition of 1 pound of zinc sulfate to 50 gallons of bordeaux mixture lowered the control slightly. On the other hand, the damage to the foliage of the Golden Delicious from spraying with bordeaux mixture was extreme, resulting in defoliation by the middle of August.

Eight forms of "insoluble" copper compounds and bordeaux mixture were applied to tomatoes with no appreciable benefit.

TOMATO LEAF-SPOT DISEASES

Field tests for leaf-spot resistance were made with 424 lines of tomatoes. Three plants were used of each line except the few more promising, of which 50 plants each were tested. Usually *Macrosporium* leaf spot is the common and important disease here. Weather conditions this year, however, were extremely favorable for *Septoria* leaf spot. There was considerable variation among the selections in their susceptibility to the leaf spot. Only one showed sufficient resistance to be of value. One plant of this selection was particularly productive, and retained its foliage until frost, while the remaining plants were defoliated by midsummer. Greenhouse tests were made for resistance to *Macrosporium* leaf spot because of the severe attack by *Septoria* before the *Macrosporium* had an opportunity to infect the plants.

APPLE BLACK ROOT ROT

About 1200 black root rot-free nursery trees of standard varieties of apples were produced during the year. Preparation was made for setting a test orchard in which disease-free trees will be interplanted with a considerable number of lots of the trees obtained from various sources, for comparative studies of development of the disease on different lots of the trees.

MIDDLE TENNESSEE EXPERIMENT STATION at Columbia

L. R. Neel, Superintendent

WEATHER CONDITIONS

In the spring and summer of 1938, weather conditions at Columbia were more favorable than usual for the growth of crops, while in the fall they were less favorable. The rainfall of 46.45 inches for the year was slightly below normal. During the spring and early summer, rains came mainly as showers, so that there was no very serious runoff, and no drouth until fall.

VISITORS

The number of farm people who made use of the Middle Tennessee Experiment Station in 1938 was larger than ever before. The visiting started in January with the annual meeting of the Tennessee Jack,

Jennet and Mule Breeders' Association. In April there was a meeting of students of vocational agriculture for the elimination contests in livestock judging and public speaking. The Farmers' Institute in May drew a record crowd. In June and early July, 6 girls' and boys' 4-H-club camps were held during 6 successive weeks. The latter part of July there was a well-attended livestock field day. In October and November, on three successive Saturdays, Future Farmers from over central Tennessee met for their annual field day. In addition to these, there were a number of smaller meetings of agricultural extension groups, farmer picnics, and other gatherings. Throughout the year the Station is constantly visited by individuals and by carloads of farm people.

PASTURE MANAGEMENT

The pasture sods which were damaged badly by the drouth of 1936 made a fine recovery, and by the fall of 1938 were back to normal. Grass made excellent growth, so that there was a great deal of surplus to be made into hay, harvested for seed, or mowed and left lying on the ground.

Pastures enriched with manure from the barns and from cattle feeding on them, and by the growth of legumes in favorable seasons, produce such an excess of forage in the early part of the season that a normal number of farm animals cannot keep the growth down. Hence, the making of hay or grass silage on a portion of the fields must be resorted to in order to avoid waste and at times the smothering of tender grass. Again, in the latter part of the grazing season, if there are abundant midsummer or late-summer rains, fertile pastures produce an excessive growth. At this time, generally it is wild grasses (crab-grass and other grasses, and weeds). Where stock cannot hold down the growth, it may need to be mowed. It will make a very good hay if cut early and saved bright. Early cutting will also prevent the smothering of the bluegrass that starts growing at that time or a little later. Clipping of pastures and the proper utilization of surpluses, therefore, is an important part of pasture management.

It was to study the possibility of all-year pasture maintenance that the McFall pasture, a 45-acre field of bluegrass and hop clover, was set aside for an experiment. Surplus grass and clover is made into hay or silage in spring and fall, if there is a surplus at both seasons.

All year the cattle have access to pasture unless the ground happens to be covered with snow. Through the winter season, when they need it, they are fed hay or grass silage and hay, produced on the pasture. Lately they have been allowed to run to the stacks of hay, but this practice is proving so wasteful of feed that it may be abandoned. About the first of February the gate in the partition fence that divides the pasture into two parts is closed and the cattle are maintained on one side until grass is good enough where it is rested to maintain them without any feed; then they are changed over, and the side that they are

taken off is allowed to grow up to make hay. After hay is made in June and a new growth has started, the cattle are again given access to the entire pasture.

At the beginning, the experiment was started the first of November with 10 steer calves and 10 yearling steers. Now the numbers have been increased to 12 of each, or a total of 24 head. The yearlings of November are sold off as fat cattle in late July or August and the calves are carried until time of the summer market of the second year, when they are past two years of age. The average gain of the yearling steers for the past two years, from November 1 to market time, in midsummer, has been 267 pounds; and the average yearly gain for the calves has been 371 pounds. Handled in this way, the steers have gotten into market condition and been sold at a profit when all costs were accounted for. No shelter is provided for the cattle.

ALFALFA-BLUEGRASS BEEF-PRODUCTION EXPERIMENT

In 1935, an experiment was started to determine how good a grade of market cattle could be produced on bluegrass pasture supplemented by alfalfa pasture at times in late summer, and alfalfa hay whenever needed, summer or winter. Eight acres of medium bluegrass, hop-clover, and white-clover pasture and 4 acres of alfalfa were set aside at first for 3 calves and 3 yearling steers. The number has been increased to a total of 7 head. The bluegrass pasture is divided so that in the spring one part can be rested while the cattle are being fed alfalfa hay on the other part.

These cattle get no grain and are never sheltered. The average gain on the yearlings from November 1 to midsummer for the past 2 years has been 278 pounds, and the average gain on the calves has been 483 pounds. These cattle get fatter than any other grass-finished cattle ever seen in this part of the country. The alfalfa hay keeps them gaining very nicely all through the winter, and the alfalfa pasture as needed in late summer or early fall prevents any let-down in the growth of the calves at any time during the year. Cost accounts have been kept on this experiment, and thus far this method of producing cattle has paid.

NITRATE TEST ON PASTURE

The Middle Tennessee Experiment Station has conducted a nitrate test on pasture for 8 years. For 4 of the years the nitrate plots gave the higher yields, and, due to the beneficial action of legumes, for 4 years the no-nitrate, or check, plots gave the higher yields. The average yield of the nitrate plots is higher, however, being 202 steer-pasture days per acre, against 182 days for the check plots.

PASTURE-SHADE EXPERIMENT

Of all the pasture work under way at the Middle Tennessee Station, the pasture-shade experiment probably is of greatest interest. The trees were started in 1926, but were not large enough to stake for protection

so that the lots could be pastured until 1932. Each lot contains three-fourths of an acre. One lot is planted to black walnuts and one to black locusts, a third lot with no trees serving as a check. While the trees were still small, in 1932 and 1933, the carrying capacity of all lots was established, and with this as a base, progress is determined. Comparing the carrying capacity of the 3 lots in 1937 and 1938 with that of the base period, the walnut lot has gained over the check 39 percent and the locust lot 43 percent.

STAGE OF MATURITY AND PASTURE VALUE OF LESPEDEZA

For several years the Experiment Station has started pasturing Korean lespedeza in July, weighing the cattle each 2 weeks. Pasturing has been continued until the cattle began to lose weight in the fall. Best gains have uniformly been made in July, August, and early September. The cattle seek for other pasturage as the lespedeza starts maturing, and always begin losing weight when the lespedeza dies. Dead lespedeza, although full of seed, is not a good pasture.

THE DAIRY CATTLE

Winter pastures versus silage.—In the fall of 1937, an experiment was started to determine in winter the comparative value of rye pasture, rye and bluegrass, and corn-sorghum silage. All comparisons are made on a strictly cost basis. Group 1 is maintained on a normal ration of silage, as much alfalfa hay as the cows will eat, and the usual grain ration. These cows have the run of the lot on all fair days. Group 2 has what alfalfa hay the cows will eat, the usual grain ration, and rye and crimson clover pasture whenever the ground is firm enough for them to be on it. On other days these cows run with group 1. Group 3 has what alfalfa hay the cows will eat, the usual grain ration, the same rye and clover pasture that group 2 has when the ground is firm, and on other days a bluegrass pasture that was saved for them. Net profits above feed cost the first year are relatively close together, and of course cannot be regarded as conclusive of anything but that it is a worth-while experiment. Group 1 showed a profit of \$30.79; group 2, \$34.95; and group 3, \$34.27.

Irrigation experiment.—In the spring an experiment was started in cooperation with the Tennessee Valley Authority to determine the value of irrigation of pastures for cows producing milk for wholesale factory market. One group of cows is run on a check lot that is not irrigated and another group is run on a lot that is irrigated as needed. All costs, of course, are charged to each group of cows. As rains were generally very well distributed in 1938, there was less irrigation than usual.

LEGUME AND GRASS SILAGE

In May, alfalfa, untreated and treated with molasses; crimson-clover, untreated and treated with molasses; and hop clover and bluegrass, untreated and treated with molasses, were put into one of the

silos. One batch of crimson clover was put up without cutting; the rest of the silage was run through the cutter. Loss in weight of each kind of silage will be determined, as will keeping quality, palatability, and general suitability for use. No feeding experiment will be run the first year, as all of the silage is in one silo.

SOURCES OF ALFALFA SEED

An experiment has been in progress for 2 years to compare Oklahoma alfalfa seed with other seed. Only a progress report can be made at this time. Average yields per acre for the 2 years are: from Kansas seed, 6.32 tons; Oklahoma seed, 5.95 tons; Grimm seed, 5.45 tons; Dakota seed, 5.27 tons; Utah seed, 5.26 tons; and Arizona seed, 4.87 tons. In the past, stands secured with Arizona seed have not lasted as well as those secured with seed from other sources.

LESPEDeza

Varieties and date-of-cutting experiment.—Average yields of the four annual varieties of lespedeza for 4 years are as follows: Kobe, 1.5 tons; Korean, 1.4 tons; Tennessee 76, 1.4 tons; common, 1.3 tons. Average yields of lespedeza the latter part of July were approximately 93 percent of those made the early part of September. The percentage of weeds and grass was larger in the September cutting, and the percentage of lespedeza leaves was smaller, so that the net feeding value of the July cutting of hay was doubtless higher.

SMALL GRAINS

Wheat.—Eight-year average yields of 9 varieties of wheat are as follows: Nittany (bearded), 32.5 bushels per acre; Forward (smooth), 32.3 bushels; Gladden (bearded), 31.4; Leap Prolific (smooth), 29; Mammoth Red (bearded) 29; Fulhio (smooth), 29; Poole (smooth), 27.5; Trumbull (smooth), 27.5; Early May (smooth), 26.3. No one of these varieties made the highest yield every year. Nittany, the highest-yielding, went as low as fifth place once, third once, second twice, and first four times.

Spring oats.—As a result of a 5-year test, the Columbia oat, a Missouri variety, went to the head of the list, but exceeded Kanota so little that the two varieties, thus far, might be said to be in the same class. Five-year average yields were: Columbia, 49.7 bushels; Kanota, 48.4; Fulghum, 48.4; Burt, 46.4; Fould Hulless, 36.1; Illinois Hulless, 36.1.

Tennessee selections of winter oats.—In the fall of 1937, several Tennessee selections of winter oats were tried out. Results were very promising. One of the selections, seeded September 17, slightly exceeded in yield one of the best standard varieties of winter oats, and several of the selections greatly exceeded Fulgrain and Winter Turf when seeded October 17 after corn.

Rye.—Balbo continues to be the best rye, both for production of grain and for pasture, although in grain production it surpasses only slightly some kinds of rye secured from farmers. These latter ryes,

doubtless, are mixed to a considerable extent, and may not be very stable.

In a 5-year rate-of-seeding test, yields from 1, 2, and 3 bushels of seed per acre, respectively, were 16.4, 16.6, and 16.2 bushels. Five-year averages for dates of seeding were as follows: September 1, 11.4 bushels; September 15, 11.8 bushels; October 1, 15.3 bushels; October 15, 19 bushels; November 1, 19.6 bushels; November 15, 17.5 bushels; December 1, 13 bushels.

CORN

In 1938, some of the best hybrid corns from the Corn Belt were compared with the Tennessee corns, including Neal Paymaster, Jellicorse, and Jarvis Golden Prolific. The Corn-Belt hybrids made good yields, but were exceeded by both Jellicorse and Neal Paymaster, with Jarvis dropping slightly behind the best hybrids. Some of the hybrids produced at the University of Kentucky and the University of Tennessee have slightly surpassed field-selected Neal Paymaster, but differences have not been great.

WEST TENNESSEE EXPERIMENT STATION

at Jackson

Ben P. Hazlewood, Superintendent

WEATHER CONDITIONS

Weather conditions at the West Tennessee Experiment Station were favorable for the production and harvesting of summer crops. The late-summer and early-fall months were much too dry for general success with seedings of grasses, clovers, and small grains. The total rainfall for the year was 53.21 inches.

VISITATION

The two annual meetings at the Experiment Station were well attended. Approximately 2000 farmers were present at the spring meeting for the study of cattle-feeding and winter-crops experiments. About 6000 were in attendance at the 3-day Farmers' Institute, which was held, as usual, in July. The mornings of the Institute were devoted to the study of experiments in progress at the Station.

PROPERTY MAINTENANCE

Only the most urgent repairs have been made to the property since the completion of the WPA projects in 1934. The most pressing needs at the present time are, a hot asphalt coating for 300 squares of built-up roof; aluminum paint for 200 squares of tin roof; approximately 250 gallons of outside white paint for the walls and trim of all the buildings. Two hundred rods of woven-wire fence, which has been in service since 1909, should be replaced. These are the largest items calling for attention at present.

COTTON

Experiments with cotton represent the most extensive field-crop work at the Station. They include tests of varieties and new strains, breeding, soil preparation, seed treatment, tillage, fertilizers, and the effects of cropping practices on yields. Cooperative cotton-spinning tests were conducted.

Varieties.—Results of varietal and new-strains tests are reported in the Crop Improvement section of this Annual Report.

Winter cover crops.—Winter cover crops in continuous cotton have proved successful for the past 3 years when planted immediately following the first picking of cotton. Even though the winter crops have to be turned from the first to the fifteenth of April, crimson clover, vetch, Austrian winter peas, and bur clover have given an average increase of 500 pounds of seed cotton per acre. Winter cover crops planted under such conditions furnish only fair cover for the soil and no winter grazing. Considerable grazing would be available from the middle of March until the crop was turned under.

CORN AFTER SERICEA

Parts of an area seeded to sericea in 1930 have been turned each year, beginning in 1933, and planted to corn. After turning, each area is planted continuously to corn. The average yields of corn after turning sericea are as follows:

First year	69	bushels
Second year	63	"
Third year	57	"
Fourth year	51	"
Fifth year	45	"
Sixth year	37	"

Corn yields averaged approximately 30 bushels per acre before the area was planted to sericea.

Jellicorse seed corn.—On rich land Jellicorse has yielded an average of 3 bushels per acre more than Neal Paymaster, over a period of 18 years. This corn is already grown extensively in the Tennessee River bottoms. Arrangements have been made to give it wide distribution throughout West Tennessee during the year of 1939.

CLOVER AND GRASS

A planting of approximately 100 clovers and grasses is maintained for the study of their adaptability to conditions in this section of the State. New kinds that may become available from year to year will replace those discarded.

Reed canary grass.—A seeding made in August, 1936, produced 1.8 tons of air-dried hay per acre in August, 1937. The stand was practically lost by the spring of 1938. The area was reseeded in October.

Dallis grass.—Three years of spring and fall seeding have failed to give a satisfactory stand. Commercial seed have been used. Seed produced by plants on the Station farm will be tried in 1939.

Ryegrass.—Good stands on fertile land gave unusually high yields. The best plots yielded as much as 20 tons green weight, or 4.75 tons of dry hay, per acre.

Perennial ryegrass.—Several strains have been used, but none have given very satisfactory results.

White clover.—Louisiana white clover and northern-grown white clover, seeded in August, 1936, have maintained perfect stands. The hay yields of the former were 3.08 and 1.44 tons per acre for the years of 1937 and 1938, respectively. The yields from northern-grown seed were 2.65 and 1.31 tons. Ladino white clover has given practically the same yields as white clover from northern-grown seed, but has been damaged more by the heat of July and August than the other two clovers mentioned.

LIVESTOCK

The all-year pasture for dairy cattle and beef cattle was continued. It consists of a permanent pasture for summer grazing and winter cover crops for winter grazing. Winter cover crops are seeded in August or early September in order that early and abundant winter pasture may be available. The permanent pasture consists of Bermuda grass, lespedeza, white clover, hop clover, and small amounts of bluegrass, orchard grass, and redtop. When sufficient grazing is supplied from winter cover crops, far more growth is available during the months of April and May than the livestock will consume. During the spring of 1938 the surplus crimson clover was placed in a silo for feeding during a possible summer drouth or the following winter. The winter pastures that were grazed continuously, with one animal unit to the acre, yielded approximately 5 tons of crimson-clover silage to the acre.

Crimson-clover silage.—Feeding trials comparing crimson-clover silage and corn-and-sorghum silage were begun with beef cattle and dairy cattle. The crimson-clover silage was consumed fully as well as the corn-and-sorghum silage, and the indications are that it will have about the same value as the latter for the production of beef and milk. This experiment will be continued for several years to determine conclusively the value of this surplus pasture crop as a silage.

All-year pasture for sheep.—A flock of pure-bred sheep has been maintained without grain feeding for 6 years. Several fourth-generation animals now in the flock appear normal in every way. It is the plan to maintain this flock on a no-grain feeding basis for some years longer.

Winter pasture for swine.—Hogs fed barley grazed less crimson clover than hogs fed shelled corn. Self-feeding was practiced in both cases. Cost of gain was slightly in favor of corn feeding for hogs.

All-year pasture for dairy cattle.—Dairy cattle fed all-year pasture, alfalfa hay, and silage are producing 85 percent of the production of cows having the same pasture and roughage with the addition of full-grain feeding. Several cows in the no-grain group have milked 5 con-

tinuous lactations without grain feeding. No ill effects from the no-grain ration have been noticed. Two of the cows have been fed a no-grain ration since they were 6-months-old calves.

TOBACCO EXPERIMENT STATION at Greeneville¹

Frank S. Chance, Superintendent

The rainfall at the Tobacco Experiment Station during this year amounted to less than 40 inches, but the rains were so distributed that the growing season was favorable.

TOBACCO

Fertilizer tests are being conducted on 3 types of soil. These tests have run for 7 years on the Decatur silt loam, 4 years on Shackleton, and 2 years on Nolichucky. The Shackleton is not in a high state of cultivation, and rarely produces good-quality tobacco, except where at least 10 tons of manure is used, with as much as 600 pounds of a 3-8-5 fertilizer, per acre. Good results were obtained also where 4000 pounds of a 5-8-6 mixture was used per acre. Profitable crops may be grown with less fertilizer, but up to these amounts there is improvement in both quality and quantity, and the returns in dollars pay big dividends on the cost of fertilizer.

A compilation of results of 12 replications over a period of 6 years on Decatur soils show that where 10 tons of manure is used an application of 600 pounds of a 3-8-5 fertilizer gives best results. When the potash content was raised from 5 percent to 10 percent, the returns in pounds per acre decreased. This was true also on the plots where 15 tons of manure was applied. It appears that where a surplus of potash is used in connection with manure, plant growth is retarded, but the quality of leaf remains about the same or is slightly improved. Sulphate of potash was used in these tests.

Fertilizer tests for tobacco on Nolichucky soil have been conducted for only 2 years. The quality of leaf grown on this type of soil has been consistently better than the quality of that grown on Decatur or Shackleton soil.

The tobacco rotation tests have run for 5 years, and some striking differences were evident this year. The plots in the 2-year tests that have grown crimson clover, and also those having hairy vetch on them, produced about one-third more pounds per acre than the average of the other plots in the group, and the quality also was better. Differences are becoming evident in the 3-year-rotation tests, but are not as striking as were those in the shorter-rotation plots.

¹The work at Greeneville is conducted in cooperation with the United States Department of Agriculture.

The varietal trials are being continued, in order to determine the quality of many of the strains of burley tobacco on soils not affected with black root rot, and also to find out which of these strains will produce a satisfactory crop in the presence of the disease. In addition to tests of the commonly known strains, many crosses are being made. Some of them are very promising.

Tests were started this year on both Decatur and Shackleton soils to determine the amount of potash that tobacco will take from the soil when an abundance of it is supplied. These applications were made in duplicate on both types of soil. Sulphate of potash was used at the following rates of K_2O per acre: Plot 1, 30 pounds; plot 2, 60 pounds; plot 3, 120 pounds; plot 4, 180 pounds; and plot 5, 240 pounds. A uniform application of 18 pounds of nitrogen and 48 pounds of P_2O_5 was used on all of these plots. No manure was used. This test has run for only one year, and the results of burning tests have not been secured, but no appreciable differences in weight and quality were evident from applications of more than 60 pounds of K_2O per acre.

PASTURE PROGRAM

The winter grazing trials were continued, and during the winter only 22 days were lost because of unfavorable weather. Eight yearling steers bought locally and 8 steer calves raised on the farm grazed 14 acres of crimson clover. The pasture was good, and when heavy growth started in March, some digestive troubles were experienced. One of the young steers died from bloat. The clover furnished more growth than the steers could eat, and when it began blooming heavily they were moved to another pasture, and a seed crop was harvested.

The steers used in this grazing experiment were divided into 2 age-groups when they went on test. One half of each group was fed alfalfa hay and the other half sericea hay. The gains of all groups were satisfactory, but those of the alfalfa groups were highest.

A field that was sown in the late summer of 1936 to bluegrass and white clover was grazed for a period of 159 days this year by yearling steers and heifers of the beef type. It furnished a little more than one cow unit of grazing per acre and returned 300 pounds of beef per acre. The field contains 12 acres, and has a good sod of white clover and bluegrass. The rainfall was not abundant, but it was so distributed that the field furnished good grazing over a long period.

BUILDING

One laborer's house was changed from a 4-room boxed-and-stripped cabin, with no inside wall finish, into a comfortable 4-room house with bath, front porch, screened back porch, and good basement. The outside was veneered with brick and the inside was ceiled and covered with sheet rock, and then papered. This makes a total of 6 good houses for the men who have full-time work on the farm.

MERICOURT EXPERIMENT STATION**at Clarksville****AGRONOMY****H. P. Ogden**

Field-crop experiments at Mericourt, consisting chiefly of varietal trials, fertilizer tests, and comparisons of rotations, have been continued without much change through 5 years. Continuing these tests for a period of years will tend to neutralize the effects of unusual seasons.

Corn

Neal Paymaster and Jellicorse, both white varieties, have led in yields at Mericourt on land of good texture but **only** fair fertility. Thompson Prolific has done well as an early white variety. Of the yellow varieties, Jarvis Golden Prolific has led until 1938, when Yellow Paymaster was introduced into the test and appreciably surpassed it. Yields of Yellow Paymaster were only slightly below those of the white Neal Paymaster.

Three rates of planting were used with all varieties—4200, 5400, and 6600 stalks per acre. The season of 1938 was favorable for corn and most varieties gave the best yields at the thickest rate. But in dry years and on poorer parts of the farm, the thinner rates have been better.

Sweetpotatoes

Fertilizer tests were made on two varieties of sweetpotatoes—Yellow Jersey and Nancy Hall. While Nancy Hall outyielded Yellow Jersey in each of the fertilizer treatments, the response to fertilizer was greater with the Yellow Jersey. For example, when 600 pounds of 4-10-8 fertilizer was used the yield of Nancy Hall was 301 bushels per acre of U. S. No. 1, while the yield of Yellow Jersey was only 228 bushels; and on the unfertilized plots, Nancy Hall yielded 193 bushels per acre and Yellow Jersey 76 bushels.

Lespedeza

Varietal trials of annual and perennial lespedezas were continued. Dates of seeding scarified and unscarified sericea were continued, also fertilizer and liming tests.

Rotations

Five different crop rotations were begun in 1933. They differ from each other chiefly in the kind of legumes used. There are different lime and fertilizer treatments in these rotations, involving over 200 plots.

LIBRARY

Sarah C. Currell

The Experiment Station library has a collection of 11,068 volumes, 195 volumes having been added during the year 1938. This increase represents the total number of books accessioned; namely, the volumes received by purchase, gift, and exchange, plus the volumes sent to the bindery, and minus withdrawals. The library of the College of Agriculture has a collection of 6,651, making a total of 17,719 for both libraries.

These two libraries are housed in the same room. They are administered as separate collections as to shelving and ownership, but as a unit in respect to catalog and other records and to service. In effect, the Station books form the reference collection and the College books the circulating collection of the unit. Together they constitute a branch of the University library.

The Station library in 1938 subscribed for 45 scientific and technical journals. In addition to these, 119 journals were received through gift and exchange. Through these journals the members of the staff are enabled to keep abreast of current scientific thought.

The interest in agricultural research is demonstrated by the frequent use that is made of the publications received from the 47 other state experiment stations; the experiment stations located in Alaska, Guam, Hawaii, and the Virgin Islands; the state extension services; foreign experiment stations; the United States Department of Agriculture; and the various state departments of agriculture.

During the year, 116 volumes have been prepared for the bindery, bound, and catalogued. The cost of the binding was \$198.77.

Accurate record is kept of material loaned. The two libraries circulated 4,756 books, 281 periodicals, and 2,766 pamphlets. It has not been considered feasible to record books used within the library.

The inter-library loan service is still used by the Station staff. This courtesy on the part of other libraries enables the librarian to secure with little expense the major amount of material needed.

The NYA appropriation has been continued. Two students were assigned to the Station and College libraries for 50 hours per month. In addition to this, the Station employs a student for 15 hours per week to assist in routine work.

The library is opened one night a week from six to ten o'clock. This has been made possible through the employment by the University of another student assistant.

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 are given the privilege of using books from the Station collection within the reading room. 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.

The librarian attended the meeting of the Southeastern Library Association, at Atlanta, in October. She is a member of the American Library Association, the Southeastern Association, and the Tennessee Library Association.

RECENT CHANGES IN STAFF

NEW MEMBERS

H. A. Arnold*, Assistant Agricultural Engineer	July 16, 1938
H. F. Butler, Assistant Horticulturist	Sept. 1, 1938
Beth Cheney, Assistant in Physics	July 1, 1936
W. A. Chriesman*, Plot Assistant	Feb. 1, 1936
Elizabeth H. Cotter, Assistant in Physics	Dec. 10, 1937
Harry Cupp, Assistant in Physics	Sept. 1, 1938
Martha J. Kemmer, Assistant Home Economist	Jan. 1, 1938
O. H. Long*, Assistant in Agronomy	Mar. 15, 1936
R. L. Long*, Plot Assistant	Mar. 15, 1936
Elise Morrell*, Assistant Nutrition Chemist	Mar. 15, 1938
Emily Louise McCamy, Assistant in Physics	July 1, 1937
M. A. Sharp, Agricultural Engineer	Sept. 1, 1937
N. O. Sjolander, Assistant Bacteriologist and Animal Husbandman	Sept. 1, 1938
A. B. Strand, Associate Horticulturist	July 1, 1938
R. R. Sullivan, Assistant Physicist	July 1, 1938
R. Brooks Taylor, Industrial Engineer	Sept. 1, 1938
R. A. Sutherland, Assistant Chemist	Oct. 10, 1938
S. H. Winterburg*, Associate in Soil Chemistry	Dec. 15, 1936
R. K. Zuck, Assistant Plant Pathologist	July 1, 1938

*Cooperative with Tennessee Valley Authority.

RESIGNATIONS

Arthur Meyer, Assistant Horticulturist	Aug. 31, 1938
H. B. Kerr, Assistant Bacteriologist and Animal Husbandman	Aug. 31, 1938
G. M. Stone, Assistant Plant Pathologist	Sept. 21, 1938

PUBLICATIONS, 1938

BULLETINS

No.	Title	Authors	Date of publication	No. of pages
163	Limited-Grain Feeding and All-Year Pasture for Dairy Cows	C. E. Wylie and L. R. Neel	January	10
164	Plant-Disease Control by Spraying	J. O. Andes	February	47
165	Clovers and Grasses for Hay and Pasture	C. A. Mooers	March	72
166	Mineral and Nitrogen Content of Lespedezas and Other Hay Crops in Tennessee	E. K. Weathers	October	32
167	A Comparison of Cottonseed Meal, Cottonseed Meal and Tankage, Peanut Oil Meal, and Soybean Oil Meal, Fed with Corn Silage for Fattening Two-Year-Old Steers	M. Jacob and H. R. Duncan	October	7

CIRCULARS

60	Fertilizers for Tennessee Soils	C. A. Mooers	April	2
61	A New Method of Delinting Cottonseed with Sulfuric Acid	N. L. Hancock	June	8
62	Fire-Blight Canker Treatments	Brooks D. Drain	September	4
63	Electricity for Curing and Storing Sweet Potatoes	John A. Schaller and Brooks D. Drain	October	4

REPORT

ARTICLES IN SCIENTIFIC JOURNALS, 1938

Title	Authors	Place and date of publication	No. of pages
Direct Determination of Available P_2O_5 Content of Fertilizers	W. H. MacIntire, W. M. Shaw, and L. J. Hardin	Jour. Assoc. of Official Agr. Chem. Feb.	9
Direct Determination of Available P_2O_5 Content of Fertilizers	W. H. MacIntire, W. M. Shaw, and L. J. Hardin	Ind. and Eng. Chem. March	10
Behavior of a New Source of Available Magnesium for Phosphatic Fertilizers	W. H. MacIntire, L. J. Hardin and F. D. Oldham	Ind. and Eng. Chem. June	9
The Leaching Action of Rain Water Upon Dolomite and Limestone Separates Incorporated with Quartz in Outdoor Lysimeters	W. H. MacIntire, W. M. Shaw, and Brooks Robinson	Soil Science, July	11
Behavior of Calcium, Magnesium, and Potassium Sulfates, as Influenced by Limestone and by Dolomite—A Lysimeter Study	W. H. MacIntire, W. M. Shaw, J. B. Young, and Brooks Robinson	Soil Science, September	19
The Breeding of Small Fruits for the South	Brooks D. Drain	Assoc. Sou. Agri. Workers, Proc. 39th.	2
The Use of Electrical Heat in Curing and Storing Sweet Potatoes	Arthur Meyer	Assoc. Sou. Agri. Workers, Proc. 39th.	1
Red Raspberry Breeding for Southern Adaptation	Brooks D. Drain	Proc. Amer. Soc. For Hort. Sci. Vol. 36	3
Tomato Importations for Breeding	H. F. Butler	Proc. Amer. Soc. For Hort. Sci. Vol. 36	3
The Entomologist and Human Health	S. Marcovitch	Scientific Monthly	3
New Facts Concerning Cryolite Spray Residues	S. Marcovitch	Jour. Econ. Ent. Vol. 31	3
A Comparison of Sodium Fluoride in the Drinking Water with Similar Levels of Cryolite in the Diet on the Fluorine Content of the Body	S. Marcovitch and W. W. Stanley	Jour. of Nutrition	9
An Evaluation of the Neubauer and the Cunninghamella and Aspergillus Niger Methods for the Determination of the Fertilizer Needs of a Soil	C. A. Mooers	Soil Science, March	17