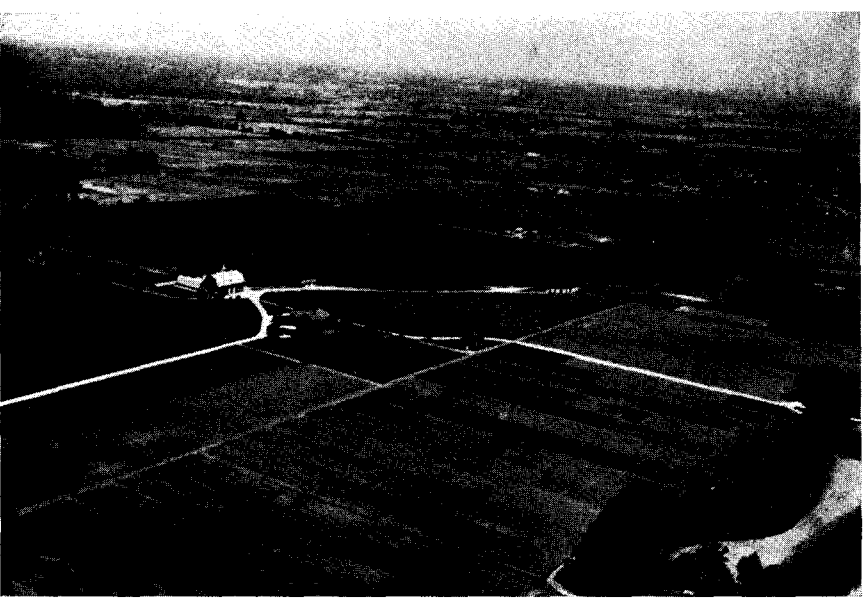
THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

FIFTY-SIXTH ANNUAL REPORT
1943



The West Tennessee Station.

KNOXVILLE, TENNESSEE

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
KNOXVILLE

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LESTER WEAKLEY, Assistant, Mericourt Experiment Station, Clarksville.
L. R. NEEL, Superintendent, Middle Tennessee Experiment Station, Columbia.
J. J. BIRD, Assoc. Agron., Plateau Experiment Station, Crossville.
E. L. BOHANAN, Assistant Agronomist, Plateau Experiment Station, Crossville.
J. L. VANDIVER, Asst. Agron.[1] Tobacco Experiment Sta., Greeneville.
B. P. HAZLEWOOD, Supt. West Tennessee Experiment Station, Jackson.

[1]Cooperative with U. S. Department of Agriculture.
[2]On leave.

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

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LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 1, 1944

To His Excellency, Prentice Cooper, 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 1943. 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

FINANCIAL STATEMENT

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

In account with

The United States Appropriations under the Hatch, Adams, Purnell, and Bankhead-Jones Acts, and Non-Federal Funds, 1942-43.

	Federal Funds				Non-Federal Funds
	Hatch	Adams	Purnell	Bankhead-Jones	
Receipts					
From United States Treasurer	$15,000.00	$15,000.00	$60,000.00	$77,136.04	
From other sources					$126,353.87
Expenditures					
Personal services	10,975.56	13,082.93	54,642.89	62,073.21	66,843.71
Travel	73.03	0.00	505.29	732.67	1,025.35
Transportation of things	95.57	15.84	84.11	307.10	955.23
Communication service	519.80	5.43	19.36	98.72	762.12
Rents and utility services	21.14	6.84	172.80	433.82	1,363.91
Printing and binding	1,540.09	0.00	390.40	53.65	919.70
Other contractual services	232.33	76.81	346.95	918.55	4,453.35
Supplies and materials	740.11	1,658.36	3,110.93	8,946.60	5,673.42
Equipment	789.77	153.79	727.27	2,959.28	40,907.43
Lands and structures	12.60	0.00	0.00	612.44	3,449.65
Total	$15,000.00	$15,000.00	$60,000.00	$77,136.04	$126,353.87

FIFTY-SIXTH ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE, FOR 1943

TWO NEW SUBSTATIONS

The state of Tennessee is divided into five major physiographic areas, each of which differs from the others in both topography and character of soils. To meet this situation from the research point of view, at least five experimental substations are required. The year 1943 is noteworthy because of legislative appropriations looking to the establishment of two new substations, one on the Highland Rim and one on the Cumberland Plateau.

THE HIGHLAND RIM STATION

For the Highland Rim Station, 191 acres of land was purchased, about three miles southeast of Springfield, on the Nashville-Springfield Highway. This acreage is conveniently situated and was selected as the best-suited to the purpose of the several places available at the time. The action of the Legislature which made the purchase possible came after the Experiment Station, over a period of years, had sought to enlarge the work being done in the vicinity of Clarksville, Montgomery County. This work has been carried on at the Mericourt Station, established through the generous gift, from Hunter M. Meriwether, of 48 acres of land and valuable buildings.

Robertson County was designated by the legislative act as the location of the new substation, probably because of the interest taken by prominent citizens of that county in the establishment of a suitable experiment station for the benefit of the entire Highland Rim area. In this connection, it is a pleasure to report a cash gift of $5000.00 by two former citizens of Robertson County, Messrs. J. H. and J. W. Dean. This gift is to be used, without reservation, in whatever way is believed to be to the best interest of the Highland Rim Station.

THE PLATEAU STATION

For a number of years the main Station at Knoxville carried out field experiments in cooperation with farmers at scattered points on the Cumberland Plateau. The chief objective of these experiments was to get information regarding the adaptability of this section to different kinds of farm and garden crops, and the lime and fertilizer needs of the various soil types. Afterward the work was concentrated on a few acres of rented land near Crossville. At a still later date, more extensive cooperative experiments

were conducted for several years at the Cumberland Homesteads. Three bulletins published by the Station are based on the results of this work: "The Rational Improvement of Cumberland Plateau Soils," "The Comparative Values of Different Phosphates," and "Potato Growing on the Cumberland Plateau."

No doubt all this preliminary work influenced the desire of Cumberland County to see a worth-while substation established on a permanent basis with a view to the future development of the Plateau. Prominent citizens presented the matter to Governor Prentice Cooper and the members of the Legislature, with the result that $30,000.00 was appropriated, to be spent over a two-year period, beginning in 1943, for buildings and general operating purposes, but not for land. The possibility of the establishment of an experiment station if the land could be granted the University was presented to the January meeting of the Cumberland County Court. In April the Court voted $10,000.00 for the purchase of nearly 600 acres of the Borer tract, eight miles northwest of Crossville, on US 70. The property fronts over a mile on the highway, has a Tennessee Central siding and spur track in the middle, and contains approximately 260 acres of cleared land.

Most of the important soils of the Plateau are found on this farm. A small part of the area was cleared by slaves nearly 100 years ago, but most of the clearing was done during the last 20 years. Vaughan's Seed Store conducted gladiola bulb-growing experiments here during the period 1936-1938. Some potatoes were grown in 1938, but the farm was practically neglected until it was taken over by the University. Buildings were of little value, and the seven miles of fence must be completely replaced. Part-year streams are well located to furnish ponds for all pastures and possible irrigation. The wooded portion contains a fair supply and quality of lumber.

The beginnings of the two new stations have been outlined. There remains to be provided the very important item of annual support.

TVA COOPERATION

In this as well as previous annual reports, reference is made to help received from the TVA for a variety of purposes. Without this help the Station could not have undertaken the large-scale soil survey in the State which has been under way for several years as a three-way cooperative project by the Tennessee Valley Authority, the Division of Soil Survey of the Bureau of Plant Industry of the U. S. Department of Agriculture, and the Tennessee Agricultural Experiment Station. This project is expensive, but is considered fundamental to the application of experimental results obtained with crop varieties, fertilizers, and liming, besides providing dependable answers to numerous inquiries received from all parts of the State.

Fig. 1—Cooperative field experiments with fertilizers, sponsored by the TVA. A Hines Valley trial in East Tennessee.

In addition to the soil survey, the TVA has cooperated most helpfully in the solution of a number of engineering problems, such as seed scarification, home dehydration of vegetables, the barn-curing of hay, irrigation, and erosion control.

Along with the development of superior new phosphates for fertilizer use, the TVA has made possible a material increase in cooperative experiments with fertilizers on various types of soil in different divisions of the State. It has fostered a very worth-while research on the comparative value of various forms of phosphate when fed to livestock raised on crops grown on soils highly deficient in phosphoric acid, such as characterize large areas in Tennessee.

The TVA has consistently displayed a keen practical interest in the agricultural development of the State, and its help is greatly appreciated by the Station.

Its contributions all have a distinct bearing on the TVA objectives, with special reference to water control, and to readjustment in areas where bottom lands have been removed from cultivation by reservoir construction.

REPORTS OF DEPARTMENTS

The reports that follow show not only the scope of the Station's work but the year's progress, in some instances giving practical details. Bulletins and circulars and articles in science journals may be consulted for more complete accounts. A list of available publications of the Station can be obtained upon request.

AGRONOMY

GENERAL

J. B. Washko and O. H. Long

WEATHER CONDITIONS AT KNOXVILLE

Temperatures during the 1943 crop year at Knoxville were abnormal. In May, June, July, and August they were higher than the average recorded in other years; whereas, in September and October they were lower. The lowest temperature recorded was 9° F. on March 4. This late, hard freeze caused considerable injury to non-winter-hardy small grains, in particular to unadapted winter oats. The last killing frost in the spring occurred on April 15 and the first killing frost in the fall on October 18. This was the shortest growing season in 26 years. Rainfall was less than normal. East Tennessee, however, had better moisture conditions during the growing season than Middle or West Tennessee. The driest month was August, in which only 1.48 inches of rain fell, and the wettest was July, with 9.29 inches. This heavy July rainfall kept pastures productive, but made hay curing difficult.

CROPS

In addition to the variety trials and cultural experiments conducted with the various field and forage crops commonly grown in Tennessee, work was continued with such war-emergency crops as soybeans, castor beans, and hemp.

Castor Beans.—Since castor oil is needed by wartime industries, commercial production of castor beans is being explored in this country so that the crop can be produced domestically in the event that Latin American supplies are cut off.

Previous yield trials have indicated that the varieties Doughty 11, Kentucky 38, and Conner are among the highest-yielding in Tennessee. In 1943 a date-of-planting test was conducted at Knoxville with these varieties as part of a regional castor-bean study cooperative among the several state experiment stations and the Division of Drug and Related Plants of the U. S. Department of Agriculture. Plantings were made at approximately two-week intervals from May 1 to June 15. The yield data for this test are given in table 1. Highest yields for all varieties were obtained from the May plantings, and lowest yields from the last June plantings. These data

Table 1—*Yields per acre of castor beans at Knoxville, planted at different dates,* 1943.

Variety	May 1	May 17	June 1	June 15
	Bushels[1]	Bushels	Bushels	Bushels
Conner	26.4	18.1	14.1	10.8
Doughty 11	24.3	25.2	19.0	9.9
Kentucky 38	20.3	18.7	15.9	8.4

[1]One bushel shelled castor beans = 46 pounds.

therefore suggest that for highest yields castor beans should be planted during May, with the fore part of the month being preferred to the latter part.

Soybeans.—This crop has become one of the most important during the war period because its oil is used for war purposes industrially as well as for human food in the form of edible fats. Since soybean oil is so important, it is being given special consideration in the Station's soybean investigations. During the past year, in addition to the regular variety tests conducted at the Knoxville, Columbia, and Jackson Stations, 25 soybean varieties, composed of the leading ones in the Southern States, were tested as part of a regional soybean study cooperative among the Southern States experiment stations and the Division of Forage Crops and Diseases of the U. S. Department of Agriculture. Yields were obtained and chemical determinations were made for oil content, oil quality, and protein at each location. The Ogden variety developed by this Station outyielded all others at Knoxville and Columbia and was among the top 3 at Jackson. The Volstate, another Station development, was among the leaders at each location. These two Tennessee varieties also were high in oil content. This regional test has indicated further that they are adapted to conditions in adjoining states.

Hemp.—This is a war crop needed for making rope and other strong cordage formerly made from fibers imported from the Philippines and the Netherlands East Indies. Farmers in Minnesota, Iowa, Wisconsin, Illinois, Indiana, and Kentucky have been requested to grow hemp for fiber. These states, with the exception of Kentucky, are not hemp-seed-producing states, and therefore have to get their seed from other areas. Tennessee is one of the states requested by Government authorities to produce such seed. Because information on this crop in Tennessee is limited, fertilizer and date-of-planting experiments were started. Observations indicate that hemp can be planted over a wide range of dates in the spring and still mature seed successfully. Yield data have been invalidated because of an attack of southern blight (*Sclerotium rolfsii*) and bird damage.

OTHER CROP EXPERIMENTS

Corn.—Since there is considerable variability within any open-pollinated corn, several growers maintaining seed of the same variety, by selection over a period of years, will tend to isolate strains differing somewhat from the original. The question naturally arises whether such isolated strains will differ in yielding capacity as well as in other characteristics. An experiment was conducted during the year to answer this and related questions. Nine strains of Neal Paymaster and 4 of Jarvis Golden Prolific were used in the test, each representing a different grower selection.

Observations indicated no pronounced differences in plant characteristics among the various strains within each variety, ex-

cept in ear type. In Neal Paymaster, ears of only 2 strains were classed as typical of this variety, as characterized by medium length, 12 to 14 rows per ear, and smooth kernels. The ears of another strain were short and thick, with 16 to 18 rows per ear, and the grain was rough and deep. The other 6 strains were intermediate in type; that is, each was made up of both types described above. In the Jarvis Golden Prolific variety the Tennessee strains differed considerably from the North Carolina strain in both ear and kernel characteristics. Ears of the Tennessee strains were smaller and "slick," ranging from 12 to 14 rows, with hard, flinty grain; whereas, those of the North Carolina strain not only were larger but ranged from 14 to 18 rows, with starchy grains. Yield differences between strains of each variety were insignificant, except between the highest-yielding and lowest-yielding. The Tennessee strains of Jarvis outyielded the North Carolina strain. It is apparent, therefore, that while some differences exist in both yield and ear characteristics between strains of the same variety selected by the various growers, these differences are minor.

Time of Seeding Winter Oats.—For the 10-year period 1933-1942, an average of approximately 93,000 acres per year of winter oats was grown and harvested for grain in Tennessee. Owing to the development and introduction by this Station of the 3 winter-hardy oats, Fulwin, Tennex, and Forkedeer, this acreage increased in 1943 to approximately 160,000. The introduction of these oat varieties made fall seeding of oats after row crops, such as corn, a safe practice. Where oats follow a cultivated crop their date of planting is determined largely by the maturity and time of removal of the preceding crop. This means that frequently oats cannot be seeded on recommended dates.

In order to determine the time of seeding for maximum yields of grain, an early seeding (average date September 22) was compared with a late seeding (average date October 25) over a 5-year period. Highest grain yields were obtained from the earlier seeding.

The average yield of all varieties for the early seeding during this period was 66.3 bushels; for the late seeding, 54.2 bushels—a difference of 12.1 bushels in favor of the early seeding. It has been observed generally that the late seedings of oats not only did not germinate as well as the early seedings, but went into the winter with poor vegetative growth, and therefore were more susceptible to winter injury. Recent work at the West Tennessee Station has indicated that oats can be seeded somewhat later than on recommended dates with good results, but only on lands well manured or under conditions of high soil fertility.

Fall Versus Spring Seeding of Oats.—Indications are that spring seeding of oats no longer can be generally recommended for high yields. During the same 5-year period when the winter oats averaged 66.3 bushels per acre for the early seeding and 54.2 bushels for the late seeding, spring oats averaged only 35.4 bushels,

or almost 20 bushels under even the late-seeded winter oats. In view of these facts, the farmer certainly would not be justified, from a yield standpoint, in delaying his seedings until spring. Moreover, in some years it is almost impossible to get spring oats seeded on time because of excess soil moisture or unfavorable weather conditions. Another disadvantage is that spring oats require a few more days to reach maturity than winter oats. This often means that their yield is cut by rust epidemics, which fall-sown oats would have escaped by virtue of their earlier maturity.

PHOSPHATE COMPARISONS

Cooperative with the Tennessee Valley Authority

Tests were continued with different phosphates on wheat, corn, cotton, and various legumes in Knox and Bedford Counties, in cooperative trials with individual farmers. The principal phosphates used were commercial superphosphate, triple superphosphate, and TVA fused calcium phosphate ground to 3 degrees of fineness, to pass through 6-mesh, 40-mesh, and 80-mesh screens, respectively.

These tests have shown the fused phosphates slightly less effective than standard superphosphate, with the coarser of the 3 materials considerably less effective than the 2 finer materials.

The tests in Bedford County indicate that some soils in that county are as much in need of phosphate as some soils in East Tennessee. Crop responses to phosphate applications have been just as marked on the Talbott and Hagerstown soil series in Bedford County as on the Fullerton and Clarksville series in East Tennessee. The effects of phosphate often are cancelled in that county by summer drouths. Winter crops, however, such as wheat, have responded consistently to phosphate fertilization, since such crops grow and reach maturity during a period when rainfall is not a limiting factor in plant growth.

CROP IMPROVEMENT

N. I. Hancock

COTTON

The season of 1943 was not as good as that of 1942 for the comparison of cotton varieties and selections. At Tiptonville a severe hailstorm injured part of the test; at Knoxville a heavy infestation of the tarnished plant bug resulted in poor yields; and at Jackson an abnormally dry July and August caused the bolls to open prematurely.

With reference to the fiber characters, however, it will be seen in table 2 that very nearly the same conclusions can be drawn as in 1942. Almost the same varieties excel in a given fiber character at each location, but no one group excels in all the characters.

Wilds No. 15, a long-staple cotton, excels all other varieties in all fiber characters. It is a poor yielder, however, and too late in maturing for this State. The Coker 100-Wilt Strain 3 is a high yielder and has a larger boll than any other of the Coker 100 strains observed thus far.

Table 2—*Rank of first four varieties in yield of lint cotton, and in length, fineness, and strength of fibers.*

TIPTONVILLE		JACKSON		KNOXVILLE	
Yield of lint cotton					
	Pounds per acre		Pounds per acre		Pounds per acre
Coker 100, Str. 6	628	Stoneville 2B	687	Coker 100 Wilt, Str. 3	459
Maretts White Gold, Str. 3	597	Coker 100 Wilt, Str. 3	598	F_2 8-66 × 37-13-19	458
F_2 8-66 × 37-13-19	565	Deltapine 14	583	Bobshaw No. 1	396
Coker 100 Wilt, Str. 3	564	Coker 200, Str. 4	581	Deltapine 14	390
Length of Fibers					
	32nds inch		32nds inch		32nds inch
Wilds No. 15	42.1	Wilds No. 15	39.0	Wilds No. 15	46.3
Stoneville 2B	36.2	Stoneville 2B	33.5	Coker 100, Str. 6	37.0
Maretts White Gold	36.1	Coker 100, Str. 6	33.3	Stoneville 2B	36.8
Deltapine 14	36.0	Deltapine 14	32.8	Deltapine 14	36.6
Fineness of Fibers[1]					
	Cm.-^{2}/mg.		Cm.-^{2}/mg.		Cm.-^{2}/mg.
Wilds No. 15	3.15	Wilds No. 15	2.73	Wilds No. 15	3.34
Maretts White Gold, Str. 3	2.99	Maretts White Gold, Str. 3	2.02	Maretts White Gold, Str. 3	2.96
Washington	2.93	Coker 100, Str. 6	2.49	Washington	2.92
Stoneville 2B	2.75	Washington	2.47	Coker 100, Str. 6	2.86
Strength of Fibers[2]					
	Lbs./mg.		Lbs./mg.		Lbs./mg.
Wilds No. 15	6.91	Wilds No. 15	7.61	Wilds No. 15	6.70
F_2 8-66 × 37-43-19	6.57	F_2 8-66 × 37-15-19	6.84	Bobshaw No. 1	6.18
Maretts White Gold, Str. 3	6.29	Washington	6.79	F_2 8-66 × 37-13-19	6.05
Bobshaw No. 1	6.26	Bobshaw No. 1	6.70	Stoneville 2B	5.98

[1]Fineness Cm^2/mg. = surface area of lint in square centimeters per milligram.

[2]Strength Lbs./mg. = force in pounds required to break 1 milligram of lint in which a bundle of fibers is approximately 1.18 cm. long.

It is apparent from table 3 that the locations rank in the same order as in 1942 with respect to the fiber characters. Jackson has the strongest cotton, but the fibers are coarse and short.

Table 3—*Rank of the three locations—Tiptonville, Jackson, and Knoxville—in length, fineness, and strength of lint.*

Location	Length	Fineness	Strength
	32nds inch	Cm.^{2}/mg.	Lbs./mg.
Tiptonville	36.0	2.76	6.21
Jackson	32.5	2.40	6.56
Knoxville	36.5	2.78	5.93

Table 4 indicates that the cotton fibers are longer and finer, but weaker, when grown after legume cover crops than when grown after fertilizer treatments. The water-holding capacity of the soil after cover crops may indicate the cause of these differences.

Numerous inbred lines of cotton are being tested against the standard commercial open-pollinated varieties. It may be noted

Table 4—*The fiber characters of cotton grown on soil after fertilizer treatments and after cover-crop treatments at the Jackson Station.*

Previous treatment	Length	Fineness	Strength
	32nds inch	Cm.²/mg.	Lbs./mg.
Fertilizers	30	2.53	6.57
Cover crops	33	2.61	6.45

in table 5 that cotton, unlike corn, does not lose its vigor and yielding capacity after a period of inbreeding. These particular lines have been inbred for 6 years. It will be necessary, however, to combine good inbreds, as is done in corn, in order to obtain complete superiority over the open-pollinated varieties. By combination and selection it may be possible to obtain cotton varieties that will maintain their ability to yield without the single- and double-crossing procedure used with corn.

Table 5—*A comparison of two 6-year, selfed, inbred Stoneville cotton lines with two standard open-pollinated varieties.*

Variety	Yield lint cotton	Earliness	Bolls per pound	Length	Fineness	Strength
	Pounds	Percent	Number	32nds in.	Cm.²/mg.	Lbs./mg.
Stoneville 2B	613	52.9	65	1.06	2.51	5.03
Deltapine 14	619	54.7	74	1.02	2.10	6.20
8108-4-3-2-1-2	636	65.9	70	0.98	2.31	6.18
8102-3-3-3-1-1	623	61.3	70	0.97	2.41	5.75

OATS

The winter of 1942-43 was rather severe. Oats were frozen out in many sections of the State, especially where no attention was given to the selection of winter-hardy varieties, and where extremely late seedings were made. At all three stations, Victorgrain plantings were almost completely destroyed. The yields of Stanton, a semi-winter-hardy variety, were 15 to 20 bushels under those of the Tennessee winter-hardy varieties. It is in a season like the past one that the winter-hardiness characters become important in the choice of oat varieties. Plantings as late as November and December should be discouraged. On account of the lower temperatures during these months, even the most winter-hardy strains of oats do not make enough growth to hold the soil or to establish a rooting system for their own protection. The selection 140-17-63-75 of the cross 090 × Bond gives some promise of being an early winter-hardy oat having the smut and rust resistance of Bond. It gave the highest yield in the late planting at Columbia.

BARLEY

The winter of 1942-43 also had an effect upon the survival of barley plants. Winter-hardy barleys are as important as winter-hardy oats. It should be remembered that in the northern and western states spring types of barley are used. They will not survive winters in Tennessee. The semi-western hardy barleys, such as Wintex from Texas, Marett Awnless from South Carolina, and Sunrise from North Carolina, will not survive winter conditions such as prevailed the past year. An attempt is being made in the breeding program to incorporate even more winter hardiness in the present Tennessee barleys.

Most barleys lodge badly under adverse conditions. Two varieties have been found, Polders and Wong, which possess considerable strength of straw. F_3 progenies of the cross Polders $\times$ Tennessee strains showed a very low lodging coefficient when compared with the parental Tennessee strains. The Wong progenies are not yet far enough removed from the parental strains for this character to be tested.

The barley variety tests at Knoxville and Columbia were not given the customary top-dressing of nitrate of soda. Under these conditions the yields of the smooth-awn varieties, Jackson and Jackson No. 1, continued to equal those of the standard variety, No. 52. At the Jackson Station, Jackson made an average yield of 57 bushels and Jackson No. 1, 69 bushels, compared with 61 bushels for No. 52.

CORN BREEDING

Frederick D. Richey

Corn breeding was continued in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering of the Agricultural Research Administration, U. S. Department of Agriculture.

The nursery comprised some 1200 rows in which to self, cross, and select. Seed set was good as a whole and a number of promising leads were followed.

Tests of white and of yellow single crosses were made at Crossville and at Knoxville. These brought to light a few lines worthy of further trial and showed that much of the material tested could be discarded. That is the nature of corn breeding.

Yield comparisons were made among hybrids and varieties at the West Tennessee Experiment Station, Jackson; the Plateau Experiment Station, Crossville; the U. S. Cotton Field Station, Knoxville; and the Tobacco Experiment Station, Greeneville; and on the Roy Harr Farm, Bristol. An additional comparison at the Middle Tennessee Experiment Station, Columbia, was abandoned because of erratic yields due to drouth.

Table 6 shows the performance, by groups, of those varieties or hybrids that were included in the comparisons at Jackson, Knoxville, and Greeneville in 1943. The corresponding results for 1941-1943 also are shown for the groups which were tested in those years in comparable parts of the State.

Of the 6 certified Tennessee varieties used as a standard, Neal Paymaster and Jellicorse made the highest yields, both in 1943 and for the 3-year period. The 3 Tennessee hybrids averaged about 19 percent more than the average of all varieties and 3 percent more than the average of Neal Paymaster and Jellicorse in the 3-year period.

Table 6—*Performance of groups of corn hybrids and varieties in Tennessee in* 1943 *and in* 1941-1943.

Data for Cumberland and Sullivan Counties not included.

Varieties or hybrids averaged	Average 1941-43				1943			
	Acre yield		Erect plants	Husk length[1]	Acre yield		Erect plants	Husk length
	Bushels	Percent	Percent	Grade	Bushels	Percent	Percent	Grade
Six certified Tenn. varieties[2]	53.7	100	75.5	2.6	57.8	100	78.8	2.7
Neal Paymaster, Jellicorse	62.3	116	75.7	2.7	65.5	113	78.5	2.8
Tennessee Hybrids 10, 14, and 15	64.1	119	71.4	2.4	68.2	118	76.2	2.4
Four Central Corn Belt hybrids[3]	.....	.....	.....	.....	55.2	96	95.1	1.2
Four Kansas hybrids	.....	.....	.....	.....	62.0	107	88.1	1.8

[1]1942-43 averages: 1, very poor, to 4, excellent.
[2]Neal Paymaster, Jellicorse, Thompson, Yellow Thompson, Yellow Paymaster, Jarvis.
[3]Not the same as in table 7.

The results in 1943 were fairly representative of the 3-year average for the entries which were included in all 3 years and afford a basis of comparison for entries that were not included in all years. Seed of the 4 hybrids representative of those being used in the Central Corn Belt was bought through regular seed channels. Their average yield in 1943 was 4 percent less than that of the average of the 6 Tennessee varieties, 17 percent less than the yield of Neal Paymaster and Jellicorse, and 22 percent less than the average yield of the Tennessee hybrids. In addition to their lower yields, these hybrids had poor husk protection with resultant damage from birds and insects.

The performance of the Kansas hybrids justifies trying them again to see what place, if any, they may have in Tennessee agriculture. They yielded more than the average variety, but less than Neal Paymaster and Jellicorse, and less than the Tennessee hybrids. Their husk protection was not too good, but was notably better than that of the hybrids from the Central Corn Belt. With a single exception, which reduced the average, they also were highly resistant to lodging.

Because of higher altitudes and consequent different climatic conditions, the Cumberland Plateau and Northeast Tennessee can use somewhat earlier-maturing corns than most of the State. The performance of certain varieties in Cumberland and Sullivan Counties in 1943 and 1942-43 is shown in table 7. The superiority of the Tennessee hybrids over the Tennessee varieties was somewhat less

in this area than in the rest of the State. Hybrids from the Central Corn Belt and the Kansas hybrids, on the other hand, yielded more than either the Tennessee varieties or hybrids. Moreover, the husk development on these earlier hybrids provided more adequate protection from damage at these higher altitudes.

Table 7—*Performance of groups of corn hybrids and varieties in Cumberland and Sullivan Counties in* 1943 *and in* 1942-43.

Varieties or hybrids averaged	Average 1942-43				1943			
	Acre yield		Erect plants	Husk length[1]	Acre yield		Erect plants	Husk length[1]
	Bushels	Percent	Percent	Grade	Bushels	Percent	Percent	Grade
Five certified Tenn. varieties[2]	42.2	100	84	2.9	45.3	100	80	2.9
Tennessee Hybrids 10, 14, and 15	46.9	111	85	2.9	48.6	107	75	2.8
Four Central Corn Belt hybrids[3]	.....	.....	....	.....	51.6	114	92	1.2
Four Kansas hybrids	.....	.....	....	.....	51.9	115	89	2.2

[1]1, very poor, to 4, excellent.
[2]Neal Paymaster, Thompson, Yellow Thompson, Yellow Paymaster, Jarvis.
[3]Not the same as in table 6.

GRASS BREEDING

J. K. Underwood

Since the initiation of the grass-breeding program, in 1938, the study of the adaptability of grasses to conditions in Tennessee has been a most interesting phase of the work. Several hundred species and strains have been tested in the nursery, and new ones will be tested as they become available. These grasses call for evaluation with reference not only to their adaptability, but to their possible uses, and their requirements as to rates and dates of seeding and seedbed preparation.

Tennessee occupies a peculiar position in that both northern and southern perennial grasses often fail here altogether, or have to struggle for existence, obviously because they are not acclimated. Bermuda, Johnson, and bluegrass are the only perennial grasses of importance in the State, the reason being that they are the only ones that are adapted. Timothy often runs out after the first year, and an orchard grass seeding must be managed carefully if the stand is to be kept for a reasonable length of time. Tennessee needs a perennial hay grass other than Johnson—one that will grow in the cool season and furnish grazing as well as hay. It is with this need in view that the major portion of the work on grasses has been done.

The grasses listed below are named in the order of yield, the highest-yielding being first in each group:

Cool-season perennial grasses tested for hay: Giant meadow fescue, smooth brome, orchard grass, one strain of timothy, perennial ryegrass, and bulbous barley. The last two were cut once per season; the others twice.

Warm-season perennials when cut twice per season: *Andropogon ischaemum,* strains of Bermuda, side-oat grama, blue grama.

Winter annuals, with one cutting per season: Italian ryegrass, field brome, rescue grass.

Summer annuals, with two cuttings per season: Tift Sudan, commercial Sudan, Rhodes grass (a perennial that must be treated in Tennessee as an annual), and browntop millet.

Experimental seedings for the study of kind of seedbed preparation, time of seeding, and seeding methods have been conducted since 1939. A firm, mellow seedbed is essential to the establishment of all grasses named above for broadcasting, as well as for drilling, as it prevents too deep covering of seed. Depth of seeding, of course, depends upon the size of seed.

Time of seeding cannot be stressed too much; it means the difference between success and failure, other conditions being equal. As a rule, the cool-weather grasses should be sown in August and in the fall to give time for the seedlings to become established before winter sets in and to eliminate the weed factor as far as possible. There are some exceptions to this rule. Smooth bromegrass, giant meadow fescue, and bulbous barley should be sown in the spring, from March 1 to March 20; rescue grass and field brome, in July, or not later than the last of August; timothy, the last of September or early in October. The earlier in the fall the ryegrasses are sown—beginning in early September—the more early grazing will be obtained. This is true of many other fall-sown grasses. Seeding should never be delayed until late October or November.

Fig. 2—Livestock on fall pasture of orchard grass and No. 76 lespedeza.

Orchard grass planted in 12-inch rows and lespedeza sown in the middles. Hop clover coming up thick under the lespedeza. Hay crop not harvested.

The warm-weather perennials, as a rule, should be sown not earlier than March 1 or later than March 20; later sowings often run into April and May drouth.

Warm-weather annuals should not be sown before the last of April, preferably early in May.

To eliminate weed competition, the seedbed should be prepared several weeks in advance, and given a final harrowing just before seeding. This will kill many seedling weeds.

Rate of seeding is important. It is better to undersow than oversow. Crowding of plants cuts down the tonnage of hay and seed to a marked degree. Seeding rates have already been calculated by the Experiment Station on most of the grasses mentioned.

Superior strains of smooth brome, orchard grass, perennial ryegrass, and giant meadow fescue are being increased for pasture trials.

Breeding work continues with bluegrass strains isolated at the Experiment Station, none of which have yet been put to the test in the nursery.

In addition, 7 other species—and strains of those species—are receiving considerable attention.

PASTURE AND BROADCAST CROPS TO PREVENT EROSION

K. B. Sanders and J. L. Vandiver

The comparative erosion losses from a 3-year rotation of corn, wheat, and lespedeza, from a 2-year rotation of barley and crimson clover, and from permanent pasture are being measured at the Greeneville Station. Equipment used for the study includes six 1/20-acre plots, each 136 feet long and 16 feet wide; metal divider strips between plots; and large concrete basins for catching the runoff. Average results for 6 years, 1937-1943, are shown in table 8.

These results indicate little difference in erosion resistance between the 3-year and the 2-year rotation. The averages, however, do not tell the whole story. For example, three-fourths of the soil

Table 8—*Average water and soil losses per year for a six-year period,*[1] *from Talbott silt loam, 10-percent slope, Greeneville Station.*

Plots 136 ft. × 16 ft. = 1/20 acre.

Plot No.	Number of plots	Cropping system	Water losses as runoff	Soil losses per acre
			Inches	Tons
1, 2, 3	3	3-year rotation—corn, wheat, and lespedeza.	1.76	2.97
4	1	2-year rotation—barley and crimson clover.	1.23	3.43
6	1	Permanent pasture.	.43	.71

[1]The average rainfall per year was 36.72 inches.

Fig. 3—What a few kudzu plants set in a gully did.

losses from the 2-year-rotation plot occurred during 2 months of the first year when unusually heavy rains caught that plot in seedbed condition. For the next 5 years the average soil loss per year was only 1.10 tons. On the other hand, sizable erosion losses were sustained by the corn plot of the 3-year rotation in 5 of the 6 years, and by the wheat plot in 3 of the 6 years, while the losses from the second-year lespedeza plot were almost negligible every year.

Erosion losses from permanent pasture were much less than from either rotation, as would be expected—and the bulk of the total erosion losses from permanent pasture occurred during the sod-establishing period of the first year.

STATE SOIL SURVEY

W. O. Whittle

During the year 1943, the State soil survey was affected materially by the loss of several employees to military service and the impossibility of obtaining replacements. We were able, however, to make arrangements with the Department of Agriculture, at Washington, to secure some of its employees who were released from special agricultural war projects. At the end of the year, 8 men were giving full-time service in the field, against almost twice that number employed prior to the war period..

During the year, the survey of 486,240 acres was completed, making a total of 6,424,447 acres, which is practically one-fourth of the entire State. In the completed surveys are 18 full counties,

parts of 2 counties, and 4 special areas. The field work of 3 additional counties is practically completed. Work inaugurated in 2 other counties was abandoned temporarily on account of the shortage of soil surveyors.

Several reports have been turned over to the Government Printing Office, but publication is being deferred on account of other demands. Pending publication and distribution of these reports, which may be delayed for months, or even years, copies of each county map are colored by hand and placed in the offices of the county agricultural agent, the Tennessee Valley Authority, and the Agricultural Experiment Station. Six of the maps were completed this year.

There have been received 1954 samples of soil, which have been analyzed for lime, phosphate, potash, and organic matter. These samples represent 152 different soil series. Also 494 profile samples from 138 different soil series have been received. All of these, with the analytical data, are being preserved for future observation and study.

This survey is being carried on with the assistance and cooperation of the Tennessee Valley Authority and the Bureau of Plant Industry, Soils, and Agricultural Engineering.

PHYSICAL PROPERTIES OF COTTON FIBER

K. L. Hertel

The Department of Physics was handicapped by reduction and changes in personnel incident to the national emergency. For this reason, its work was confined to the continuation of those aspects of the program already in progress.

FIBER RESEARCH LABORATORY

The University of Tennessee Fiber Research Laboratory was established to make recent fiber-testing technics available to the cotton industry and to serve as a proving ground for new instruments and methods. During the year, 5389 fiber samples were submitted and 23,529 total determinations of length, specific surface (fineness), and strength index were reported. The samples were received from 7 plant breeders and 14 manufacturers.

The same tests were conducted on standard cottons as a check on instruments and methods. On those samples submitted for test, length measurements with the fibrograph and specific surface measurements with the arealometer were reported as determined; whereas, measurements made with the Pressley tester were adjusted to the standard cottons by means of a factor determined each day. The small variations in results on standard cottons obtained with the fibrograph and arealometer have been attributed to residual heterogeneity in the standard cottons and not to changes in the instruments.

FIBER PROPERTIES

The arealometer is the instrument developed in this laboratory for determining the specific surface of fiber or the external surface of a given weight of fiber. It is expressed in square centimeters per milligram of fiber and varies from 1.5 cm^2/mg for coarse cottons to 4.0 cm^2/mg for fine sea island cottons. With an instrument available for measuring fiber fineness, the plant breeders have found both coarser and finer cottons. This has made it desirable to compare again the arealometer measurements with those obtained from microscopic cross sections on a wider range of cottons.

The very nature of the air-permeability method used in the arealometer offers little opportunity for biased sample or alteration of the fiber size. The method of measuring the fiber surface is indirect and the theory so involved and imperfect that a check method is desirable. The microscopic method is used as an independent method because of its directness, although it requires much processing of the fibers, which may modify the original cross sections. The method is being re-examined with a view to obtaining the most reliable and precise results possible.

Owing to the toughness and flexibility of the cotton fiber, the problem of preparing good microscopic cross sections offers more difficulties than are encountered with most fibers. The 4 methods tried for preparing cross sections were:

1. Hardy section cutter with Neg-O-Lac
2. Imbedding in paraffin
3. Imbedding in gelatin
4. Imbedding in plastic

Samples prepared by the last 3 methods were sectioned with a rotary microtome, but were not satisfactory. Even fibers treated with ultra-violet light to produce artificial deterioration could not be sectioned quite satisfactorily, and they were much more difficult to handle. The Hardy section cutter, with untreated fibers, gave the best results and was adopted. Three methods for recording the sections were tried:

1. Drawings were made by means of a microprojector
2. Photomicrographs were made of the slides
3. Drawings were made with the aid of the camera lucida

The camera-lucida method was selected as being the most rapid and accurate for obtaining the perimeter and area of the fiber sections. The selection of a representative sample was difficult because of the wide variations in fiber cross section along the fiber, from fiber to fiber in the same length group, and among length groups. The fibrograph sampling technic was adapted to minimize bias in fiber selection. Fifty-three slides of 9 widely different cottons and 3 synthetic fibers were prepared, from which 13,509 cross sections were traced. The perimeters were measured with a map measurer and the areas with a planimeter. Using the magnification, the actual perimeter per unit area was calculated. The

perimeter divided by the area is equivalent to the fiber surface per unit volume. This quotient divided by the fiber density gives the specific surface.

Measurements of specific surface and strength index were made on selected samples of the Regional Cotton Variety Study and compared with weight per unit length and Chandler Modified Bundle results obtained in the Government laboratories. The factor for converting Pressley strength index as obtained in this laboratory to equivalent Chandler Modified Bundle results agreed with the similar factor obtained on 4 check cottons. From data on the weight per inch and the specific surface, a value of the average perimeter could be obtained. The results indicated that the average perimeter was about the same for all of these cottons.

Attention was given to some of the mechanical details of the arealometer. Attempts were made either to replace the inclined liquid manometer with a non-liquid sensitive pressure-measuring device or to make the manometer non-spilling. Further experiments were carried out to obtain a reliable variable air resistance. Improvements were obtained in both cases.

AGRICULTURAL ENGINEERING

M. A. Sharp

IRRIGATION

Studies on irrigation equipment, cooperative with the TVA, which were started by A. L. Kennedy in 1942, were continued in 1943. Developments and adaptations of such equipment for Tennessee conditions have resulted in a system that makes it possible for the farmer to irrigate his fields with a minimum of expense, labor, and inconvenience. The 200-gallon-per-minute sprinkler irrigates a square area of about half an acre at each setting. With 2 of these sprinklers and 2 short laterals it is possible to irrigate an area of 5.4 acres with 1 inch of water in 7 hours without stopping the pump. Mr. Kennedy states that the amount of labor involved in moving the lateral line and sprinklers would be only 5 percent of that required for some systems in common use. The output of each sprinkler can be varied from 100 to 400 gallons per minute, giving a range adjustable for any situation.

Data obtained in studies of the infiltration capacity of soils show that 1 inch per hour will be absorbed readily when the ground is so dry that plants need irrigation.

Experiments were conducted to determine the practicability of introducing liquid fertilizer into the irrigation water at the pump. Results showed that any liquid or thin paste can be mixed readily with the water in the intake pipe near the pump. Dry fertilizers could be used, but they appear to offer no advantage over the liquid form. Several liquids, such as ammonium nitrate, phosphoric acid, and potash solutions, can be used in the proportions desired, and

can be introduced through separate openings to avoid the formation of precipitates from impure solutions. The cost of applying the fertilizer is negligible, since the process does not require a separate operation. Liquid ammonia could be used very easily, but studies with ammonium hydroxide showed a loss of about 20 percent in the air between the sprinkler and the ground. With non-volatile liquids there would be no loss. Heavy applications of fertilizer could be used on growing plants at the desired time without damage to the roots, because there would be no small areas of high concentration such as occur with dry fertilizers.

Small shallow-planted seeds, such as those of legumes and turnips, often cannot germinate, or continue to grow after germination, unless rains come at the right time; and since some are seeded in the fall, adverse conditions are often encountered. A small application of water can be made rapidly, insuring a good stand and protection from erosion on land seeded in the fall. A good green-manure and cover crop of crimson clover could be assured by this method.

The equipment is readily portable, is quickly and easily set up, and makes custom irrigation practical. Its adaptability to a wide variety of conditions indicates a usefulness much broader than was originally anticipated.

THE TWO-SPRINKLER SYSTEM OF IRRIGATION

The 2-sprinkler system requires only 2 inexpensive sprinklers. It permits a capacity range from 100 to 800 gallons per minute, giving a rate of application of ¼ inch to 2 inches per hour. This makes possible the irrigation of large areas quickly and easily with a minimum amount of equipment.

To irrigate a strip 420 feet wide, extending 560 feet back from the water supply, would require 630 feet of pipe,

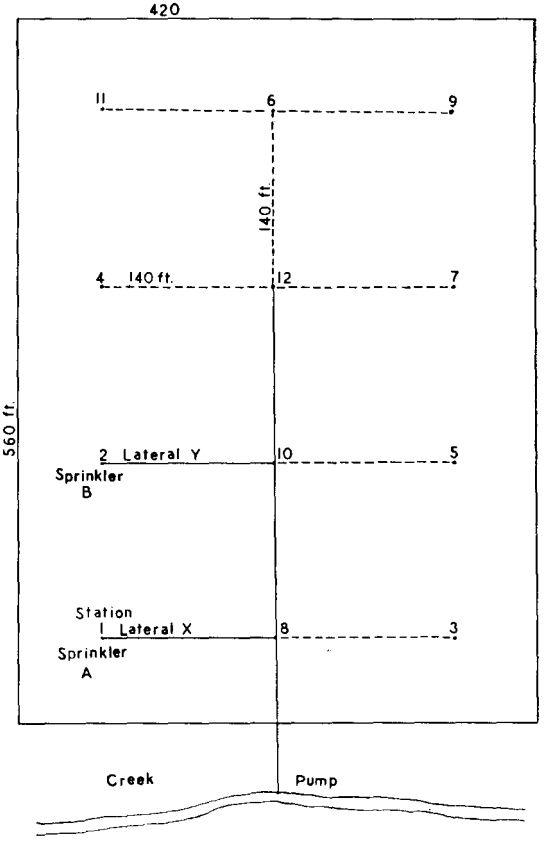


Fig. 4—The two-sprinkler system of irrigation.

2 sprinklers, and 4 valves. At the beginning of the application the pipe would be in the position indicated by the solid lines in figure 4. The 2 sprinklers, A and B, would be at stations 1 and 2. One valve would be at station 8, one at 10, and two at 12. The valves project vertically above the main pipe. Those at 8 and 10 are open to feed water to A and B at 1 and 2. When enough water has been applied at these stations, the valve at 8 is closed, and lateral X with sprinkler A is moved to 3. For the brief period of from 3 to 8 minutes for this move, the sprinkling is continued at 2. The valve at 8 is then opened, and the one at 10 is closed for the moving of lateral Y to 4. The 2 laterals will stay at these positions for from 15 to 60 minutes, or longer, giving the operator time to do something else. By a similar procedure, X is moved to 5, and Y is moved to 6, where it remains as part of the main line. After 6 is finished, sprinkler B is removed for use on the main line at 8, 10, and 12. The next moves are X to 7 and B to 8, X to 9 and B to 10, X to 11 and B to 12. Moving the sprinkler B takes one man about one minute per move.

Table 9—*Response of crops to one application of water by a 400-gallon-per-minute sprinkler.*

One inch applied except as noted.

Date, Time Amount of Water	Crop	Stage of crop	No. of days till rain	Date tested for yields	Increased yield or growth on irrigated plots
					Percent
June 10 6 a.m.	Cobbler potatoes	Late-bloom	6	June 20	9
June 10 6 a.m.	Tobacco	8 inches tall	6	June 26	No effect
June 10 10 a.m.	Cobbler potatoes	Middle-bloom	6	June 26	44
June 10 10 a.m.	Green Mt. potatoes	Early-bloom	6	June 26	32
June 10 12 noon	Cobbler potatoes	Middle-bloom	6	June 26	35
June 12 11 a.m.	Cobbler potatoes	Middle-bloom	4	June 26	35
June 12 6 p.m.	Cobbler potatoes	Middle-bloom	4	June 26	41
June 22	Cabbage	Heads formed but small	10	June 29	150
July 17	Tobacco	4 feet tall	....	October	15
July 17 July 23	Tobacco	Same field as above	....	October	25
July 17	Hybrid corn	Before silking	....	October	15
July 17 July 23	Hybrid corn	Same field as above	....	October	50
July 20 1" water	Alfalfa	Soon after cutting	7	July 30	117
July 20 2" water	Alfalfa	Same field as above	7	July 30	150
July 20 3" water	Alfalfa	Same field as above	7	July 30	185
Sept. 14	Bunch beans	.....	5	Oct. 18	475
Oct. 1 ¼" water	Crimson clover	Seeded Sept. 24	14	Nov. 6	400

The number of trips required for one man to move the pipe and sprinklers to the various positions is 25, only 15 of which are on partly muddy or wet ground. With a 400-gallon-per-minute pump and two 200-gallon sprinklers, the time required to put 1 inch of water on the 5.4 acres would be about 7 hours. The estimated total cost for labor and gasoline would be 75 cents per acre-inch.

Large fields may require 2 or more pumping stations and a longer main. Small areas may be irrigated from the main line without the use of laterals.

Some changes have been made in the design of the sprinkler nozzle, and a second truck has been constructed, giving 2 complete units for soil-erosion studies or irrigation.

Two semi-portable units, operated by stationary gasoline engines, and using heavy irrigation pipe equipped with commercial sprinklers, were installed for comparison.

CASTOR-BEAN SHELLER

Mr. H. A. Arnold did some work on refinement of the castor-bean sheller described in the 1942 report, and constructed a sheller to have on hand for use in further experimental work if needed. This project is cooperative with the TVA.

Reports indicate that the shellers purchased by the Commodity Credit Corporation are giving very good service. Some replacement of parts has been necessary where wood was used because steel could not be obtained, and some damage to the rubber facing has resulted from rocks and other material fed into the machine with the beans. A detailed description of the procedure for constructing and operating this sheller has been written by Mr. Arnold and will appear in print as Bulletin No. 187 of this Station. There has been considerable interest in the sheller in Central and South American countries.

LEGUME-SEED SCARIFIER

A comprehensive work, describing the legume-seed scarifier, summarizing data obtained with this machine, and reporting available literature on the subject, is being prepared by Mr. Arnold for publication as a bulletin of this Station. Check tests were conducted on previous experiments with scarified legume seeds.

This project also is cooperative with the TVA.

PLYWOOD SILOS

The two plywood silos constructed in the fall of 1942 have given very good service. In the octagon silo, however, the asphalt lining, applied by an inexperienced man, was left very rough, and the silage has a tendency to stick to it. This silo was not filled in the fall of 1943 because of a shortage of labor and materials. The round silo was filled in the fall and has shown no sign of deterioration at any

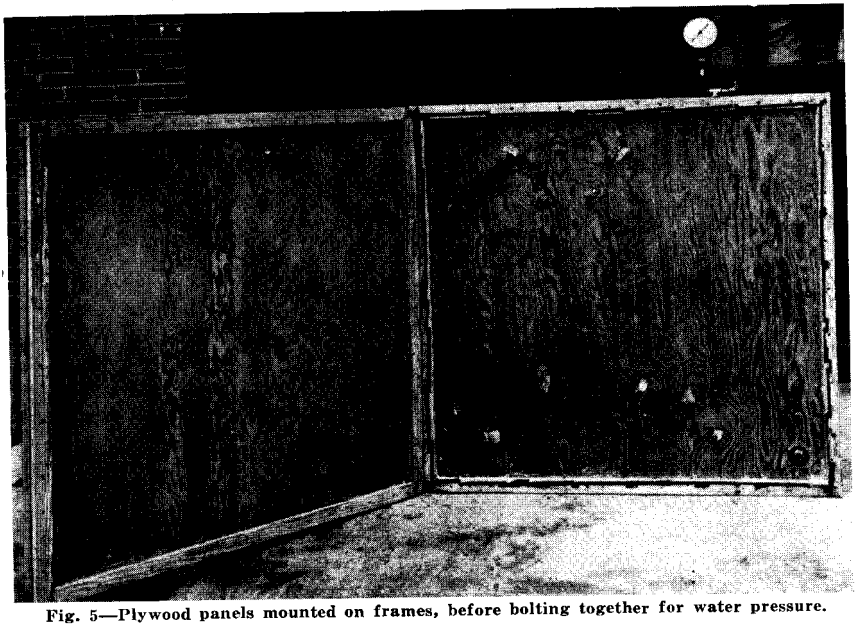


Fig. 5—Plywood panels mounted on frames, before bolting together for water pressure.

Fig. 6—Plywood panels under test, showing pressure and deflection gages.

point. It appears that the plywood and the construction principles are satisfactory.

In order to determine the amount of pressure which the plywood panels could be expected to sustain, Mr. Arnold conducted tests, using water as a controlled source of pressure. The equipment for making these tests, with recording gauges, is shown in figures 5 and 6. It is probable that a new type of glue now used in the manufacture of plywood will give a higher tensile strength.

LIQUID FERTILIZER DISTRIBUTOR

The problem of distributing ammonium hydroxide as a liquid fertilizer became acute in August, 1943, when the TVA began experimenting with this material as a possible source of nitrogen for fertilizer. Owing to its high volatility, it must be kept completely protected from exposure to the air at all times. This condition required that a pump be designed which would meter the desired amount of liquid and distribute it through as many outlets as necessary, and at the same time place the liquid so that it would be covered immediately as it reached the conductor-pipe outlets, to prevent loss by evaporation. This problem was assigned to H. A. Arnold and G. M. Petersen.

They found that the hose pump developed for adding acid to silage, as reported in 1941, could be adapted to the pumping of

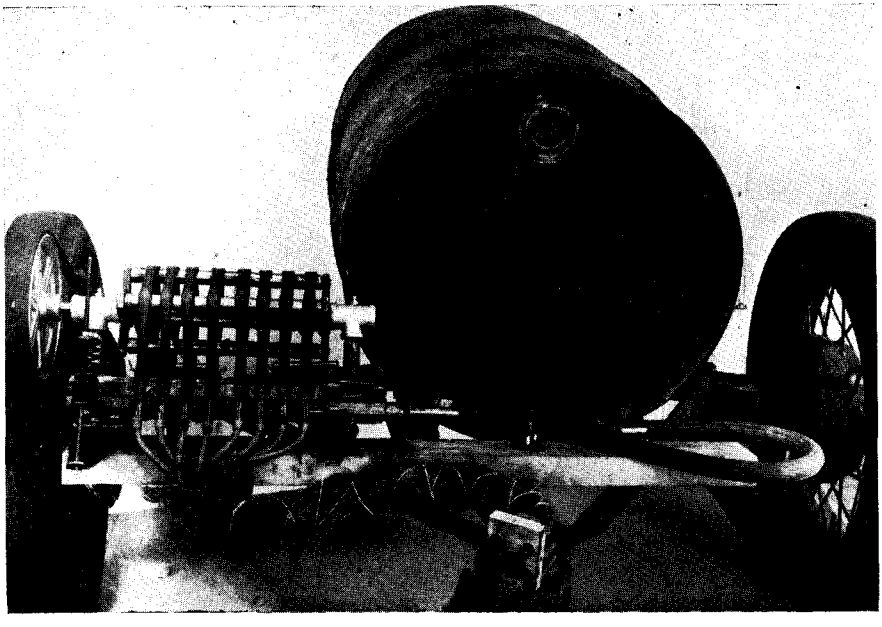


Fig. 7—Liquid fertilizer distributor: pump and tank mounted on trailer.

liquid fertilizer. A pump and delivery system which met all of the requirements was designed and constructed. The device has enabled workers experimenting with fertilizers to make accurate studies of the value of this source of nitrogen. The unit may be attached to any farm machine, but its chief use to date has been with a disk and a grain drill. The pump and supply tank may be mounted on an implement instead of on the trailer, if desired. They are shown in figure 7 mounted on a trailer. A complete description of this apparatus and instructions for operating it have been prepared and will be published as Circular No. 87. A small pump, which will be suitable for use on a 1-row planter, and which also may be used on a tractor plow to place fertilizer in the bottom of the plow furrow, is to be constructed. This project will be continued in 1944. It is cooperative with the TVA.

ANIMAL HUSBANDRY

H. R. Duncan

EXPERIMENT AT KNOXVILLE STATION

COMPARISON OF CORN SILAGE WITH SORGHUM SILAGE FOR FATTENING TWO-YEAR-OLD STEERS

The second trial in the experiment comparing corn and sorghum silage for steers was completed in March 1943. Results are given in table 10.

The sorghum silage made and used for this trial was somewhat more mature and of better quality than that used the previous year. Possibly because of this condition, the lots fed sorghum silage made a better showing this year than last in daily gains, finish, and acre returns. Although sorghum gave an average of 53 percent more yield per acre than corn silage during the two years, the returns per acre were in favor of the corn silage. Two difficulties in the growing and harvesting of sorghum have been experienced. The first year the seedbed was dry at time of planting, which resulted in much poorer stands of sorghum than of corn. The corn germinated and grew off much better than the sorghum under these conditions. Then, when soil and moisture conditions were favorable, the sorghum grew much ranker than the corn and was more apt to lodge and tangle. It has been possible to handle the corn fairly satisfactorily with a corn harvester, even where the growth was heavy, but the sorghum has been a difficult and in some cases an impossible job for the harvester. The experiment will be repeated another year, and should give more conclusive results.

Table 10—*Comparison of corn and sorghum silage in fattening rations for two-year-old steers.*

Item	Lot 1 Corn silage, full feed, plus 5.5 lbs. cottonseed meal daily	Lot 2 Corn silage, full feed, plus 2.0 lbs. cottonseed meal daily	Lot 3 Sorghum silage, full feed, plus 5.5 lbs. cottonseed meal daily	Lot 4 Sorghum silage, full feed, plus 2.0 lbs. cottonseed meal daily
Number of steers per lot	10	10	10	10
Number of days fed	120	120	120	120
Av. daily ration (lbs.):				
Corn silage (ad libitum)	39.5	41.4	.....	.....
Sorghum silage	.....	.....	[3] 55.1	[3] 59.4
Cottonseed meal (41%)	5.5	2.0	5.5	2.0
Salt	.042	.048	.056	.047
Av. initial wt. of steers (lbs.)	918.5	910.7	910.4	915.8
Av. final wt. of steers (lbs.)	1155.2	1074.8	1118.4	1085.6
Av. gain per head, 120 days (lbs.)	236.7	164.1	208.0	169.8
Av. daily gain (lbs.)	1.972	1.367	1.733	1.415
Feed for 100-lbs. gain (lbs.)				
Corn silage	2002	3027	.....	.....
Sorghum silage	.....	.....	3178	4196
Cottonseed meal	278.8	146.3	317.3	141.3
Salt	2.11	3.48	3.38	3.40
Av. dressing percentage (final exp.-wt. and chilled-carcass-wt. basis)	55.91	55.33	55.61	53.11
Initial cost of cattle per cwt.	$11.70	$11.70	$11.70	$11.70
Initial cost per head	$107.46	$106.55	$106.52	$107.15
Appraised value per cwt. of finished cattle	$15.16	$14.66	$14.58	$14.03
Actual margin	$3.46	$2.96	$2.88	$2.33
Value of finished cattle per head (3% off final exp. wt. for selling weight	$169.87	$152.85	$158.16	$147.74
Gross returns per head	$62.41	$46.30	$51.64	$40.59
Value of feeds fed other than silage[1]	$14.07	$5.18	$14.10	$5.16
Cattle returns from silage, per head	$48.34	$41.12	$37.54	$35.43
Tons of silage fed, per head	2.370	2.484	3.305	3.562
Acres of silage fed per head[2]	.290	.304	.242	.261
Cattle returns per ton silage fed	$20.39	$16.55	$11.36	$9.94
Cattle returns per acre silage fed	$166.79	$135.37	$154.83	$135.48
Percentage acre returns, with lot 1 as 100 percent	100.0	81.2	92.8	81.2

[1]With cottonseed meal @ $42.50 per ton and salt @ $20.00 per ton.
[2]Silage yields per acre: corn 8.18 tons and sorghum 13.63 tons.
[3]Sorghum silage made 5 days later than corn and was good, excelling that of previous year.

EXPERIMENTS AT WEST TENNESSEE STATION
Jackson

CHOPPED SWEETPOTATOES FOR FATTENING CATTLE

The sweetpotato is a promising source of carbohydrates in the South, since it grows well and yields abundantly on soils that are not highly productive of such feeds as corn and barley.

Two years' work at the West Tennessee Station revealed the fact that dehydrated sweetpotatoes were a satisfactory substitute for corn-cob-shuck meal in a fattening ration for cattle. This feed, however, has not yet been produced and put on the market, and until it is available at a fair price, some other method of utilizing the sweetpotato for cattle feeding must be used if potatoes are to be fed to cattle.

It seemed that chopped raw sweetpotatoes might be a partial answer, since they could be fed in the fall and early winter without

great expense for storage, or stored on many farms without additional facilities.

A project for feeding chopped sweetpotatoes was planned and executed with results shown in tables 11 and 12.

Table 11—*Cost of feeds and average daily rations.*

Feeds	Lot 1	Lot 2
	Pounds	Pounds
Silage @ $6.66 per ton	30	....
Chopped sweetpotatoes @ $10.00 per ton.	....	20
Cottonseed meal @ $40.00 per ton	5	5
Corn-cob-shuck meal @ $30.00 per ton	5	5

Table 12—*Weights, gains, and cost of gains.*

Item	Lot 1	Lot 2
Number of steers	6	6
Number of days in experiment	120	120
Average initial weight Nov. 28, 1942 (lbs.)	634	634
Average weight at end of 120-day period (lbs.)	879	910
Average gain per steer (lbs.)	245	276
Average daily gain per steer (lbs.)	2	2.3
Cost per cwt. gain	$13.47	$11.95

SORGO SILAGE VERSUS CORN-SORGHUM SILAGE

A very dependable silage crop for Tennessee is a mixture of corn and sweet sorghum. This mixture is more dependable in drouthy years, gives increased tonnage, and contains plenty of moisture to insure a good pack in the silo. The mixture does not mature as early as corn and may be ensiled over a long period to better advantage than corn. Corn must be ensiled during a relatively short period to make the best silage.

Atlas, a comparatively new sweet sorghum, seemed promising as a silage crop in Tennessee, and it was decided to compare silage from this crop with silage from a mixture of corn and sorghum. Tables 13 and 14 give the results of the first trial.

Table 13—*Cost of feeds and average daily rations.*

Feeds	Lot 1 Corn-sorghum silage	Lot 2 Atlas sorgo
	Pounds	Pounds
Silage @ $6.66 per ton	30	30
Cottonseed meal @ $40.00 per ton	5	5
Corn-cob-shuck meal @ $30.00 per ton	5	5

Table 14—*Weights, gains, and cost of gains.*

Item	Lot 1	Lot 2
Number of steers	6	6
Number of days in experiment	120	120
Average initial weight Nov. 28, 1942 (lbs.)	634	634
Average weight at end of 120-day period (lbs.)	879	867
Average gain per steer (lbs.)	245	233
Average daily gain per steer (lbs.)	2	1.9
Cost per cwt. gain	$13.47	$14.16

ONCE-DAILY FEEDING COMPARED WITH TWICE-DAILY FEEDING

This project was undertaken for the purpose of studying the possibility of reducing the labor requirements for fattening yearling cattle on a silage-grain ration. Tables 15, 16, and 17 give the plan and results of the first trial.

Table 15—*Cost of feeds and average daily rations.*

Feeds	Lot 1 Fed twice daily	Lot 2 Fed once daily
	Pounds	Pounds
Silage @ $6.66 per ton	33.5	33.5
Cottonseed meal @ $40.00 per ton	3.75	3.75
Corn-cob-shuck meal @ $30.00 per ton	3.75	3.75

Table 16—*Weights, gains, and cost of gains.*

Item	Lot 1	Lot 2
Number of steers	6	6
Number of days in experiment	120	120
Average initial weight Nov. 28, 1943 (lbs.)	634	633
Average weight at end of 120-day period (lbs.)	850	867
Average gain per steer (lbs.)	216	234
Average daily gain per steer (lbs.)	1.80	1.95
Cost per cwt. gain	$13.50	$12.46

Table 17—*Financial statement.*

Item	Lot 1	Lot 2
Average initial cost per steer @ $12.00 per cwt.	$ 76.08	$ 75.96
Average feed cost per steer	29.15	29.15
Total cost per steer (initial and feed)	105.23	105.11
Necessary selling price per cwt., with 3% shrinkage to break even	12.76	12.50

The two lots were fed the same amount of feed daily. Lot 2 was considerably slower in cleaning up its feed, but did not hold back lot 1 in the amount of the ration it would consume. This trial was conducted during the winter, from November 28, 1942, to March 28, 1943. The results might have been different had it been conducted in the summer, when silage is inclined to heat and become unpalatable if left exposed in a trough very long before being consumed.

EXPERIMENTS AT MINERAL-DEFICIENCY FARM

Crossville

GROWTH AND REPRODUCTION STUDY WITH BEEF CATTLE

This study was continued through 1943 on the setup described in the 1942 report with 3 lots of grade beef cows receiving the following treatments:

Lot 1—Grazed and wintered on forage from an area receiving a low application of phosphate (72 pounds of 20-percent superphosphate annually).

Lot 2—Grazed and wintered as lot 1, plus a dicalcium phosphate supplement of 1 ounce per day.

Lot 3—Grazed and wintered on forage from an area receiving a high application of phosphate (266 pounds of 20-percent superphosphate annually).

Of the 24 females originally selected in the fall of 1940, there were still 23 in the herd October 31, 1943, at which time the number of the foundation cows was reduced to 4 for each lot in order to make room for 4 heifers produced on the farm and coming into production.

The growth and performance of the cows, heifers, and calves are shown in tables 18, 19, and 20.

Table 18—*Growth and development of the breeding herd.*

Item	Lot 1 Fed from low-phosphate area	Lot 2 Same as lot 1, plus dicalcium phosphate	Lot 3 Fed from high-phosphate area
	Pounds	Pounds	Pounds
Av. weight of heifers selected for founding herd Dec. 23, 1940	439	433	440
Av. weight of bred heifers Nov. 13, 1941	750	777	799
Av. gain first year (325 days)	311	344	359
Av. weight of cows second year Oct. 31, 1942	887	915	933
Av. gain second year (352 days)	137	138	134
Av. weight of cows third year Oct. 31, 1943	892	893	938
Av. gain of cows third year (365 days)	5	22	5
Av. gain during three years	453	460	498

Table 19—*Performance of cows.*

Item	Lot 1 Fed from low-phosphate area	Lot 2 Same as lot 1, plus dicalcium phosphate	Lot 3 Fed from high-phosphate area
Number of original heifers	8	8	8
Number of original heifers in herd Oct. 31, 1943	8	7	8
Percent calf crop, 1942	100	100	100
Average birth weight of calves dropped 1942 (lbs.)	65.3	65.7	71.6
Average weight of all calves Oct. 31, 1942 (lbs.)	299	338	408
Average age of calves Oct. 31, 1942 (days)	130.3	142.9	153.4
Average daily gain of calves, 1942	1.80	1.90	2.13
Percent calf crop, 1943	100	100	100
Average birth wt. of calves, 1943 (lbs.)	64.6	67.6	69.9
Average weight of calves, Oct. 31, 1943 (lbs.)	314	329	333
Average age of 1943 calves, Oct. 31 (days)	139	148	134
Average daily gain (lbs.)	1.72	1.76	1.98

Table 20—*Weights and gains of 1942 heifers added to the herd.*

Item	Lot 1 Fed from low-phosphate area	Lot 2 Same as lot 1, plus dicalcium phosphate	Lot 3 Fed from high-phosphate area
Number retained	4	4	4
Number bred	4	4	4
Number in calf Dec. 31, 1943	4	4	3
Av. weight Jan. 1, 1943 (lbs.)	351	375	410
Av. weight Dec. 31, 1943 (lbs.)	520	566	654
Av. gain for year (lbs.)	169	191	244

The season of 1943 was dry on the Plateau. The pasture was much shorter than during the two previous seasons and the drouth was so severe during July and August that an inadequate supply of hay for the winter was produced. Table 21 gives analyses of the forage and shows the light yield on July 22, 1943. These samples include those taken from both the pasture and hay areas. On some of the pasture areas the lespedeza, redtop, and other grasses were so short that it was difficult to get a sample.

Table 21—*Analyses of forages and soils,* 1943.

Item	Low-phosphate area	High-phosphate area
Number samples of forage analyzed	35	25
Yield per acre (air dry) July 22, 1943 (ton)	.47	.75
Percent calcium in first 6" of soil	.82	.86
Percent P_2O_5 in first 6" of soil	.38	.48
pH factor in first 6" of soil	4.9	5.2
Available P_2O_5 in first 6" of soil (lbs. per acre)	30	27

The original foundation heifers probably were 12 months old December 23, 1940, when this project was started. These heifers have subsisted on grass and cured forage of an indifferent character, produced from the run-down farm for 3 summers and 3 winters. The only additional feed they had, other than the dicalcium phosphate for lot 2, was approximately one-half pound of corn meal per day, which was fed all cattle to insure the consumption of the phosphate by lot 2. These cows have grown out well, and show no evidence of malnutrition either by appearance or weight. Cows that will nurse a calf on short pasture and weigh 982, 983, and 938 pounds, respectively, are good average cows in weight. The high-phosphate area was the better part of the farm, and the additional phosphate no doubt stimulated plant growth so that the area produced more pasture and hay. The amount of feed or quality of feed, or both, produced more growth, or weight, on the cows and calves in lot 3, as compared with lots 1 and 2.

Observation was made at stated intervals on the amount of time which the various lots of cows spent in grazing. The cows on the high-phosphated area spent an average of 8.56 hours per day grazing, while those on the low-phosphated area spent an average of 10.83 hours.

The addition of dicalcium phosphate to the ration of lot 2 apparently did not influence the growth of the original foundation cows, as they finished the third year on even terms; but there may be a noticeable difference in the growth of the heifers kept for the breeding herd from the first crop of calves. The calf weights show differences, but these are due partly to differences in age. If weights are computed on an equal age basis there is a difference of only 13 and 6 pounds for the 1942 and 1943 calves, respectively, in favor of lot 2 over lot 1. The phosphorus supplement may have produced somewhat earlier calves.

Because of limitations in feed and facilities, the cows were bred to calves on pasture in May and June. The calves therefore were only 5 months of age, or less, when weighed October 31, near the end of the pasture season. Weights of 300 to 400 pounds for calves of this age are good. In fact, it is surprising how well these cows and calves looked and how much they weighed in comparison with those grown under conditions that seemed more favorable.

EXPERIMENTS AT MIDDLE TENNESSEE STATION

Columbia

EWE TYPE STUDY

A project was started in 1940 to compare northwestern, Cumberland Plateau, and native ewes for spring-lamb production. The northwestern ewes selected were of the sort being brought into Kentucky and Tennessee. They were Hampshire-Rambouillet crossbreds, showing considerable scale, bone, and substance. Mottled and brownish faces predominated in these ewes, and they were fairly smooth (fig. 8).

The Cumberland Plateau ewes were the top yearling ewes at the cooperative sale of ewes at Crossville. Practically all of them were black-faced and showed evidence of Hampshire blood. They

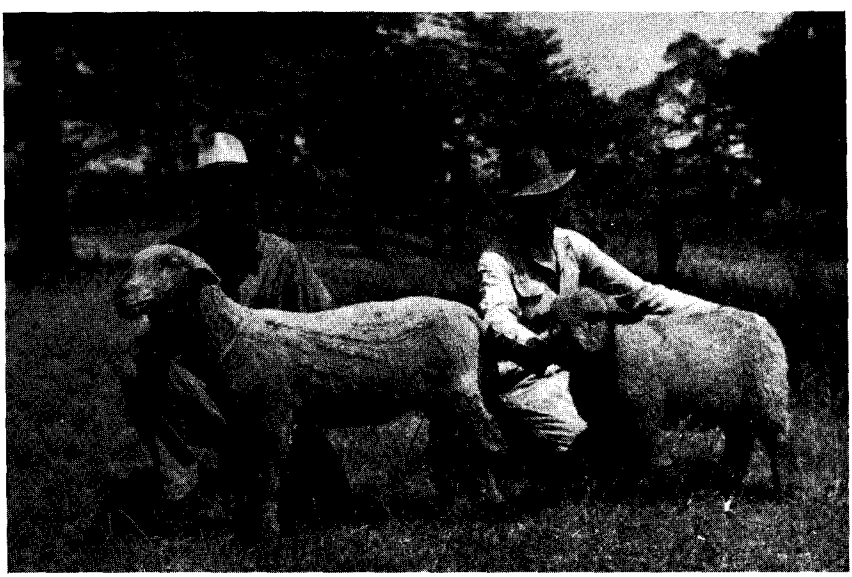


Fig. 8—Northwestern ewe 881, May 30, with her 85-pound choice lamb, sired by a purebred Hampshire ram. Knoxville Station.

The ewe weighed 125 pounds after being in Tennessee for nine months. Her first fleece weighed 8.5 pounds.

also showed the effects of native blood in their fine bone, alertness, disposition, and fleece. When these ewes were bought as yearlings they were thin and showed evidences of parasites and poor feed. Under Station feed they recovered and grew out into respectable ewes.

The native ewes were produced on the Station farm and represented the top end of the ewe-lamb crop from native ewes and Hampshire rams. An effort was made to select ewe lambs from the better-performing mothers. In reality these were high-grade Hampshires. Under Station feed and management these lambs grew out into thrifty ewes. All lots of ewes and lambs were handled

Table 22—*A four-year average for the years* 1940, 1941, 1942, *and* 1943, *on ewes of the same ages.*

Item	Plateau ewes	Northwestern ewes
Number ewes	35.5	45.0
Lambing date	Jan. 22	Jan. 24
Birth weight of lambs (lbs.)	9.42	9.31
Percent lambs raised of ewes bred	87.4	100.6
Market weight of lambs (lbs.)	76.07	75.60
Age of lambs at marketing (days)	128.0	131.6
Daily gain per lamb (lbs.)	.520	.519
Lamb returns per ewe bred	$7.94	$9.16
Wool clip per ewe (lbs.)	5.9	8.2
Wool return per ewe	$2.64	$3.73
Gross return per ewe	$10.58	$12.89

Fig. 9—The Middle Tennessee Station flock of northwestern, native, and Cumberland Mountain ewes on "winter" pasture October 31.

This pasture, seeded on prepared land with 1½ bushels Balbo rye and 15 pounds crimson clover, is in condition to furnish most of this flock's feed up to April 15, when it is turned for corn.

in the same way. The lambs were not creep fed, as previous work had shown that creep feeding under conditions prevailing on the Station farm was not necessary for the production of high-class lambs (fig. 9). Tables 22 and 23 give the results of this study to date.

Table 23—*A two-year-average for the years* 1942 *and* 1943 *on ewes of the same ages.*

Item	Plateau ewes	Northwestern ewes	Native ewes
Number of ewes	12.0	13.5	14.5
Lambing date	Feb. 8	Jan. 25	Feb. 13
Birth weight of lambs (lbs.)	8.95	8.73	8.11
Percent lambs raised of ewes bred	91.5	103.3	79.3
Market weight of lambs (lbs.)	72.88	73.32	66.91
Age of lambs at marketing (days)	132.9	136.5	122.8
Daily gain per lamb (lbs.)	.481	.470	.472
Lamb returns per ewe bred	$8.92	$10.35	$6.81
Wool clip per ewe (lbs.)	6.3	7.2	5.2
Wool return per ewe	$3.02	$3.78	$2.52
Gross return per ewe	$11.94	$14.13	$9.33

PASTURE VERSUS PASTURE AND GRAIN FOR FINISHING YEARLING HEIFERS

This project, initiated in 1942, was repeated in 1943, with results shown in table 24.

The object of this experiment was to determine the practicability of finishing heifer yearlings for an early market by feeding grain on grass in comparison with heifers carried for a later market on grass only. The lots were wintered together on a ration of 1½ pounds of cottonseed meal, 7.82 pounds of sorghum silage, and 7.97 pounds of hay.

Table 24—*Comparison of pasture with pasture and grain for finishing yearling heifers.*

Item	Lot 1 Pasture and grain	Lot 2 Pasture
Number of heifers	6	6
Weight April 1, 1943, when turned on grass (lbs.)	539.3	543.0
Number of days on grass	98	161
Ration on grass:		
Cottonseed meal (lbs.)	1	0
Corn-cob-shuck meal (lbs.)	4	0
Pasture	Ad libitum	Ad libitum
Weight when sold (lbs.)	681.5	704.0
Date sold	July 7	Sept. 11
Gain for summer period (lbs.)	142.3	165.3
Daily gain for summer period (lbs.)	1.45	1.02
Feed charge for summer period	$12.88	$10.00
Cost of 100 lbs. gain for summer period	$9.05	$6.04
Selling price per 100 lbs.	$13.56	$10.93
Returns per head above feed	$28.42	$10.64

In 1942, the two lots sold for the same price, although lot 2 was carried 64 days longer and into the September market. Under these conditions the lots were equally profitable. In 1943, the September market broke badly and the grass heifers made a poor financial showing, although they were as well finished as the grain-grass heifers that were sold in July, 63 days earlier.

Ordinarily the market on 700-pound fat heifers does not break much before October; but this year's results show the advisability

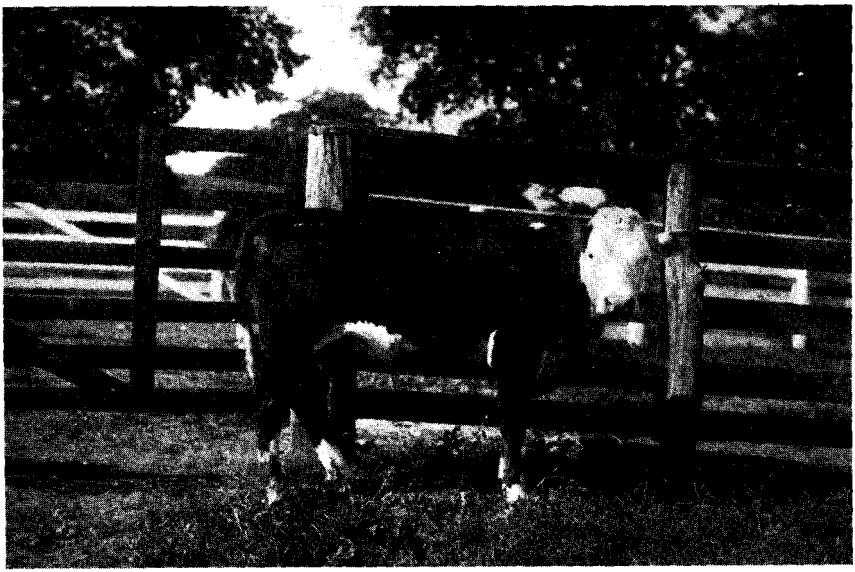


Fig. 10—One of the better heifers in the "grass-without-grain" lot.

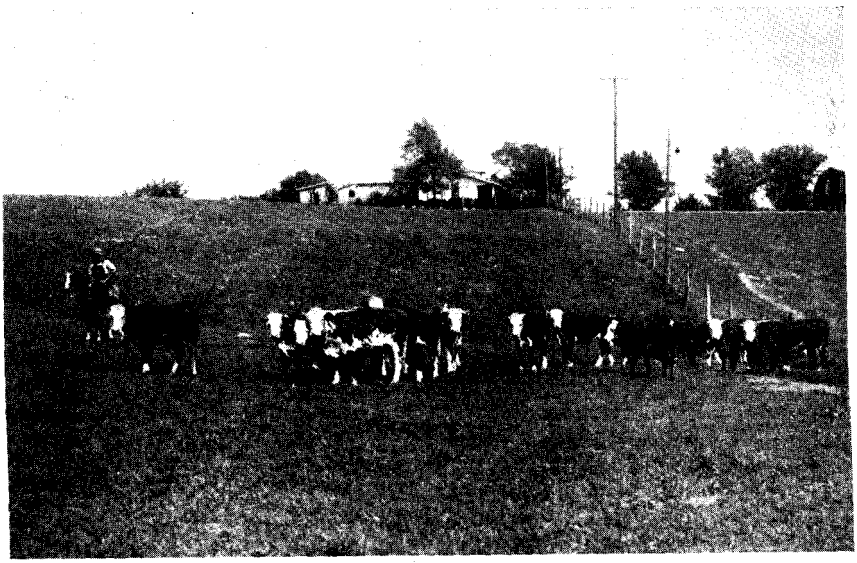


Fig. 11—The "McFall" cattle in summer on the permanent pasture of bluegrass, white and hop clover, and wild grasses from which their year's subsistence is obtained.

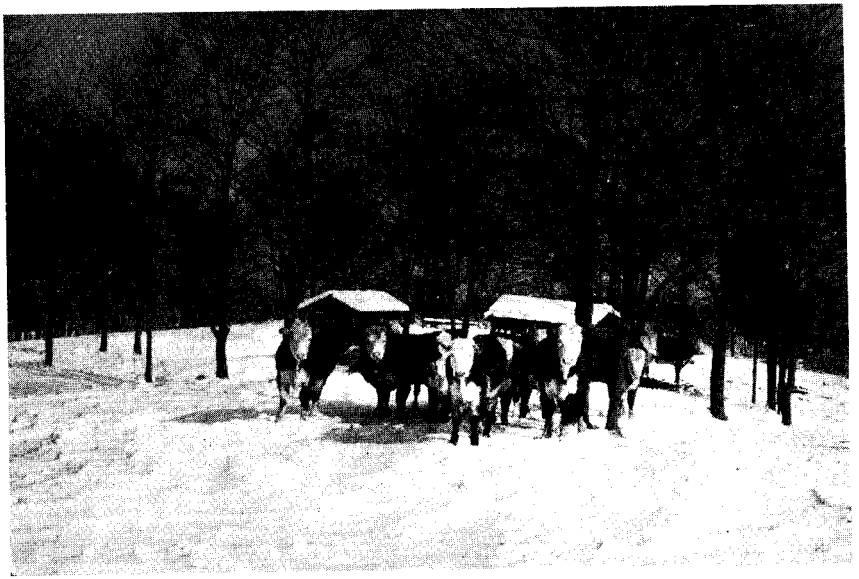


Fig. 12—The "McFall" cattle in winter quarters.
The thermometer stood at 17° below zero when this picture was taken. These cattle winter well without shelter on hay produced from their pasture.

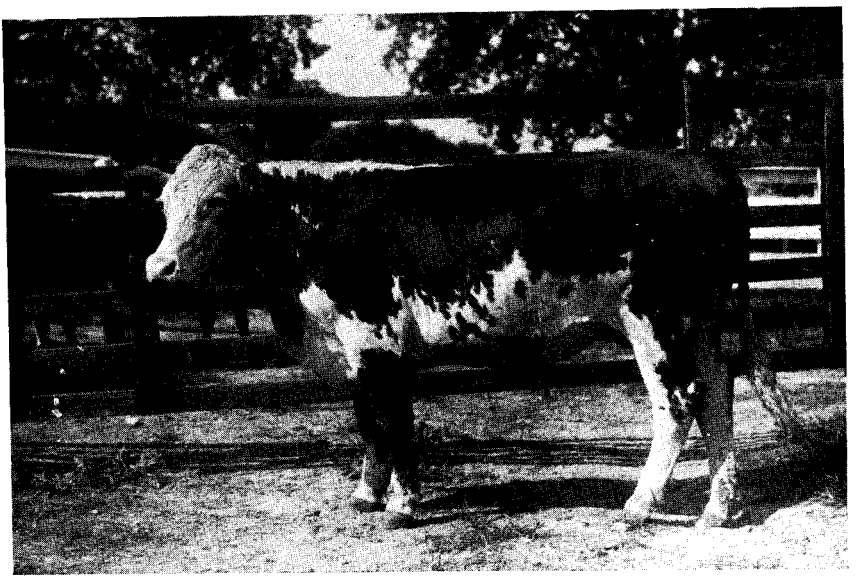


Fig. 13—One of the best "McFall" steers.
This steer was from the cow herd at the Station and was carried on the "McFall" pasture 469 days, without any feed other than that secured from the pasture as grass or hay. His initial weight was 380 pounds; weight when sold, 1002 pounds—a gain of 622 pounds. He sold for $13.75 per cwt. and grossed $137.77.

of using a small amount of grain in order to market in July, when a good market usually prevails. Either of the plans followed produced acceptable cattle for Tennessee markets (fig. 10).

McFALL AND ALFALFA-BLUEGRASS PROJECTS

These projects on continuous and complete subsistence from definite boundaries of land, described in some detail in the 1942 report, were continued during the year 1942-43. The acre-beef gains were 87.8 and 101.4 pounds, respectively. The gain this year, due partly, at least, to severe drouths during the summer of 1942 and 1943, were considerably below the average obtained since the projects were initiated. Figure 13 shows the type of cattle which can be produced by this system of beef production which does not involve the use of a plow.

JACKSTOCK AND MULE BREEDING

This project was initiated in the fall of 1937 for the purpose of conserving and improving jackstock and for a study of jack type and mare type for mule production. Foundation stock was purchased as opportunity offered, and matings have been made to try out the various sires, jennets, and mares. An inventory taken November 1, 1943, showed the following stock:

Herd jacks	5
Original foundation jennets	7
Jennets of breeding age sired by U. T. Logan	9
Jennets of breeding age sired by Limestone U. T. Monarch	4
Jack and jennet foals and yearlings	9
Tennessee Walking mares for mule production	6
Draft mares for mule production	5
Mules of all ages	23
Total	68

Offspring of the various foundation jacks, jennets, and mares are reaching maturity and are being studied. The mules are being put through tests on farm implements. Great variations in type, size, and quality have been noted in the jackstock. Like does not beget like. Several freaks, or off-type individuals, have been produced from the foundation animals, which were carefully selected. This condition emphasizes the need for constructive work in breeding jackstock.

The work above reported on the Animal Husbandry projects at the various stations was made possible by the cooperation of the men directly responsible for it. Mr. L. R. Neel, Superintendent of the Middle Tennessee Station, Mr. Ben P. Hazlewood, Superintend-

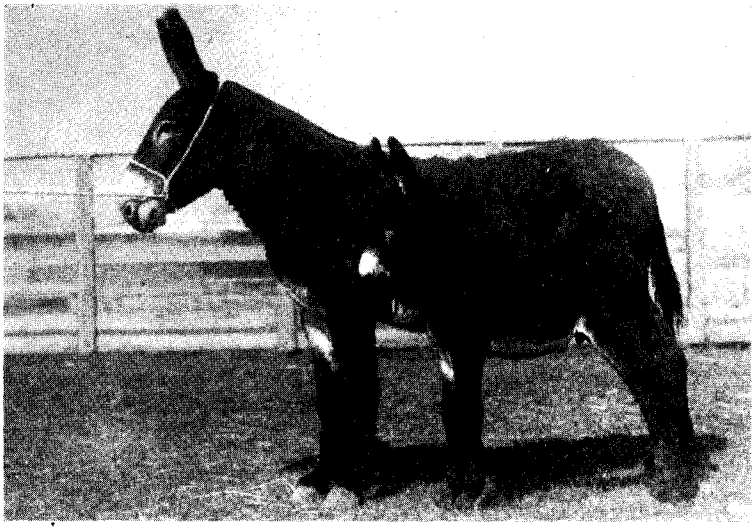


Fig. 14— Miss Derryberry 34357, an outstanding foundation jennet, with her third jack colt. This colt was dropped March 12, 1943, and is sired by Limestone U. T. Monarch 32973.

ent of the West Tennessee Station, Mr. J. J. Bird, of the Crossville Station, Mr. John N. Cummings, Assistant Superintendent of the Jack and Mule Breeding Farm at Columbia, Professor George W. Bible of the Animal Husbandry Department, Mr. K. B. Sanders of the General Chemistry Department, and others gave valuable assistance in carrying out the year's program.

FUSED TRICALCIUM PHOSPHATE AS AN ANIMAL FEED SUPPLEMENT

Cooperative with Tennessee Valley Authority

Dorothy E. Williams, and Elise Morrell

Rat-feeding tests were continued, with fused rock phosphates of 0.2 percent and 0.3 percent fluorine content as sources of phosphorus in the diet. The experiments were designed to show (1) the availability to the animal of the phosphorus of the fused rock phosphates in comparison with the phosphorus of a salt mixture known to be readily available, and (2) the effect of fluorine, per se, at levels of the same order of magnitude as those present in the fused phosphates being tested.

The diets were adequate in all respects except that the phosphorus content was about minimal for normal growth and bone development. They were all modifications of the control diet, 1, which consisted of the following parts per 100: lactalbumin 18, starch plus yeast extract 68, "Snowdrift" vegetable fat 8, Osborne and Mendel salt mixture 4, and codliver oil 2. Diet 2 was the same

as the control, except that the salt mixture was modified by the omission of all phosphorus and calcium, the fused rock phosphate under examination being the chief source of these minerals. In diet 3, the salt mixture was modified so that the total phosphorus and calcium was approximately the same as for the other diets, the dicalcium phosphate being the chief source of phosphorus. Diet 4 was the same as the control, except that sufficient sodium fluoride was added to make the fluorine content the same as that in the diet containing the fused rock phosphate being studied. By using sodium fluoride, a very soluble form of fluorine, we might expect to get a more pronounced fluorine effect than with the same amount combined as fluorapatite, as in the fused rock phosphate.

The rats were started on experiment at 30 to 31 days of age, with experimental periods of 30 days (period of most rapid growth), 60 days, and 90 days. Long-time experiments with breeding animals also have been carried on to determine whether or not there is a detrimental cumulative effect of the fluorine. In analyzing the data statistically, Student's t-test has been used as a basis for determining whether or not any given difference is significant.

RESULT DURING THE GROWTH PERIOD

Table 25—*Comparison of fused rock phosphates of two different proportions of fluorine with dicalcium phosphate, Osborne and Mendel salt mixture, and Osborne and Mendel salt mixture plus fluorine as phosphorus supplements, when fed to white rats.*

Criteria used	F in fused phosphate	Duration of Exp't	Averages for 5 rats			
			O. & M. Salt	Fused Phos.	$CaHPO_4$	O. & M. Salt + F
	Percent	Days				
Gain in weight (gm.)	0.2	30	100	97	90	97
	0.3	30	76	72	67	71
	0.2	60	156	150	145	155
	0.3	60	154	152	143	157
	0.2	90	196	197	197	201
	0.3	90	185	181	180	183
P in rat at end of experiment (gm.)	0.2	30	0.736	0.632	0.677	0.716
	[1]0.3					
	0.2	60	1.074	0.982	0.992	1.097
	[1]0.3					
	0.2	90	1.354	1.346	1.365	1.403
	[1]0.3					
Appearance of teeth	0.2	30	Yellow, faint striations occasionally	Whitish, definite striations	Yellow, usually faint striations	Whitish, very definite striations
	0.3	30	do	do	do	do
	0.2	60	do	do	do	do
	0.3	60	do	do	do	do
	0.2	90	do	do	do	do
	0.3	90	do	do	do	do

[1]Analytical data not complete.

GROWTH

A summary of the results to date through the period of most rapid growth and to maturity of the rat is given in table 25. The data seem to indicate that for rats receiving the experimental diets described above, growth is not significantly different for compar-

able animals for the varying durations of the experiment when the source of phosphorus is fused rock phosphate or an Osborne and Mendel salt mixture either with or without fluorine added as indicated. However, the rats receiving the dicalcium phosphate during both the 30-day and 60-day experimental periods made significantly less growth than those fed the control diet for the same durations.

PHOSPHORUS RETENTION

Analysis of the rat's body for the amount of phosphorus present at the end of the experimental period offers a more sensitive criterion than growth for detecting differences in phosphorus utilization. All diets have been kept at a phosphorus level designed to be just minimal for normal growth and phosphorus retention. A slight difference in the availability from two sources should thus be readily detected. In table 26, we have applied the statistical device for significance known as Student's t-test, and have broken down and rearranged the data concerned with the phosphorus content of the rat at the end of the experiment.

Table 26—*Significance of differences in phosphorus content of rats fed phosphorus from different sources.*

	A	O. & M. Salt	Fused Phosphate	Significance of difference
F in fused phosphate	Duration	P content of body	P content of body	
Percent	Days	Percent	Percent	
0.2	30	.736	.632	Significant
0.2	60	1.074	.982	Not significant
0.2	90	1.354	1.346	Not significant
	B	O. & M. Salt	O. & M. Salt + F	
0.2	30	.736	.716	Not significant
0.2	60	1.074	1.097	Not significant
0.2	90	1.354	1.403	Not significant
	C	O. & M. Salt	$CaHPO_4$ (0.04% F)	
.....	30	.736	.677	Significant
.....	60	1.074	.992	Not significant
.....	90	1.354	1.365	Not significant
	D	Fused Phosphate	$CaHPO_4$ (0.04% F)	
0.2	30	.632	.677	Barely significant
0.2	60	.982	.992	Not significant
0.2	90	1.346	1.365	Not significant

A. The phosphorus of a 0.2-percent fluorine fused phosphate fed to rats over a 30-day period was not so readily available as the phosphorus from Osborne and Mendel's salt mixture. As the rate of growth slows down and the relative need for phosphorus decreases in the longer experimental periods of 60 and 90 days, we find that the difference in the amount of phosphorus stored from the control diet and from the diet containing 0.2 percent fluorine fused phosphate is no longer significant.

B. When fluorine is added in a readily available form as sodium fluoride and to the extent of that present in the diets con-

taining the 0.2-percent fluorine fused phosphate, there is no significant difference in the amount of phosphorus retained as compared with results from feeding normal Osborne and Mendel salt mixture. This finding indicates that the difference in the availability of the phosphorus from the Osborne and Mendel salt mixture and the 0.2-percent fluorine fused phosphate is not due to the fluorine, per se, contained in the phosphates.

C. When the dicalcium phosphate containing only 0.04 percent fluorine is compared with the Osborne and Mendel salt mixture, we find that during the time of most rapid growth (30-day period) the phosphorus of the dicalcium phosphate is not quite so available as the phosphorus of the Osborne and Mendel salt mixture. When, however, the rate of growth slows down during the longer periods of 60 and 90 days, the relatively decreased need for phosphorus obscures the small but actual difference in the availability of the phosphorus from the two sources.

D. Although neither the dicalcium phosphate nor the fused phosphate gave such good retention during the 30-day period as the Osborne and Mendel salt mixture, there seemed to be a slight and barely significant difference in favor of the dicalcium phosphate as compared with the 0.2-percent fluorine fused phosphate. For the 60- and 90-day periods the two sources proved to be equally good.

APPEARANCE OF TEETH

Examining the teeth for the characteristic fluorine effects of striation and mottling, we find faint striations often present in the teeth of rats fed the control diet containing Osborne and Mendel salt mixture, and also in those given dicalcium phosphate as a source of phosphorus. Marked striations and in some instances a mottling effect were evident in the teeth of the animals given fused rock phosphate and those with sodium fluoride added to the Osborne and Mendel salt mixture. In general there was a slightly more pronounced effect when sodium fluoride was added than with the fused rock phosphate. It is to be remembered that the added sodium fluoride had no significant effect on growth or phosphorus retention at any levels fed so far. There seemed to be very little difference in the appearance of the teeth in the rats fed the 0.2-percent fluorine fused phosphate and those fed the 0.3-percent fluorine material. There was perhaps more of the mottling effect in the case of the fused phosphate with the lower fluorine content and more pronounced striations with the phosphate of higher fluorine content.

BREEDING

Rats receiving a fused rock phosphate containing 0.2 percent fluorine have been able to produce young of the fourth generation during a 1-year period. The comparison between numbers of young born and raised on a control diet and a diet containing fused rock phosphate cannot be justifiably made on the basis of the small number of breeding lots carried up to the present time.

SUMMARY OF RESULTS

Rats receiving 0.2-percent fluorine fused phosphate showed no difference in growth as compared with controls, although there was a slight but significant difference in phosphorus content at the end of the 30-day experimental period. Rats receiving this same fused phosphate for the 60- and 90-day periods showed no significant differences either in growth or phosphorus retention when compared with controls.

The growth records for the animals on the 0.3-percent fluorine fused phosphate show no significant difference when compared with the controls. Analytical data for the rats in this series are not yet complete.

Rats fed the dicalcium phosphate diet for 30 days and for 60 days showed a significant difference in growth in favor of the controls. Phosphorus retention during the 30-day period for the animals analyzed to date showed a significant difference in favor of the controls.

When sodium fluoride has been added to the control diet so that the amount of fluorine in the diets is the same as in the corresponding diets containing the fused rock phosphates, the rats in all cases have done equally well with the controls in regard to growth to maturity and phosphorus retention.

Examination of the teeth has shown consistently either a very slight or no effect of fluorine in rats fed the control diet and that containing dicalcium phosphate, and very definite but not necessarily harmful effects in those receiving the fused rock phosphates or the sodium fluoride.

TENTATIVE CONCLUSIONS

In view of the two objectives as set up earlier, evidence has been presented indicating that the phosphorus of 0.2-percent and 0.3-percent fluorine fused phosphates are not quite so available to the white rat as the phosphorus of Osborne and Mendel's salt mixture. When, however, the 0.2-percent fluorine phosphate was fed at a sufficiently high phosphorus level in relation to the rate of growth of the animal, the rats were able to achieve equal gains and phosphorus retentions with the control animals.

There seems to be no detrimental effect on growth to maturity and phosphorus content of the rat when fluorine is present in the diet as sodium fluoride to the same extent as in any of the fused phosphates studied here. Any positive statement as to the effect of the fluorine on reproduction in the rat must be deferred until more data are collected.

EFFECT OF IRON AND ALUMINUM COMPOUNDS IN HAYS ON PHOSPHORUS UTILIZATION

Fourteen samples of red clover or alfalfa hay were collected from test-demonstration farms to analyze for the ratio of iron and aluminum compounds to phosphorus present. Seven samples were

collected from check strips which had not been fertilized and 7 from corresponding adjacent areas which had been fertilized.

The high phosphorus content in all pairs of samples except one made the ratio of iron and aluminum to phosphorus negligible as a factor in interfering with the availability of the phosphorus. None of these hays, then, was suitable for use in animal-feeding tests for this problem. The phosphorus analyses of the treated and untreated hays seem sufficiently interesting, however, to report (table 27).

Table 27—*Phosphorus analyses of treated and untreated hays.*

Treated			Untreated		
Sample No.	Hay	P content	Sample No.	Hay	P content
		Percent			Percent
1	Alfalfa	0.272	2	Alfalfa	0.203
3	Alfalfa	0.393	4	Alfalfa	0.366
5	Alfalfa	0.204	6	Alfalfa	0.191
7	Red Clover	0.121	8	Red Clover	0.117
9	Alfalfa	0.342	10	Alfalfa	0.368
11	Alfalfa	0.317	12	Alfalfa	0.298
13	Red Clover	0.226	14	Red Clover	0.187

With the exception of samples 9 and 10, the phosphorus content on the untreated check strip is lower than that on the corresponding treated plot. It is perhaps not surprising that there are no large differences in phosphorus content noted in hays from treated versus untreated land, since the soils, with the exception of those from which came samples 5 and 6, and 7 and 8, were indicated as being good productive soils before treatment.

In connection with samples 7 and 8, both were low in phosphorus content, and addition of phosphate to the soil made only a negligible increase in phosphorus percentage. It should be pointed out, however, that the application of triple superphosphate had not been large and also that whereas there was very scanty growth on the check plot, there was a good yield from the treated area. The increase in amount of phosphorus and other nutrients made available to animals from the whole crop was considerable.

OFF-FLAVOR IN MILK

W. M. Roberts and C. E. Wylie

The Dairy Department has made a study of the flavor defect commonly occurring in winter milk described as "strong," "rancid," "salty," "bitter," or "goaty." This defect is most often present in the milk of cows in the later stages of lactation, but develops readily when they receive dry feeds with no pasture or succulent roughage.

CAUSE

The enzyme lipase, a normal constituent of cow's milk, breaks down the fat into compounds which have a pronounced odor and flavor, and it is these compounds that impart the characteristic

rancid flavor to the milk. There is very little trouble with off-flavor in the milk of cows that are on pasture or of those that have just freshened, because the volume of milk is very large in proportion to the enzyme content. In the fall and winter, the volume often is smaller, for the reason that the cows do not get enough feed to maintain their production. Moreover, many cows naturally decline in the amount of milk they produce. The proportion of lipase increases as the quantity of milk decreases. It is this condition, and not something the cows eat, that causes the off-flavor to occur more often in the fall and winter.

It is a common belief, however, that the flavor is caused by cows' eating acorns, oak leaves, and the like. As a rule, a cow will not eat acorns if she can get suitable feed. If she does eat such things it is an indication that she is not getting enough feed for good milk production. The likelihood that rancidity will develop is greater if the cow has been giving milk for a long period of time.

CONTROL

There is no way by which lipase can be kept out of milk. There are ways, however, by which the enzyme can be controlled.

1. If the cow is giving bitter, rancid, or salty milk, and is nearing the end of her lactation period, the best solution probably is to dry her off.

2. If the cow is not due to calve for several months, and her milk goes rancid, the off-flavor can be prevented by the mixing of her milk, while it is still warm, with the warm milk from two or more fresh cows or cows whose milk is still normal in flavor. Usually, about 1 gallon of milk that goes rancid can be mixed with 5 gallons of normal milk without harmful results. The milk must be mixed while it is warm and fresh. If rancidity is allowed to develop before the milk is mixed, all of the milk will be ruined.

3. If there is only one cow that is not due to freshen soon, the lipase can be destroyed readily by the heating of the fresh milk to 143° F. for 30 minutes. If the milk is to be consumed as whole milk, it should be cooled to 60° F., or preferably lower, immediately after heating. The off-flavor will not develop after the enzyme is destroyed. The heating should be done in a double boiler to keep the cooked-flavor at a minimum. A thermometer should be used to check the temperature. The milk will not be harmed, but the cream will not rise to the top as readily as in raw milk.

CHURNING

Milk that has been heated to 143° F. for 30 minutes, and cooled, will not sour very quickly because practically all of the souring bacteria are killed. Therefore, if one wishes to make buttermilk or to get sour cream for churning, he can cool the heated milk to from 70° to 80° F., or warm the previously heated milk or cream to this temperature, and add approximately one-half teacup of buttermilk, from a previous day's churning, to 1 gallon of the milk or cream.

The milk or cream should be kept in a warm place (70° to 80° F.) until it sours.

It is practically impossible to churn extremely rancid milk or cream. The fat globules will not gather to form butter. Often, a condition results that may be described as soapy or foamy. Actually, a small amount of soap is formed by the action of milk salts and the free fatty acids which are liberated by lipase activity. This condition may be prevented by control of the lipase in the fresh milk.

The hard butterfat which results when cows are put on winter rations may prolong the churning time. This difficulty can be reduced greatly by the feeding of 1 to 2 pounds of linseed meal daily.

OFF-FLAVOR IN BUTTER

Lipase causes objectionable flavor in butter as well as in milk. Butter made from rancid milk or cream will have a rancid flavor. The lipase will continue its activity in the butter and cause the flavor to become more pronounced. This off-flavor can be prevented by the treatments described for control of the lipase in fresh milk.

POULTRY HUSBANDRY

Jesse E. Parker and B. J. McSpadden

PASTURE STUDIES

GREEN FEED COMPENSATES FOR PROTEIN DEFICIENCY IN HENS' RATIONS

Results of one exploratory trial of 20 weeks' duration, with 4 pens of 22 Rhode Island Red hens each, show that hens on a restricted-protein intake that were fed green feed laid almost as well as hens on a high-protein diet without green feed. This may be seen by a comparison of pens C-2 and C-5, in table 28. In the case of hens on the restricted-protein diets, as well as those on the high-protein diets, the groups fed green feed not only laid more eggs

Table 28.—*The effect of restriction of protein intake of Rhode Island Red hens with and without green feed.*

May 19 to October 5, 1943.

Pen No.	Variations in amounts of protein supplement[1] per head per day.	Green feed	Protein in ration[2]	Egg production	Feed required per dozen eggs	
					Total	Protein supplements[3]
			Percent	Percent	Pounds	Pounds
C-1	9 gms.	No	14.0	39.3	6.42	0.58
C-2	9 gms.	Yes	14.0	43.6	5.77	0.53
C-5	18 gms.	Yes	17.0	51.6	5.40	0.96
C-6	18 gms.	No	17.0	46.0	5.82	1.00

[1]Supplement, fed undiluted and in hoppers to all pens, was composed of 50 pounds meat meal, 50 pounds soybean meal, and 1 pound salt.

[2]Percentages protein in rations calculated on basis of data in USDA Yearbook 1939, pp. 839-943. Protein in pasture not considered.

[3]Salt not included.

than groups without green feed, but required less feed to produce a dozen eggs. Pen C-5, which received the high-protein diet and green feed, produced eggs more efficiently than any of the other groups, as measured by the amount of total feed required per dozen eggs. It is noted, however, that the amount of protein supplements required to produce eggs in this pen was relatively large. All pens were fed ad libitum a mixture of 2 parts of yellow corn and 1 part each of wheat and oats.

These studies have particular significance when interpreted in the light of the present protein-supplement and grain-feed shortages.

METHODS OF FEEDING HENS ON PASTURE

Investigations were carried out during the year on methods of feeding laying hens with restricted access to pasture. Four pens of 31 Barred Rock pullets were started on an experiment October 31, 1942, which lasted for 48 weeks. The same feeds were fed to all pens, but in different forms or under different systems of feeding, as shown in table 29.

Table 29—*Influence of method of feeding on the performance of Barred Rock hens.*

Pen No.	A-1	A-2	A-3	A-4
Grain	Grain mixture ad libitum	Grain mixture ad libitum	None	Grain mixture restricted to ½ total feed
Supplement	Meat meal + 5% salt	Mash (18.6%) ad libitum	All-Mash (14.7%) ad libitum	Mash (18.6%) ad libitum
Egg production (%)	51.4	51.8	53.4	58.2
Feed per doz. eggs (lbs.)	6.0	6.4	5.3	5.3
Mortality (%)	25.8	22.6	19.4	22.6
Change in body weight (lbs.)	+0.18	+0.18	−0.10	+0.11
Egg weight (grams)	60.0	60.3	59.4	59.5
Hatchability (%)	86.1	78.4	81.1	83.1

In this one trial all groups performed satisfactorily. Egg production, however, was a little higher in the pen that was fed half mash and half grain. The all-mash pen did not lay so well during the winter months, but a compensatory effect was observed when the weather became warmer. Winter egg production was highest in the pens receiving the ration of grain and meat meal and the ration of half mash and half grain. These experiments will be repeated next year.

LEGUME SILAGE FOR BREEDING HENS

Results of previous investigations at this Station showed that legume silage has a stimulating effect on the egg production of pullets. To determine the value of legume silage compared with alfalfa meal as a green-feed supplement for breeding hens, one 36-week trial was conducted with two pens of 2- and 3-year-old Rhode Island Red hens that were confined to the laying house. The two pens laid at about the same rate and required similar amounts of feed (not including silage) to produce a dozen eggs (table 30).

Table 30—*Legume silage compared with alfalfa meal for the breeding flock.*

Duration of experiment—December 22, 1942, to August 31, 1943. Twenty-nine 2- and 3-year-old Rhode Island Red hens per lot.

Performance	Pen E-1	Pen E-2
	Alfalfa meal[1]	Legume silage
Egg production (%)	32.6	31.4
Mortality (%)	3.5	6.9
Feed per dozen eggs (lbs.)	8.7	8.9
Hatchability of fertile eggs (%)	69.2	79.2
Egg quality:		
Thick albumen (%)	61.7	61.5
Yolk-color index: Range	15-17	15-17
Average	16.1	16.3

[1]Five percent in mash portion of ration.

Hatchability was somewhat higher in the pen fed legume silage. Mortality rates were low in the two groups; the small difference was not significant. There were no appreciable differences in yolk color or in albumen quality of the eggs.

During the first 2 months of the experiment, silage was consumed at the rate of from 5 to 8.5 pounds daily per 100 birds. After the birds became accustomed to it, the rate increased to from 10 to 15 pounds.

FERTILITY STUDIES

INFLUENCE OF TIME OF INSEMINATION ON FERTILITY AND HATCHABILITY

Two experiments, involving 107 hens and approximately 900 eggs, were conducted to determine the influence of time of insemination of hens on their subsequent fertility. Three groups of hens were inseminated artificially at different hours of the day — one group in the morning, from 6:30 to 7:00; one group at noon; and one in the late afternoon, from 5:30 to 6:00. The percentage of fertile eggs laid by the morning group was only 51; whereas, the percentages for the noon and afternoon groups were 72 and 78, respectively. Hatchability of fertilized eggs was significantly higher for hens that were inseminated in the afternoon than for either the morning or noon group.

In the morning many of the hens have not laid, and the presence of a hard-shelled egg in the oviduct may serve as an impediment to the passage of spermatozoa to the place of fertilization. Hens that laid following insemination, but on the same day, produced only 42 percent fertile eggs in the subsequent 2-week period; whereas, those that laid before insemination, or not until the next day, produced 75 percent fertile eggs during the same period.

The results of these experiments suggest that higher fertility and hatchability could be obtained in breeding flocks if the males were allowed to run with the females only in the afternoons during the hatching season.

CHEMISTRY: SOILS AND FERTILIZERS

W. H. MacIntire, W. M. Shaw, and S. H. Winterberg

LYSIMETER STUDIES OF LIMING MATERIALS

DECOMPOSITION OF CALCIC AND MAGNESIC CARBONATES IN SOILS

This lysimeter experiment deals with the cumulative fixation capacity of a soil for 7 calcic, magnesic, and dolomitic materials, incorporated in equivalence at variant rates. During the progress of the fixations, annual outgo of calcium, and of magnesium, is being determined, and the several ultimate soil systems then will be subjected to a chemical examination to establish the changes induced by the several liming materials. The results of leachate analyses for 28 annual periods are summarized in terms of $CaCO_3$ in table 31 as to outgo and residues of Ca + Mg from the 3 natural materials—limestone, dolomite, and magnesite.

The mean annual outgo of Ca + Mg from the 8-, 32-, and 100-ton CaO-equivalent incorporations of limestone were 654, 693, and 682 pounds, respectively, as against 629, 740, and 810 pounds from the corresponding incorporations of dolomite, and 739, 880, and 885 pounds from the magnesite. The mean annual outgo for all incorporations of limestone, dolomite, and magnesite was 404, 449, and 501 pounds, respectively. The present results for soil-alone demonstrate that increase in rates to heavy proportions (a) did not augment the outgo of Ca + Mg from the limestone, (b) caused slight increases in such outgo from the dolomite, and (c) induced appreciable increases in the outgo from magnesite. Within the conventional rates for liming, an increase in rate brings an increase in the leachings of Ca + Mg; but when the rates are such as to provide substantial excesses of the liming materials, the biological end products become the governing factors as to the outgo of the 2 bases.

The Ca + Mg outgo from the unlimed control was 212 pounds and was accounted for virtually by neutral salts. Apparently, the residues from the 8-ton parallels of precipitated $CaCO_3$ and precipitated $MgCO_3$ have been diminished to a level that does not support dissolution of bases to the extent shown for the heavier incorporations of these 2 materials.

The difference between the outgo from an incorporation in soil with and without an underlying stratum of subsoil serves as a measure of retention of Ca + Mg by the subsoil. It may be, however, that the chemical and biochemical activities are not identical for soil alone and soil with an underlying layer of clay subsoil. In general, the quantity of Ca + Mg retained by the subsoil increased with increase in the input of magnesium, as indicated by annual retentions of 150, 188, and 230 pounds from the heaviest incorporations of limestone, dolomite, and magnesite.

The quantities of residual Ca + Mg were computed by respective subtractions of the aggregates of 28-year outgo from the sums of the quantities incorporated and increments through rainwaters.

Table 31—*Current annual and 28-year outgo of Ca + Mg and residues from incorporations of limestone, dolomite, and magnesite at variant rates in a Cumberland silt loam.*[1]

Liming rate	Soil column	Twenty-eighth annual outgo from			Cumulative, 28-year period					
					Outgo from			Residues[3]		
		Limestone	Dolomite	Magnesite	Limestone	Dolomite	Magnesite	Limestone	Dolomite	Magnesite
Tons[2]		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
8	Soil only	384	427	436	18,300	17,600	20,700	14,240	14,940	11,840
	Soil and subsoil	276	263	225	14,000	12,900	11,500	18,540	19,640	21,040
	Retention by subsoil	108	164	211	4,300	5,300	9,200	.....	.....	.....
32	Soil only	431	440	526	19,400	20,700	24,100	97,820	96,520	93,120
	Soil and subsoil	268	251	297	12,400	13,800	15,800	104,820	103,420	101,420
	Retention by subsoil	163	189	229	7,000	6,900	8,300	.....	.....	.....
100	Soil only	402	480	540	19,100	22,700	24,800	340,880	337,280	335,180
	Soil and subsoil	262	294	309	13,300	15,500	15,200	346,680	344,480	344,780
	Retention by subsoil	140	186	231	5,800	7,200	9,600	.....	.....	.....

[1]In terms of $CaCO_3$-equivalence, pounds per 2,000,000 pounds of soil.

[2]In terms of tons of CaO per 2,000,000 pounds of soil.

[3]Residual Ca + Mg in terms of $CaCO_3$-equivalence, by computation from amount incorporated plus 28-year increment of Ca + Mg from rainfall minus 28-year outgo.

Residual Ca + Mg is accounted for by two distinct compositions—the complexes formed through reaction with the soil and the residues from the original incorporations. The residues from the 8-ton incorporations are mostly in the absorbed state, although small carbonate fractions still remain. The residues from the 32- and 100-ton additions are predominantly in the carbonate form, along with absorptions larger than those derived from the 8-ton incorporations. The quantities of Ca and Mg that have been absorbed from the several liming materials will be determined with exactness through detailed chemical analysis when the several soil systems have attained conditions of equilibrium. Attendant examination of the several systems will reveal any distinctive alteration in physical and chemical properties attributed to a specific liming material.

ECONOMIC ADDITIONS OF LIMING MATERIALS

The lysimeter experiment on the conservation of economic incorporations of 4 liming materials has been continued, in cooperation with the Virginia Experiment Station. Burnt lime, limestone, dolomite, and calcium silicate were applied at integral rates of 2000 pounds of CaO-equivalence, repetitions after 4 years, and at quarterly rates during 4-year and 8-year periods. The current results represent the 19th year of leaching data. In some instances the outgo of calcium and magnesium has attained a common level during the past few years, the variations from year to year being attributable chiefly to variations in periodicity of rainfall. During the past year a heavy rainfall caused larger outgo of Ca + Mg from the residues and from the unlimed soil. The current leachings of Ca + Mg are given as respective means for the 4 materials, incorporated as indicated.

	$CaCO_3$-equivalence, pounds per acre
Leached from the unlimed soil	204
Single integral full-depth incorporation	230
Two integral incorporations, 1st and 5th years	249
Four one-quarter full-depth annual incorporations	207
Eight one-quarter annual incorporations	262
Single integral incorporation, upper third of soil	239
Four one-quarter annual incorporations, upper third of soil	250

The outgo of potassium was from 6 to 9 pounds, in comparison with an input of 10 to 12 pounds through rainwaters. The sulfate outgo was close to 165 pounds of $CaCO_3$-equivalence, regardless of variation in treatment. The average outgo of nitrogen was about 14 pounds and only a few pounds above the increment from rainfall.

Since outgo of Ca + Mg, and also that of K, had attained considerable uniformity, annual additions of potassium sulfate were inaugurated to determine any variance in the effect of the several residues of the alkaline earths upon outgo of additive K and SO_4. Every unit except one of unlimed soil received an addition at the rate of 50 pounds K_2O per 2,000,000 pounds of soil, but initial effects will not be known until the leachates have been analyzed.

LIMESTONE VERSUS QUENCHED CALCIUM SILICATE SLAG

The objective of this lysimeter investigation, cooperative with TVA, is to determine (a) the speed with which the slag undergoes dissolution in the soil, (b) the extent to which fluorides appear in ground waters, and (c) whether the slag affects the formation of biological end products. Hence, in addition to the customary determinations of Ca, Mg, K, SO_3, NO_3, bicarbonates, and pH, the leachates were analyzed for solute fluorides and, in some cases incidence of solvated SiO_2. The soil content of carbonates was determined at the end of each annual period to establish the incidence of slag-derived carbonates and the rapidity of the disintegration of the limestone parallels.

Equivalent incorporations of slag and limestone of 4-, 20-, and 100-mesh had been made to Hartsells fine sandy loam and Baxter silt loam at per-acre rate of 2 tons of $CaCO_3$. The underground, or "4-mesh," slag was incorporated likewise at the 5-ton rate and the 100-mesh screenings of the slag and limestone were used also at 10- and 20-ton rates.

The analytical results for the leachates from the single incorporations of the past 3 years are summarized in table 32. The mean annual outgo for the 3-year period is more representative than the outgo for any single year, because of the subnormal rainfall during the initial year and the abnormal precipitation during the second year. Leachings of calcium from the limestone and the slag reveal the fact that the calcium silicate slag is dissolved more rapidly than the corresponding applications of limestone, when the amounts incorporated were beyond the immediate fixation capacity of the soil. The outgo of calcium from the 5-ton incorporation of slag was 134 pounds per annum over the outgo from the limestone, whereas the corresponding increase for the 20-ton application amounted to 388 pounds, as respective means for the two soils. The soil absorption of calcium from the silicate probably was greater than that from the limestone and was an offset to the more rapid dissolution of the slag in the soil water. The repressive effect of the slag upon the outgo of magnesium and potassium is in accord with previously observed effects from incorporations of lime, $CaCO_3$, and limestone. Since the Baxter soil contains greater supplies of exchangeable Mg and K, the repressive effects upon the outgo of those two bases from this soil were less accentuated than corresponding releases to the leachates from the Hartsells soil.

The calcium silicate stimulated nitrification and sulfofication in both soils. The nitrate outgo from the slag was virtually the same as that from limestone at the 2-ton rate, but the 5-ton and 20-ton incorporations of slag caused a decided decrease in the outgo of nitrate. Both of the liming materials caused an increase in sulfate outgo. The uniformly greater outgo from the slag is attributed to the oxidation of its sulfide content.

The fluorine introduced by the slag was equivalent to 1/10 of the neutralizing value of the silicate content. The annual leachings of fluorine from the 2-, 5-, and 20-ton incorporations of slag

Table 32—*Outgo of acidic and basic elements in lysimeter leachates from two soils treated with limestone and quenched calcium silicate slag from Wilson Dam.*

3-year annual means in terms of $CaCO_3$-equivalence per 2,000,000 pounds of soil.

Soil	Leachate components	Control	Rate and mesh of liming materials[1]								
			5 tons of 4-mesh		2 tons of 20-mesh		2 tons of 100-mesh		20 tons of 100-mesh		
			Stone	Slag	Stone	Slag	Stone	Slag	Stone	Slag	Wollastonite
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Hartsells fine sandy loam	Basic										
	Ca	287	978	1046	629	611	671	627	1136	1566	1342
	Mg	114	65	59	83	84	71	86	31	33	29
	K	5	1	1	1	2	1	1	2	5	2
	Sum (B)	406	1044	1106	713	697	743	714	1169	1604	1373
	Acidic										
	N	242	510	436	353	350	386	371	503	343	528
	S	170	261	300	230	254	231	255	283	293	301
	F	0.8	2.4	34.2	2.1	8.4	1.8	10.5	1.0	202.5	2.9
	$HCO_3 + SiO_4$	77	259	281	137	115	134	124	399	773	472
	Sum (A)	490	1032	1061	722	727	753	761	1186	1612	1304
	Excess (A) or (B)	84A	12B	45B	9A	30A	10A	47A	17A	8A	69B
Baxter silt loan	Basic										
	Ca	257	827	1026	619	601	624	613	1056	1411	1312
	Mg	125	95	95	117	114	108	109	43	62	41
	K	20	10	17	13	12	14	9	10	10	15
	Sum (B)	402	932	1138	749	727	746	731	1109	1483	1368
	Acidic										
	N	296	461	478	428	396	436	371	453	361	475
	S	133	244	309	230	244	226	239	260	313	283
	F	0.8	2.1	28.9	1.3	6.6	1.6	7.9	2.1	161.4	3.7
	$HCO_3 + SiO_4$	64	235	344	148	123	136	117	371	744	595
	Sum (A)	494	942	1160	807	770	800	735	1086	1579	1357
	Excess (A) or (B)	92A	10A	22A	58A	43A	54A	4A	23A	96A	11B

[1]The blocked-off figures represent tons of $CaCO_3$-equivalence and mesh of material, respectively.

were 8, 32, and 182 pounds, respectively, in terms of $CaCO_3$-equivalence. Upon the assumption of complete dissolution and leaching of the fluorine introduced by the slag, outgo of fluorine would be respectively equivalent to 133, 333, and 1333 pounds of $CaCO_3$ for the 2-, 5-, and 20-ton incorporations. It is reasonable to assume that the 2-ton incorporations of slag had been decomposed completely during the 3-year period. The heavier incorporations probably did not undergo complete disintegration during that period; fractions have reacted with the soil, whereas, major fractions have been transformed to $CaCO_3$ and SiO_2. Because of the preponderance of calcium ions in the soil waters, the expectancy is that the dissolution of the slag in the soil would promote the deposition of CaF_2. Such deposition would account for 400, 1000, and 4000 pounds of $CaCO_3$-equivalence for the 2-, 5-, and 20-ton incorporations, respectively. The established enhancements in fluorine outgo as an effect of increase in the rates of slagging are not explainable on the basis of surface effect. The fluorine outgo, in relation to rate and periodicity of incorporation, suggests the postulation that the liberated fluorides become integrants of soil complexes and hence become less dissoluble than the freshly precipitated CaF_2, especially so for the 2-ton incorporation and to a less degree for the heavier incorporations.

The outgo of calcium as bicarbonate and as solute silicate, if any, was determined by titration of the leachate against methyl orange. It was expected that the largest proportion of solute silicate would occur in the leachates from the heaviest incorporation of slag, and SiO_2 determinations therefore were restricted to leachates from the 20-ton incorporations. These leachates showed a mean annual outgo of 84 pounds of SiO_2, or a $CaCO_3$-equivalence of 138 pounds, which accounts for only 18 percent of the leached bicarbonates. Obviously, the soil retained most of the colloidal silica generated through the disintegration of the slag. The leachates from the lighter incorporations of limestone and slag were alike as to bicarbonate content, but the bicarbonate concentration in the leachates from the 20-ton incorporation of slag was twice that in the leachates from the limestone parallel.

The dependability of analytical procedures is demonstrated by the general concordance between totals for the basic components and totals for the acidic components in the leachates. Any apparent excess of the acidic ions, especially in the leachates of minimal titration value, is attributable to the proximations that characterize methyl orange titrations of solutions of low bicarbonate concentration.

LIME-POTASH STUDIES

The effect of additive liming materials upon dissolubility of soil potassium is of prime importance and is registered effectively in the lysimeter investigations. The addition of potassium salts to the soil introduces a number of secondary effects of importance in overall appraisals. Thus, the absorption of additive potassium by

the soil is concomitant with an enhancement in the outgo of calcium and magnesium. This exchange occurs in variant degree and is governed by the quantity of K added and by the soil's content of exchangeable forms of the two divalent elements. Moreover, the anion combination of the additive potassium affects the extent of the K absorption and concomitant replacement of Ca and Mg.

To study the effect of light incorporations of limestone upon conservation of potassium, and of sulfates, from heavy additions of K_2SO_4, a Cumberland loam and a clay subsoil have been subjected to a potassium build-up, since 1940. Annual applications of K_2SO_4 were made at the rate of 800 pounds of K_2O per 2,000,000 pounds of soil. An initial incorporation of limestone at the per-acre rate of 2000 pounds of CaO did not effect complete neutralization of the acidity of either the surface soil or the subsoil. The 3-year leachate data, therefore, afford a comparison between the retention of potassium and of sulfate by both soil and subsoil in their initial acidic state and after partial neutralization. When corrected for outgo from the untreated soils, retentions were established, as shown in table 33.

Table 33—*Annual retentions of K_2O and SO_3 from K_2SO_4 additions that supplied 800 pounds of K_2O per acre per annum.*

Year	K_2O retained by				SO_3 retained by			
	Soil		Subsoil		Soil		Subsoil	
	Unlimed	Limestoned	Unlimed	Limestoned	Unlimed	Limestoned	Unlimed	Limestoned
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
First	699	756	800	800	264	—79	680	622
Second	244	421	652	769	—82	—38	336	— 7
Third	176	339	505	580	—32	76	61	—148
Total	1119	1516	1957	2149	150	—41	1077	467

These data point several findings. The retentions of potassium and SO_4 ions are divergent, K being absorbed more extensively in the limestone soils, whereas the SO_4 is retained to a greater extent by acidic soil systems. The potassium retention is sustained by a 60- to 75-percent absorption from the third annual direct addition to the clay subsoil; SO_4-retention ceased after the initial year in the limestoned soil and after the second year in the acidic clay. The SO_4 is leached from the soil usually in combination with Ca and Mg. In highly acidic soils, however, part of the SO_4 is fixed by the soil and part is leached as $Al_2(SO_4)_3$. The K absorption proceeds with equivalent displacement of Ca and Mg from the soil complex, unless the depletion of these bases induces displacement of absorbed hydrogen.

By continuation of the annual K_2SO_4 additions, it is hoped that K-absorption equilibrium will be established in a few years, and the experiment then will proceed without further additions, so that rate of potassium outgo from the K-saturated soils can be determined, after which the soils will be analyzed to determine the exchangeability of the absorbed K.

EFFECT OF HEAVY LIMING UPON THE OUTGO OF ABSORBED POTASSIUM IN THE SOIL LEACHATES

Four types of surface soil and one clay subsoil were built up in K content through several annual applications of K_2SO_4. Heavy incorporations of $Ca(OH)_2$ were made thereafter, in 1939. The substantial build-up of potassium and SO_4 prior to the heavy liming and outgo for the subsequent 4-year period are shown by the tabulations of table 34. The extent of K retentions varied with the type and reaction of the soil, whereas, the sulfate retentions were fairly uniform, except for the greater retention by the acidic clay.

Table 34—*Effect of heavy $Ca(OH)_2$ applications upon the release to lysimeter leachates of absorbed K_2O and SO_3 from previous treatments with K_2SO_4.*

No.	Soil		K_2O outgo			SO_3 outgo			Annual average Ca outgo[3]
			Build-up prior to liming[1]	Since liming[2]		Build-up prior to liming[1]	Since liming[2]		
				Actual	Relative to build-up		Actual	Relative to build-up	
			Pounds	Pounds	Percent	Pounds	Pounds	Percent	Pounds
1	Freelands silt loam	A	1288	485	38	775	400	52	239
		B	1288	618	48	775	409	53	1086
2	Hartsells fine sandy loam	A	406	138	34	780	402	51	156
		B	406	69	17	780	591	76	1229
3	Sevier silt loam	A	453	191	41	908	442	49	156
		B	453	75	17	908	671	74	1006
4	Chickamauga clay loam	A	2438	147	6	697	544	78	649
		B	2438	152	6	697	962	138	2574
5	Red clay subsoil	A	1531	403	26	1309	460	35	55
		B	1531	214	14	1309	871	67	743

A—unlimed.

B—limed.

[1]Computed from the amounts of K_2SO_4 applied plus K_2O and SO_3 increments in rainwater for the 1934-39 period before liming, less K_2O and SO_3 in leachates covering same period.

[2]Four-year period, 1940-43, corrected for 12 pounds K_2O and 157 pounds SO_3 found annually in rainwater.

[3]Three-year average after the leachates became free of $Ca(OH)_2$. Three-year average calcium from rainwater—83 pounds $CaCO_3$-equivalence.

The effect of the heavy subsequent additions of $Ca(OH)_2$ upon the outgo of previously added potassium should be appraised in the light of the results from the initially acidic soils 2, 3, and 5. The $Ca(OH)_2$ exerted a markedly repressive effect upon the outgo of the built-up supply of potassium. One of the two slightly alkaline soils showed a slightly increased outgo of potassium, probably as a result of the marked effect of the $Ca(OH)_2$ upon soil structure. The other alkaline soil, which had attained maximal build-up of K, showed the lowest percentage outgo of potassium and no outgo effect from the $Ca(OH)_2$. The calcium outgo from the limed soils was from 4 to 8 times as large as that from those unlimed and was due largely to calcium bicarbonate, although a part of the increase was accounted for by leachings of nitrate and sulfate.

The 4 years of rainwater leaching failed to recover the build-up of sulfates from the previous additions of K_2SO_4; the acidic and the limed clay subsoil systems still showed respective retentions of

65 and 33 percent from the 1309-pound input of SO_3. The retentions by the surface soils were less extensive, but these values probably would be considerably greater if they could be corrected for the indeterminate increment of sulfates derived from the sulfur compounds native to the soil.

COMPARATIVE ACTIVITIES OF POTASSIUM SULFATE AND POTASSIUM METAPHOSPHATE

Potassium metaphosphate presents an ideal combination of 2 fertilizer elements in high concentration, with resultant economy in transportation and handling. It therefore is desirable to ascertain how the 2 components of this fertilizer behave after incorporation. The meager quantities of the phosphate ion that appear in the lysimeter leachates demonstrate retention, but this does not establish transition of the PO_3 ion to ortho form in the soil. The lysimeter phase of the study, therefore, is restricted to the fate of the potassium ion of the metaphosphate and its effects upon the leaching of Ca and Mg.

The Hartsells fine sandy loam and the Fullerton silt loam were limestoned and dolomited at the respective rates of 5000 pounds and 2775 pounds of $CaCO_3$ per 2,000,000 pounds of soil, and additions of potassium metaphosphate at rates of 200 and 1000 pounds of K_2O, potassium sulfate being the control. The outgo of potassium, Ca + Mg, and sulfates is given in table 35.

Although potassium metaphosphate is sparingly soluble in cold water, that phosphate yielded its K readily to the soil leachates. The repressive effect of limestone and of dolomite upon outgo of potassium was evidenced more distinctively in the absence of additive K and for the 200-pound additions than for the larger addition. The repressive effect was more pronounced with the Hartsells soil than with the Fullerton.

A substantial fraction of the SO_4 introduced alone as K_2SO_4 was retained by the soil. Outgo of sulfates was enhanced greatly by liming, the enhancement being greater for the Hartsells soil than for the Fullerton; and the metaphosphate additions caused a similar result.

The effect of potassium metaphosphate upon outgo of calcium, and of magnesium, is opposite to the effect of conventional potassium salts. The addition of potassium as either muriate, sulfate, or nitrate causes an increased outgo of calcium in the leachates; whereas, additions of potassium metaphosphate induced significant repression in the amounts of calcium and magnesium in the leachates. This may be explained by the postulated conversion of PO_3 to PO_4 and the formation of water-insoluble ortho phosphates of calcium in the soil, in concomitance with the absorption of K by the soil complex. The transitions may be more involved, however, since the effect of KPO_3 upon Ca + Mg outgo from the limestoned and the dolomited Hartsells soil was opposite to the effect upon the parallels of Fullerton soil. Additional data probably will afford a clearer insight as to the various factors that influence the exchange reactions.

Table 35—*The divergence in the behavior of potassium incorporated as the metaphosphate and as the sulfate in two soils, with and without limestone and dolomite.*

Liming material[1]	Outgo, pounds per 2,000,000 pounds of soil									
	From Hartsells fine sandy loam					From Fullerton silt loam				
	No K added	Additions of K_2O				No K added	Additions of K_2O			
		200 pounds		1000 pounds			200 pounds		1000 pounds	
		as KPO_3	as K_2SO_4	as KPO_3	as K_2SO_4		as KPO_3	as K_2SO_4	as KPO_3	as K_2SO_4
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
POTASSIUM, AS K_2O										
None	19	96	118	426	321	55	114	147	345	264
Limestone	5	23	29	295	134	30	87	98	407	240
Dolomite	6	25	.....	348	.....	31	83	.....	380	.....
Ca + Mg, AS $CaCO_3$										
None	254	269	315	209	433	510	352	455	189	405
Limestone	1216	1193	1423	945	1522	848	649	838	441	881
Dolomite	1212	1251	.....	1165	.....	919	566	.....	424	.....
SULFATES, AS SO_3										
None	55	94	181	190	405	75	75	184	105	318
Limestone	229	228	381	242	594	170	135	285	162	500
Dolomite	224	246	.....	269	.....	184	136	.....	163	.....

[1]At per-acre rate of 5000 pounds and 2775 pounds of $CaCO_3$ for Hartsells and Fullerton soils, respectively; full-depth incorporation.

LIME-PHOSPHATE STUDIES

The lysimeter study of the relationship between phosphate and fluoride tie-up in the soil has been continued by repetitive additions of CaF_2, which have reached a total of 1660 pounds of fluorine per 2,000,000 pounds of soil. The fluorine outgo has increased to 15 pounds during the current year. Contra to expectancy, the outgo of fluorine from that incorporated with the dicalcium phosphate, and with calcium metaphosphate, has been only ½ to 2/3 of the outgo from that incorporated with precipitated tricalcium phosphate. A 7-year summary of the mean net annual outgo of calcium from the several additive phoshates, with and without CaF_2, is given in table 36 and reveals the extent to which the phosphates and the combinations yield calcium to the leachates.

Table 36—*Mean annual net*[1] *outgo of calcium from three phosphates over a 7-year period, in terms of* $CaCO_3$ *per* 2,000,000 *pounds of soil.*

	Pounds
From Ca-metaphosphate	33
From dicalcium phosphate	129
From precipitated tricalcium phosphate	148
From Ca-metaphosphate + CaF_2	64
From diCa-phosphate + CaF_2	114
From precipitated triCa-phosphate + CaF_2	209

[1]Corrected for outgo from the no-treatment soil.

The leachates show that although the PO_3 and the PO_4 are retained tenaciously by the soil, most of the calcium introduced by dicalcium and tricalcium phosphates passed into the soil leachings. The outgo of calcium was least for the acidic phosphate and greatest for the tertiary compound. The enhancement in mean annual outgo of calcium from a 2-ton addition of limestone to the same soil was 200 pounds per acre. The data indicate also that the additive CaF_2 yielded calcium to the leachates without an equivalent outgo of fluorine.

COOPERATIVE INVESTIGATIONS

METHODS FOR THE DETERMINATION OF THE NEUTRALIZATION VALUES OF CALCIUM SILICATE SLAGS

The rock phosphate reduction furnaces in Tennessee, Alabama, and Florida are producing large quantities of calcium silicate slag. The value of this slag as an agricultural liming agency, and as an emergency source of phosphate, has been established by the investigations conducted at this Station in collaboration with the Tennessee Valley Authority. A distinctive slag from the blast furnaces of the steel industry also is being used extensively. Both of these slags are complex materials, the neutralization values of which are not determinable by the A.O.A.C. titrative procedure prescribed for limestone. That procedure has been found to register neutralization values that vary from 5 to 35 percent of potential values computed from analysis of the slags.

The principal cause of erroneous results has been established as the inadequacy of the amount of standardized acid prescribed for the parallel dissolution of limestone. The quantity of acid required for the dissolution of slags exceeds that appropriate for equivalent charges of limestone. The larger requirement of acid is due to the considerable incidence of dissolvable alumina, which immobilizes a fraction of the acid as aluminum chloride, the back titration of which produces an absorptively active precipitate of alumina and silica. The true titration end point varies with the composition of the slag. Potentiometric titration to a pH range between 4.8 and 5.0 has been found to give satisfactory results for blast-furnace slag; whereas, a titration of the phosphate-furnace slag to pH 6.5 is required for accuracy within 2 percent of the true value. The tentative analytical procedure proposed for the evaluation of the phosphate-furnace slag is an improvement over the absolute analysis, one that would not be feasible in control laboratories. Details of the experimental attack and the proposed procedure will be presented as a report on liming materials to the Association of Official Agricultural Chemists.

The proposal for the substantial defluorination of concentrated superphosphate was advanced to confirmation in semi-works operations in the Cooperative Chemical Engineering Research Unit. The proposal involves the immediate processing of the fresh acidulate and thus obviates the need for conventional curing of superphosphate. The resultant is a stabilized and storable concentrate characterized by inactivated Fe and Al content and by incidence of skeletonized particles comprised of ortho and meta forms, both being readily extractable.

In a study to integrate the properties of precipitated tricalcium phosphates of industrial origin with the properties of the several tertiaries formed by either the liming, slagging, or ammoniation of superphosphate, the precipitates obtained from several dependable vendors were found to be decidedly variant. Although the purported tricalcium phosphates were labeled identically, the purchased products were found to be severally dicalcium phosphate and hydrated and hydroxy tertiary phosphates. They were markedly variant as to composition, dissolubility, optical properties, and X-ray pattern, in their uptake by rye seedlings, and in their response to crops in pot cultures. In the last-mentioned aspect the several tertiaries showed decidedly different responsiveness in limestoned soils. A simple chemical test has been devised for the differentiation of normal tertiary and hydroxy phosphates.

Although crystalline tricalcium phosphate has been considered non-occurrent, a hydrated product of definite crystallinity has been obtained and studied, as such and as its beta derivative. The product has been made in 5 replications by as many operators and should serve as a standard carrier of P_2O_5 in pot cultures.

Contributions were made to the study of the efficacy of different coatings on ammonium nitrate granules to cure the hygroscopicity of that concentrate. The paraffin component in the most

effective organic coating mixture did not promote determinable denitrification and did not hinder dissolution of the capsuled nitrate.

Fused tricalcium phosphate is a glass-like product obtained by the TVA thermal process for the substantial defluorination of rock phosphate. The influence of degree of defluorination upon the fertilizer value of quenched fusions of rock phosphate, therefore, was studied in the chemical and Neubauer laboratories, by X-ray, and through pot cultures. It was found that 80-percent defluorination was requisite to the attainment of a satisfactory product comprised chiefly of the alpha form of tricalcium phosphate. The availability of the P_2O_5 of the product obtained by substantial defluorination and quenching was not repressed in soils limestoned at rational rates. In this respect the quenched fusion differed from both raw rock phosphate and the hydroxy precipitate.

Direct incorporations of ammonia as the hydroxide were found to be nontoxic and virtually as effective as equivalent quantities of the sulfate, at rational and economic rates. The NH_4 of the hydroxide was found to be fixed by the soil immediately and held tenaciously against aqueous leaching until biochemical transition to nitrates; whereas, extractions with an aqueous solution of KCl effectuated 85-percent recovery of the fixed NH_4.

The factors that affect P_2O_5 availability in the ammoniation of superphosphate were studied. Intensity and duration of the ammoniation, temperature during aging of the ammoniated systems, and percentage content of calcium sulfate and fluorides were found to affect the reversion reactions.

A study of citrate digestion of phosphatic fertilizers resulted in the development of an electrically heated air chamber for the continuous agitation of digestates. The apparatus improves reproducibility of analytical values, eliminates the uncertainty inherent in periodic manual agitations, increases analytical output, and has other obvious advantages.

The influence of particle size of calcium metaphosphate and the effect of liming upon the availability of its PO_3 content were studied. It was concluded that a product of minus 20-mesh, and even of minus 10-mesh, and carrying substantial proportions of minus 60-mesh fines, would assure maximal plant response. Liming at the per-acre surface rate of 3 tons of $CaCO_3$ did not repress effectiveness of the metaphosphate.

Further studies indicated that, in general, the P_2O_5 content of the quenched calcium silicate slag and its liming potential were jointly as beneficial as equivalent corresponding joint incorporations of superphosphate and limestone.

Pollution of ground waters by the fluorine content of the quenched slag was found negligible for 2-ton incorporations and considerable for the heavier incorporations. The greater solubility of the quenched slag was reflected by calcium outgo beyond that from equivalences of limestone. The slag apparently repressed the dissolution of the potassic and magnesic compounds native to the

soil. Incorporated in fine condition at undue rates, the slag repressed nitrification.

W. M. Shaw again has served the A.O.A.C. as Associate Referee for Liming Materials, and has concentrated his efforts upon a procedure for the determination of CO_2 in soils. W. H. MacIntire has served that organization as General Referee for Soils and Liming Materials and as its designate on the Board of Governors of the Crop Protection Institute.

CHEMISTRY: GENERAL

G. A. Shuey

FROZEN FOODS

The good qualities of foods preserved by freezing are gaining in recognition. It is predicted that after the war both commercial and home freezing of foods will increase rapidly, especially in areas of abundant and low-cost electricity. The processing is easy, and frozen fruits and vegetables retain much of the appearance and quality of the fresh product. For these reasons they are desired by many people. While considerable progress has been made in developing technics for home freezing, there is still plenty of room for improvement.

For freezing-preservation, fruits and vegetables are prepared much the same as for canning, then treated in various ways to arrest the activity of enzymes, after which they are packaged and frozen. This treatment seals in much of the garden and orchard freshness. Recently there have been important developments in the preparation of new frozen products. Mixtures of fruits and of vegetables are being frozen. Frozen-fruit purees and vegetable purees undoubtedly will become popular items of food as time goes on. Cooked foods held in the frozen state are finding their way into the home dietary. Frozen vegetable- and fruit-juice concentrates are being prepared experimentally in our laboratories.

During the year, fruits and vegetables, many of which were grown by the Station Department of Horticulture, were frozen and stored in the zero-degree room for 6 months, after which they were cooked and judged for quality.

The frozen products studied included 17 varieties of lima beans, both large- and small-seeded; 53 varieties of snap beans; 16 varieties of edible soybeans; 13 varieties of table beets; 4 varieties of cabbage; 6 varieties of sweet corn, 3 white and 3 yellow; 20 varieties of peas; 8 varieties of raspberries, and 4 varieties of strawberries. The experiments also included the freezing of blueberries, broccoli, cantaloup, carrots, diced turnips, sour cherries, cucumbers, okra, summer apples, peaches, pumpkin, sweetpotatoes, rhubarb, tomatoes, turnip and mustard greens, and sauerkraut.

Frozen products were judged on general appearance before cooking; and on color, firmness, odor, flavor, and texture after cooking. Of 12 varieties of large-seeded lima beans studied, 6 were found to be satisfactory for freezing-preservation; and of 5 varieties of small-seeded lima beans, 1 was successfully frozen. Eleven of the 53 varieties of snap beans were satisfactory. Three of the 16 varieties of edible soybeans made excellent frozen products. Three of the 13 varieties of table beets made good frozen products. The 6 varieties of sweet corn all proved to be satisfactory. Of the 20 varieties of garden peas, 8 made good-quality frozen products.

Fig. 15—Harvesting snap beans for freezing and dehydration studies.

Blueberries, specially treated for tenderizing, produced a desirable frozen pack. Broccoli, carrots, turnip and mustard greens, okra, squash, rhubarb, sour cherries, and freestone peaches—both plain and sugar-sirup pack—were satisfactorily preserved by freezing. Cabbage—whole heads and cut—did not yield a desirable frozen product. Frozen sauerkraut had very good quality. Pumpkin, pulped to a heavy consistency suitable for pie stock, held well in the frozen state. Pulped and diced sweetpotatoes held their quality well. Frozen whole tomatoes lose their crispness, and upon thawing become flabby and unattractive. Good results may be obtained, however, with tomatoes prepared as for canning, or pulped, seasoned with a little salt, and frozen. Frozen whole and sliced cucumbers and cantaloup were very unsavory and flabby.

It was found that fruits such as raspberries, blackberries, and peaches that become soft when fully mature should be frozen when firm ripe. Since freezing seals in defects as well as good qualities, it is important that all moldy and otherwise defective pieces of fruits and vegetables be discarded. All fruits and vegetables, particularly the latter, should be promptly processed after harvest.

Experiments are being conducted to determine the effectiveness of several permissible substances in the prevention of brown-

ing of sliced apples and peaches. The protective qualities of wrapping and packaging materials are receiving attention.

Best sizes of containers for home freezing of fruits and vegetables are those holding 1 pound (1 pint), and 2 pounds (1 quart). Foods should be frozen promptly after packaging, and stored at or near 0° F.

Frozen foods are perishable at ordinary room temperature and should be consumed soon after removal from low-temperature storage. Such products, however, may be kept for several days in the kitchen refrigerator.

SORGHUM SIRUP

The current year brings to a close our experimental work on the processing of sorghum sirup. Tennessee harvests 21,700 acres of sorghum cane annually[1] for sirup-making purposes. The average yearly production of sorghum sirup in the State is 1,234,830 gallons, or about 56.9 gallons per acre. Makers of sirup strive to produce the best in their respective communities, but usually this is not good enough to insure wide preference on the part of the consumers. It was thought advisable to work out a method suitable for processing sirup on a community-enterprise scale, so that a uniform product of good quality can be made each year. Likewise, attention has been given to some of the factors that affect both yield and quality of sorghum sirup, such as date of maturity of cane, and method of handling at time of harvest. The method and the care used in making sirup are found to be of great importance. Juice tanks, evaporators of our own design, and other equipment were arranged according to our plan of processing. The cane was hauled to the plant, where it was weighed and milled. The juice was conducted by gravity to wooden tanks, and there measured, tested, and treated for clarification prior to evaporation to sirup. Yields of cane, juice, and sirup were obtained.

Some of the major results and conclusions are as follows: (1) Over a period of 5 years, 15 varieties of sorghum cane have been grown and processed in our experimental plant. Of this group, Honey Drip, Kansas Orange, and Red X produced the highest yields of cane and juice per acre. (2) The amount of invert sugar present in many sorghum juices, with that formed during evaporation, is not always sufficient to prevent "sugaring" of the sirup. The addition of invertase enzyme, a pure substance made from yeast, will prevent "sugaring" of the finished sirup. (3) Various substances in sorghum juice other than sugars, commonly known as impurities, can be removed by heat-coagulation, settling, and skimming prior to concentrating to sirup. (4) A rectangular, open-style, coil-equipped steam evaporator designed by us proved to be satisfactory. (5) A uniform product can be obtained by blending, in a tank, sirups of different varieties of cane. (6) Sorghum cane grown in Tennessee should be processed when the seed is in the

[1]Average for 10-year period, 1926-1935.

early dough stage. Frost-damaged cane produces sirup of inferior quality. (7) It has been demonstrated that uniform sirup of good quality can be produced in quantity by the use of rather inexpensive equipment.

Sirup was produced from Tennessee-grown cane at the average rate of 13.5 gallons per ton, or 108 gallons per acre yielding 8 tons of stripped cane. 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 labor, fuel, containers, electric power, and miscellaneous items. A group of business men located in one of the better sorghum-growing areas of the State have been making sorghum sirup by our process for several years, in conjunction with their vegetable-canning plant. This plan appears to offer possibilities for extension of the operating period of smaller canneries, since sorghum-sirup processing closely follows the canning season.

DEHYDRATED FOODS

Dehydrated foods have proved to be of great value to a world at war. The consumption of these foods by the armed forces, as well as by the civilian population, has increased immensely during the past two years. Victory gardens have added considerably to the total food supply, and dehydration has been used in many homes as an alternate method of preserving fruits and vegetables, especially where canning equipment was lacking.

Within the past two years the number of commercial plants for dehydrating vegetables has increased from 18 to 133, with a corresponding increase in the amount of dehydrated vegetables, from 20 million pounds to well over 250 million pounds. The rapid growth is due to a ready market, and to the fact that many operators believe that commercial dehydration of certain kinds of vegetables has a reasonably good future after the war.

During the past year, research on home dehydration of fruits and vegetables was conducted jointly by the General Chemistry Department of the Station and the Agricultural Engineering Development Division of the Commerce Department of the Tennessee Valley Authority.

Studies have been made of losses in the preparation of vegetables for dehydration. Our cabinet-type electric dehydrator has been improved. The effects of different conditions of packaging and storage on quality of dehydrated products have received attention. Consideration has been given also to the varieties of several kinds of vegetables best suited to this method of preservation.

It should be emphasized that dehydrated vegetables and fruits have undergone special treatments in their preparation which impart to them certain characteristics. Blanching of vegetables, sulfuring of fruits, and exposure to heat and air during processing produce changes that characterize them as dehydrated products. It is not possible, therefore, to make a fair comparison of dehydrated

fruits and vegetables with fresh or canned products of the same kinds merely on the basis of palatability and appearance; their nutritive value also must be considered.

Dehydrated fruits and vegetables, particularly the latter, must be protected from the absorption of moisture, and from oxidation caused by the interchange of air, if they are to keep well. Practical containers for home use include glass jars, tin cans with slip-covers or friction lids, cylindrical and cylindrical-tapered waxed-paper boxes, tin-and-fiber cans waxcoated on the inside, and wax-coated cardboard boxes lined with moisture-proof paper such as heat-sealing cellophane. Products may be packed also in cellophane bags, heat-sealed, and stored in a larger tin container having a well-fitted lid. An important requirement of packaging materials is that they must not impart foreign odors or flavors to the product.

It was found that in their ability to refreshen readily, and in their general appearance and flavor, dehydrated snap beans and carrots packed in sealed containers in which the air was displaced with carbon dioxide gas were superior to the same material similarly packed without displacement of air.

Dehydrated fruits and vegetables are perishable, and therefore must be protected by packaging in air-tight, insect-proof containers, and storing in places where the temperature does not get too high. Since high storage temperature appears to be the greatest single factor in the deterioration of quality, regardless of how well the material is packed, it is recommended that dehydrated fruits and vegetables be stored in the coolest place in the home, usually the basement. Dehydrated products lose some of their ability to reconstitute (refresh in water) readily if stored at temperatures much in excess of 75° F. for several months. These products keep well at freezing temperatures and below if protected by suitable packaging.

While not conclusive, studies with Tennessee-grown snap beans, vegetable soybeans, sweet corn, beets, white potatoes, and sweet-potatoes indicate that some varieties of vegetables are more desirable than others for dehydration. Then, too, we have found that there is a stage of maturity at which each variety suited to dehydration will make its best product. These data are being compiled for publication.

As shown in the annual report for 1942, our research resulted in the development of a cabinet-type electric dehydrator suitable for use in the home. Engineering studies are being made of different drying temperatures, air velocities, relative humidity, sources of heat and ways of applying it, and tray construction, as they affect drying cycle and quality of product.

Work now in progress includes a study of the nutrient losses that occur through water and steam blanching in the process of dehydration, and in storage.

Whether dehydration will be employed in the home for preserving fruits and vegetables after the war, is not an easy question to

answer. When we again have ample supplies of fresh, frozen, and canned foods, many city dwellers will discontinue their vegetable gardens. Families living on farms, and many in the towns, who have been accustomed to canning and drying products of their gardens, and will not be in position to purchase a freezer-storage cabinet, will continue the dehydration and canning of fruits and vegetables. Generally speaking, many dehydrated vegetables, such as sweet corn, vegetable soybeans, green peas, green snap beans, squash, and greens, are of good enough quality to hold their own with home-canned products.

LEGUME SILAGE

Studies of the making and feeding of legume silage were continued at the Tobacco Experiment Station, Greeneville. Eight silos of 10-tons capacity each were used. Two silos were filled with alfalfa, 2 with sericea, 2 with alfalfa-sericea mixture, and 2 with corn and sorghum. Blackstrap molasses was applied to 1 silo each of alfalfa, sericea, and alfalfa-sericea mixture. Feeding experiments with farm animals have been conducted, and data are being compiled. Samples from each silo were taken periodically for chemical analysis. A trial batch of soybean-sweetpotato silage was prepared and fed to beef animals.

Feeding trials of the silages were made during the fall and winter. Results will be reported after a study of the data is completed. Silage made of alfalfa-sericea mixture was eaten readily. This suggests a method of utilizing sericea as silage and thus making it more palatable. Cull sweetpotatoes fed into the silage cutter with the green soybean stalks, at the rate of about 3.5 bushels (193 pounds) per ton of soybeans, provided carbohydrate for proper fermentation, and made good sour silage.

FRUIT JUICES

During the past year, small-scale experiments in the preparation of fruit-juice concentrates were conducted with strawberries, blackberries, and blueberries. Juice concentrates were prepared from the undiluted fruit juices by the removal of water as ice (freezing) and subsequent separation of the ice from the concentrated material. This work was limited by the scarcity of small fruits.

It has been found that fruit-juice concentrates will retain their quality for a longer period of time if prepared from pre-heated fruit and stored in a cool place. Since centrifugal separation of ice from juice concentrates is not practicable in the average home, we have found that small juice presses may be adapted to this purpose. Juice concentrates of 45° Brix have been obtained.

The wholesomeness of fruit juices is well known. Fruit-juice concentrates provide excellent flavoring for beverages and ice creams. The diet may be considerably improved by the use of more fruit juices.

SWEETPOTATO STUDIES

During the year, 16 varieties of sweetpotatoes grown by the Station were dehydrated experimentally in equipment designed for home use. The potatoes were peeled, diced, blanched, and dehydrated under controlled conditions of temperature and air-flow. The ability of dehydrated sweetpotatoes to reconstitute in water, and their quality after cooking, are being studied. Unblanched samples of each variety were dried and prepared for chemical analysis. Several of the deepest-colored varieties were partially dehydrated, then frozen, and are being held at 0° F. for examination later. Experiments were performed on the removal of peels by submergence of the sweetpotatoes in hot solutions of brine and lye.

Qualities desired in dehydrated sweetpotatoes are: uniform color, low moisture content, ability to reconstitute in water, good texture and flavor after cooking, and yield of dehydrated product. Six of the 16 varieties studied were found to be suitable for dehydration. Yellow Strasburg produced a yellow-gray dehydrated product; Nancy Hall (selection 11), a light golden-yellow; U. S. 47442, yellow orange; Nancy Hall (selection 103), red-orange; Nancy Gold, orange-red; and Bunch Porto Rico, medium brown. Because of the differences among varieties, and also the differences that occur in a given variety grown under diverse soil and climatic conditions, it is impossible to state definitely, without dehydration tests, whether a particular variety will or will not be satisfactory. As a result of our experiment we shall be in position soon to write instructions for the preparation, dehydration, and storage of sweetpotatoes in the home.

COTTON BY-PRODUCTS UTILIZATION

Owing to a scarcity of cottonseed and lack of trained personnel, no cottonseed was processed during the year. However, a few exploratory experiments in connection with pressure cooking in small equipment were conducted. Experimental work on the utilization of cottonseed hulls in the making of a thermosetting plastic molding compound was continued during a part of the year. In order to find a formulation that would produce good, uniform molding material, it was necessary to make a considerable number of trial batches. Effects of temperature, time of reaction, moisture content, and amounts of materials on the molding process and molded materials were studied. Cottonseed-hull residue, a by-product of furfural manufacturing, was used as filler in several batches.

A formula was developed and a process worked out for making a granular, free-flowing compound that molds under heat and pressure to a nice finish and is of exceptionally good strength. Cottonseed-hull residue, from furfural recovery, appears to offer possibilities as a filler in phenolic plastics. This, however, will require further experimentation. The many uses of plastics, and the importance to the South of the utilization of cottonseed by-products, now and in postwar days, are well known.

MISCELLANEOUS

Analytical and cooperative services have been rendered to other departments of the Station, the Extension Service, and the College of Agriculture.

NITROGEN AND ASH CONSTITUENTS OF PLANTS

K. B. Sanders

BORAX FERTILIZATION OF LEGUMES[2]

Samples of untreated and borax-treated alfalfa from major areas of Tennessee have been analyzed for boron content, and selected samples have been analyzed for other elements. A technic for the extraction of water-soluble boron in soils has been worked out and a few determinations have been made. The pH of soil samples taken at 0- to 6-inch and 7- to 12-inch depths in alfalfa fields in major areas in Tennessee has been determined. Borax applications in old alfalfa stands have consistently increased the boron content of the hay, sometimes doubling it. The nitrogen content of alfalfa hay in some cases has been increased and in some cases decreased by borax applications. The reason for this and its significance are unknown.

HIGH VERSUS LOW PHOSPHATE APPLICATIONS[3, 4]

Effects of high versus low phosphate applications on the composition of pasture, hay, soils, and cattle blood were noted from samples obtained at the Mineral Deficiency Farm, Cumberland Plateau. Samples of pasture mixtures, lespedeza hay, and redtop hay, and of soils, were taken at 13 locations on that farm in July 1943. Heights of crops were noted and yields recorded. The crops were analyzed for total ash, calcium, phosphorus, and crude protein. The soils were analyzed for field-moisture percentage, pH, available phosphate, available potash, and organic matter.[5] Samples of blood from cattle on the high- and low-phosphate areas, respectively, were analyzed at intervals during the year.

High-phosphate applications, both with pasture mixtures and with lespedeza or redtop separately, caused (1) yield increases and (2) increases in percentage of phosphorus, but (3) decreases in percentage of total ash. Calcium and crude protein percentages were decidedly increased and phosphorus percentage was slightly in-

[2]The hay samples for this study were obtained by J. B. Washko at the Knoxville Station and on private farms in the vicinity of Knoxville; by Ben P. Hazlewood at the Jackson Station; and by L. R. Neel at the Columbia Station. These men noted the effects of borax fertilization on alfalfa yields at their respective locations.

[3]This work was undertaken in conjunction with a beef cattle production experiment, at the request of H. R. Duncan and J. J. Bird. The blood samples were obtained by Mr. Bird. C. B. Bumbalough, Farm Superintendent of the Mineral Deficiency Farm, assisted in taking the crop samples.

[4]The low-phosphate area was treated with 72 pounds and the high-phosphate area with 266 pounds of 20-percent superphosphate per acre annually in 1940, 1941, 1942, and 1943.

[5]A. G. Burg determined available phosphorus by the *Cunninghamella blakesleeana* method, available potassium by the *Aspergillus niger* method, and organic matter by a colorimetric method developed by the Central Scientific Company.

creased by increase of soil pH. The available phosphate content of the soils was not measurably influenced by the phosphate applications and was "very low" at each of the 13 locations on the farm. Available soil potash varied considerably at different locations, but averaged "low" on both the high-phosphate and low-phosphate areas.

HAY-CURING METHODS[6]

Samples of Korean lespedeza hay were obtained and cured as follows: (1) Green—cured indoors in the shade; (2) barn-cured—after partial field curing; (3) field-cured; (4) field-cured, rained on. Leaves and stems were separated and weighed, and percentages of leaves and stems calculated. Leaves and stems were analyzed separately for crude protein. Crude-protein content of the cured hay (leaves plus stems) was calculated from separate analyses of leaves and stems. Selected samples of leaves and stems also were analyzed for calcium and phosphorus content.

Hay cured by the first three methods outlined above did not differ significantly in percentage of leaves, but the hay that was field-cured and rained on had a considerably smaller proportion of leaves than the samples cured without exposure to rain. Stems had less than half the protein percentage that leaves had. Crude-protein percentages of leaves and of stems were altered only slightly by the curing method. The effect of the curing method on crude-protein percentage was greater with stems than with leaves. Crude-protein percentages were: 14.6 in green hay, 14.4 in barn-cured, 13.7 in field-cured, and 13.1 in field-cured-rained-on hay. Thus the percentage of crude protein in the hay was progressively less with increasing exposure to the weather. The curing method slightly affected the percentages of calcium and phosphorus in leaves and stems, especially in stems.

ECONOMICS AND SOCIOLOGY

C. E. Allred[7]

The Agricultural Economics and Rural Sociology Department has continued its function as a fact-finding agency for farmers, farm agencies, and other interests related to agriculture. Events moving swiftly under the impact of war, emphasize the need for quick adjustments in farm planning, and indicate the essential nature of dependable data and their impartial analysis. Members of the Department have cooperated with war agencies by furnishing economic information and technical assistance, serving on committees, and making special studies when requested.

[6]This work was undertaken at the request of C. E. Wylie. Specific directions for cutting, handling, and curing the hay samples were prepared by a group consisting of W. C. Gillham, S. A. Hinton, J. A. Schaller, J. B. Washko, C. E. Wylie, and K. B. Sanders. The samples were taken and cured, leaf percentages determined, and the samples prepared for analysis by W. C. Gillham.

[7]The following members of the Department participated in the work here reported: H. J. Bonser, M. M. Guilford, M. B. Johnson, B. H. Luebke, C. C. Mantle, F. N. Masters, W. P. Ranney, and W. S. Rowan.

AGRICULTURAL ADJUSTMENT

The Department assisted state and county war boards in revising 1944 production goals. The general assignment was that of cooperation with other divisions of the College, the Bureau of Agricultural Economics, and the Tennessee Valley Authority in arriving at an estimate of maximum wartime production capacity.

As a special assignment, two civil districts of Jefferson County were selected as a sample area in which to determine the feasibility of greater production on farms of varying size and resource combinations. Projection to the county situation was made from an analysis of 369 AAA records and an intensive study of 27 farms. Farms were classified in four major groups according to their suitability for providing full-time employment to an average farm family. It was estimated that a production increase of 15 percent was feasible. Of this, 84 percent would come from 33.2 percent of the farms, which were classified as having adequate resources. These farms had 65.8 percent of the farm land, and 78.4 percent of the arable land. To secure the increase indicated would require greater emphasis on cattle and dairy products, more land in alfalfa and pasture, less land tilled, marked increase in the use of lime and fertilizer, more labor, larger dairy-barn and poultry-house capacity, new fencing, more adequate water supply (wells), additional haying machinery, and machinery repairs. A monograph embodying results of the study is nearing completion.

Agricultural adjustment and relocation problems arising from the construction of Douglas Dam were dealt with in a series of cost-of-production studies begun in 1942 and completed in 1943. Analysis was made of the relative profitableness of burley tobacco, canning-factory tomatoes and beans, whole milk, poultry, and hog enterprises on upland farms (fig. 16)). Results were published in Monographs 146, 147, 150, 154, and 156.

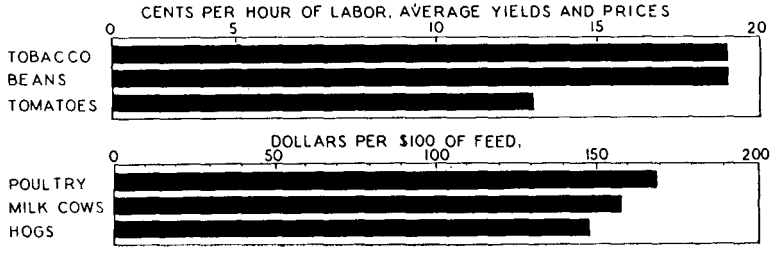


Fig. 16—Returns from selected crop and livestock enterprises, upland farms near Douglas Reservoir, 1942.

Net returns per acre from sample farms in 1942 were: tobacco, $277.94; beans, $2.30; net loss, tomatoes, $9.81. Net returns per $100 feed in 1942 were: $156 for dairy cows, $168 for poultry, and $147 for hogs. Net returns per acre, with normal yields, and aver-

age prices and costs for canning-factory beans would be $15.29; canning-factory tomatoes, $4.84 (table 37).

Table 37—*Returns from selected crop and livestock enterprises, upland farms near Douglas Reservoir.*

Item	Canning-factory		Burley tobacco	Milk cows	Hogs	Poultry
	Beans	Tomatoes				
Returns per hour of labor (average prices and yields)	19¢	13¢	19¢	15¢	20¢	12¢
Actual returns per hour, 1942	16¢	9¢	67¢	20¢	104¢	30¢
Net returns per acre (average prices)	$15.29	$4.84	[1]$9.04 [2]$43.27	.....	.....	.....
Net returns per acre, 1942	$2.30	—$9.81	$277.94	.....	.....	.....
Net returns per $100 feed, 1942	.....	.....	.....	$156	$147	$168

[1]Based on 800 pounds yield. [2]Based on 1000 pounds yield.

Study of the land loss in the Douglas Reservoir area, in cooperation with the Tennessee Valley Authority, was continued. Data were gathered, tabulated, and analyzed for an inventory of land use before flooding on over 1000 ownership tracts. A preliminary report is in preparation.

Because of interest in snap beans as another source of farm income, of the contribution the crop has made to the food-canning industry, and of possible marketing difficulties arising from increased production, a study of the industry was carried out in Johnson, Sevier, and Knox Counties. Cost-of-production and farm-practice data were obtained from farmers in these counties. Canners and other marketing agencies were interviewed. Results of the study are being prepared for publication.

A survey of the farm machinery available for farm production in a sample county of East Tennessee was made during the year. The data are being analyzed and will be prepared for publication.

Progress of the purebred livestock industry in the State was compared with that of the United States, and the results were published in Monograph 158, "Graphic Summary of Purebred Livestock, Tennessee and United States."

Reasons given by farmers for moving or changing tenure status were summarized for 448 farm families in Middle and West Tennessee. Data include all moves made by these farmers from 1859 to 1920, inclusive. Of the 2485 moves made, or changes in tenure status reported, 70.4 percent were voluntary. Over half of the voluntary changes were made either because the farmer had dealt somehow in land or merely because he preferred a change. These results were published as Monograph 159, "Why Farmers Move or Change Tenure Status."

TYPE OF FARMING

In cooperation with the Division of Farm Management and Costs, Bureau of Agricultural Economics, a study of the relative position of competing crops in type-of-farming areas 4 and 5 was

undertaken. Cost and returns data on sweetpotatoes, cotton, and corn were gathered from farmers (fig. 17). Use of machinery and equipment and other farm practices were studied in relation to possible savings in labor during the emergency.

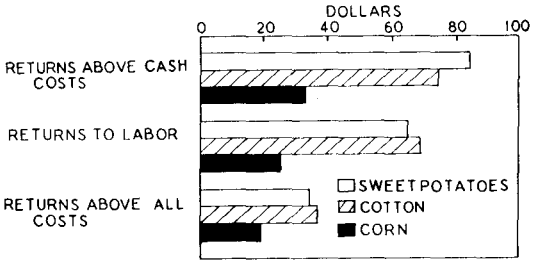


Fig. 17—Average returns per acre from sweetpotatoes, cotton, and corn, Henry County, 1942.

A series of reports based on this study will be published, showing the possibilities of sweetpotato production for food and feed uses; and an analysis of costs, returns, and production requirements for each of the three enterprises.

Farm-management problems expected to arise in connection with possible postwar movement of settlers to the Cumberland Plateau were studied. A brief summary is being prepared of available information relating to this region, to be distributed to persons interested.

During the month of December a cost-of-clearing survey was made on 100 farms in 5 Plateau counties. The purpose of the study was to compare the effectiveness and costs of the various practices involved in clearing land for farming.

SOUTHERN APPALACHIAN STUDY

Study of farm marketing problems in the Knoxville trade area was continued. To cooperate in the national plan for conservation of critical materials by elimination of excess truck mileage, the Department studied dairy collection routes in the Knoxville milk shed, and milk delivery within the city. The aspects of the problem were tied in with a more complete survey of the milk industry of the area, its processing facilities, milk supply, milk consumption, and milk-price problems (fig. 18).

Two preliminary reports have been issued on the dairy-marketing study: Monograph 161, "Farm Supply Aspects of the Knoxville Milk Market"; and Monograph 162, "Collection of Milk from Farms in the Knoxville Milk Shed Area."

These studies revealed the fact that farmers who bring in their own milk haul an average of 2.9 gallons per mile traveled, compared with 6.6 gallons for route haulers. Route trucks have an annual unused capacity of about 11 percent, compared with 66 percent for self haulers.

Including mileage already saved in 1943, and possibilities for further savings, a 37.5-percent reduction from prewar mileage is probably feasible.

Two reports on grain marketing in East Tennessee were issued: Monograph 152, "Disposition and Outlets for Grain in Knoxville Trade Area"; and Monograph 153, "Movement, Transportation, and

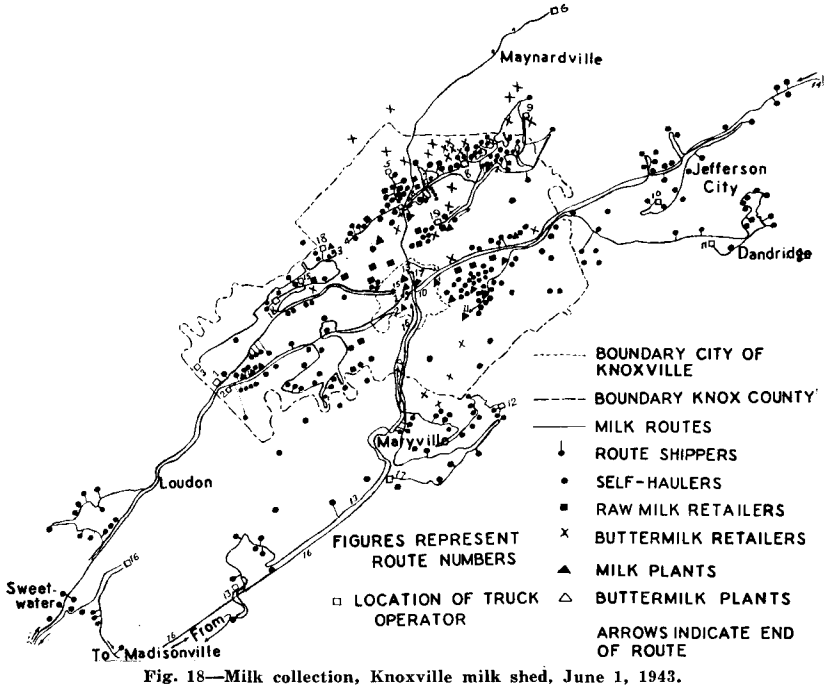


Fig. 18—Milk collection, Knoxville milk shed, June 1, 1943.

Prices of Grain in Knoxville Trade Area." During the 1940-41 grain-marketing season, 51.5 percent of all grain marketed in this area was from other states. Percentages for the various grains were: yellow corn, 87.1; oats, 81.6; wheat, 55.3; barley, 44.1; white corn, 16.7; and rye, none.

A report on "Facilities and Agencies at Knoxville Livestock Market" was completed and issued as Monograph 148. It was based on the livestock-marketing survey made in 1941.

Analysis was completed on family living costs of farm families residing on upland farms near Douglas Reservoir, and reported in Monograph 155, "Family Living Costs on Upland Farms Near Douglas Reservoir." Average cost of living per family was $898 for the calendar year 1943. Of this amount, $505 was paid in cash or credit, while $393 was contributed directly by the farm (fig. 19). The farms produced directly all of the house rental, 69 percent of the food on a value basis, 52 percent of the fuel, 41 percent of the brooms, 10 percent of

Fig. 19—Percent of food consumed that was home-produced, 81 farm families, Douglas Reservoir area, 1942.

the soap, and 6 percent of the tobacco used by the families.

Analysis of food consumption by 81 farm families residing on upland farms near the Douglas Reservoir was completed and reported in Monograph 160, "Food Consumption by Farm Families Near Douglas Reservoir." Meals were found to be high in energy foods. Nearly 53 percent of the proteins were from vegetable sources. Families spending more money for food had a greater proportion of their calories furnished by proteins; and a larger percentage of the proteins were from animal sources (fig. 20).

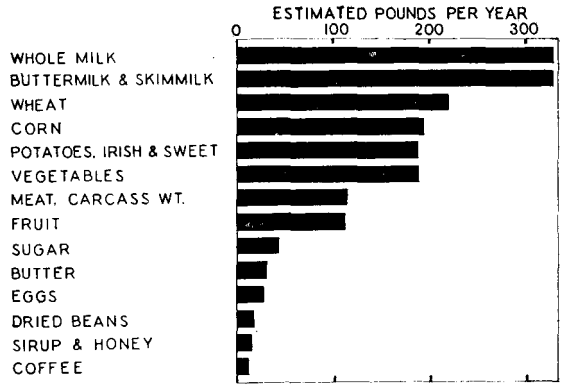


Fig. 20—Principal foods consumed per farm person, four Douglas Reservoir counties, 1942.

COOPERATIVE MARKETING

Analysis of poultry and egg marketing in the Knoxville trade area, begun in 1942, was completed, and a typewritten report of 575 pages prepared. Information was secured on the accomplishments and role of cooperative poultry and egg organizations, such as the state-wide Tennessee Poultry Producers' Association.

Other important phases on which data were secured include marketing practices of farmers, country stores, rolling stores, produce dealers, poultry-dressing plants, meat-packing companies, milk plants, and grocery stores; volume handled by different agencies; facilities for grading, storing, and processing; prices and price problems; marketing programs; the New York market for Tennessee poultry; and possibilities for enlarging local and distant outlets.

FARM TAXATION

"Areal and Functional Consolidation of Tennessee Counties," Monograph 151, was published during the year. It compares the relative overhead costs of government in small and large counties. The study shows that by the doubling of the average distance to county seats the number of counties in the State would be reduced from 95 to 24. In 11 counties studied, overhead expenses, consisting of such items as salaries of trustee, county court clerk, and assessor, and upkeep of court house, represent more than half of the total operating and maintenance expenses, the revenue for which is raised within the county. Per-capita costs for overhead expenses, highways, and education are lowest in counties with more than 40,000 population (fig. 21).

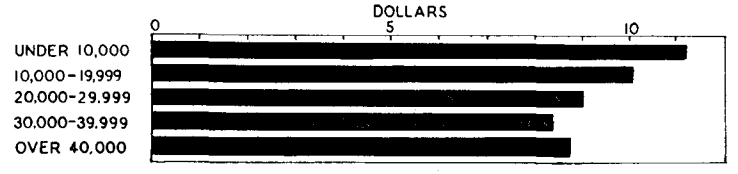


Fig. 21—Per-capita cost of governmental functions, including expenditures from state funds, average of Tennessee counties, grouped according to population, 1932.

COTTON MARKETING

In cooperation with the Food Distribution Administration, Cotton Division, a study was made and published on "Cotton Loan Program in Tipton County, Tennessee, 1941 and 1942," Monograph 149. In this county, selected as a sample area, 7.4 percent of the 1941 cotton crop was placed under loans, broken down as follows: 5.3 percent with the Commodity Credit Corporation, 0.6 percent with the Mid-South Cotton Growers' Association, and 1.5 percent with local banks.

Work in the determination of cotton grades and staples was continued. There is indication of remarkable improvement in the quality of cotton grown in Tennessee since this project was started.

FOREST AND FARM ECONOMIC SURVEY

(Project sponsored by the General Education Board of New York, A. R. Mann, Vice President and Director).

R. F. Kroodsma

The forest and farm economic survey has proceeded along the lines established in 1942. During the present year, the survey covered 195 farms.

A field inventory of farm woodlands is being taken under the direction of the Assistant Forester, R. D. Carpenter. The work consists of visits to the various tracts of farm timber, for each of which a tally is made of all trees, and separate records are kept of merchantable and unmerchantable stands. In addition to the tree tally, a narrative record is made of each woodland tract, covering such points as fencing, condition of the forest floor, condition of woods borders, damage from grazing and fire, amounts and kinds of reproduction, topography, soil, exposure, erosion, and evidences of wildlife. During the year, 1830 acres of woods, amounting to about 7 million board feet of standing timber, on 87 farms, were tallied and classified under this procedure.

In conjunction with the inventory work, research is being conducted on the economic status of the farm woods and its importance in the farm economy. An effort is being made also to get the farmer's attitude toward his woods, to determine whether there is any correlation between such attitude and the status of the farm forest

as shown by the survey. The research data are being collected by means of personal visits to each farm having at least 5 acres of woods. The owner or operator is interrogated and the information is recorded on a special form. Most of the data cover the following points: Farm crop and livestock income; farm investment in wood materials, such as buildings and fences; wood products used by the farm; sales of woods products; woods tools compared with farm tools; intangible values of the farm woods.

In addition to the regular program, it has been possible to aid the war effort by cooperating with the State District Forester in the marketing of some 400,000 board feet of standing timber.

In making the personal contacts with woods owners, we are in position to hand-pick farmers who have sufficient interest in the farm woods to form a nucleus for an educational program in farm forestry.

These individual cases have been brought to the attention of G. B. Shivery, Extension Forester, who has endeavored to establish demonstrations.

ENTOMOLOGY

S. Marcovitch and W. W. Stanley

INVESTIGATIONS OF FLUORINE COMPOUNDS

The general safety of cryolite on plants is now well established. While two crops, corn and peaches, are injured by cryolite, both the plum curculio and the European corn borer are readily controlled by it. To make cryolite safe on these crops, 3 lines of attack may be employed: (1) correctives, (2) coating agents, and (3) other fluorine compounds.

The correctives are chemicals that will remove from solution the soluble fluorine that injures foliage. Walker[8] successfully employed several materials for removing fluorine from drinking water. These materials were aluminum oxide, aluminum phosphate, tricalcium phosphate, and magnesium oxide.

With his results as a guide, we tried the following materials as sprays on corn:

(1) Cryolite, 2 lbs.; water, 50 gals.; tricalcium phosphate, 4 lbs.
(2) Do. and aluminum oxide, 4 lbs.
(3) Do. and aluminum phosphate, 4 lbs.
(4) Do. and magnesium oxide, 4 lbs.
(5) Do. and aluminum sulfate, ½ lb.
(6) Do. and sodium carbonate, ½ lb.
(7) Do. and sodium phosphate (secondary) ½ lb.
(8) Do. and sodium chloride, ½ lb.
(9) Do. and sodium aluminate, ½ lb.

[8]Can. Jour. of Research, Vol. 7, p. 308.

These sprays were applied when the corn was 18 inches high. All of the materials injured the corn, and no corrective effect could be observed. Perhaps the reason that tricalcium phosphate can be used for the removal of fluoride from drinking water is that only 5 p.p.m. of fluorine is the original concentration employed. In cryolite, 150 p.p.m. of fluorine is present in solution, and this large amount may not all be adsorbed, or removed from solution.

The other phase investigated concerned coating agents, such as wheat flour, pyrophillite, soybean flour, 2-percent linseed oil, and aluminum stearate. These were employed as dusts, in a mixture of 50 percent cryolite and 50 percent coating agent. Only the aluminum stearate gave appreciable protection, and this was not enough to be of practical value.

TESTS WITH OTHER FLUORINE COMPOUNDS

Since no correctives were found that will make cryolite safe for use on corn and peaches, tests with other fluorine compounds were conducted in the hope of finding a material that would not be injurious to these plants, a material that might be equivalent to basic lead arsenate among the arsenicals. The materials included in these tests, and the effect on foliage, are shown in table 38.

Table 38—*Effects of various fluorine compounds on the corn plant.*

Material	Solubility No. of cc. water to dissolve 1 gram	Strength used	Degree of foliage injury
Magnesium fluoride	7,692	2 lbs.-50 gals.	None
Natural cryolite	2,800	2 lbs.-50 gals.	Severe
" "	.....	¼ lb. -50 gals.	Severe
" "	.....	⅛ lb. -50 gals.	Slight to moderate
Strontium fluorine	2,564	2 lbs.-50 gals.	None
Lead fluoride	1,515	2 lbs.-50 gals.	Severe
Ferric fluoride	1,098	2 lbs.-50 gals.	Moderate to severe
Barium fluoride	826	2 lbs.-50 gals.	Slight to moderate
Aluminum fluoride	178	2 lbs.-50 gals.	Slight to moderate
Sodium fluoride	25	1 lb. -50 gals.	Severe
" "	.....	½ lb. -50 gals.	Moderate to severe
" "	.....	¼ lb. -50 gals.	Slight
" "	.....	⅛ lb. -50 gals.	Slight

The degrees of solubility are those reported by Carter in *Industrial and Engineering Chemistry*, in 1928. Magnesium fluoride in spray form, with a much lower solubility than cryolite, did not burn the foliage of corn at the rate of 2 pounds to 50 gallons of water. Three applications were made. Strontium fluoride also was safe. Although its solubility is about the same as that of cryolite, it is a straight salt and does not hydrolyze as the cryolites do. Apparently, hydrolysis as well as solubility in water must be taken into account in evaluating a material.

Ferric fluoride produced moderate injury, while lead fluoride was very injurious.

Barium fluoride, judged on the basis of its solubility, should be injurious; yet it[9] appeared to be fairly safe, causing but slight injury most of the time.

[9]Furnished by Aluminum Ore Company.

Our own test gave a figure of 660 for barium fluoride, which is still lower than that given in the table. This solubility test was made by W. M. Shaw, of the Chemistry Department, with 7 grams of barium fluoride in 200 cc. of distilled water, agitated by a shaking machine for 20 hours. However, when only 1 gram of barium fluoride in 660 cc. of distilled water was employed, the figure 1,120 was obtained. If the barium fluoride is simply stirred a few times in a beaker during the 24-hour period, the solubility drops to 2,400. Considering that this chemical is only about 20 percent fluorine, its potential burning power is seen to be comparatively small.

If stoimetric solutions of sodium fluoride and barium chloride are used, the barium fluoride produced shows no precipitate in 330 cc. of water. Thus the solubility of 1 gram of barium fluoride in water may vary from 330 to 2,400 cc., depending on the method employed.

As an insecticide, barium fluoride shows good toxicity against potato beetles and compares favorably with cryolite. One sample from the Harshaw Chemical Company injured corn severely. The material was found to be decidedly acid, and probably contained impurities. The safer barium fluoride was alkaline.

A sample of aluminum fluoride from the Aluminum Ore Company appeared similar to barium fluoride in its effect on foliage. Here again solubility is not an index to what may be expected.

The results of this investigation indicate that magnesium fluoride, strontium fluoride, barium fluoride, and aluminum fluoride are worthy of further testing. It is planned to carry out toxicological experiments on various insects, to determine which of these materials possess the most toxicity and which is least injurious to foliage.

TESTS WITH SODIUM FLUORIDE

To determine how much fluorine in solution is required to injure corn, known amounts of soluble fluorine as sodium fluoride were tested. One-half pound of sodium fluoride to 50 gallons of water, or approximately a 1-1000 solution, produced moderate to severe injury on corn. A 1-4000 solution produced but slight injury. At this dilution, cryolite was somewhat more injurious. Tests with sodium fluoride were made also on other plants. The effect is so pronounced on some plants that the possibilities of this material as a herbicide merit attention. Crabgrass, for example, a bad weed in lawns, can be killed by sodium fluoride. A 2-percent solution killed the weed or injured it severely. Crabgrass was found to be difficult to wet—water rolled off the plants. Wetting resulted, however, from the use of a 1-percent solution of soap, which decreased the surface tension of the liquid. The combination of 2 percent sodium fluoride and 1 percent soap powder gave good control of crabgrass without causing permanent injury to bluegrass. Some browning of the bluegrass occurred, but growth started again with the first good rains.

Perennials do not seem to be injured easily by sodium fluoride. Quick-growing, succulent annuals with thin cuticle are most susceptible. There appears to be wide variation in the effects of this chemical on different plants. Some plants, notably oxalis, sheep sorrel, persimmon, scrub pine, coleus, smartweed, and crabgrass, are readily injured; while others, such as red cedar, hickory, Russian olive, and holly, sustain little or no injury from a saturated solution of 4-percent sodium fluoride.

A large number of factors are involved in the cause of injury. There appears to be no correlation as to calcium content. The stage of growth or succulence seems to be important. Early in the season, when the foliage was tender, black gum was injured by a 1-4000 solution on June 18; whereas, on July 28, a 1-500 solution produced little or no injury. It appears that with the progress of the season, the cuticle becomes thickened, especially in dry weather.

BEAN BEETLE THREATENS MOUNTAIN CITY CROP

Mountain City, Tennessee, has become the greatest bean market in the United States. In 1943, about 9,000 acres of beans were grown in Johnson and Carter Counties. With so large a concentrated acreage it is natural to expect bean beetle injury—and during the past season the entire crop was threatened.

The Experiment Station investigated the situation and found 3 primary causes: (1) the growing of 2 crops of beans; (2) the planting of late beans near early beans that are left in the field; (3) shortage of materials and equipment.

Experiments were undertaken to determine the best means of control under existing conditions. Some of the rotenone available was not sufficiently strong to be of value. Cryolite when properly used gave excellent results. Fortunately, this material is available. As a dust, it was diluted with wheat flour or dusting sulfur and used at the rate of 20 to 40 pounds per acre, depending on the size of the vines.

Where the insect was not controlled, a new type of injury was observed. This was known locally as "bug bite" and was caused by the feeding of the adult beetles on the newly formed small pods. It resulted in scarred and crooked pods. When such beans were numerous in the hampers, they sold at a discount by as much as 25 percent. The control of the beetle, therefore, is especially important if a grade-A bean is to be produced. The importance of destroying the early crop immediately after picking was stressed. This may be accomplished by plowing, disking, or mowing.

HOME ECONOMICS

Florence L. MacLeod and Mary L. Dodds

During 1943 the two lines of investigation which were being followed in the study of the ascorbic acid metabolism of college students were completed. Two articles presenting the data were ac-

cepted for publication by the *Journal of Nutrition* and will appear early in 1944.

The first completed study was the survey of the ascorbic acid status of college students which has been under way for parts of 3 years. The data obtained were based on two separate fasting blood plasma ascorbic acid values of 345 college women. The freshmen were shown to have a mean value of 0.67 mg.%, which was significantly lower than the mean value of 0.8 mg.% found for the upperclassmen. The values obtained in this survey agree well, both in means and distribution, with findings of other workers using comparable methods of analysis for similar populations differing in locality and eating habits.

At the time the blood samples were taken a record was made of the previous day's dietary, and it was calculated for ascorbic acid intake. Correlation based on a linear relationship between these two values, intake and plasma ascorbic, was limited and indicated the operation of other factors in fixing plasma ascorbic levels. It was this lack of correlation which led to the following investigation on human requirements.

This second completed study on the daily requirements for ascorbic acid of the normal adult woman was undertaken in 1942 with 4 subjects and continued in 1943 with 8 subjects. The purpose was to determine daily blood plasma ascorbic acid values when ascorbic acid intakes were those ordinarily encountered. Intakes were studied at 4 levels. An intake of 7-10 mg. of ascorbic acid per day was provided by the basal diet. This was supplemented daily by 25, 50, 75, and 100 mg. of synthetic ascorbic acid. These periods were maintained at each level long enough to indicate adjustment. The change to succeeding levels was made without interruption by large test doses, according to a general custom in human studies. These test doses are greater than the ascorbic acid of the diet or recommended intakes, and in using them the assumption is that the body quickly readjusts to a state of equilibrium with the lower levels. Our data indicate that for changes involving only 25 mg., adjustment takes nearly a week.

The subjects were brought into equilibrium or slight deficiency, as shown by blood plasma ascorbic acid averages, which were slowly decreasing or only maintaining themselves. This was accomplished by an initial period on a 32-37-mg. intake of ascorbic acid. At this point the increase in supplemental levels was begun. It was found that weekly averages of daily plasma ascorbic acid values give better reflections of the vitamin status of the individual than single determinations. Trends thus established showed the dynamic status of the individual with respect to the intake. Throughout the experiment there seemed to be an indication that individual requirements differed and that the difference was related to body weight. One subject weighing 51.4 kg. showed blood plasma values reaching a maximum on a 57-mg. intake, while another weighing 84.1 kg. showed no tendency to have the blood plasma ascorbic acid increase until the intake rose to 82 mg. All subjects of intermediate weights,

55-69 kg., began to show plasma average increases on the 57-60-mg. level.

In order that this apparent relation to body weight might be observed more quantitatively, urinary excretion studies were made on 3 subjects for the last 30 days of the experimental period. "Utilization" values were shown to be close to 1 mg. per kilogram of body weight, and 3 subjects reached "saturation" on such a retention.

This weight relationship is one which needs further study on a group whose ages are more nearly uniform, as there is indication that age also is a factor. There is, too, a possibility that exercise and activity have a bearing on the requirement.

Owing to the heightened interest in losses of nutrients in foods prepared in institutional kitchens, a new study was initiated on the ascorbic acid retention in foods served the army units stationed at The University of Tennessee. The opportunity for such a study was exceptional, as the Institutional Management Department of the School of Home Economics operates the institutional kitchens and offers excellent cooperation. The foods were limited to those which should contribute appreciable amounts of the vitamin, owing either to original content or the quantity eaten. Another factor in the choice of foods was frequency of occurrence; enough replication was needed to make the data statistically valid. This work is in progress.

HORTICULTURE

At Knoxville Station

Brooks D. Drain, A. B. Strand, and Donald S. Burgis

FIRE BLIGHT-RESISTANT PEARS

Severe cold weather in April destroyed the pear crop at Knoxville and killed many of our handmade crosses. A few crosses on late-blooming seedlings fruited. About 10,000 inoculations of fire blight were made in seedling trees in the nursery, and the trees that developed the disease were destroyed. Several hundred seedlings, more or less disease resistant, were top-worked into stock trees in the orchard.

PYRETHRUM

The high-testing clonal-strain selections of pyrethrum—an insecticidal crop formerly secured largely from Japan—was continued. The dried blossoms from many seedlings were assayed chemically and biologically, and those of superior insect-killing properties were saved and propagated. A large shipment of pyrethrum crowns was sent to Limestone, Tennessee, where a commercial planting is being developed. All chemical and biological assays were made at the Gulf Research and Development Company's laboratory at Pittsburgh, Pennsylvania.

RED-RASPBERRY IMPROVEMENT

A shortage of labor[10] seriously delayed the work on the red-raspberry project. Hybridizing was discontinued and part of our effort devoted to black-raspberry breeding. Some of the more promising selections were isolated and further inheritance data taken.

STRAWBERRY IMPROVEMENT

An irrigation test on the newer varieties of strawberries was started in 1942. The 1943 crop was slightly larger on the non-irrigated plots. Table 39 presents data on Blakemore in comparison with the 3 new varieties developed in breeding work at this Station.

Table 39—*Tests of new strawberries in comparison with Blakemore at Knoxville,* 1943.

Variety	Number of plots	Average per plot	Crates per acre—calculated
		Pounds	
Tennessee Shipper	8	20.52	243.0
Tennessee Supreme	8	20.19	239.0
Tennessee Beauty	8	26.87	327.5
Blakemore	34	17.05	202.3

Tennessee Beauty outyielded Blakemore by 125 crates per acre and produced the largest yield of the 10 varieties in this test. A heavy frost in April killed a few early blossoms on all varieties, but did not greatly affect the yield.

BLACKBERRY IMPROVEMENT

Commercial, native, and exotic varieties have been collected and are growing at the Station. Breeding work will begin in the spring of 1944. Generally speaking, this project has three prime objectives: (1) to improve fruit quality above the present commercial level, (2) to increase productiveness, and (3) to develop greater disease resistance. The ultimate goal will be the combining of these characters in one or more new horticultural varieties.

BLACK-RASPBERRY INHERITANCE

None of the present commercial varieties of black raspberry (*Rubus occidentalis* L.) are sufficiently disease resistant to be ideal for growing here. Selections are being made from the black raspberries indigenous to the mountainous regions of the State in an attempt to discover individuals that are disease resistant. Some introduced species are available and apparently are immune from all diseases, but these make unsatisfactory growth and have poor fruit characters. Breeding work will be carried on with plants of these three sorts.

[10]Maurice E. Dahmus resigned April 30, 1943.

INHERITANCE IN GARDEN BEANS

A report of trials of hybrid beans, using the oriental species urd as the male parent and Asgrow Stringless Greenpod as the female, was published in *Proceedings of the American Society for Horticultural Science,* Vol. 42, 1943, under the title "Species Crosses in the Genus Phaseolus." Backcrosses are being made with a view to securing more desirable horticultural qualities and Mexican bean beetle resistance. New species of beans have been secured from various sources. These have been tested for resistance to insect pests and diseases, and the most promising are being used in crosses with common garden beans. Results of work so far have been encouraging. Strains from the U. S. Bureau of Plant Exploration and Importation show disease resistance surpassing that of our common garden varieties. They do not possess horticultural qualities, but are being used as parental material in bean breeding.

New bean varieties from the U. S. Department of Agriculture show promise for home-garden and processing purposes. Some of these were more productive than standard varieties.

LIMA BEANS

A number of new lima bean varieties have been grown for several years, along with standard sorts. Two of these—Clark's Bush, a green-seeded Henderson Bush type, and Concentrated Fordhook, a green-seeded Fordhook type—appear promising.

EDIBLE SOYBEANS

New Kabott, Seminole, and a selection from Green and Black soybeans are very high in quality, as shown in cooking test. Other varieties are more productive and larger in size, but are lacking in flavor. Selections are being made with the best of these.

BROCCOLI AND CABBAGE

Broccoli has proved to be a satisfactory crop in Tennessee. Variety trials have shown that Green Sprouting, early strain, is productive. The limiting factors are insect injury and cultural methods. These two problems are being considered in plans for future plantings.

Resistant Detroit cabbage has proved to be a promising variety for market-garden purpose at Knoxville. Green Acre and Golden Acre are two other varieties that show promise. It is not advisable for one to undertake the growing of varieties of cabbage without thorough knowledge of their preformance in his locality.

Broc rab and celtuce, two new green leafy vegetables, have been grown. They are not as satisfactory as broccoli, but can be grown successfully in Tennessee.

TABLE BEETS

Thirteen varieties of table beets were grown to determine their yielding capacity and their quality for processing (canning, freezing, and dehydration). Detroit Dark Red, Landreth's Best, and Good For All gave highest yields. Burpee's Black Ball, Asgrow Canner, and Asgrow Wonder were intermediate in yield. It is difficult to secure a good stand under average conditions on upland soils at Knoxville.

RHUBARB

Cultivated varieties of rhubarb have been found to be attacked seriously by crown rot, a soil fungus. The crop is grown to a limited extent at higher elevations in Tennessee. A number of selections from these localities were set in the rhubarb test plots in 1935. The plants were subjected to disease organisms that cause crown rot. Some of them are still growing, whereas 60 varieties collected from various parts of the world all died after from 1 to 6 years in the test grounds.

SWEETPOTATOES

Twenty-two new varieties of sweetpotatoes were grown the past summer. Sixteen of the best of these were used by the General Chemistry Department for processing. Valuable information is being secured through this cooperative arrangement. Two seedlings from the Louisiana Station, L9 and L26, show promise. Eighty-four percent of the potatoes of L9 were placed in U. S. No. 1 grade. The potatoes are globular and smooth. There is very little waste when they are peeled. This variety appears to have qualities desirable for dehydration. Nancy Hall Selection 103 and Nancy Gold appear to be very promising for processing purposes. Nancy Hall has outyielded Porto Rico. Some strains of Porto Rico, however, are very productive.

Selections and bud sports of sweetpotatoes have been gathered from all sections of the State. Some of these show promise for disease resistance and yielding capacity.

New varieties are being studied that appear resistant to stem rot. These are to be tested for disease resistance and horticultural qualities.

ELECTRIC HOTBEDS

The University of Tennessee Agricultural Experiment Station, in cooperation with the Agricultural Engineering Development Division of the Tennessee Valley Authority, began a series of experiments in 1941 with electric hotbeds. The results will be published in a bulletin now in course of preparation.

GARDEN PEAS

Wando, a new variety of garden peas, secured from the Regional Vegetable Breeding Laboratory, Charleston, South Carolina,

withstood severe cold in early March and gave the largest yield in our experimental plots. The new variety ranked with the best for the fresh-produce market and made a very good frozen-pack. Creole, a tender field pea from Louisiana, gave a large yield, but was of poor quality and ranked last in food-processing tests. Thomas Laxton has ranked high in quality and in yield over a period of years, but is injured by high temperatures in May. About 20 varieties were included in this trial.

TOMATOES

Baltimore, Essary, Marglobe, and Rutgers, in the order named, produced the largest yields in the tomato variety trials. Baltimore produced 9.8 tons of U. S. No. 1 and No. 2 per acre. The fruit from these plots was furnished to the General Chemistry Department for processing. All trial plots of tomatoes were staked.

SAGE, BELLADONNA, AND HENBANE

The several plantings of henbane and belladonna failed to make satisfactory growth, and the trials were discontinued. Sage has grown very well and produced good yields of dried leaves. More extensive trials have been made at Jackson, in West Tennessee.

FLOWERING PLANTS AND SHRUBS

A large number of flowering plants and shrubs, including some imported from foreign countries, are under trial in the Station plots. A new Tradescantia from England has been grown for 2 years. The mauve-blue flowers are very attractive. The plants are about 18 inches tall, and hardy. A large collection of new day lily varieties have proved of interest to many local gardeners. These new lilies are healthy, vigorous, and easy to grow, and are likely to find a prominent place around Tennessee homes.

TREE FRUITS

Cold injury in late winter and early spring destroyed the crop on many of the Station's fruit trees. Small crops of apples, Montmorency cherries, crab apples, and Boysenberries survived. Such partial crops have little value from an experimental point of view except as they indicate ability to survive cold. The *Pyrus calleryana* pear seed crop was a complete failure this year.

CROWDER PEAS

An effort is being made to determine the degree of productivity and palatability of the Crowder peas that can be grown in Tennessee. During the 1943 season, 7 varieties were tried. Four were productive, while 3 failed altogether. Of the 4 that bore well, 2 were thought to be of good quality for use as fresh vegetables. Some work was done with a view to determining the possibilities of the field pea for frozen-pack. The results suggest further study.

PROCESSED FRUITS AND VEGETABLES

The 1942 frozen-packs of fruits and vegetables were opened and the products cooked and scored during late winter, in cooperation with the General Chemistry Department. The scoring covers methods of processing and frozen-pack variety trials. Gooseberries, Boysenberries, cherries, apples, strawberries, and red raspberries were included in the fruit pack. Asparagus, rhubarb, snap beans, lima beans, edible soybeans, sweetpotatoes, tomatoes, sweet corn, cabbage, and broccoli were included in the vegetable pack. Further details are given in the report of the General Chemistry Department.

HORTICULTURE AT MERICOURT EXPERIMENT STATION

Clarksville

Brooks D. Drain, A. B. Strand, and Donald S. Burgis

FIRE BLIGHT-RESISTANT PEARS

The fire blight-resistant pear orchard was started at Mericourt in 1936. One hundred and ninety selections of varying degrees of blight resistance have fruited to date (fig. 22). Many of the later-blooming selections produced good crops, but cold injury destroyed the fruit on earlier-blooming trees. Seven selections were isolated as having commercial possibilities provided they continue to be free from fire blight. Such selections will be set in larger plots. Over 100 trees were discarded because of poor and undesirable fruit, fire blight susceptibility, or other objectionable characters. There are nearly 500 trees now that have not fruited.

SWEETPOTATOES

Dry weather at time of setting resulted in a poor stand of sweetpotatoes. Missing plants were replanted, but there was some variation among the plots. Nancy Hall and Nancy Gold gave nearly the same total yield, 307 and 309 bushels per acre, respectively. Porto Morado and Unit No. 1 Porto Rico were first among sweetpotatoes of this type, but over 30 bushels per acre behind Nancy Gold. Bunch Porto Rico gave a large yield of U. S. No. 1 roots.

GARDEN PEAS

Glacier, Thomas Laxton, and Wando gave the largest yields in the garden-pea trials. Glacier produced at the rate of over 1 ton per acre of peas in the pod, although the planting was not made until April 2.

IRISH POTATOES

The March 1 planting of early Irish potatoes was badly injured by cold. A March 30 planting gave a good yield and more than one-third more tubers per acre than a planting on April 15.

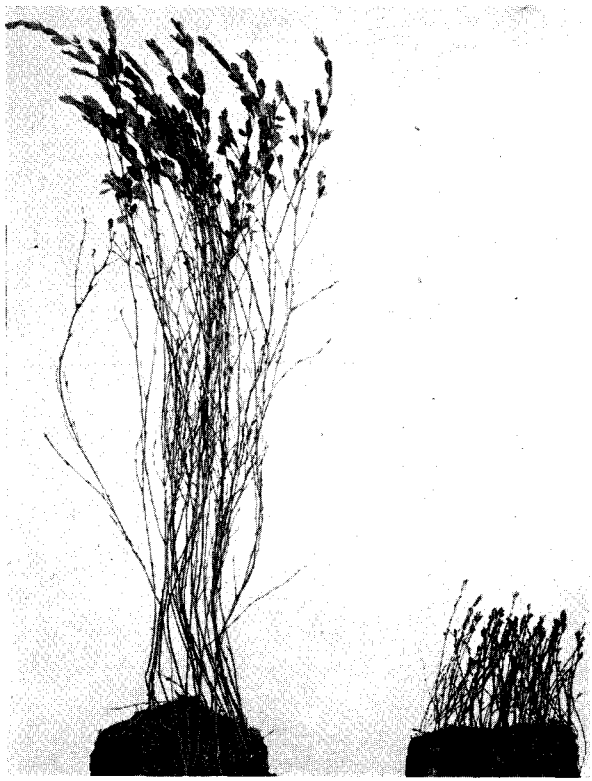
Fig. 22—One of the blight-resistant pear selections in the foreground, Mericourt Station. This tree produces fruit of good quality and commercial possibilities.

ASPARAGUS

The asparagus planting has averaged over 2 tons per acre for the past 10 years. This indicates the possibilities of the crop in this part of the State. The plots were managed sometimes to produce green asparagus and sometimes blanched. The 1943 yields averaged over 2½ tons per acre.

BUSH BEANS

Bush beans were planted in a spacing test. Seventy-five rows, 60.5 feet long and 3 feet apart, were planted to beans. Seeds were spaced 5 inches apart in one row and 3 inches apart in the other. Rows were alternated throughout the field. From 2 to 8 replications and 2 pickings were made for each variety. Yields were low because of insufficient rainfall. The total yields on 1/12 acre for all varieties were as follows: from 5-inch spacing, 146.54 pounds; from 3-inch, 189.79 pounds. There were 1853 plants living at the



Phosphated Unphosphated

Fig. 23—Sericea samples from the pear orchard at Mericourt.

time of the last harvest in the 1/12-acre area of the 5-inch spacing, and 3012 plants in an equal area where 3-inch spacing was used.

The beans sold for $3.00 per bushel. There was a calculated acre-yield difference of 17.30 bushels in favor of the 3-inch spacing. The record shows a direct correlation of stand and yield which indicates that close spacing is desirable.

CHESTNUTS

A good crop was produced on the blight-resistant chestnut trees. This species, *Castanea mollissima*, has grown well on the more fertile plots.

TOMATOES

The date-of-setting trials with tomatoes were almost a failure, owing to dry weather in May. Stands were poor on all plots. Best results were from May 5 and May 15 plantings. Rutgers and Essary varieties gave approximately the same yields.

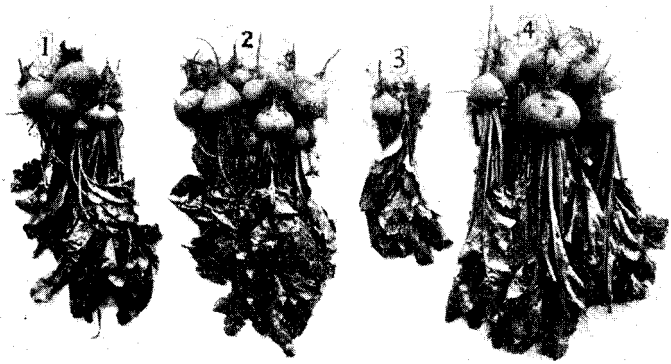


Fig. 24—Beets may be greatly helped by light applications of lime, as in experimental trials at Mericourt Station.

1 and 3—Without limestone; 2 and 4—600 pounds per acre of ground limestone mixed with fertilizer.

1 and 2—Complete fertilizer; 3 and 4—phosphate and nitrogen applied, but no potash.

HORTICULTURE AT WEST TENNESSEE EXPERIMENT STATION

Jackson

J. P. Overcash and Brooks D. Drain

STRAWBERRY BREEDING AND INHERITANCE STUDIES

Inheritance data on plant and fruit characteristics were recorded for 185 progenies of crosses between promising Tennessee strawberry selections. Forty-one of these progenies were selected for further trial, either because they show promise as new varieties or because it was desirable to maintain the best seedlings from certain parents for further breeding.

Many of the selections from earlier years were discarded because of their failure to meet the rigid standards set up for a new strawberry variety for Tennessee. Strawberry yields were drastically reduced by temperatures below freezing after April 15. The early-season selections and varieties were in full bloom at that time. Varieties and selections of the midseason to late type escaped a great deal of this injury and gave better yield than the early-season selections.

GROWING GARDEN SAGE

A plot of garden sage (*Salvia officinalis*) 21 by 28 feet was harvested for the second summer. The yield was at the rate of 3899 pounds of air-dry leaves and stems per acre. The first season, this plot gave a yield of only 1363 pounds per acre. In a trial with 3 different spacings, and 6 replications of each spacing, the best

yields were obtained from plants spaced 18 inches apart. The yields in pounds per acre from the different spacings were as follows: 18 inches, 758 pounds; 24 inches, 590 pounds; 36 inches, 418 pounds. The application of an oat-straw mulch around a plot of garden sage plants caused a marked increase in yield. The mulched plot gave 1740 pounds per acre, while the unmulched plot gave 840 pounds.

Fifteen varieties of garden sage were selected from a heterogeneous group of seedlings. These plants were selected on the basis of vigor, width of leaves, general appearance, and abundance of blossom. A supply of plants of each variety has been obtained by means of cuttings. Each variety will be tested for yield and adaptability during 1944.

SWEETPOTATO VARIETIES

A part of the West Tennessee sweetpotato crop is dug early and sold as uncured potatoes. A variety trial was made for this crop, the plants being set 20 inches apart in the row, which is wider spacing than is used in the fall crop. Three-row plots were used and the data taken from the center row. There were 4 replications, and the plots were randomized. The yields are shown graphically in figure 25. Nancy Gold gave the largest yield and Nancy Hall the next largest.

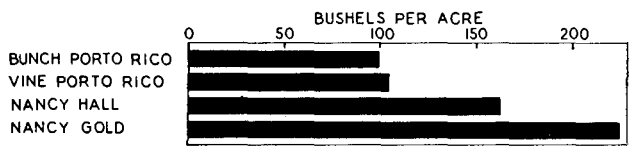


Fig. 25—Yield of U. S. No. 1 sweetpotatoes, four varieties, when dug in August and graded for the market. West Tennessee Experiment Station, Jackson.

A wide spacing was used for this crop.

A second variety trial of sweetpotatoes was made for the late crop. The planting was set 12 inches apart in the row, with 4 replications, and the plots randomized. Figure 26 presents graphically the data secured in this test. While the two variety trials are not comparable, since they were made on different soils and by different cultural methods, it is to be noted that Nancy Gold and Nancy Hall gave the largest yields.

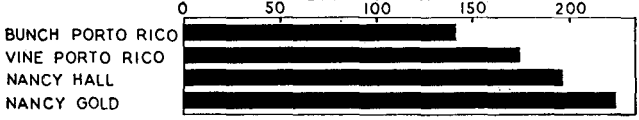


Fig. 26—Yield of U. S. No. 1 sweetpotatoes when dug in late September and graded for storage. West Tennessee Experiment Station.

CABBAGE VARIETIES

Eight varieties of cabbage were grown in a variety trial, and the yields in tons per acre were as follows: Succession, 11.1; Early-krop, 8.7; Henderson's Premier, 8.1; Golden Acre, 7.8; Charleston

Wakefield, 7.6; Copenhagen Market, 7.3; Early Jersey Wakefield, 6.9; Marion Market, 6.8. Marion Market and Succession were about 10 days later in maturing than the other varieties. The average weights in pounds per head were: Succession, 3.7; Marion Market, 2.9; Henderson's Premier, 2.8; Copenhagen Market, 2.7; Charleston Wakefield, 2.7; Earlykrop, 2.6; Golden Acre, 2.6; Early Jersey Wakefield, 2.0.

GROWING AND TRANSPLANTING TOMATO PLANTS

Plants grown in 4-inch dirt bands or in 3-inch clay pots produced over twice as many tomatoes as plants grown by the ordinary method—that is, "pulled" from the bed and set in the field. The results of a trial with 4 replications of each treatment in a randomized block are given in figure 27. Plants grown in 2½-inch clay pots gave almost twice as large a yield as the check, or pull, plants. An increase in yield of .65 ton of U. S. No. 1 tomatoes per acre was obtained by the application of 1 pint per plant of a starter solution at the time the plants were set in the field. The starter solution was made by dissolving 12 ounces of 4-8-8 fertilizer in 25 gallons of water.

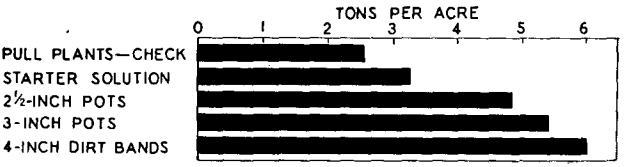


Fig. 27—Yield of U. S. No. 1 tomatoes from different methods of growing and transplanting plants during 1943. West Tennessee Experiment Station.

STRAW-HAY TEST WITH TOMATOES

In 1941, an experiment was started in which 2.5 tons of oat straw, 2.5 tons of alfalfa hay, and a combination of the two were plowed under several months before the tomato plants were set in the field. In 1942 and 1943 these treatments were repeated and were found to have a marked influence on the yield of tomatoes (table 40). One half of each plot in the 3 replications received an application of 120 pounds per acre of nitrate of soda at the time the first fruits began to set. This application caused an increase in yield in every case. This increase was most pronounced on the plots receiving an application of straw alone. In both 1942 and

Table 40—*Effect of plowing under oat straw, alfalfa hay, and a combination of the two on the yield of Rutgers tomatoes at the West Tennessee Experiment Station, Jackson.*

Treatment	Yield of U. S. No. 1 tomatoes	
	1942	1943
	Tons	Tons
No treatment	5.1	2.1
2.5 tons alfalfa hay	6.4	3.8
2.5 tons oat straw	4.5	1.7
2.5 tons straw and 2.5 tons hay	5.9	2.5
400 pounds 8-5-5 fertilizer	5.9	2.9

1943 the largest yields were obtained from the plots receiving alfalfa hay alone, and the smallest from the plots receiving straw alone. The plots receiving no treatment gave better yields than the plots receiving only straw.

SWEET CORN VARIETIES

The yields from the sweet corn variety trial are given in table 41. The largest number of ears per acre were obtained from Cream-O-Gold and Golden Cross Bantam, which are small-eared varieties. Pontiac and Silver Cross Bantam gave the largest yields in pounds. Pontiac and Tennessee Hybrid had the largest ears, and for this reason they would be desirable for local markets, which prefer large ears.

Table 41—*Yield and weight of ear of seven sweet corn varieties at the West Tennessee Experiment Station, Jackson,* 1943.

Variety	Ears per acre		Av. wt. of ear in husk
	Dozens	Pounds	Pound
Cream-O-Gold	970	5000	.425
Golden Cross Bantam	960	5000	.440
Golden Sunshine	380	2000	.455
Ioana Hybrid	630	4700	.540
Pontiac	740	5900	.670
Silver Cross Bantam	870	5700	.555
Tennessee Hybrid	680	5100	.620

VARIETIES OF VINEBERRIES

The yields in pints per acre from a 4-year-old planting of vineberry varieties were: Boysenberry, 2700; Thornless Boysenberry, 2655; Nectarberry, 2655; Youngberry, 1575; Thornless Youngberry, 855; Thornless Loganberry, 225. In 1942, winter injury was very serious in all varieties and was especially bad in Loganberry. In 1943, very little winter injury was noticed on any variety except Loganberry, which was almost entirely killed.

VARIETIES OF GLADIOLI

Fifteen varieties of gladioli were grown and the dates of blossoming, lengths of spikes, and corm production recorded. The varieties were classified on the basis of their general adaptability after one year's trial. The best varieties are listed after 4 asterisks (****), and the poorest after 1 asterisk (*), the others being intermediate: ****American Commander, Blue Beauty, Debonaire, Euterpe, Morocco, Shirley Temple, Yellow Emperor; ***Ave Maria, Golden Chimes, Loyalty, Vagabond Prince; **Bagdad, Senorita; *Charles Dickens, Zauberflote. Euterpe blossomed 10 days earlier than the other varieties, while Bagdad, Debonaire, Senorita, and Shirley Temple blossomed somewhat later than the rest of the varieties. Debonaire, Blue Beauty, Shirley Temple, and Yellow Emperor produced the largest corms.

EROSION CONTROL IN THE PRODUCTION OF TRUCK CROPS

K. B. Sanders, N. D. Peacock, and A. L. Kennedy

In the fall of 1937, six 1/20-acre plots, each 120 feet long and 18.15 feet wide, were established and equipment was installed for the measurement of subsequent runoff and soil losses.[11] For 5 years, 1938-1942, one plot was kept in cultivation every year; 2 other plots were rotated, the first being in sod for 2 years and subsequently in cultivation for 3 years, and the second being in cultivation for 2 years and subsequently in sod for 3 years; and 3 plots were strip-cropped, with half of each plot in sod and the other half in cultivation, the sodded and cultivated areas of each plot also being rotated. Average water and soil losses per year for the 5-year period are shown in table 42.

Table 42—*Average water and soil losses per year for a five-year period, Wolftever silt loam, 10 percent slope, Knoxville Station.*

Plots 120 ft. × 18.15 ft. = 1/20 acre.[1]

Plot No.	Number of plots	Cropping system	Water losses as runoff	Soil losses per acre
			Inches	Tons
6	1	Continuous cultivation	7.52	38.08
4 & 5	2	Rotation	5.05	18.44
1, 2, & 3	3	Strip-cropped and strips rotated	4.51	8.62

[1]The average rainfall per year was 46.83 inches.

These results show that water and soil losses were greatest with continuous cultivation, as would be expected; that the one practice of rotation caused a great reduction in erosion losses; and that the combined practices of rotation and strip cropping caused an even greater reduction in erosion losses. The saving of soil by these erosion-control practices was greater than the saving of water.

In April 1943 the entire experimental area of the six 1/20-acre plots—the sodded portions and the fallow portions—was plowed and prepared, and sweet corn, followed by rye, was grown on all plots alike. The objects were to obtain a crop index of the entire experimental area and to note effects of previous management on erosion losses. There was a decided tendency for erosion losses from the several plots to become equal, during 1943, under uniform cropping. Nevertheless, decided differences among plots occurred, in consequence of differences in the previous management of the plots.

PLANT PATHOLOGY

C. D. Sherbakoff

Most of the results of studies by the Department of Plant Pathology that have practical applications were incorporated in Bulletin No. 186, "The More Important Diseases and Insect Pests of Crops in Tennessee," published in December, 1943.

[11]N. D. Peacock. Strip-Cropping Project. Tenn. Agr. Exp. Sta. Annual Report, 1938, pp. 24-27.

Fig. 28—Wheat stem rust.

Left, stems and kernels of rust-resistant wheats, not affected by the rust; right, stems and kernels of rust-susceptible wheats, severely injured. Harvest, 1942.

The services of two members of the Department were not available during the year. Hence, except for necessary assistance to other departments in the matter of plant-disease information, attention was confined to previously organized projects—mainly to the breeding of disease-resistant red clover, cotton, strawberries, dark tobacco, tomatoes, watermelons, and wheat. Progress in the several projects is briefly reported below.

Red clover breeding for resistance to anthracnose and powdery mildew, and for uniform plant and seed appearance, resulted in fur-

ther improvement in resistance and uniformity of several lines. Some of these are being increased.

Wheat breeding for rust resistance resulted in a number of lines resistant to both stem and leaf rust. Several hundred of the head rows and 284 lines in rod rows were planted during October. The striking difference between stem rust-resistant and susceptible wheat is shown in figure 28.

Certain data of interest to the farmers, obtained in connection with the wheat studies, were published in Circular No. 86, entitled "Wheats for Tennessee Growers."

Breeding of cotton, tomatoes, and watermelons for resistance to Fusarium wilt gave a number of very promising wilt-resistant lines.

In the case of the watermelon breeding, carried on in cooperation with the Department of Plant Pathology of the Mississippi Agricultural Experiment Station, a wilt-resistant watermelon of high

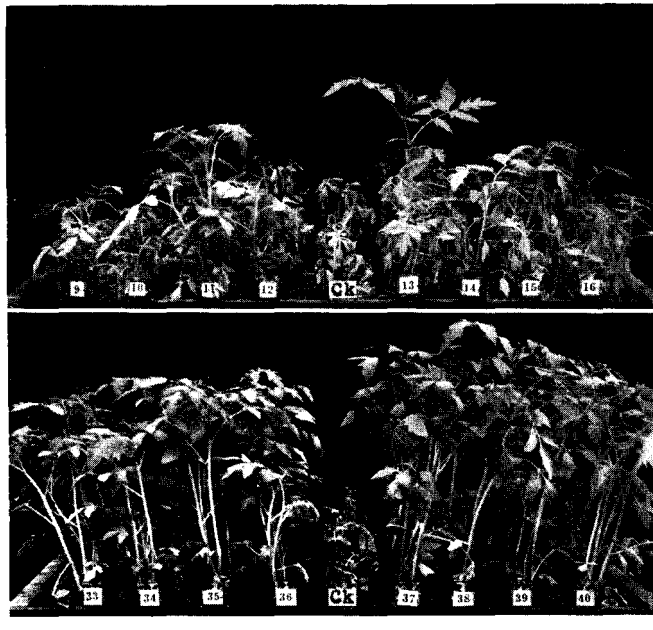


Fig. 29—Two flats of tomato seedlings grown in greenhouse and inoculated, through soil drenched with liquid culture of the tomato wilt fungus, Fusarium lycopersicum.

The middle row (check) in each flat was planted to a susceptible variety. All plants were dead or dying when the photograph was made.

Rows 9 to 16 were planted to pure lines of resistant tomatoes, of Marglobe and Rutgers varieties. Many of the plants were dead, and all showed definite symptoms of wilt. All died after transplanting.

Rows 33 to 39 were planted with wilt-immune selections made at this Station from Missouri crosses of a number of horticultural varieties with wilt-immune cherry tomato, and row 40 with Panamerica tomato. All plants were of normal growth, with no wilt symptoms. All were transplanted and lived to maturity.

quality was obtained. This melon will be released to the growers shortly—it requires only further improvement in appearance.

A number of wilt-resistant cottons have been isolated from simple and multiple crosses made during the years 1937-1939. These cottons are being further pure-lined, and the best of them will be tested also for yield, staple length, strength, and lint percentage.

The testing of various segregates of tomatoes from the crosses between the horticultural varieties and wilt-immune cherry tomato, received from the Missouri Station in 1940, resulted in the isolation of a number of very promising tomatoes possessing immunity from wilt equal to that of Panamerica. This variety was developed by workers of the U. S. Department of Agriculture. Some of our immune lines appear to be higher-yielding and of good quality. The differences among the susceptible, resistant, and immune tomatoes are shown in figure 29.

Dark tobacco breeding for disease resistance has been carried on for the most part by Dennis H. Latham, at the Highland Rim Experiment Station, near Springfield. The main purpose of this project is to develop mosaic-resistant dark tobacco, though some attention has been given to the breeding of tobacco resistant to black shank. In most cases Medole variety was used as the susceptible parent. The other resistant parents were of different varieties obtained from Dr. E. E. Clayton, of the U. S. Department of Agriculture. Substantial progress has been made in the development of mosaic-resistant tobaccos approaching the Medole type. F_1 of the crosses of Medole on 6 black shank-resistant parents also have been made.

LIBRARY

Sarah C. Currell

The Experiment Station library basically is a research library. Its collection has developed along different lines from those of the College library, being built of material actually needed by the research workers for their particular projects. The majority of the books bought for the Station staff are used in the same manner as laboratory equipment. Such books, however, are the property of the library and are cataloged and loaned as other books.

The Extension library, in the summer of 1943, was combined with the College library. The three agricultural libraries now are housed in the same room, making a convenient and economical set-up. The appropriation for each collection is administered separately. In respect to catalog and other records, they are a unit.

In a specialized library such as that of the Experiment Station, which serves as the eyes and ears of its organization, periodicals and bulletins are an invaluable asset. The most recent information is necessary for the development of the work, and this information

can be secured only from current literature. The agricultural libraries now receive 307 periodicals, 124 belonging to the Station and 183 to the College, as shown in the following tabulation:

Periodicals received in 1943.

Libraries	Subscriptions	Exchanges	Donations	Total
Experiment Station	46	40	38	124
College, including Extension	41	10	132	183
Total	87	50	170	307

For various reasons, since 1929 as many as 113 periodicals have been discontinued. These are divided as follows:

Periodicals discontinued since 1929

Libraries	Subscriptions	Exchanges	Donations	Total
Experiment Station	10	1	22	33
College	7	2	71	80
Total	17	3	93	113

In 1942 and 1943 a number of complimentary copies were discontinued because the publishers were not financially able to furnish libraries with periodicals free of charge. Some of these have been taken over as subscriptions.

The Experiment Station library continues to receive bulletins from the United States Department of Agriculture and state experiment stations and extension divisions. There has been a decided falling off in the bulletins received from foreign countries.

During the year, 112 volumes have been prepared for the bindery, bound, and cataloged, just 4 fewer than last year. The cost of the binding was $166.01. As noted in the report for 1942, the falling off in the number bound since 1940, which was 144, is due to the reduction in the number or foreign periodicals received.

The agricultural libraries now contain a total of 20,249 volumes. Of this number, 12,234 belong to the Experiment Station, 187 having been acquired this year.

The growth of the collection has necessitated a new two-sectioned stack, which cost $253.90.

NYA assistance was discontinued in the spring. The librarian at present has only one student assistant, whose services are paid for by the Experiment Station and the College of Agriculture.

In spite of loss of help, the library stands ready in this time of emergency to assist in any research or educational program fostered by the Station or College.

CUMBERLAND PLATEAU PROJECTS

HOME PRODUCTION OF FOOD SUPPLIES

J. J. Bird

During the early part of the year, the carry-over effect of the farm and dietary practices established during the period 1936-1939 on the cooperating farms of the Cumberland Homesteads was noted through survey. In the majority of cases the owners placed little dependence upon the small farms, in view of the availability of lucrative employment in the surrounding region. In a limited number of cases the small farms were fully utilized and continued in the pattern established during the earlier phase of the project. Gardens have not been neglected, largely because they are grown by the women. Certain dietary improvements have continued, such as the increased use of tomato juice made possible through easier methods of home manufacture. However, other radical departures from the native diet, such as replacement of white flour and white breads with whole-wheat materials, even though these are presented in the most palatable form and temporarily adopted, have been largely dropped. The soybean is not now being used by any family formerly on the diets including the soybean. This fact may be attributed in large measure to the difficulty of raising small individual quantities involving harvesting, threshing, and cleaning by hand methods. The same trials with soybean diets in a soybean-growing community, where the small quantities needed could be bought cheap, might result in a more favorable carry-over of this important food item in the diet.

Compilation and analysis of data pertaining to this project were continued during the early part of the year.

THE PLATEAU STATION

During the season, a large part of the work at the new Station was devoted to reshrubbing approximately 50 acres and hauling stone from approximately 100 acres in an effort to make full crop use of the land. Much of the rock was boulder stone and required a great deal of manual breaking with 16-pound stone hammers to make hauling off possible. A 36-acre spring seeding of clover and grass largely failed because of drouth and an extremely heavy weed growth. Fifty-seven acres were prepared for crimson clover and 36 acres for Fulwin foundation oats. Seedings were somewhat late and stands were deficient. Fifteen acres of soybeans were grown for hay. Building work consisted of repair and modernizing of two of the three dwellings on the property. The third dwelling and three small barns did not justify repair, although usable temporarily.

Field experiments were limited to work with potatoes, corn, and small grains. The potato work in cooperation with the U. S. Department of Agriculture was continued. Approximately 8,000 seed-

lings and varieties were grown for selection and distribution to the southern states in the new potato-breeding program for the southern area. Variety yield tests were continued with 12 named varieties. Four hundred promising seedlings developed in the northern potato-breeding program also were increased for observation, from which 73 were selected for further increase. A study of the spread of potato virus disease was started, with two isolated plantings containing controlled percentages of viruses A and Y. The spread of these viruses will be determined in 1944 and plotted.

In cooperation with F. D. Richey, a standard corn variety test of 22 varieties was planted on Tilsit soil, which produced yields up to 60.5 bushels per acre of Ohio 3126 hybrid. The hybrids ranked considerably ahead of the open-pollinated varieties, with the exception of Jellicorse.

Small-grain plantings were made in cooperation with Mr. N. I. Hancock, in which 30 oat and 40 barley varieties were planted for winter-hardiness tests; and 35 new oat strains, 4 standard oat varieties, and 5 barley varieties were planted for yield test.

Practically all of the experiments were conducted on Tilsit soil this season for the sake of convenience. It is planned to duplicate the important plot work in the future on the more important soil types—Hartsells, Tilsit, and Crossville—where practicable. The general productiveness of the farm is rather low at present, and the soil-building program is being given first attention.

MIDDLE TENNESSEE EXPERIMENT STATION
Columbia

L. R. Neel, Superintendent

DROUTH

Rainfall at Columbia for the year 1943 was 37.36 inches, about 10 inches below normal. January and February were much below normal; the total for the two months being only 2.99 inches. The period when the drouth hurt most was from late April until September; the rainfall for the four months May, June, July, and August was but 8.86 inches. Pasture was short and the corn yield poor.

DRY-WEATHER CROPS MADE GOOD SHOWING

Drouth is so regular a visitor to the fertile Central Basin, and the soil has such poor drouth-resisting qualities that the importance of crops that suffer least from dry weather probably has not been emphasized sufficiently. In other words, crops that give a good account of themselves with a fair degree of regularity should have more attention.

Sorghum for silage a stand-by.—In 1943, when Tennessee Hybrid corn in the good second-bottom land that had been manured produced only 30 bushels, or 1685 pounds of digestible nutrients, per acre, Texas Seeded Ribbon sorghum produced 19 tons per acre of silage (as it comes from the silo), or a total of approximately 5700 pounds of digestible nutrients per acre. The silage planted in May made only a moderate growth through May, June, and July, but improved with the better rains of August, and made its final growth with the abundant rains of September.

Alfalfa always makes good.—While alfalfa was affected by the dry weather, and the yield was reduced somewhat, the average of the variety trials in the plot grounds was somewhat more than 4 tons of hay per acre, or a total of 4024 pounds of digestible nutrients. Corn on the same kind of land in the plot grounds produced 26 bushels, or a total of 1499 pounds of digestible nutrients, if cob and shucks as well as grain are fed.

Tobacco well cared for makes good.—If burley tobacco is properly prepared for, and is given good attention, it rarely fails on account of drouth. While the land of the Middle Tennessee Experiment Station is not well suited to tobacco, the average yield in 1943 in the variety trials on land that was manured but not given commercial fertilizer was 1668 pounds of leaf per acre, which sold for an average of $784.

Bermuda-bluegrass pasture withstands the drouth.—The famous 52-acre Bermuda, bluegrass, and clover pasture, while affected somewhat by the drouth, still produced 182-2/3 animal-unit pasture days in 1943, or a full 6 months of pasture for a mature beef cow. It supplied 45 cows, a bull, and 40 calves nearly all of the pasture they had through the grazing season.

Other hot-weather pasture plants.—In a test with yearling beef cattle, Tiff Sudan grass furnished 182 pasture days per acre; common Sudan grass, 178 days; and soybeans, 152 days. This pasture was furnished in July, August, and September, when most needed, and of course was of much higher quality than the Bermuda grass.

WINTER PASTURE CROPS

Central Basin farmers can get as big returns from their winter pasture crops as farmers in any other part of the country and can excel most of them. In the winter of 1942-43, ryegrass, Tennex oats, and Balbo rye were compared, with the results shown in table 43. Steer calves were used in pasturing the crops off.

SMALL GRAINS

The use of nitrogenous fertilizer on small grain has been most profitable at the Middle Tennessee Station. In the past, nitrate of soda has been the main material used, as in the test reported in

table 44. Ammonium nitrate would be expected to be approximately twice as effective per pound of material.

Table 43—*Dates of seeding ryegrass, oats, and rye, and results in pasture days.*

Crop	Date seeded	Steer days per acre
Ryegrass	Aug. 12	120
	Sept. 2	160
	Oct. 1	160
Average		147
Tennex oats	Aug. 12	150
	Sept. 2	140
	Oct. 1	170
Average		153
Balbo rye	Sept. 2	280
	Oct. 1	200
Average		240

Table 44—*Comparative effects of different amounts per acre of nitrate of soda on yields of barley, oats, rye, and wheat.*

Crop	Yield	No nitrate	50 pounds	100 pounds	150 pounds	200 pounds
Barley	Bushels	16.4	22.2	26.7	39.3	47.7
	Pounds	789	1068	2174	1274	2292
Oats (W)	Bushels	23.4	47.8	60.0	58.1	.....
	Pounds	748	1530	1920	1859	.....
Rye	Bushels	21.3	24.6	28.3	35.3	39.6
	Pounds	1197	1379	1590	1980	2220
Wheat	Bushels	13.3	20.0	25.7	.....	29.0
	Pounds	798	1200	1542	.....	1740

Probably the most instructive thing in the results of variety trials of small grain in 1943 was the behavior of some varieties in the severe cold weather of the winter of 1942-43. It should be noted that yields were not up to normal for the Experiment Station. This was due to the Station's inability to secure an adequate supply of nitrogenous fertilizer.

Wheat.—Yields in 1943: Fulcaster No. 612, 26.1 bu.; Bluestem No. 2, 25.5; Cornell No. 5-7, 25.4; Thorne, 22.9; Red Rock, 22.5; Forward, 22.3; Hardired, 18.2; Carala, 17; Sanford, 14.1 bu.

Winter Oats.—Yields of oats seeded on well-prepared land October 15: Tennex, 34.9 bu.; Fulwin, 32.9;Forkedeer, 31.9; Fulghum, 29.9; Fulgrain, 27.1; Lee, 27.0; Winter Turf, 21.9; Hastings' Hundred-Bushel, 10.9; Victorgrain, 6.6 bu.

Spring Oats.—Again no nitrogen fertilizer was used. Yields in 1943: Brunker, 32.6 bu.; Fulghum, 29.9; Columbia, 29.9; Trojan, 28.7; Tennex, 28.5; Coker's Fulgrain, 28.3; Forkedeer, 28.2 bu.

Barley.—The barley varieties made a very poor showing on the medium soil of the plot grounds without any nitrogenous fertilizer; but the severe winter did afford an indication that Wintex, a good barley of Texas, is not adapted to Tennessee. This variety produced 13.2 bushels, against 21 bushels for Jackson No. 1.

ALFALFA SOURCE-OF-SEED AND VARIETY TRIAL

Yields of alfalfa in the source-of-seed and variety trial were as follows: Argentine alfalfa, 4.56 tons per acre; Argentine Chebut, 4.48 tons; Kansas common, 4.43 tons; Grimm, 4.37 tons; Oklahoma common, 4.29 tons; Utah common, 4.16 tons; Dakota common, 4.16 tons; New Mexico common, 3.91 tons; Arizona Chilean, 3.91 tons; Arizona common, 3.68 tons. This is the second year from this seeding, and Arizona, New Mexico, and Utah seedings may be expected to go down ahead of the others.

TOBACCO EXPERIMENT STATION [12]

Greeneville

J. L. Vandiver, Assistant Agronomist

WEATHER CONDITIONS

The total precipitation for the year at the Greeneville Station was 37.82 inches. This was 6 inches below the average for the past 11 years. The water that fell was not well distributed during the growing season. A general drouth prevailed from the last of March to September 3, with the exception of a few days following June 7, when a very helpful rain fell. Most of the rains during the summer came in showers too light to connect with the soil moisture, and because of abnormally high temperatures the moisture evaporated without doing much good.

TOBACCO INVESTIGATIONS

Tests of the effects of various fertilizers on the quality and quantity of burley tobacco have been continued. Owing to unusually hot weather at transplanting time, poor stands were obtained on most plots. Since the percentage of stand materially affects the quality of leaf, it is difficult to appraise the results. Some differences, however, are worthy of note.

It is evident that there is a definite need of potash on all of the soils used and that the amount required varies with the soil type. On Decatur soil it appears to be unprofitable to use more than 30 pounds of K_2O per acre unless nitrogen is applied in excess of 18 pounds of N. Moreover, on this type of soil, where 10 to 15 tons per acre of barnyard manure was used and potash was applied in excess of 30 pounds of K_2O, the yield of tobacco was decreased. Responses to potash and manure on Shackleton and Nolichucky soils, where 18 pounds of N and 48 pounds of P_2O_5 were kept constant and K_2O was applied at the rates of 18, 30, and 60 pounds per acre, both quality and yield of leaf were improved with each increase of potash. Where 10 tons of manure per acre was applied with the

[12] All of the tobacco work is cooperative with the U. S. Dept. of Agr.

Fig. 30—Black root rot resistance.

These burley tobacco plants all were transplanted to the field at the same time. The small plants are of a variety susceptible to black root rot; those on each side are of varieties that have been bred for resistance to the disease.

fertilizer mixture containing 60 pounds of K_2O, the yield was greatly increased and the quality of leaf was improved in like proportion.

On Shackleton soil, where 10 tons of manure was applied with 600 pounds of 3-8-10 fertilizer, the value of the crop was increased $214.00 per acre. The 10-ton application of manure on Nolichucky soil increased the value of leaf $84.00 per acre. It is also worthy of note that these two types of soil are so deficient in available phosphate that plots receiving 600 pounds of 3-0-5 fertilizer per acre sometimes yield no more than plots receiving no fertilizer.

ROTATION TESTS

The drouth seriously affected the rotation tests. Crop stands were poor and yields were light. The injurious effect of Korean lespedeza is becoming more evident in the 3-year rotation, and the weed rotation is not as good this year as on the plots where sweet clover, alfalfa, grass mixture, or bluegrass is used in the cropping system.

VARIETY TESTS

Low rainfall and high temperatures during June and July prevented serious injury from black root rot. It was not possible, therefore, to learn much more about the resistance of the varieties

even where the plots were on infested soil. Of the 15 varieties tested, Kentucky 41-A rated first on both black root rot-infested soil and clean soil. Many of the new strains developed at the Station proved superior to Kentucky 16.

INVESTIGATIONS IN THE ECONOMIC USE OF SOD CROPS IN EROSION CONTROL

In connection with investigations of the broadcast system of farming, a series of 6 plots was laid out on a 10-percent slope and enclosed so that water and soil losses can be measured from each plot. Three of the plots are used in a corn-wheat-lespedeza rotation, 2 in a barley-crimson clover rotation, and 1 in permanent sod.

Total soil and water losses have been greatest on the corn-wheat-lespedeza rotation, but losses from single rains have been greater on the crimson clover-barley plots. Losses in the 3-year rotation are greatest during corn- and wheat-growing months. There has been very little loss after the lespedeza formed a sod. In the 2-year rotation, heaviest losses have occurred at the time of preparation of the soil and sowing of crimson clover. Soil and water losses in the grass-sod plot have been slight.

CATTLE FEEDING

ALFALFA HAY COMPARED WITH SERICEA HAY AS A SUPPLEMENT TO CRIMSON CLOVER GRAZING IN WINTERING CALVES AND STEERS

In the winter feeding experiment, 20 head of cattle were used, 10 of them steer calves and 10 yearling steers. Each of the two groups was divided into lots of 5. One lot in each group was given as much sericea hay as the animals would consume and the other lot was fed alfalfa hay. The test lasted 168 days, from November 3, 1942, to April 22, 1943. The lot of calves fed sericea hay made a total gain of 395 pounds, while the lot fed alfalfa hay gained 702 pounds. In the yearling steer group, the lot that was fed sericea hay gained 184 pounds and the lot that received alfalfa hay gained 551 pounds. The weather was favorable for grazing; there were less than 20 days when the cattle were not on crimson clover long enough to get a fill.

It may be noted that the alfalfa groups made better gains than the sericea groups. But previous tests have shown that this difference is largely overcome during the summer grazing period.

COMPARISON OF ALFALFA AND SERICEA AS SILAGE

Uniform lots of medium-grade yearling steers weighing 700 pounds were used in a comparative test of alfalfa silage and sericea silage. In addition to silage, the steers were given an average daily ration of 10 pounds of crushed corn-and-cob meal per head per day. The feeding test ran 91 days. The steers receiving alfalfa

silage ate an average of 28 pounds of silage per head per day and made an average daily gain of 1.95 pounds, while those fed sericea silage consumed 25 pounds and made an average daily gain of .34 pound.

The silages compared in this test were made without any preservatives and could be classed as good.

In tests with other lots of steers, 3 preservatives were used in making the silage. The average results obtained were about the same as those shown here. This year's results are very similar to those of previous years. They all show that sericea does not make a satisfactory silage to supplement grain in a finishing ration for steers.

ALFALFA SEEDING PRACTICES

Owing to the danger of soil losses from erosion when the land is prepared in the summer for alfalfa seeding in August, the Station began sowing alfalfa on small grain in March. The results have not been perfect, but the practice has been highly satisfactory. During the past 10 years this method of seeding has proved much more dependable with alfalfa than with red clover. When sowing alfalfa on small grain in the spring, one must keep in mind the fact that alfalfa seed require a light cover of soil if best results are to be obtained. A double-gang cultipacker has always been used at the Greeneville Station to cover the seed after they were sown on top of the soil. Spring seeding on fall-plowed land without cover crop has been practiced with excellent results and with slightly less danger of soil losses than one might expect from late-summer seedings.

CRIMSON CLOVER

The danger of loss of soil by erosion during the seedbed preparation for crimson clover, and until the growing plants give protection, may be overcome to some extent by the breaking of the soil to normal plow depth with a subsoil plow. This should be done in June or early July. It stops or greatly retards weed growth, and leaves the stubble and trash on top, so that the soil is in condition to absorb a considerable amount of rainfall without danger of erosion. As soon as weeds start, they should be killed by disking. By the last of July or early August the soil should be thoroughly disked and rolled to a firm, smooth seedbed. The seed should be sown on top of the ground and covered with a double-gang corrugated roller. This method has been used at the Station for the past 10 years, and only twice has failed to give a satisfactory stand and a growth that furnished good grazing by the first of November. Even with this method there still is danger of erosion except on relatively level land or on land that has been properly terraced.

WEST TENNESSEE EXPERIMENT STATION

Jackson

Ben P. Hazlewood, Superintendent

ADDITIONAL LAND

Two land purchases for the West Tennessee Experiment Station were made during the year 1943, one consisting of a 14-acre farm within the boundaries of the Station and the other a partly developed subdivision fronting the Memphis highway.

Control of the small farm has been needed for many years. Because of its location, it has interfered with the production of pure seed by the Station, has been a source of plant diseases, and otherwise has proved detrimental to the Station's interests.

Possession of the subdivision area eliminates similar problems, and at the same time gives the Station continuous frontage on the Memphis highway. This frontage now extends from the sand branch, near the Jackson city limits, to the Forked Deer River, a distance of about 2500 feet. The frontage on the Dyersburg highway extends for a distance of 1000 feet. The frontage on each of these highways has been increased by recent land purchases. Much more of the Station is now in view of the public traveling these highways.

MEETINGS

The Spring Field Day, for the study of winter crops and livestock experiments, was resumed after a lapse of one year due to the war. The attendance was above average, which was not expected on account of travel conditions.

The attendance at the Farmers' and Home Makers' institute in July was the largest for the past ten years. A part of the program was devoted to recognition of Governor Cooper's interest in the Station, and his response. Mr. I. B. Tigrett, a trustee of the University, in presenting the Governor, spoke of the contribution he had made to the Station by providing $48,000 from the State's general fund to pay on indebtedness which had been incurred for the enlargement of the Station during the past three years. Governor Cooper's response was an outstanding address.

FOUNDATION SEED PRODUCTION

The increased acreage has made it possible for the Station to contribute to the propagation of certain seed stocks for distribution to farmers who wish to grow pure seed. The work has been confined to introductions by the Tennessee Experiment Station plant breeders or to crops introduced from sources no longer able to supply foundation seed.

Seed of Tennessee No. 52 barley was supplied to 33 growers living in 15 Tennessee counties, and to 46 growers living in 3 states other than Tennessee.

The new variety of barley, Jackson, was supplied to 27 growers living in 8 Tennessee counties.

The new Tennessee oat, Forkedeer, was supplied to 62 growers living in 16 Tennessee counties, and to 5 growers in 5 other states.

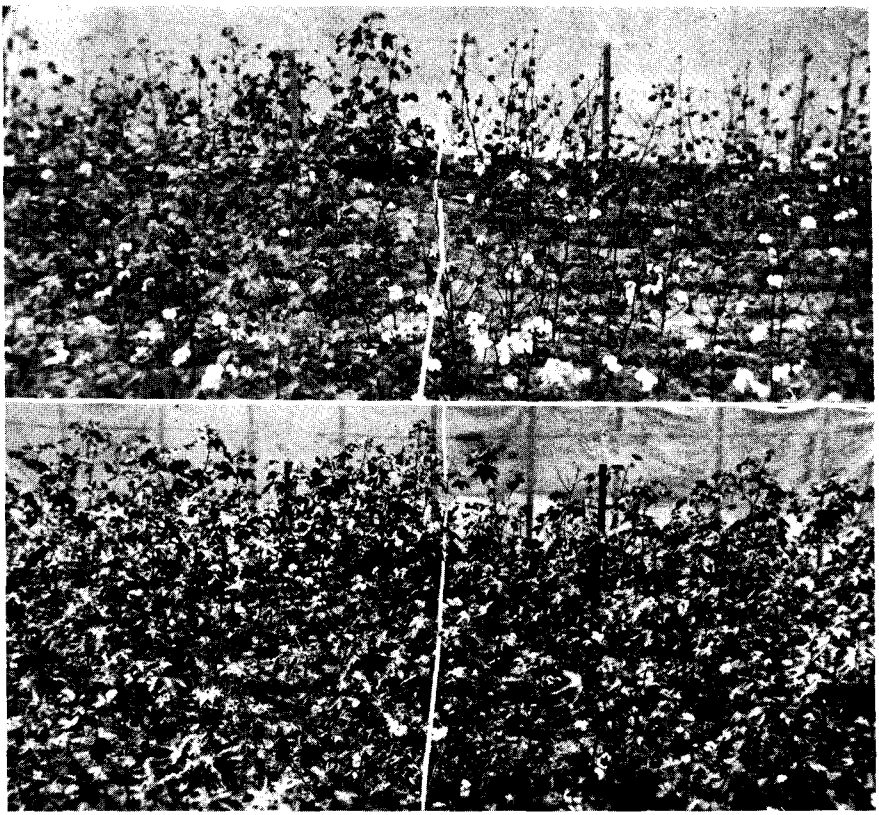
Jellicorse corn was supplied to 45 growers in 16 Tennessee counties, and to 2 growers in other states.

Limited quantities of other new-crop seeds were provided.

DRAINAGE

A considerable part of the bottom land, drained by a system of ditches previously constructed, was cleared. The clearing of this land made available 40,000 feet of lumber, which is being used for building repair and bridge construction. The first crop of corn produced after the land was cleared gave a yield of 15 bushels per acre on an area of 35 acres. The yield apparently was reduced by low rainfall, stumps, and general rough condition of the field. It is not expected that corn yields will ever be exceptionally high, but they may easily be from 30 to 50 bushels per acre. More experimental work will be started on this area as soon as clearing and fencing can progress far enough.

Fig. 31—Permanent pasture at the West Tennessee Station.



Unlimed Limed

Fig. 32—Limestone was detrimental to cotton on a potash-poor soil (top) at the West Tennessee Station. Potash corrected the trouble (bottom); 75 pounds per acre of muriate greatly increased the yield on both limed and unlimed plots.

WEATHER

The rainfall for the year was about 25 percent below average, and the distribution did not favor crop production. The early summer months were very dry. September had a rainfall of 6.04 inches, and cotton was damaged by it.

LIVESTOCK

Feeding work was continued with beef cattle, swine, and dairy cattle. The work with hogs and dairy cattle relates to greater use of pasture. Beef cattle feeding relates to use of new silage crops, whole chopped sweetpotatoes, and limited rations for fattening cattle.

Detailed reports of the swine and beef cattle feeding may be found in the Animal Husbandry section of this report.

PUREBRED LIVESTOCK PRODUCTION

A flock of purebred Hampshire sheep and purebred herds of Duroc hogs and Jersey cattle are maintained. The offspring are used in feeding tests and for distribution to farmers for the improvement of their flocks and herds.

FIELD CROPS

The extensive experimental crop rotations were continued. This work includes 9 rotations, 2 of them conducted on 2 soil types. Each rotation is planned to determine the value of different liming materials, fertilizers, and manure.

Other field-crop work includes: varieties of cotton, corn, clover, grasses, soybeans, and sorghum; dates of planting cotton and corn; soil-improvement value of winter crops and sericea; and fertilizer tests.

Detailed reports regarding varieties of cotton, corn, and small grain may be found in the Crop Improvement section of this report.

PLANT DISEASES

Plant-disease work at the West Tennessee Station is reported in the Plant Pathology section of this report.

FRUITS AND VEGETABLES

Work with fruits and vegetables is covered in the report on Horticulture at West Tennessee Experiment Station.

CHANGES IN STAFF

Resignations

P. W. Allen, Bacteriologist, August 31.

H. H. Block, Associate Physicist, December 31.

E. B. Browne, Assistant Agronomist, December 31.

Vincenta Cooper, Assistant in General Chemistry, August 31.

M. E. Dahmus, Assistant Horticulturist, April 30.

L. J. Fenske, Assistant Agricultural Economist, May 23.

E. B. Fickel, Assistant Agricultural Economist, August 15.

A. H. Fitzgerald, Assistant Chemist, August 7.

Helen Huffman, Assistant in Physics, December 31.

*M. B. Johnson, Assistant Agricultural Economist, October 9.

W. M. Roberts, Assistant Dairy Husbandman, July 31.

W. S. Rowan, Assistant Agricultural Economist, June 30.

*Cooperative with USDA.

Appointments

Mary Nell Black, Assistant in Physics, March 15.
H. H. Block, Associate Physicist, March 18.
E. B. Browne, Assistant Agronomist, February 1.
D. S. Burgis, Assistant Horticulturist, July 1.
A. H. Fitzgerald, Assistant Chemist, July 1.
*M. B. Johnson, Assistant Agricultural Economist, January 1.
C. C. Mantle, Assistant Agricultural Economist, January 18.
*F. N. Masters, Assistant Agricultural Economist, October 4.
W. S. Rowan, Assistant Agricultural Economist, March 8.
Juanita Smith, Assistant in Home Economics, September 1.
F. S. Chance, Assistant Director, July 1.

*Cooperative with USDA.

PUBLICATIONS, 1943

BULLETINS

No.	Title	Authors	Date	Pages
183	Dehydration of Fruits and Vegetables in the Home	G. A. Shuey	May	23
184	Quenched Calcium Silicate Slag. A By-Product Substitute for Limestone and Superphosphate	W. H. MacIntire S. H. Winterberg	March	32
185	Pasture Studies with Laying Hens	Jesse E. Parker B. J. McSpadden	October	19
186	The More Important Diseases and Insect Pests of Crops in Tennessee	C. D. Sherbakoff W. W. Stanley	December	142

CIRCULARS

82	Recommendations for Control of Tomato Insects	W. W. Stanley S. Marcovitch	April	2
83	Influence of Borax and Potash on Alfalfa Yellows	John B. Washko	February	4
84	A Select List of Varieties of Fruits and Vegetables	Brooks D. Drain	May	8
85	Control of Mexican Bean Beetle and Bean Leaf Beetle	S. Marcovitch W. W. Stanley	May	4
86	Wheats for Tennessee Growers	C. D. Sherbakoff	October	7

MONOGRAPHS

(Mimeographed)

No.	Title	Authors	Date	Pages
145	Efficient Use of Farm Taxes by Tennessee Counties	B. H. Luebke C. E. Allred	December ('42)	40
146	Tomato and Bean Enterprises on Upland Farms Near Douglas Reservoir	L. J. Fenske	January	52
147	Burley Tobacco Enterprise on Upland Farms Near Douglas Reservoir	L. J. Fenske C. E. Allred	March	43
148	Facilities and Agencies at Knoxville Livestock Market	W. S. Rowan B. H. Luebke	April	27
149	Cotton Loan Program in Tipton County, Tennessee, 1941 and 1942	M. B. Johnson	April	47
150	Whole Milk Enterprise on Upland Farms Near Douglas Reservoir	L. J. Fenske	April	50
151	Areal and Functional Consolidation of Tennessee Counties	C. E. Allred B. H. Luebke	April	43
152	Disposition and Outlets for Grain in Knoxville Trade Area	M. B. Johnson B. H. Luebke	April	41
153	Movement, Transportation, and Prices of Grain in Knoxville Trade Area	M. B. Johnson B. H. Luebke	April	55
154	Poultry Enterprise on Upland Farms Near Douglas Reservoir	L. J. Fenske	May	32
155	Family Living Costs on Upland Farms Near Douglas Reservoir	H. J. Bonser R. L. Tontz C. E. Allred	May	38
156	Hog Enterprise on Upland Farms Near Douglas Reservoir	L. J. Fenske C. E. Allred	May	30
157	Comparison of Six Selected Enterprises on Upland Farms Near Douglas Reservoir	L. J. Fenske C. E. Allred	May	25

No.	Title	Authors	Date	Pages
158	Graphic Summary of Purebred Livestock, Tennessee and United States	M. B. Johnson C. E. Allred	June	41
159	Why Farmers Move or Change Tenure Status	C. E. Allred Margaret Guilford H. J. Bonser	August	44
160	Food Consumption by Farm Families Near Douglas Reservoir	H. J. Bonser R. L. Tontz	September	47
161	Farm Supply Aspects of Knoxville Milk Market	B. H. Luebke C. C. Mantle W. S. Rowan	September	44
162	Collection of Milk from Farms, Knoxville Milk Shed Area	B. H. Luebke C. C. Mantle W. S. Rowan C. E. Allred	December	45

ARTICLES AND PAPERS

CHEMISTRY

Title	Authors	Publication	Pages
Potassium Retention from Annual Additions of Chloride, Sulfate and Nitrate, as Influenced by Limestone and by Dolomite	W. H. MacIntire W. M. Shaw Brooks Robinson J. B. Young	Soil Science, Vol. 55, No. 4, 321-332, April, 1943	11
Steam Distillation—A New Procedure for the Determination of Carbonate CO_2	W. M. Shaw W. H. MacIntire	J. O. A. C., 357-396 August, 1943	39
Response of Sudan Grass to Ammonium Hydroxide in Pot Cultures	W. H. MacIntire S. H. Winterberg H. W. Dunham L. B. Clements	Proc. Soil Science Soc. of Am., Vol. 8: 205-210, 1943	6

HORTICULTURE

Species Crosses in the Genus Phaseolus	A. B. Strand	Amer. Soc. for Hort. Sci. Vol. 42: 569-573, 1943	5
Strawberry Breeding and the Inheritance of Certain Characteristics	J. P. Overcash L. A. Fister Brooks D. Drain	Amer. Soc. for Hort. Sci. Vol. 42: 435-440, 1943	6
Southern Pear Breeding	Brooks D. Drain	Amer. Soc. for Hort. Sci. Vol. 42: 301-304, 1943	4

POULTRY

Title	Authors	Publication	Pages
Seasonal Variation in Semen Production in Domestic Fowls	Jesse E. Parker B. J. McSpadden	Poultry Science, Vol. 22, No. 2, March, 1943	6
Influence of Feed Restriction on Fertility in Male Domestic Fowls	Jesse E. Parker B. J. McSpadden	Poultry Science, Vol. 22, No. 2, March, 1943	8
Influence of Thyroactive Iodocasein on Growth of Chicks	Jesse E. Parker	Proceedings of Soc. for Exp. Biology and Medicine, 52: 234-236, 1943	3