

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

SIXTY-FIRST ANNUAL REPORT

1948

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KNOXVILLE, TENNESSEE

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CONTENTS

	Page		Page
Letter of Transmittal	4	Entomology	92
Financial Statement	4	Sweetpotato insects	92
Introduction	5	Soil tests with cryolite and arsenic	93
Agronomy	6	New insecticides	94
General	6	Miscellaneous insect pests	97
Uniform variety trials of farm crops	8	Home Economics	99
Fertilizer investigations	10	Food-consumption study	99
Pasture studies	14	Housing study	100
Lespedeza strains test	14	Tennessee cotton in fabrics	101
Crop improvement	14	Precooked and ready-to-cook frozen-food products	103
Corn breeding	17	Calcium and phosphorus metabolism	106
Grass breeding	19	Horticulture	111
Fiber research	19	At Knoxville	111
Nutrient availability in soils	20	At Clarksville	118
Subsoiling studies	21	At Highland Rim Station	118
State soil survey	21	At Plateau Station	119
Chemical weed control	22	At West Tennessee Station	121
At West Tennessee Station	24	Douglas Truck-Crop project	127
Animal Husbandry	28	Plant Pathology	131
At Knoxville	28	Wheat breeding for rust resistance	131
Effluent study	29	Cotton breeding for wilt resistance	133
At Middle Tennessee Station	34	Tomato wilt and early blight	134
At West Tennessee Station	36	Red clover breeding	135
At Tobacco Station	39	Strawberry breeding for resistance to black root	135
At Grassland Substation	43	New fungicides	136
Veterinary Science	44	At West Tennessee Station	136
Chemistry: Soils, fertilizers, and fluorine effluents	47	Poultry	138
Chemistry: General; frozen foods, dehydrated foods; Food Industries Building; proteins and minerals in pastures	59	Quality of Tennessee-produced chicks	138
Dairying	68	Animal-protein factor (Vitamin B ₁₂)	139
Mastitis control	68	Control of internal parasites	139
Winter grazing	68	Incidence of internal parasites	139
Grazing investigations	69	Resistance of inbred chickens to coccidiosis	140
Strains adapted to southern conditions	70	Improvement through breeding	140
Influence of pasture on bull semen	70	Breed resistance to coccidiosis	143
Livability and fertility of bull semen	70	Cooked cottonseed meats for chicks	143
Raising dairy calves	71	Value of protein concentrates	143
Milk production in late lactation	72	Pastures for growing stock	144
At Dairy Station, Lewisburg	72	Influence of pasture on egg quality	144
Economics and Sociology	73	Highland Rim Experiment Station	145
Agricultural Adjustment	73	Middle Tennessee Experiment Station	149
Type of Farming	74	Plateau Experiment Station	157
Marketing Farm Products	75	Tobacco Experiment Station	159
Cotton Marketing	77	West Tennessee Experiment Station	165
Tomato Marketing	78	Library	167
Cooperation	78	Changes in staff	167
Financial Problems of Farmers	79	Publications	168
Engineering	79		
Farm machinery and equipment	79		
Irrigation	87		
Strawberry capper	90		

LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 1, 1949.

To His Excellency, Jim McCord, 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 1948. 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,

C. E. BREHM, President.

FINANCIAL STATEMENT

THE UNIVERSITY OF TENNESSEE AGRICULTURAL EXPERIMENT STATION

In account with

The United States Appropriations under the Hatch, Adams, Purnell, Bankhead-Jones, and Research and Marketing Acts, and Non-Federal Funds, 1947-48.

	Federal Funds					Non-Federal Funds
	Hatch	Adams	Purnell	Bankhead-Jones	Research and Marketing	
Receipts						
From United States Treasurer	\$15,000.00	\$15,000.00	\$60,000.00	\$83,564.10	\$56,809.25	\$384,906.98
From other sources						
Expenditures						
Personal Services	14,217.51	14,371.79	54,858.89	69,791.64	26,786.04	199,627.69
Travel			622.37	1,043.48	1,749.17	6,515.64
Transportation of Things	1.63	14.75	92.94	132.63	298.61	2,859.58
Communication Service	228.53		4.53	14.59	58.70	2,241.74
Rents and Utility Services	23.45	9.33	199.14	150.69	429.07	3,030.44
Printing and Binding				5.70		1,892.76
Other Contractual Services	13.28	45.00	943.43	1,923.11	299.05	18,482.78
Supplies and Materials	515.60	417.34	2,290.33	7,547.38	12,375.21	105,063.81
Equipment		141.79	988.37	2,846.58	6,395.08	39,081.65
Land and Structures (Contractual)				108.30	101.00	9,896.41
Total Expenditures	\$15,000.00	\$15,000.00	\$60,000.00	\$83,564.10	\$48,491.93	\$384,906.98

INTRODUCTION

Discoveries in the field of agricultural science are being applied more and more by farmers of the State. The results are reflected in higher returns from crops and livestock. The increased use of Tennessee-produced and -adapted strains of hybrid corn, along with better fertilization and care, raised the State's corn average to approximately 33 bushels per acre. This is about 10 bushels higher than the yield of twenty years ago. Ten bushels per acre multiplied by the 2,255,000 acres of corn grown in the State makes an increase of 22,550,000 bushels. With corn at one dollar per bushel, the increase amounts to \$22,550,000.

On a percentage basis, the use of Forkeddeer oats, Jackson No. 1 barley, and other recommended varieties of small grains developed by the Experiment Station has made the increase in yields of these crops greater than that of corn. The small-grain acreage is less than the corn acreage, but even so, the financial gain through the use of these improved crops amounts to millions of dollars per year.

During 1948 a contract was entered into with the Atomic Energy Commission for a study of the cattle that were injured when the experimental atom bomb was exploded in New Mexico. In connection with this study, other projects were developed for investigations on the use of isotopes in the study of animal and plant metabolism, with special emphasis on minerals. The Commission set aside about two thousand acres of tillable land in the Oak Ridge area for the University's use in prosecuting these investigations.

Greater emphasis is being given to the study of improved pastures in the production of livestock and livestock products. The work in this field is beginning to show results beyond the expectation of many livestock and dairy farmers. The use of good pastures lowers the cost of beef and dairy products, and at the same time reduces the loss from soil by erosion.

The TVA is giving valuable cooperation in many studies, especially in the fields of Agricultural Engineering, Soil Fertility Investigation, and Forestry.

Reports by Departments follow.

AGRONOMY

GENERAL

L. N. Skold

WEATHER CONDITIONS AT KNOXVILLE

The early part of the 1948 growing season was generally favorable for spring planting and for pasture and hay crops, being nearly normal in temperature and slightly drier than usual. As the season progressed, a succession of several months, each deficient in rainfall, was very unfavorable for pasture and hay production. This was typical of the State generally, though Knoxville and vicinity were less affected than many other areas. The extended drouth lasted through October and delayed the fall planting of small grains. Yields of corn, tobacco, and other crops were excellent in spite of the dry summer. Rainfall in November was approximately three times more than normal, making the total for the year about average.

The last killing frost in the spring occurred on March 29, and the first in the fall on October 18, giving a growing season of 203 days, or about two weeks shorter than normal.

The lowest temperature, 7° F., was recorded on January 1, and the highest, 100° F., on July 5. Temperatures generally were about average.

ALFALFA

Methods of Seeding.—Spring seeding of alfalfa is sometimes practiced in Tennessee because of the damage from the *Sclerotinia*



Fig. 1.—Typical symptoms of *Sclerotinia* crown rot of alfalfa. The three plants on the right have been killed by this disease.

crown rot disease, which is often serious in fall-sown legume fields the spring after seeding. Another factor in favor of spring seeding is the severe erosion that sometimes occurs on fields with considerable slope when alfalfa is sown in the fall on a well-prepared seedbed. Figure 1 shows typical symptoms of *Sclerotinia* injury.

No further data were obtained in 1948 from the study of various methods of seeding, because unfavorable growing conditions and severe washing in certain portions of the test plots made comparisons of treatments impossible. Preliminary data taken in previous years have indicated that fall seeding without a companion crop is more apt to result in a satisfactory stand of alfalfa than spring seeding on fall-sown grain. The study is being continued to include red clover as well as alfalfa. A mixed seeding of alfalfa and oats is shown in figure 2.



Fig. 2.—A good stand of alfalfa sown in fall-planted small grain.

Seed Production.—In the fall of 1947, a study of the factors affecting seed production of alfalfa was initiated at Knoxville and at the substations at Greeneville, Columbia, Springfield, and Jackson. This work was undertaken for the reason that practically all of the alfalfa seed used in Tennessee is produced in the western and midwestern states. Failure to produce seed locally has been an effective bar to the breeding and selection of varieties better adapted to this region than those grown farther west under soil and climatic conditions very different from those in Tennessee.

Data obtained in 1948, the first year of the test, were preliminary. No attempt was made to control injurious insects or to provide honeybees to give more adequate pollination—factors which will be considered in the future. Growth was curtailed at Greeneville, Springfield, and

Columbia because of dry weather, and yields of both hay and seed were very poor. At Knoxville, however, yields of about 75 pounds per acre were obtained when the second cutting was allowed to go to seed, and less than half of this amount when the third cutting was used as a seed crop. At Jackson, the seed yields were about 75 pounds per acre when either the second or third cutting was taken as a seed crop. Applications of borax did not significantly affect the yield of hay or seed the first year.

Varieties.—In cooperation with the U. S. Department of Agriculture, many of the newest selections of alfalfa are given a preliminary trial in the Uniform Alfalfa Nursery, which is grown at many stations throughout the country. The more promising selections are retained for intensive studies.

A variety test, concluded this year, indicates that Kansas and Oklahoma Common alfalfa and Buffalo, a selection from Kansas Common, are about equally productive and are superior to others for Tennessee conditions. Seed lots of Oklahoma Common obtained in different parts of the State did not differ significantly in performance over a 4-year period at Knoxville.

SOYBEANS

A soybean breeding and testing project is being conducted in cooperation with the U. S. Department of Agriculture, to produce superior varieties of soybeans for Tennessee conditions and to furnish data for the evaluation of newer selections from other southeastern states. This work is located at Knoxville and Jackson. Established varieties of commercial importance are tested in the Uniform State Performance Trials, discussed elsewhere in this Report.

TEMPORARY PASTURES

The use of winter pasture is an important part of a balanced pasture program. A study of the production of fall, winter, and spring pasture from winter annual species such as small grain, ryegrass, and crimson clover, compared with the production from semi-permanent pastures of orchard grass, tall meadow fescue, and Ladino clover, under high levels of fertility, was initiated in the fall of 1948. The seeding was a failure because of the extreme fall drouth followed by excessively high rainfall in the early winter. The test will be re-established in the fall of 1949.

UNIFORM VARIETY TRIALS OF FARM CROPS

S. F. McMurray

The Uniform Variety Trials of farm crops included corn, soybeans, winter oats, spring oats, wheat, and barley. Tests were conducted at the main Experiment Station and the 5 substations, which are at widely separated locations in the State.

The 1947 data were published in January, 1948, in Bulletin No. 206, "Variety Performance Trials of Oats, Barley, Wheat, Corn, and Soybeans."

CORN

There were 36 entries in the corn variety test. Only 2 of the entries, Jellicorse and Neal Paymaster, were open-pollinated; the other 34 were hybrids. The 7 best-yielding entries were experimental hybrids from the Tennessee corn-breeding program, indicating that there will be better corn varieties for the State in the future. The commercially available corns that are well adapted for Tennessee conditions were next in yield. The varieties recommended for the State by the Experiment Station are as follows: White hybrids—Dixie 17, Tennessee 10; yellow hybrids—Tennessee 602, N. C. 27, Funk G711, Dixie 44, and, where earliness is desired, Kentucky 102 or Kentucky 103; and white open-pollinated varieties—Jellicorse and Neal Paymaster. Most of the low-yielding entries in the test are Corn Belt hybrids that are being sold in the State. These corns are low yielding in Tennessee because the State is outside their range of adaptation.

SMALL GRAINS

Winter Oats.—One of the 2 experimental oats from the Station's oat-breeding program led most of the 6 oat tests, and both showed many good qualities. Forkedear and Stanton continue to be the best-yielding oats on the market in Tennessee. Fulgrain does not have a high yield record, but is adapted for early seedings on highly fertile soil where other oats lodge.

Spring Oats.—Spring-oat tests were conducted at only 4 locations this year. Columbia and Clinton varieties have produced the best yields for several years. In Tennessee, spring oats seldom yield more than half as much as winter oats. Moreover, they lack the advantage possessed by winter oats of providing winter cover and winter grazing.

Barley.—In the minds of many farmers, barley suggests rough-barbed awns, or beards. Jackson No. 1, the highest-yielding entry in the 6 barley tests, has smooth awns, which should not be objectionable, especially if the grain is to be combined. It has been a consistent high-yielding barley in the barley variety tests.

Wheat.—The average yields of Fulcaster 612, Carala, and Thorne

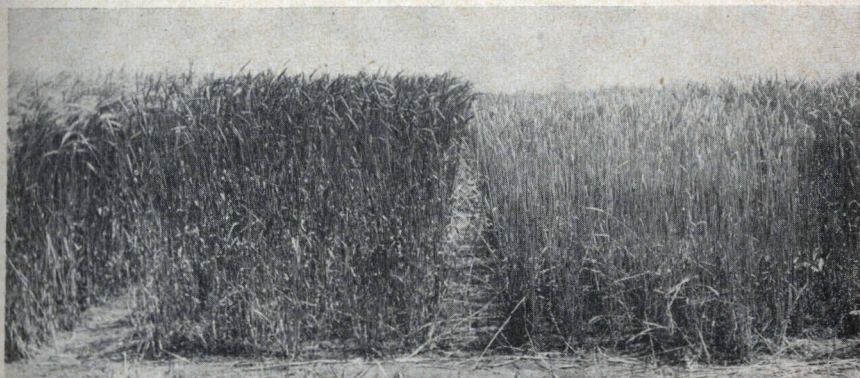


Fig. 3—Part of the wheat variety trial at Knoxville, showing, from left to right, Fulcaster 612, Experimental 47:13, Carala, and Thorne varieties.

were about the same (fig. 3). Two new experimental wheats from the Experiment Station led the tests in yield. Vigo was added to the test this year, and its average yield was about the same as that of the 3 varieties mentioned above.

SOYBEANS

Hay and seed yields were obtained from tests at four locations this year. The varieties S-100 (early), Ogden (midseason), and Volstate (late) made good yields of hay and seed. The difference in maturity makes it possible to distribute harvesting over a period of a month or more.

FERTILIZER INVESTIGATIONS

O. H. Long

Field fertilizer experiments were continued along the same lines as those of previous years. These experiments are conducted for the most part in cooperation with the Tennessee Valley Authority, Agricultural Relations Department. The work on private farms was continued and that on University lands was enlarged. There were 42 separate experiments this year, comprising a total of 1815 plots.

COMPARISON OF PHOSPHATE SOURCES

Fused Tricalcium Phosphate.—Fused tricalcium phosphate is a product developed by the Tennessee Valley Authority. This material, at 3 particle sizes (6-, 40-, and 80-mesh), has been compared with ordinary superphosphate and concentrated (triple) superphosphate for a number of years on several crops. A summary of 3 years' results on alfalfa is presented in figure 4. With a value of 100 percent assigned to the yield from standard superphosphate, the relative yields from the other treatments were as follows: Triple superphosphate, 95; fused, 80-mesh, 100; fused, 40-mesh, 90; fused, 6-mesh, 76; no phosphate, 50. The inferiority of the relatively coarse 6-mesh particle size of fused tricalcium phosphate has been apparent with other crops when comparisons have been made on soils notably deficient in phosphate. As a rule, triple

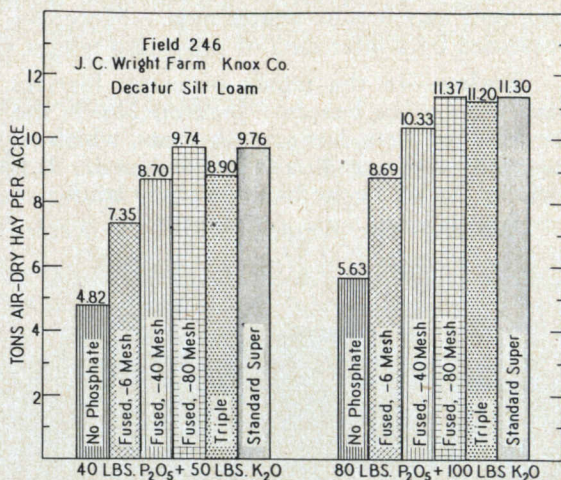


Fig. 4—Three-year (1946, 1947, 1948) yield of alfalfa and orchard grass in a phosphate comparison at two rates of fertilization.

Three crops harvested each year—a total of nine cuttings.

superphosphate gives better results than fused tricalcium phosphate. There has been very little difference in the performance of 40- and 80-particle sizes in most of the trials.

Rock Phosphate.—Trials of rock phosphate in comparison with standard superphosphate were made by C. A. Mooers and results published in Bulletin 141, 1929. In the present studies, rock phosphate is being compared with concentrated superphosphate and fused tricalcium phosphate in a 3-year rotation of corn, small grain, and red clover, at the main Station at Knoxville, the Plateau Station at Crossville, and the Highland Rim Station at Springfield. The experiments at Crossville were started in the spring of this year, and those at the other locations in the fall. Several years will be required to evaluate rock phosphate. It gave poor results on oats, red clover, and corn in the first year of the study on a virgin Tilsit silt loam, a soil very low in available phosphorus, even though it was applied at a total P_2O_5 rate three times that of concentrated superphosphate.

SUBSURFACE APPLICATIONS OF PHOSPHATE AND POTASH ON PERMANENT-PASTURE SODS

The experimental machine used for subsurface applications was developed by the TVA, Agricultural Engineering Division. With this machine it is possible to place the fertilizer at various depths with a minimum disturbance of the sod. In the present work, started in fall of 1947, the subsurface applications were placed at a depth of 3 inches, at intervals of 1 foot. The surface applications were broadcast by hand. The rate of fertilization was 80 pounds P_2O_5 and 50 pounds K_2O per acre in all trials. In most trials there was an untreated check.

Yield data were collected from 6 experiments, totaling 156 plots. Following is a summary of results:

1. Pasture sods did not show pronounced response to phosphate and potash when these fertilizers were applied either on the surface or by subsurface machine. In some trials, differences over the untreated check were not statistically significant. One year's results indicate that surface applications are equally as good as subsurface applications, and possibly better.

2. The use of the subsurface machine in the latter part of the summer, when the soil is hard and dry, results in some kill of the plants along the edges of the furrow slice. This may account in part for the lower yields obtained with the subsurface treatment.

3. It appears that the subsurface machine can best be used in the winter or early spring, when the soil is moist. At that time there should be very little killing of the plants in the furrow slice, and comparatively little power would be needed to pull the machine.

PASTURE FERTILIZATION AND FORAGE-QUALITY STUDIES

Fertilization experiments were initiated in 1947 with new seedings of a permanent-pasture mixture at 15 locations. The objectives are to determine (1) the phosphate and potash requirements of permanent pastures on several soil series in the State; (2) which is the better practice, a large initial fertilizer application or smaller annual applications; (3) the relative efficiency of fused tricalcium phosphate of 10-mesh particle size as compared to concentrated (triple) superphosphate; and (4) the influence of nitrogen on yields and legume content of the pasture mixture.

Rates of phosphate application ranged from 0 to 200 pounds P_2O_5 per acre; rates of potash ranged from 0 to 150 pounds K_2O per acre. Lime was applied where necessary to bring the soil reaction up to the range pH 6.0 to 6.5.

Forage yields are measured by means of clippings with a reel-type mower, a $2\frac{1}{2}$ -foot swath being cut the length of the plot. After clipping, the area is heavily stocked, and grazings are completed usually within 4 days. The number of clippings and subsequent grazings ranged from 2 to 6.

The relative yields during 1948 of 9 of the 12 fertilizer treatments, as an average of the 15 trials, are shown in graphic form in figure 5. The 5 black bars indicate the yields obtained from the various increments of phosphate where 100 pounds K_2O per acre was applied. The 4 bars to the right indicate the effects of the various increments of potash where 200 pounds P_2O_5 per acre was applied. The last bar indicates the yields obtained from the full phosphate-potash treatment plus 30 pounds of nitrogen. Attention is called to the fact that there was a leveling off in phosphate response beyond the 150-pound P_2O_5 level. Thirteen trials showed an appreciable response to phosphate. For the 15 trials, the average gain resulting from the 200-pound P_2O_5 application was 810 pounds of air-dry forage, representing an increase of 56 percent over the unphosphated check.

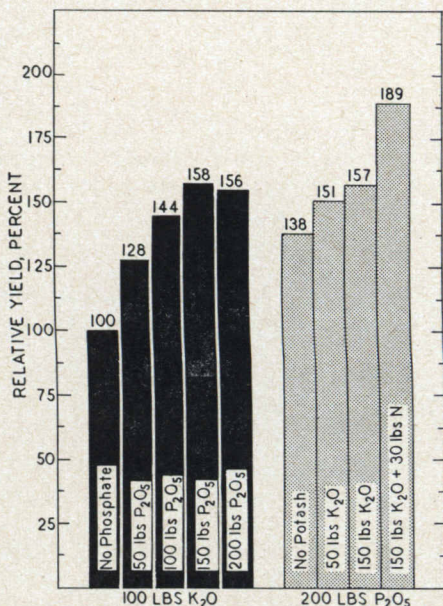


Fig. 5—The influence of increments of phosphate and potash on pasture forage production (average of fifteen trials).

Eight trials showed an appreciable response to potash. In most of the trials 100 pounds of K_2O appeared to be sufficient. The gain from a 100-pound K_2O application was 265 pounds of forage as an average of the 15 trials, an increase of 13 percent over the no-potash check.

Yields on all trials except one were increased where nitrogen was applied in the fall at time of seeding and again the following spring. The average gain from the nitrogen applications was 455 pounds of forage, an increase of 20 percent over the no-nitrogen check.

There was considerable variation in pasture production at the various places. Results on one of the low-producing locations are graphically presented in figure 6, which shows that forage yields ranged from a low of 629 pounds per

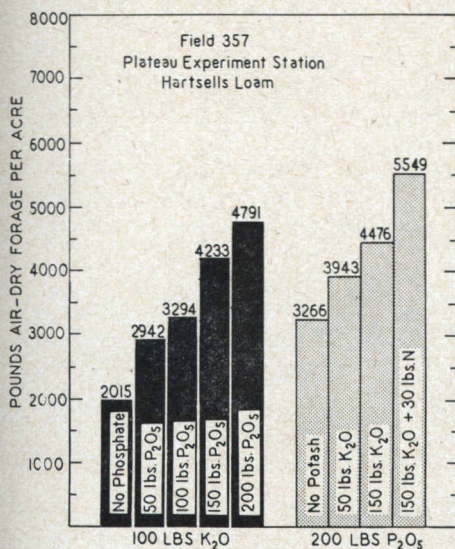


Fig. 7—The influence of increments of phosphate and potash on pasture forage production in a high-producing trial.

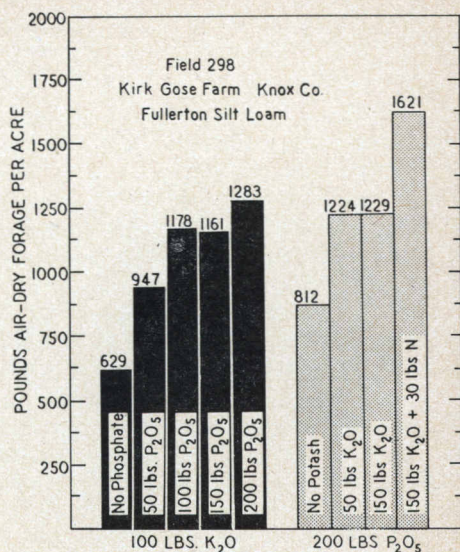


Fig. 6—The influence of increments of phosphate and potash on pasture forage production in a low-producing trial.

acre, where no phosphate was applied, to a high of 1621 pounds, where 200 pounds P_2O_5 , 150 pounds K_2O , and 30 pounds N were applied. One of the high-producing locations is represented in figure 7. Here the yields ranged from a low of 2015 pounds of forage to a high of 5549 pounds. (See photograph on front cover.)

Such results show the importance of soil, previous fertilization history, amount and distribution of rainfall, and possibly other factors, in pasture production.

Changes in botanical composition of the pastures are being studied by J. K. Underwood. Determinations of nitrogen, phosphorus, and calcium in the forage are being made by K. B. Sanders.

PASTURE STUDIES

J. K. Leasure

The long-range program of pasture investigations initiated in 1947 was further expanded during 1948.

In the fall of 1947, a series of 16 pasture mixtures was seeded on plots at all the substations. Owing to the lack of moisture following seeding, these fall seedings failed at Greeneville, Springfield, and Columbia but were reseeded successfully in the spring of 1948. Clippings were taken from the plots which were established from fall seeding in 1947, and an evaluation of the data for a single year shows that mixtures of orchard grass with alfalfa, tall fescue with alfalfa, and orchard grass with Ladino clover yielded highest.

Moderate to steep slopes at Springfield were divided into series of plots and seeded to various mixtures in the fall of 1948. It is hoped that from observations of the cover, and from stand counts to be made in the spring of 1949, it will be possible to determine the best grass mixtures for establishing sod on slopes.

Studies were made at Knoxville and Columbia of methods for obtaining species composition of plots with less time and labor. Visual estimation of species composition of pasture plots has been shown to give reliable results when properly checked with more precise methods.

LESPEDEZA STRAINS TEST

J. K. Leasure

Sixteen of the most promising strains of lespedeza now available were tested in 1948. These strains, obtained from the U. S. Department of Agriculture, were also tested in 1947. The result of two years' test shows that nine of these strains, including the named variety Climax, were significantly better than commercial Korean lespedeza. Five of these nine strains produced very little seed at Knoxville, and it probably will not be practical to produce seed of these strains in Tennessee.

Since it is almost impossible to produce pure seed of a variety of lespedeza where other lespedezas volunteer, these superior strains will not be available commercially until a satisfactory regional arrangement can be made to produce pure seed.

CROP IMPROVEMENT

N. I. Hancock

COTTON

The season of 1948 was one of the most favorable for production and performance of cotton varieties at the Jackson Station. Yields of over a bale per acre are reported; in fact, the state average is over 420 pounds of lint. At the beginning of the season, temperatures were low and seedling plants grew very slowly. Growth was retarded also by lice and thrips. Dusting the small seedling plants with toxaphene de-

stroyed these infestations. The use of such materials might well become a common practice in the early stages of plant growth.

A Tennessee Station introduction, Tenn. 241, continued its productive power as well as its retention of early maturity, and is being increased at Jackson. This strain came out of a cross between two Stoneville inbred lines, 68-3 and 136-4-1. The former is intensified by backcrossing the F_1 cross to 68-3. The progenies from this backcross were more vigorous and had more yielding power than the reciprocal backcross to 136-4-1. Other promising new strains were Coker 100 Staple and White Gold Wilt. Coker 100 Staple is a full $1\frac{1}{8}$ -inch-staple cotton and is no later in maturity than the medium-staple varieties. White Gold Wilt excels in strength and is nearly as early as Empire and Tenn. 241.

Table 1—Comparison of some Tennessee strains of cotton with Coker 100 Wilt in test at Jackson, 1948.

Variety	Lint per acre	Size of boll	Earliness	Upper- half mean length	Strength	Fineness
	Pounds	No. per lb.	Percent	Inches	Lbs./mg.	Cm. ² /mg.
Tenn. BCA-1.....	832	57	64.0	1.15	6.38	3.13
Tenn. BCA-7.....	709	60	62.8	1.08	6.08	3.13
Tenn. BCA-2.....	832	55	74.1	1.16	6.56	3.12
Tenn. BCA-6.....	747	55	62.2	1.11	6.26	3.48
Tenn. BCA-9.....	808	53	64.7	1.15	6.35	3.00
Tenn. BCA-4.....	766	61	54.9	1.21	6.42	3.10
Coker 100 Wilt 46-96.....	732	63	42.8	1.16	6.44	2.89

Early maturity has been emphasized in the breeding program in Tennessee. Results on some Tennessee strains are shown in table 1. It is seen that around 60 percent of their cotton is obtained on first picking; that yield and lint characters have been maintained at levels comparable to those of Coker 100 Wilt.

BARLEY

New strains of barley, combining stiff straw with winter hardiness and yield, gave favorable results the past season. The progenies from crosses of Jackson No. 1 x Purdue are exceptionally winter-hardy, but do not have the stiff straw of Jackson No. 1 x Wong. A large number of heads were inoculated on F_1 populations of crosses for resistance to *Ustilago nuda*, or internal floral smut. New resistant varieties from Missouri were crossed with local varieties for resistance to this smut, which is one of the major diseases of barley. Mildew is another disease which affects barley in the seedling stage and impairs its value for forage purposes. The short-awn D20-7 and other strains of the cross awnless x Jackson No. 1 have considerable resistance to mildew and are being used as parental material. The hooded strain 921-14 yielded considerably better than Missouri Early Beardless in uniform tests at all six stations, but it is 8 to 10 bushels under the yields of the awned barleys Jackson No. 1 and Kentucky 1.

OATS

Oats are not subject to as many diseases as barley. The past season crown rust did not appear on the leaves until the oats were almost mature or at time of harvesting. Stiffness of straw and winter-hardiness are primary considerations in the breeding program. Strains of the winter-hardy varieties 1884 x Bond and 090 x Bond show added strength of straw, although their yields are not yet equal to those of Forkedeer.

One of these strains, 1884 x Bond, 138-14-427, has made a good record, and 20 acres were seeded for increase at the Jackson Station the past season. This strain goes under name of Tenn. 14.

Tenn. 14 came from a cross of Tennex (Tenn. 1884), a winter type, x Bond, a stiff-strawed, rust-resistant, spring type from Australia. The cross was made in 1938. Tenn. 14 has the winter-hardiness of Tennex and the stiffness of straw of Bond. It is adapted primarily to soils of high fertility levels, and on this type of soil its yields are almost equal to those of Forkedeer. Tenn. 14 is a week later in maturity than Forkedeer, but it is more resistant to rust, and stands up for the combine better than Forkedeer. It has an average yield of 10 bushels above Fulgrain and is considerably more winter-hardy than Fulgrain. A comparison of Tenn. 14 with Forkedeer and Fulgrain is given in table 2.

Table 2—Uniformity tests of oats, average of all six stations.

Variety	Yield		Winter hardiness	Relative maturity	Standing ability
	1947	1948			
Tenn. 14.....	62.0	92.4	Good	Med. late	Good
Forkedeer.....	68.9	95.2	Fair	Medium	Good
Fulgrain.....	52.1	84.1	Good	Early	Fair

ANNUAL LEGUMES

The selfed lines of crimson clover were not infected with disease as in 1947. Selfed seed were obtained, but they are not as viable as open-pollinated seed, especially under adverse weather conditions such as the drouth in the fall of 1948. The strains show small differences of no particular importance except in their variation in maturity.

Colchicine is being used on crimson clover and lespedeza to bring about mutations which might be of some value. In the spring of 1948, solutions of 0.2, 0.1, and 0.5 percent strength were used. A number of methods were tried, such as sprinkling the solution on small seedlings when cotyledons first appear, and soaking seed during the growing season. It was found that 0.2 percent is too strong and kills young seedlings as well as the branches. The 0.1-percent solution appears to be the most valuable, but further tests are needed before definite conclusions are drawn. Branches showing effects of the treatments were observed and seed were saved from these branches for plantings and future observations.

CORN BREEDING

F. D. Richey and H. C. Kincer

Progress continued along several lines in the corn-breeding program, cooperative with the Bureau of Plant Industry, Soils and Agricultural Engineering of the Agricultural Research Administration, U.S.D.A. Attention here will be given only to the new hybrids now being or just about to be released for farm utilization.

Experimental hybrid T6002, first mentioned in the 1946 report as a probable addition to the family of Tennessee hybrids, has now been certified as Tennessee 602. Some 40 bushels of seed were distributed in 1948 for final demonstrations, and 140 acres of seed were produced under certification the same year. This will provide for about 20,000

acres in 1949. Tennessee 602 is reasonably resistant to lodging, has a better husk than most yellow hybrids heretofore available, and has a large proportion of two-eared plants. This prolific tendency permits it to make large yields where conditions are favorable, as shown by the 153 bushels per acre grown in Montgomery County in 1948 by Leroy Bosley. A basket of the attractive ears of

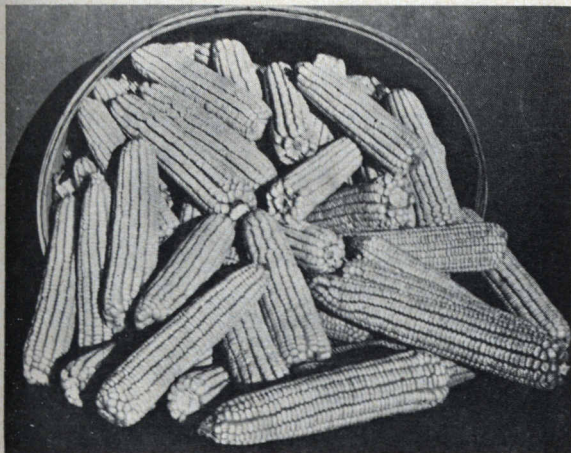


Fig. 8—Ears of the newly released yellow hybrid Tennessee 602.

this variety is shown in figure 8.

Another yellow hybrid, T6013, first tested in 1946 has continued to perform better than Tennessee 602. For three years in the state yield trials it has averaged 80 bushels to the acre, compared with 76 bushels for Tennessee 602. About 30 bushels of seed of this new yellow hybrid were produced in 1948 for demonstration plantings in 1949. At the same time, seed stocks were built up sufficiently for producing a reasonable acreage of seed. It is planned to certify this under a Dixie number, inasmuch as its better husk protection and wider adaptation will permit it to go considerably south of Tennessee.

The experimental white hybrid T7112, which yielded most in the state yield trials in 1947, did the same in 1948. As an average for the two years, this hybrid yielded 83.6 bushels per acre, compared with 79.2 bushels for Dixie 17, and had 96 percent erect plants, compared to 89 percent erect for Dixie 17. In addition to its superiority as a

hybrid, it possesses definite advantages in seed production. Accordingly, seed stocks will be increased with a view to releasing this hybrid just as soon as possible.

The progress being made in the corn-breeding program can be shown best by comparing the yields of various entries in the state corn-yield tests. In 18 of these tests between 1941 and 1943 hybrid Tennessee 10 yielded 10.8 bushels

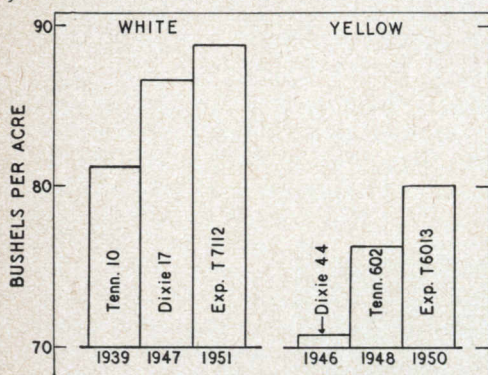


Fig. 9—Excess average yield, for the three years 1941-1943, of hybrid Tennessee 10, released in 1939, above that of six certified open-pollinated varieties, and the increasingly larger yields of newer hybrids released or to be released in the years indicated by dates at the bases of the columns.

Tennessee 10. The heights of the bars for the newer hybrids, based on the values in table 3, thus show their superiority above the certified varieties. Among the white hybrids, experimental T7112, to be released as soon as seed can be made available, is definitely superior to Dixie

Table 3—The average yields and percent of erect plants for six hybrids in three experiments in 1946 and in six experiments in 1947 and 1948, and the three-year averages.

Years	Tenn. 10		Dixie 17		T7112		Dixie 44		Tenn. 602		T6013	
	Yield	Erect	Yield	Erect	Yield	Erect	Yield	Erect	Yield	Erect	Yield	Erect
1946	Bu. 88.6	Pct. 83	Bu. 101.5	Pct. 86	Bu. 88.7	Pct. 99	Bu. 81.9	Pct. 93	Bu. 84.8	Pct. 99	Bu. 89.6	Pct. 97
1947	84.3	97	85.9	97	88.7	99	71.2	97	72.2	99	78.0	99
1948	70.7	93	72.4	89	78.5	96	59.3	96	71.8	94	72.7	92
Avg.	81.2	91	86.6	91	88.8	96	70.8	95	76.3	97	80.1	96

¹Computed to a basis comparable with the 1946-1948 averages.

17, released in 1947, just as Dixie 17 was a marked improvement over the older hybrid, Tennessee 10. In the same way, the yellow hybrids of today and tomorrow, Tennessee 602 and experimental T6013, are increasingly superior to the older Dixie 44. These are the steps leading to more profitable corn production through breeding.

GRASS BREEDING

J. K. Underwood

The drouth which began the middle of April, following months of wet weather, was disastrous to the seeding and setting of grasses. An effort was made to save the settings at Knoxville by watering individual plants. Gradually, however, as the season advanced, the stand thinned out until most plots were a complete loss. A few plots of rescue grass strains and several smooth brome strains survived, up to 25 percent.

The rescue grass strains have reseeded to a full stand in spite of the drouth. All plots were disked for reseeding and resetting for the 1949 season.

A new site was selected at the Plateau Station, Crossville, for plot work in grasses and legumes. Seedings were a failure, as they were at Knoxville.

FIBER RESEARCH

K. L. Hertel

TESTING DIVISION

During the past year, 5,730 samples were tested by the laboratory testing service. A total of 35,409 determinations were made on these samples. Four percent were commercial samples, 25 percent were for the United States Department of Agriculture, and 71 percent for the Tennessee Experiment Station. Length of the samples was measured on the fibrograph, strength on the Pressley breaker, and fineness on the arealometer.

FIBER PROPERTIES

New Arealometer Design.—The design of the arealometer has been altered to include three comparison resistances. This extends the range of the instrument to allow specific surface determinations to be made on any fibers between coarse wool and extremely immature cotton.

A complete recalibration of the arealometer scale is being made, round or semi-round continuous filaments being used. This eliminates some of the difficulties connected with an earlier calibration with cotton fibers, due to variation in shape and cross section from fiber to fiber and throughout the length of a single fiber.

Compression Study.—An investigation has been made of the relation between the compressional force on a plug of cotton and the length to which the plug is compressed in a definite interval of time. It has been found that over a wide range the relation may be expressed to a close approximation by the expression

$$P=aLb$$

where P is the pressure on a cotton plug and L is the length of the plug, a and b are constants for a given type of cotton, but vary for

cottons of different types. Attempts to correlate the parameters *a* and *b* with other significant physical properties have so far been unsuccessful.

Counting of Fibers.—Further work has been done on the problem of developing a convenient and rapid method for counting the total number of cotton fibers, all trimmed to a known length, in a sample of known mass. It seems probable that this information, when combined with a specific surface measurement, would determine the state of maturity, or mean cross-section shape of the fibers. An electronic counting circuit has been devised which has made counts that checked satisfactorily with optical counts made under a microscope, and some results have been obtained which indicate significant correlation with fiber maturity. The methods used to prepare the samples for counting, however, have not been satisfactory. Further work is planned on this problem.

Strength Tester Study.—One possible cause of scatter in results obtained on a fiber-bundle strength tester was thought to be the dependence of bundle strength on the location of the break with respect to the midpoints of the tapering fibers in the bundle. Data have been taken in which the two parts of the broken sample were weighed separately, but statistical analysis failed to show any significant correlation between strength index and inequality of weight.

NUTRIENT AVAILABILITY IN SOILS

L. F. Seatz and E. Winters

The nutrient-availability work during the past year has been concerned mainly with a laboratory study of soil properties that may affect the availability of phosphorus to different crops. Representative soil samples were taken from areas where fertility trials had been conducted on corn, cotton, oats, and pasture. Both topsoil and subsoil samples were taken from some areas. Laboratory studies made on these samples included pH, organic matter, total phosphorus, dilute-acid-soluble phosphorus obtained with several different extractants, exchangeable or hydroxide-soluble phosphorus, and anion-exchange capacity (Piper).

A wide range of soil and climatic conditions were represented by the samples studied. As a result, no general correlation was found between any one soil property and the yield response obtained from phosphate fertilization.

When ranked according to the amount of acid-soluble phosphorus extracted, the soils were placed in approximately the same order regardless of the dilute acid used. The addition of the fluoride ion to the extractant increased the amount of phosphorus extracted in most cases.

In some of the fertility trials, crops gave high yields and failed to show any response to added phosphate, even though the topsoil ranked low in the amount of acid-soluble phosphorus extracted. In several such cases, however, the subsoil ranked high in extracted acid-soluble phosphorus. Thus, testing only topsoil samples may lead to incorrect fertilizer recommendations in some situations.

SUBSOILING STUDIES

J. N. Odom

A subsoiling project was started at the Knoxville Station this year. The soil selected was a Dewey silty clay loam having about a 7-percent slope. Three methods of preparing soil for corn were used:

1. Ordinary turning to a depth of 6 inches in midwinter.
2. Subsoiling to a depth of 18 inches at intervals of 18 inches during the dry fall period, followed by ordinary turning in midwinter.
3. Subsoiling as above, followed by bush-and-bog disking just prior to final seedbed preparation.

Final seedbed preparation, fertilization, seeding, and cultivation were the same on all plots.

Observations at time of emergence and immediately following indicated that the stands were affected by the tillage treatments. Ten days after seeding, plant emergence was: (1) uneven on the plots which were turned only, (2) complete and uniform on the subsoiled and turned plots, (3) decidedly incomplete and uneven on the subsoiled and disked plots. Emergence under conditions of third treatment was slower and continued over a much longer period than under the first and second treatments.

The plants on the plots that were subsoiled and disked were weak and yellow during the early part of the growing season and appeared decidedly inferior to those on the other plots. During the latter part of the season, however, from the tassel stage to maturity, the corn on these plots grew vigorously and appeared to withstand the drouth better than that on the other plots.

The yield was higher and the stand was more uniform under the subsoiled and turned treatment than under either of the other 2 treatments. Since these results are for one year only, it is not safe to conclude that subsoiling should be recommended on Dewey soils.

The cost of subsoiling, in addition to turning or disking, was calculated to be \$4.07 per acre.

STATE SOIL SURVEY

E. Winters

The state soil survey is being made with the assistance and co-operation of the Tennessee Valley Authority and the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

A detailed soil survey of 419,936 acres was completed during 1948, bringing the total to 8,507,567 acres. Field work has been completed for 28 counties, parts of 2 counties, and 6 special areas. The work continues in 4 counties.

Two reports—Rhea and Claiborne Counties—were made available

to the public during the year, bringing the total of available published reports to 9. The manuscripts for 3 others were prepared for publication.

In order to make soil survey data available more quickly, prints of the original field sheets are colored by hand, and assembled in atlas form for the use of the county agent, the Tennessee Valley Authority, and the Agricultural Experiment Station. Such atlases were prepared for 4 counties during 1948.

The acreages of the various soil types mapped were determined for 3 counties by the weight method.

Profile samples are collected of all important soils in the areas surveyed, and are tested for acidity, organic matter, and available phosphate and potash. The samples are then preserved for possible future study. Analyses of soil samples for available plant nutrients were completed for 4 counties during 1948.

CHEMICAL WEED CONTROL

S. F. McMurray

The chemical weed-control project was officially started July 1, 1948, although the Experiment Station had been testing herbicides for several years. The objective is to determine what chemicals are (a) most effective and (b) most economical for killing noxious, common, and poisonous weeds and weed seeds in row crops, small grain, pastures, plantbeds, animal manures, idle land, and fence rows.

Most of the chemicals used as weed killers in the past have been soil sterilants, such as sodium chlorate and ammonium sulphamate. These materials have been expensive to use as agricultural herbicides because of the large amounts required per acre for good results. Moreover, they make the treated area toxic to plant growth for a year or more.

In 1944, it was discovered that a hormone-like organic chemical, now known as 2, 4-D, when sprayed on plants in small amounts would cause many of the broad-leaf plants to die, while narrow-leaf plants were not affected. The normal rate of application is $1\frac{1}{4}$ pounds per acre. It was found that this selective herbicide did not make the soil sterile, and in usual concentrations was nonpoisonous to livestock and man, noncorrosive to metals, and noninjurious to soil microorganisms. Owing to the rapid rise in popularity of this chemical, the Experiment Station, in April, 1948, issued a mimeographed circular on the use of 2, 4-D weed killers.

Experiments were conducted this year to determine rates, dates, and formulations that give the best results in controlling weeds in tobacco plantbeds, cotton, corn, small grain, permanent pasture, and fence rows. Results showed that 2, 4-D is not a satisfactory herbicide for tobacco plantbeds. Its use on cotton is risky, even as a pre-emergence spray; but stimulation of growth was observed when it was applied in very small amounts—about $\frac{1}{4}$ pound per acre. The control of crabgrass and broad-leaf weeds in the corn was good when 2, 4-D was applied



Fig. 10—Oat plot on left is clear of the broad-leaf weeds that are showing in the untreated plot on the right.

The treated plot was sprayed April 27 (one month before picture was taken) with $\frac{1}{4}$ pound per acre of 2, 4-D acid (ester form).

as a pre-emergence spray—and the test included all corn varieties recommended for Tennessee. The test on oats (fig. 10), where 2, 4-D



Fig. 11—Permanent sod, heavily infested with wild garlic. Treated plot on right, showing top kill, compared with untreated plot on left.

was applied in the early spring, showed good control of several of the broad-leaf weeds that infest small grain in Tennessee.

On a permanent pasture, 2, 4-D was tried for control of wild garlic. This weed grows in late fall and early spring, and the tops can be killed at either time by the use of 2 to 3 pounds of the ester form of 2, 4-D acid applied when the weather is

warm and humid (fig. 11). The underground bulblets are not affected by the 2, 4-D and will grow the next season. Work will be continued to determine whether it is practicable to use 2, 4-D to control this noxious weed. Good control of honeysuckle and sassafras was obtained with one spraying of 2 pounds per acre of 2, 4-D acid of the ester formulation. Persimmon was injured, but not killed. It is necessary to spray 2 or more times to kill poison ivy.

Two new chemicals tested this year were 2, 4, 5-T on woody weeds, and Sodium T. C. A. on Johnson grass and bermuda grass. Work with these chemicals will be continued.

Farmers are advised against the use of spray equipment that has



contained 2, 4-D for spraying insecticides on plants. Damage from 2, 4-D on tobacco (fig. 12), tomatoes, and okra was reported this year by farmers who sprayed these susceptible crops with equipment they thought had been thoroughly cleaned.

Fig. 12 — Two stalks of tobacco that came from adjacent rows of a tobacco field in Grainger County.

The plant on the right was sprayed with equipment which had been used to apply 2, 4-D. The plant on the left was sprayed with equipment free of 2, 4-D.

AGRONOMY AT WEST TENNESSEE STATION

Jackson

E. J. Chapman

Rotations.—In 1929, a 5-year general farm rotation was started at Jackson on each of two soil types, Lintonia and Calhoun. Although these soils occupy the same topographic position and are derived from similar parent material, Lintonia is a well-drained soil but Calhoun has very poor internal drainage.

For the past 20 years the same crop and fertilizer treatments have been followed on the two soils. With the yields on Lintonia expressed as 100 percent, the yields on Calhoun were 57, 74, 70, 69, and 73 percent, respectively, for cotton, corn, cowpeas, wheat, and red clover and grass.

Table 4—*Influence of lime, phosphate and potash, and nitrogen, on yields of continuous cotton—averages for 1919-1948—one replication.*

Treatment	Seed cotton—acre	
	Limed	Unlimed
No fertilizer.....	Pounds 931	Pounds 818
200 lbs. 16% superphosphate..... 50 lbs. 50% muriate of potash.....	1189	1059
200 lbs. 16% superphosphate..... 50 lbs. 50% muriate of potash..... 100 lbs. nitrate of soda.....	1610	1382

Cotton.—The response of continuous cotton to lime, phosphate and potash, and nitrogen on a Lintonia silt loam soil has been studied at the West Tennessee Experiment Station since 1919. Results are presented in table 4. The data show, as an average of all treatments, an increase from lime of 14.5 percent. Phosphate and potash together gave an increase of 28.5 percent over the check plot. When 100 pounds of nitrate of soda was added to the above treatment, an increase over the check of 71.0 percent was obtained (fig. 13).



Fig. 13—Response of cotton to nitrogen. Left, no nitrogen. Right, 100 pounds nitrate of soda.

Corn.—The value of nitrogen fertilizers on corn is illustrated in figure 14. This test is located on land which had been cropped in

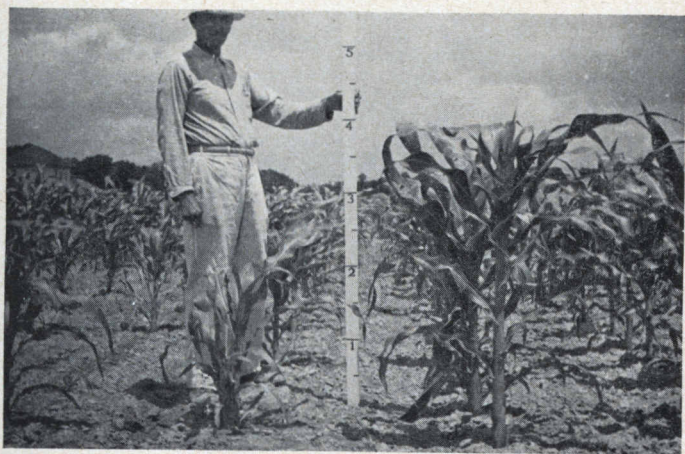


Fig. 14—Response of corn to nitrogen. Left, no nitrogen. Right, 185 pounds ammonium nitrate.

continuous corn for many years without any addition of fertilizer and had reached a low level of fertility, producing an average of around 17 bushels per acre.

The no-fertilizer plot produced 22.8 bushels per acre, while the plot which received 60 pounds of nitrogen (185 pounds ammonium nitrate) produced 54.6 bushels per acre, an increase of 139 percent.

Silage.—During the past 33 years, sorghum and peas have been grown on single plots to determine the value of farm manure in silage production. The results of this test show an average annual yield per acre of 9.27 tons of silage on the plot which did not receive any fertilizer, whereas a yield of 15.36 tons was produced with the application of 5 tons of farm manure annually.

Winter Cover Crops.—Varieties of winter legumes that will produce satisfactory volunteer stands are becoming increasingly important. In 1947, plots of common crimson, hardseeded crimson, button clover, and sub clover were allowed to mature seed. In the fall, the seed on one half of each plot was covered lightly with a disk harrow, while the other half received no cultivation. The results of this test (table 5) emphasize the importance of cultivation if maximum yields are to be expected. Where the disk harrow was used, the seed germinated and came to a stand considerably earlier in the fall.

Table 5—*Effect of land preparation on volunteer winter legumes—averages for 1948—four replications.*

Variety	Average acre yields		Increase over no cultivation
	Cultivated	Not cultivated	
	Tons No yield	Tons No yield	Percent
Common crimson clover.....	0.73	0.31	135
Hardseeded crimson clover.....	1.17	0.48	144
Button clover.....	0.99	0.41	141
Sub clover (Tallarook) ¹	0.91	0.44	107
Sub clover (Mt. Barker) ¹			
Average.....	0.95	0.41	132

¹ Only 2 replications.

Winter Pasture Established on Bermuda Sod.—For many years an effort has been made at the Jackson Station to establish winter crops on bermuda grass sod to provide some pasture on land which otherwise would be unproductive during the winter months. Results have proved that this can be done if the seeding of the winter cover crops on the bermuda sod is made at the proper time. Success has followed when seedings were made around October 1, whereas seedings 2 weeks later have resulted in failure.

Preliminary Studies With 2,4-D.—Because of the increased interest in chemical weed control, preliminary tests with 2,4-D were started at



Fig. 15—Control of weeds in corn with 2, 4-D.

Top, pre-emergence treatment, $2\frac{1}{2}$ pounds acid per acre applied six days after planting. Middle, $\frac{1}{2}$ pound acid applied when corn was 8 inches tall. Bottom, no treatment.

Jackson in 1948. Conclusions cannot be drawn from the limited results thus far obtained.

A study was made of the effects of pre-emergence and post-emergence treatments with the amine salt of 2,4-D on weeds in 5 recommended varieties of corn: Tennessee 10, Dixie 44, Jellincorse, Dixie 17, and Funks G711. All the corn varieties appeared to be equally resistant to this chemical.

It was observed that the pre-emergence treatment— $2\frac{1}{2}$ pounds acid per acre, applied 6 days after planting—gave almost complete control of both broad-leaved weeds and crabgrass, whereas the post-emergence treatment— $\frac{1}{2}$ pound acid per acre, applied when corn was 8 inches tall—resulted in control of the broadleaved weeds but not the crabgrass (see fig. 15).

A test was initiated to determine

the effect of 2,4-D on the germination of cottonseed. The amine salt was used. Plantings of fuzzy and acid-delinted seed were made at depths of $\frac{1}{2}$ inch and 1 inch. The rate of application of 2,4-D ranged from 1 pound to $2\frac{1}{2}$ pounds of acid per acre, applied at planting time.

The results of this test indicate that success with 2,4-D at the above rates as a pre-emergence spray on cotton is doubtful. The germination was affected significantly by all treatments—less than 50 percent of a stand was obtained. The fuzzy seed were less affected than the delinted on all 4 replications.

ANIMAL HUSBANDRY

EXPERIMENTS AT KNOXVILLE

Sam L. Hansard and C. S. Hobbs

FEEDING THYROPROTEIN TO LACTATING EWES FOR EARLY LAMB PRODUCTION

It has long been recognized that the secretion of the thyroid gland is largely responsible for the regulation of general body metabolism. Investigations soon demonstrated that a temporary but definite increase in milk production could be obtained by feeding thyroid materials. Recently a material having a high thyroid potency has been developed by the chemical process of adding iodine to milk proteins. These materials are known as thyroproteins, and one of the commercial forms of this product, known as "protomone," was used in this study.

The dairy industry has conducted numerous investigations to evaluate the effects of thyroproteins on milk production, but relatively few studies have been made with other classes of livestock. An effort has been made to determine the feasibility of using this drug in the production of Tennessee milk-fed spring lambs.

The experiment was initiated (1) to evaluate the effects of adding thyroprotein (protomone) to the ration of lactating ewes upon the daily and total gains, and upon the market grade of lambs; (2) to determine the effects of thyroprotein on weight, pulse rate, respiration, temperature, and feed consumption of ewes maintained on pasture and in dry lot; and (3) to study the relative costs of producing spring lambs in dry lot and on temporary pasture under Tennessee conditions.

Twenty-eight lactating ewes and their lambs were selected from the purebred Hampshire, Southdown, and crossbred Southwest flocks of the University.

Twelve ewes and their lambs were selected for the dry-lot phase of the experiment and 16 ewes and their lambs for the pasture study. The ewe weights, respiration, pulse rate, and rectal temperatures were checked for 3 consecutive days during the 14-day preparatory period following lambing, and once weekly throughout the 105-day experimental period.

The results of one year's study indicate that the feeding of thyroprotein (protomone) to lactating ewes causes a decrease in body weight and an increase in respiration, with little, if any, effect on body temperature, pulse rate, or blood ascorbic-acid level.

The effects of thyroprotein feeding were more clearly exemplified when ewes were on limited feed than when they had free access to a good temporary pasture.

Average body temperature, pulse rates, and gain of lambs were consistently higher for the pasture-fed lots than for ewes in dry lot. The effect on lamb gains from feeding thyroprotein to ewes was less significant in the pasture lots.

The data indicate that thyroprotein reduced the feed cost of producing spring lambs when ewes were fed in dry lot. However, on good winter pasture there was no indicated advantage.

On the basis of cost of gains and market grade of lambs produced, winter pasture appears to be superior to dry lot for the production of spring lambs (table 6).

Table 6—*Rations used, thyroprotein administered, and details of the study.*

Item	In dry lot			On pasture	
	Lot			Lot	
	1	2	3	4	5
No. of ewes.....	4	4	4	8	8
No. of lambs.....	5	5	5	10	10
Total feed consumed by ewes.....					
Corn (lbs.).....	315	395	315	210	210
Oats (lbs.).....	315	395	315	210	210
Alfalfa hay (lbs.).....	1260	2100	1260	1264	1264
Thyroprotein (gms.).....	None	630	630	630	None
Avg. wt. change per ewe (lbs.).....	-7.25	-7.50	-9.00	-3.50	8.60
Avg. total gain of lambs (lbs.).....	40.8	49.3	44.2	56.4	57.4
Avg. daily gain per lamb (lbs.).....	0.39	0.47	0.42	0.54	0.55
Market grade of lambs					
Choice (percent).....	0	40	40	100	100
Good (percent).....	100	60	60	0	0
Feed cost—per cwt. lamb produced.....	\$26.71	31.99	22.98	\$9.20	\$9.20

¹ The ewes in lot 2 received 25% more TDN than lots 1 and 3. (Morrison's Standard of Requirements).

² These ewes and lambs were on pasture for the 105-day period.

³ The cost of the 1.5 gms. thyroprotein per ewe per day was not included in this figure.

⁴ Pasture was figured at 0.25 per ewe per month.

THE ANIMAL HUSBANDRY PHASE OF THE EFFLUENT STUDY

C. S. Hobbs, Sam L. Hansard, Dennis Sikes,

H. R. Duncan, and John A. Ewing

Only a few years ago farmers were using raw rock phosphate as a mineral supplement in rations for livestock. Although this supplement did supply the necessary calcium and phosphorus at a lower cost than many other sources, it produced abnormal calcification of the teeth and other changes which greatly limited its use. These associated changes were similar to those produced experimentally by feeding chemically pure fluorine salts.

Observations in Europe, and more recently in this country, have shown that cattle grazing near industrial plants, such as aluminum or phosphate plants, which emitted fluorine in the smoke, demonstrated excessive teeth wear, immature aging, decreased growth rate and milk production, and in many cases premature death.

Since Tennessee is one of the larger producers of phosphates, and there is a tendency toward increased industrial expansion, the State is in a strategic position as a testing ground for effluents emitted from these operations. Farmers owning land adjacent to these plants are interested in these effects from an economic standpoint. The extent of the injuries and the possible means of alleviating them are paramount problems in our State.

Experimental studies, in cooperation with the Agricultural Chemistry Department, are under way at the Knoxville, Columbia, and Springfield Stations. It is the purpose of this phase of the experiment to study the chronic effects on pilot animals and cattle of known fluorine intake and to determine the relative toxicity of the fluorine present in hays and pastures grown near aluminum and phosphate plants.

STUDIES WITH ALBINO RATS

Plans have been initiated and facilities procured at the Knoxville Station for the utilization of the albino rat in the fundamental and preliminary pilot studies relative to chronic fluorine intoxication.

It is now a recognized fact that fluorine poisoning occurs in domestic animals in areas where large natural deposits of phosphate are being mined and in localities where industries utilize materials containing fluorine. The expense of detailed experiments with livestock, on the multitude of problems arising from such a study, necessitates the use of a less expensive animal for these pioneer investigations. The rat phase has been initiated to assist and guide the present cattle studies and for the preliminary investigations of the problems arising in the experiment.

More than 400 rats have been used in the preliminary studies to determine the relative toxicity of fluorine from several chemical combinations in which it exists, and for a study of the nature and time of appearance of the characteristic chronic fluorosis syndromes. On the basis of this comparative toxicity study and a comprehensive survey of the literature, sodium fluoride was selected as the basic fluorine source for our studies of relative toxicity of the fluorine effects appearing in animals fed on hays and pastures grown near aluminum and phosphate plants.

In these preliminary studies, teeth changes and bone fluorine storage have been the major criteria for measuring the fluorine toxicosis in weanling albino rats. This retrogression of the enamel organ, and the delay in enamel maturation, as manifested by the observed tooth injury in our livestock from affected areas, are recognized major problems confronting farmers in these areas. An effort is being made to evaluate the alleviating properties of several compounds for these active principles.

A study of the storage of fluorine in bones indicates that storage is directly proportional to the amount ingested when fed at minimal chronic levels for a definite time interval (fig. 16). Bone storage of fluorine from ingested hays grown near aluminum or phosphate plants was comparable to like amounts of fluorine from sodium fluoride. However, the tooth effects were more severe from fluorine in hays grown near phosphate and aluminum plants, in that order, than from sodium fluoride (figs. 17 and 18). When low fluorine rations were supplemented with 30 p.p.m. copper sulfate, these changes were augmented.

Preliminary studies indicate that defluorinated phosphate supplementing low fluorine diets reduces the bone fluorine storage and appears to retard, while it does not prevent, the characteristic tooth effects in rats.

The data of table 7 illustrate the bone fluorine storage for a 15-day experimental period at the known levels of fluorine fed through hay, and as sodium fluoride, with and without defluorinated phosphate or other alleviator.

Table 7—*Bone storage of fluorine from different sources, fed to rats at different levels, with and without alleviators.*

Ration		Rats	Fluorine fed	Supplement fed	Source of fluorine	Avg. fluorine in long bones ¹
		Number	p.p.m.			Percent
Basal	Effluent	28	(-3)	None	Ration ²	.016
"	"	26	25	None	NaF	.067
"	"	19	30	None	NaF	.115
"	"	5	30	2% Df.P ³	NaF	.100
"	"	5	30	None	BI hay	.140
"	"	5	30	2% Df.P	BI hay	.100
"	"	5	35	None	BI hay	.130
"	"	5	40	None	BI hay	.150
"	"	32	50	None	NaF	.190
"	"	15	50	None	BI hay	.167
"	"	5	50	2% Df.P	NaF	.150
"	"	5	50	3% Df.P	NaF	.116
"	"	10	50	4% Df.P	NaF	.124
"	"	5	50	2% Df.P	BI hay	.150
"	"	5	50	3% Df.P	BI hay	.122
"	"	10	50	4% Df.P	BI hay	.100
"	"	31	75	None	NaF	.280
"	"	5	80	None	BI hay	.200
"	"	12	75	30 ppm Cu	NaF	.265
"	"	5	75	3% fat	NaF	.310
"	"	5	75	10% fat	NaF	.350

¹ Fluorine analyses of bone were made in the Chemistry Department.

² Normal hays and hays known to contain fluorine were incorporated as 30% of the total ration.

³ Defluorinated phosphate containing less than 200 p.p.m. fluorine.

⁴ Marked tooth wear and bleaching was noted, resembling tooth characteristics demonstrated in teeth of rats receiving fluorine from fluorine hays.

STUDIES WITH RABBITS

The rabbit is particularly adapted to piloting these fluorine studies because of its low tolerance for fluorine and its ability to consume large quantities of roughages. Thirty-three weanling rabbits were fed in groups of 3, on 11 different levels of fluorine intake, for a 110-day period. Specific observations and bone fluorine analyses were made in an effort to determine the fluorine tolerance of the rabbit and the

relative toxicity of fluorine from hays grown near industrial and phosphate plants with those of like levels of fluorine as sodium fluoride. A duplicate experiment is under way with 72 rabbits, replicating the levels in the previous experiment and the effluent-cattle experiment in progress at the Blount County Farm and the Columbia Station.

The results of this preliminary study are presented in table 8, and the bone storage and teeth effects are shown in figures 16, 17, and 18.

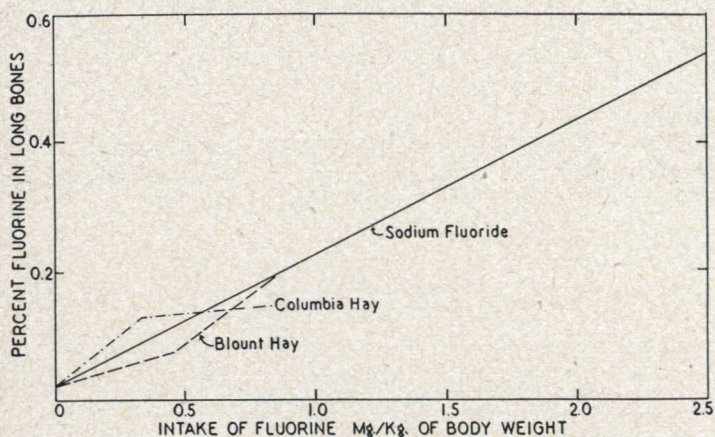


Fig. 16—Storage of fluorine in the long bones of rabbits fed diets supplemented with fluorine as sodium fluoride and as hays grown near aluminum and phosphate plants, 1948.

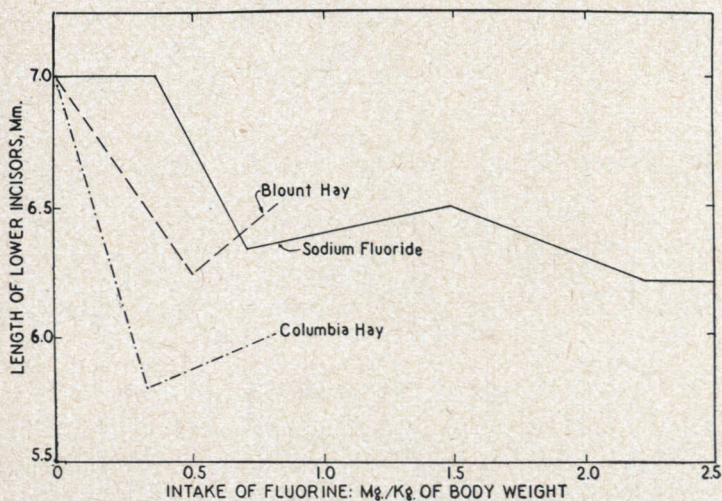


Fig. 17—Effects of fluorine ingested as sodium fluoride and as hays, from aluminum- and phosphate-plant areas, on length of lower incisors in the rabbit, 1948.

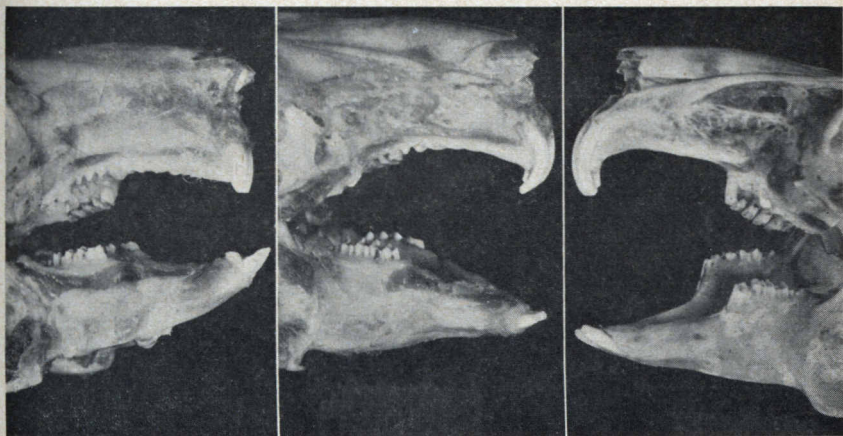


Fig. 18—Effects of fluorine on teeth of rabbits.

Left, normal teeth; middle, 100 p.p.m. sodium fluoride consumed; right, experimental hay containing 10 p.p.m. fluorine, consumed as 50% of the diet.

Table 8—Summary of results from feeding to rabbits rations containing known levels of fluorine from sodium fluoride and from hays grown near aluminum and phosphate plants, during a 110-day experimental period.

Lot	Animals	Avg. daily gain	Feed consumed per 100 gms. gain	Fluorine intake per kg. body wt.	Fluorine fed	Source of fluorine	Long ¹ bone fluorine	Avg. length of lower incisor
	Number	Grams	Grams	Mgs.	p.p.m.		Percent	Mm.
1R	3	13.0	1014	0.02	0	NaF	.06	7.0
2R	3	16.1	651	0.37	10	"	.13	7.0
3R	3	15.7	669	0.71	20	"	.19	6.3
4R	3	15.5	678	1.48	40	"	.30	6.5
5R	3	15.7	670	2.22	70	"	.50	6.2
6R	3	15.8	662	3.60	100	"	.68	6.2
7R	3	17.5	601	0.48	14	BI hay	.08	6.2
8R	3	16.8	599	0.83	24	BI hay	.20	6.5
9R	3	17.6	595	0.34	10	C hay	.13	5.8
10R	3	19.5	537	0.81	25	C hay	.15	6.0
11R	3	16.3	643	4.28	120	NaF	.84	6.2

¹ Fluorine analyses were made by the Chemistry Department.

STUDIES WITH CATTLE

At the Knoxville Station, a study with cattle has been under way since early March, 1948. Thirty-nine selected yearling Hereford females are being maintained in dry lot and fed hay and grain of known fluorine content individually in 13 lots. An additional 34 heifers have been maintained during the grazing season on 3 pastures with known fluorine histories, and barn-fed, in 3 lots, hays of known fluorine content and a grain supplement during the winter months. Rations for the dry-lot group are mixed weekly and the fluorine, as sodium fluoride, is added to the grain to give the total ration the equivalents of 10, 20, 30, 40, 50, 70, and 100 parts per million fluorine. One lot receives 100 p.p.m. fluorine, plus defluorophosphate as a possible alleviator, and the 5 other lots receive normal hay and high- and low-fluorine hays from Blount and Maury Counties. Composite samples of the grain and the

hays fed are maintained with fixative and analyzed chemically for fluorine content at regular intervals. Likewise, during the pasture season composite pasture samples from the 3 pastures are analyzed for fluorine content each 14 days in the Chemistry Department.

Periodic observations of the teeth, urine analysis for fluorine, bone changes, and general appearance details are recorded. Surveys of the livestock in the affected areas are planned to determine the extent of these damages, and metabolism studies to determine the utilization of the fluorine from the different sources, and the alleviating properties of specific supplements, are under way. Biological testing of hays from the affected areas and pilot experimentation with rats are being continued.

A study is being made of the effect of moving cattle with normal teeth into an affected area, and vice versa. Fourteen animals, from 8 months to 6 years of age, were transferred from the Columbia Station (affected) to the Springfield Station (normal) and 18 animals from like age groups were purchased in normal areas and removed to Columbia for observation.

The cattle studies at the Columbia Station, similar in setup to the Knoxville effluent study, were started December 15, 1948, and involve 31 beef heifers, in 10 lots of 3 animals each, receiving the following fluorine supplements and alleviators:

Lot	Ration					
1	High-fluorine Columbia hay					
2	Pasture					
3	High-fluorine Columbia hay plus Ferro-Cal Phos					
4	Normal hay					
5	Normal hay plus	30	p.p.m.	fluorine	as NaF	
6	"	50	p.p.m.	"	"	"
7	"	50	p.p.m.	"	"	" plus Ferro-Cal-Phos.
8	"	70	p.p.m.	"	"	"
9	"	50	p.p.m.	"	"	rock phosphate
10	"	50	p.p.m.	"	"	fluorine dust

Sufficient data are not available to warrant definite conclusions on this project.

ANIMAL HUSBANDRY AT MIDDLE TENNESSEE STATION

Columbia

H. R. Duncan, C. S. Hobbs, and John A. Ewing

BARN-WINTERING VERSUS PASTURE-WINTERING OF STOCKER CALVES

A lot of calves were fed in the barn an average of 12.4 pounds of medium-grade alfalfa hay and $1\frac{1}{2}$ pounds of concentrates per day for 149 days, in comparison with a similar lot run on winter oats and fed 3.25 pounds of hay and $1\frac{1}{2}$ pounds of concentrates. It was necessary to remove the calves from the pasture during 38 days of severe weather. Table 9 shows the most important results of this trial.

NATIVE EWES COMPARED WITH NORTHWESTERN AND PLATEAU EWES FOR SPRING-LAMB PRODUCTION

The native ewes in this experiment were produced at the Station, from the best of the ewe lambs in this flock. Hampshire rams had been used for several generations and the ewes were therefore high-grade

Table 9—*Barn wintering versus pasture wintering of stocker calves.*

Item	Barn-wintered	Pasture-wintered
Number of calves per lot.....	10	10
Average initial weight Nov. 12, 1947 (lbs.).....	487.4	486.2
Average gain during winter of 149 days (lbs.).....	85.5	160.3
Average gain on summer pasture (lots run together) (lbs.).....	217.0	204.0
Average gain for both periods Nov. 12, 1947, to Sept. 24, 1948 (lbs.).....	302.5	364.3
Average weight at end of summer grazing period (lbs.).....	791.9	850.5
Cost of wintering per head, exclusive of pasture.....	\$ 30.91	\$ 13.81

Hampshires. The Northwestern ewes were selected as yearlings from some of the better consignments of ewes from Montana. The Plateau ewes were some of the top yearling ewes sold through the annual sheep sale at Crossville. The ewes varied in age, but the 3 groups contained about equal numbers of ewes of the various ages.

These ewes were also employed in the study of permanent versus annual pasture for spring-lamb production, one half of the ewes of each origin being placed in each pasture-study division. Rye, ryegrass, crimson clover, button clover, lespedeza, alfalfa, and other fresh pastures were used for the annual-pasture ewes. The permanent pastures, composed of bluegrass and hop and white clover, were used for the other group. Tables 10 and 11 give a brief summary of the results of these two studies of spring-lamb production.

Table 10—*Performance of Station-raised, Northwestern, and Cumberland Plateau ewes.*

Item	Station-raised ewes	North-western ewes	Cumberland Plateau ewes
Number of ewes starting year per lot.....	39	29	32
Average date of lambing.....	Jan. 19	Jan. 18	Jan. 28
Average birth weight (lbs.).....	9.4	9.8	8.6
Percent of lambs raised to ewes bred.....	74.60	80.76	90.62
Average weight of lambs marketed (lbs.).....	75.0	82.6	79.7
Average age of lambs at marketing (days).....	133	137	111
Average weight of fleece (lbs.).....	4.0	6.5	5.3
Average gross returns per ewe bred, in lamb and wool.....	\$ 18.60	\$ 19.43	\$ 21.48

Table 11—*Performance of ewes run on annual versus permanent pastures.*

Item	Annual pasture	Permanent pasture
Number of ewes starting year.....	51	49
Average date of lambing.....	Jan. 12	Jan. 31
" birth weight (lbs.).....	9.2	9.3
" market weight of lambs (lbs.).....	80.6	81.0
" age when marketed (days).....	127	126
" lamb returns per ewe bred.....	\$19.20	\$16.78
" wool clip per ewe.....	5.4	5.1
" gross returns per ewe bred, in lamb and wool.....	\$21.20	\$18.47
" weight at beginning of year (lbs.).....	149.0	127.7
" weight at end of year.....	158.0	126.3

The Station ewes, very probably, were affected more by fluorine than the other groups, since they were at the Station the first year of their lives, when their bones and teeth were making rapid growth. The first pair of permanent incisors of the Northwestern and Plateau ewes were in much better condition than those of the Station-raised ewes. Judging by the percent lamb crop, teeth, weights, and condition of these ewes, it was apparent that they were affected by fluorine.

CREEP FEEDING VERSUS NON-CREEP FEEDING FOR BEEF CALVES

Although the Station herd was visibly affected by fluorine from the industrial plants of the area, this project was continued. A pasture of bermuda, bluegrass, and white and hop clover was divided into two equal areas. On one the calves from a herd of grade cows by a pure-bred bull were creep fed from June 6 until October 19, in comparison with a similar lot which went through the summer without any grain. Table 12 gives a brief summary of results. The pastures were very dry during September and October, and the creep-fed calves made much more favorable gains than those of two previous trials. There was a difference of 88.9 pounds in favor of the creep-fed lot for the entire period, 53 pounds of which was made during the last 53 days of the trial.

Table 12—*Performance of creep-fed calves compared with calves not creep-fed.*

Item	Creep-fed	Not creep-fed
Number of calves per lot.....	14	15
Average initial weight June 5, 1948 (lbs.).....	261.0	255.7
" weight at end of period, Oct. 1948 (lbs.)....	513.2	419.1
" gain during creep-feeding period, 135 days (lbs.)	252.2	163.3
" age when weaned (days).....	240.6	241.8
" grain consumption per calf (lbs.).....	783.6	None
" value of grain consumed @ \$70.00 per ton..	\$ 27.42	None
" appraised value of weaned calves per cwt...	\$ 24.80	\$21.96
" appraised value of calves per head.....	\$127.26	\$92.02
" profit attributable to creep feeding.....	\$ 7.82	.....

ANIMAL HUSBANDRY AT WEST TENNESSEE STATION

Jackson

C. S. Hobbs, H. R. Duncan, and B. P. Hazlewood

FATTENING AND WINTERING YEARLING STEERS ON CORN SILAGE, ALFALFA HAY, COTTONSEED MEAL, AND CRIMSON CLOVER-RYEGRASS PASTURE

The first trial of this project was completed in 1948. The project is unique in that it involves winter pasture for fattening cattle. Weather conditions were unfavorable for the growth of pastures during the winter and for having the cattle on the fields. The cattle were allowed out on the pastures only 59 days of the 111-day period. During the second and third 28-day periods, snow and ice kept the cattle in the barn practically all the time. The 9 days they were out seemed to upset them. This trial indicates, as shown in table 13, that access to winter pasture is not advisable for fattening cattle, but may be beneficial for stockers.

Table 13—*Fattening and wintering yearling steers on corn silage, alfalfa hay, cottonseed meal, and crimson clover-ryegrass pasture, at Jackson*

Item	Fattening		Wintering	
	Lot 1 without pasture	Lot 2 with pasture	Lot 3 without pasture	Lot 4 with pasture
Number of steers per lot.....	10	10	10	10
Average initial weight, Dec. 20, 1947 (lbs.).....	781.6	781.8	721.3	721.1
Average final weight, April 9, 1948 (lbs.).....	1004.0	984.0	878.0	891.0
Average gain per head for period, 111 days (lbs.).....	222.4	202.2	156.7	170.3
Average daily gain for 111-day period (lbs.).....	2.003	1.821	1.411	1.536
Average daily ration:				
Corn-sorghum silage (lbs.).....	49.2	39.6	49.1	33.9
Alfalfa hay (lbs.).....	.....	.....	4.0	4.0
Cottonseed meal (lbs.).....	4.5	4.5	.....	.....
Crimson clover-ryegrass pasture.....	.....	Grazed 59 days	.....	Grazed 59 days
Average feed requirements for 100-lbs. gain:				
Corn-sorghum silage (lbs.).....	2456	2171	3490	2241
Alfalfa hay (lbs.).....	.....	.....	286	263
Cottonseed meal (lbs.).....	226	249	.....	.....
Crimson clover-ryegrass pasture.....	.....	1 acre per head	.....	1 acre per head
Feed cost of 100-lbs. gain, exclusive of pasture ¹	\$23.58	\$23.30	\$23.17	\$16.46
Feed cost of fattening or wintering per head, exclusive of pasture.....	\$52.52	\$47.18	\$36.23	\$28.05
Average slaughter grade April 9, 1948 ²	Low Good-	Low Good-	Medium+	Medium+

¹ Corn-sorghum silage, \$10.00; cottonseed meal, \$100.00; and alfalfa hay, \$40.00 per ton.

² The 20 steers in lots 1 and 2 were sold for \$26.75 straight on the Nashville market. The carcasses were graded as follows: Low choice 1, High good 6, High medium to Low good 12, and Medium 1. No criticisms were made of the carcasses of lot 2.

SUMMER FINISHING TWO-YEAR-OLD STEERS WITH AND WITHOUT CONCENTRATES

The second trial of this project was completed during the summer of 1948. Weather conditions were not as favorable for pastures as in 1947. Because of this and possibly other conditions, the gains on the 1948 steers were only about 65 percent of the gains on the 1947 steers. Although there was some difference in slaughter grade of these cattle on July 31, when they were sold, and in their dressing percentage, the buyer of the finished cattle did not make any distinction between the 2 lots. Under these conditions, the cattle receiving the concentrates returned \$8.52 less profit over feed and initial cost than those which were finished on grass alone.

INFLUENCE OF PASTURE AND MANAGEMENT ON GAINS AND COST OF GAINS ON YEARLINGS DURING THE FALL

Very little study has been given to pasture and management practices for stockers during the fall months. This probably is the most critical period in the growth of stocker and feeder cattle. Many of the pasture plants are mature, or dormant, or exhausted; the rainfall is low, and farmers are busy harvesting or seeding, and neglect their cattle. Work was done during the fall of 1948 in which the influence of type of pasture and supplemental feeding on yearling steers was studied. The steers were divided into 3 lots.

Lot 1. Steers grazed on undeveloped, overgrazed bottom-land

pasture consisting of redtop and bermuda grasses with lespedeza and wild onions.

Lot 2. Steers grazed on improved permanent pasture supplemented with sudan grass (5 acres for 20 steers). Permanent pasture consisted of alsike, white and red clovers, with redtop and fescue grasses.

Lot 3. Steers grazed on same pasture as lot 2 but supplemented with 3.9 pounds of cottonseed meal per head daily.

Results are summarized in table 14.

Table 14—*Performance of yearling stockers during the fall under different systems of management, Jackson.*

Weights, Gains, and Feed Costs		Lot 1	Lot 2	Lot 3
Number steers per lot.....		45	10	10
Average initial weight Aug. 28, 1948.....		693	766	765
" gain first period, Aug. 28, to Sept. 25 (28 days) (lbs.).....		21	30	39
" gain second period, Sept. 25 to Oct. 23 (28 days) (lbs.).....		5	14	25
" gain third period, Oct. 23 to Nov. 20 (28 days) (lbs.).....		-37	3	28
" gain fourth period, Nov. 20 to Dec. 18 (28 days) (lbs.).....		0	10	39
" gain for all periods (112 days) (lbs.).....		-11	57	131
" daily gain for all periods (lbs.).....		-.098	.509	1.178
" final weight Dec. 18, 1948 (lbs.).....		682	823	896
" daily ration:				
Permanent pasture.....	ad lib.	ad lib.	ad lib.	
Cottonseed meal (lbs.).....	.....	.....	.....	3.9
" feed cost per head (112 days pasture, 7c day for lot 1 and 10c for lots 2 and 3, and CSM \$70.00 ton).....				
" feed cost per 100 lbs. gain.....	\$ 7.84	\$11.20	\$26.46	
" slaughter grade Dec. 18, 1948.....	No gain	\$19.65	\$20.20	
	Not made	Med.-	High Med.-	
Financial statement				
Average value per head Aug. 28, 1948, @ \$23.00 cwt.				
" initial and feed cost Dec. 18, 1948.....	\$159.39	\$176.18	\$175.95	
" necessary selling price Dec. 18, 1948, to cover initial and feed cost on final experimental weights.....	167.23	187.38	202.41	
	24.52	22.77	22.59	

THE DEVELOPMENT OF STOCKER CALVES

To provide 65 calves for experimental use, about 90 head have been bought annually. These calves have been secured in West Tennessee, from county stocker sales, stockyards, and farmers. Grading out the light, heavy, and off-type calves insures a fairly uniform lot.

Many of these calves, although 6 to 9 months of age, have not been dehorned or castrated. This year, only 12 percent had been standardized; 14 percent required castration only; 30 percent, dehorning only; and 44 percent required both castration and dehorning.

Records have been kept for several years on the effects on the winter gains of these various operations. This year, as usual, castration gave the calves a greater setback than dehorning, and castration and dehorning was more severe than either operation singly. The calves that were castrated and dehorned gained 71 pounds during the

149-day winter period, while the no-treatment calves gained 77 pounds. In addition, a few calves have been lost through these operations, which are always disagreeable. Either the seller or the buyer is penalized about \$2.00 per cwt., at the present price level, because the calves were not dehorned or castrated while they were young.

After these calves were bought, in October, they were given the run of a permanent pasture and were fed 4 pounds of shelled corn, oats, and cottonseed meal for a period of 67 days. During the winter period of 102 days, they were run on crimson-clover pasture and fed in addition 13.74 pounds silage, 3 pounds alfalfa hay, and 2 pounds cottonseed meal. From April 2 to August 28, they were pastured on a mixed permanent pasture and gained 231 pounds in 140 days. The fall, winter, and summer gain, over a period of 289 days, averaged 308 pounds. They paid market price for the dry feeds, 4 cents per day for crimson-clover pasture in the winter, 8 cents per day for the permanent pasture, and reduced the initial cost of \$20.00 per cwt. to \$17.76.

ANIMAL HUSBANDRY AT TOBACCO STATION

Greeneville

H. R. Duncan, C. S. Hobbs, and J. Hugh Felts

COW-CALF PRODUCTION STUDIES

The first calf crop produced from a grade herd of Hereford heifers involved the following factors:

1. A comparison of calves dropped in January and February with calves dropped in March and April.

2. A comparison of calves sired by an Angus bull with calves sired by a Hereford bull.

The cows were wintered in 2 groups, split into 4 lots for the breeding season, and run together during the major portion of the pasture season. Table 15 shows briefly the results of the date-of-calving phase of the project.

Table 15—Performance of early- versus late-calving cows, at Greeneville.

Item	Jan. and Feb. calves	Mar. and April calves
Number of cows	24	24
Average weight of cows Nov. 10, 1947 (lbs.)	1053.5	1050.0
" gain for year, Nov. 10, 1947, to Nov. 10, 1948 (lbs.)	50.2	42.3
" winter ration Jan. 1 to April 20:		
Alfalfa-orchard grass hay (lbs.)	18.8	17.6
Straw (lbs.)	.35	
Silage (lbs.)	.70	1.12
Grain mixture (lbs.)	3.56	
Average feed cost per cow for year	\$ 80.66	\$ 63.92
Number calves weaned	21	21
Average date of birth of calves	Jan. 20	Mar. 13
" birth weight (lbs.)	62.8	66.7
" weight when weaning Nov. 3, 1948	519.4	461.8
" age when weaned (days)	287.7	235.1
" daily gain, birth to weaning	1.586	1.680
" appraised value per head at weaning	\$121.85	\$106.60
" returns per cow bred over feed cost	\$ 26.00	\$ 29.39

Since it was necessary to feed the cows which calved early, some grain in order to keep them in equal condition with the late-calving group, their feed costs were higher, and although their calves were heavier and worth more per head, the early-calving cows returned \$6.61 less per head over feed cost than the late-calving cows.

Table 16 gives some of the more important findings of the breeding phase of the project. The calves by the Angus bull were lighter at birth, gave less delivery trouble, gained more, and were somewhat more profitable than the calves by the Hereford bull.

Table 16—Calves by Angus bull compared with calves by Hereford bull, Greeneville.

Item	Calves by Angus bull	Calves by Hereford bull
Average birth weight (lbs.)	61.0	68.4
" daily gain birth to weaning (lbs.)	1.672	1.594
" appraised value per head at weaning	\$115.01	\$113.54

EWES BREEDING AND SPRING-LAMB PRODUCTION

A project was started in 1947 for the purpose of comparing two kinds of Tennessee-bred ewes for spring-lamb production. The initial step was the production of the ewes. Native yearling grade Hampshire ewes, developed at the Crossville Station from No. 2 and No. 3 ewe lambs purchased at the Plateau sheep sale, were selected for the foundation flock. (See 1947 annual report on the management and weights of these ewes.) A graded-up flock secured by 2 successive matings of Hampshire rams on the foundation flock and a crossbred flock secured by making 2 successive crosses of Dorset rams on the native ewes are being developed.

While the ewe flocks are being produced the 2 original flocks are being studied for spring-lamb production. The ewes and lambs were carried largely on pasture, with alfalfa hay and a small amount of grain being fed during the winter. Tables 17 and 18 show briefly the performance of these flocks.

Table 17—Spring lambs produced from Hampshire and Dorset rams, Greeneville.

Item	By Hampshire rams	By Dorset rams
Number ewes in each flock	31	31
Average weight of ewes Aug. 2, 1947	114.0	112.8
Number lambs weaned or sold prior to June 16, 1948	24	27
Percent of lambs raised to ewes starting year	77.4	87.1
Average birth weight of lambs	9.9	7.9
" weight of lambs when weaned, June 16, 1948	92.7	80.7
" actual or appraised price per cwt.	\$29.55	\$29.20
" value per head	27.39	23.57
" lamb returns per ewes starting year	21.21	20.53
" fleece returns per ewes starting year	3.55	3.64
" returns in lamb and fleece per ewe starting year	24.76	24.17

Table 18—Summary of information on sheep-breeding experiment, Greenville.

Ewes in the Experiment

Item	Bred to Hampshire ram	Bred to Dorset ram
Number ewes starting year Aug. 2, 1947	31	31
Average weight Aug. 2, 1947	114.0	112.8
Average weight Dec. 31, 1947	139.4	135.2
Average weight Aug. 6, 1948	139.4	135.8
Number ewes finishing year	30	29
Average gain for year	125.4	122.4

Ewe Lambs Produced and Retained for New Flocks.

Number weaned June 16, 1948	14	12
Average weight when weaned June 16	96.8	77.8
" age at weaning, June 16 (days)	140.3	126.0
" birth weight	10.3	7.37
" gain birth to weaning, June 16	86.5	70.43
" daily gain birth to weaning	.602	.559
" weight Aug. 2, 1948	102.0	82.5
" weight Dec. 31, 1948	114.0	100.8
" gain June 16 to Dec. 31	17.2	23.0

A COMPARISON OF GRASS ALONE AND GRASS SUPPLEMENTED WITH GRAIN FOR FINISHING TWO-YEAR-OLDS AND YEARLINGS

The second trial of this project was completed this year. Good bluegrass and white and hop clover pastures on creek-bottom and hill lands were used for both the 2-year-olds and yearlings. These pastures, lying at an elevation of 1500 feet, are on good soils and have been well fertilized. The pastures were stocked at the rate of one head per 1.1 acres for the 2-year-olds and one head per 1.16 acres for the yearlings.

Table 19—Performance of cattle in an experiment with grass alone compared with grass supplemented with other feeds.

Item	Two-year-olds		Yearlings	
	Lot 1	Lot 2	Lot 3	Lot 4
Avg. weight April 21 when turned on grass (lbs.) ..	59	.....	599	633
" gain to July 31 (101 days) (lbs.)	107.2	96.2	125.0	110.5
" gain July 31 to Sept. 25 (56 days) (lbs.)	107.2	144.6	81.5	124.0
" weight September 25 (lbs.)	1186.4	1208.8	805.0	867.5
" grain mixture consumed July 31 to Sept. 25 (lbs.) ..	None	15.2	None	14.0
" weight Nov. 20 (lbs.) .....	.....	.....	946.5	988.0
" gain during dry-lot period (56 days) (lbs.) ..	.....	.....	140.5	120.5
" daily ration during dry-lot period:				
Grain mixture (corn-and-cob meal 7 parts, CSM 1 part) (lbs.) .....	.....	.....	19.4	15.8
Alfalfa hay (lbs.) .....	.....	.....	11.0	11.4
Avg. appraised value per cwt. Sept. 25	\$29.61	\$29.79	\$25.35	\$26.64
" appraised value per cwt. Nov. 20 .....	.....	.....	\$26.02	\$26.69
" profit over initial and feed cost when sold ..	\$93.52	\$86.58	\$60.05	\$60.69
" slaughter grade when sold	Good	Good	Low Good	Good —
" carcass grade (Federal)	Low Good+	Good —	Low Good +	Good —
" dressing percentage (final experimental-wt. and warm-carcass-wt. basis)	59.8	59.9	58.8	58.6

The setup for the finishing period was as follows:

Two-Year-Olds—

Lot 1—Grass only to September 25.

Lot 2—Grass only to July 31 and full-fed grain on grass for 56 days, to September 25.

Yearlings—

Lot 3—Grass only to September 25, then full-fed grain and alfalfa hay in dry lot for 56 days.

Lot 4—Grass only to July 31, then full-fed grain on grass for 56 days, to September 25; then full-fed in dry lot for the additional 56 days, similarly to lot 3.

Table 19 gives a brief summary of the information obtained on these cattle.

GENERAL OBSERVATIONS

1. There was little difference in the carcass grades of the 4 lots. The full-feeding of a grain mixture during 56 days in the latter part of the grazing period had only a slight effect on the carcass grade and no effect on the dressing percentage. These carcasses, grading low good or slightly better, were satisfactory for the local markets. The yearling carcasses, because of lighter weight, were much more desirable than the 2-year-olds.

2. All lots, owing to the wide margins secured, made unusually high returns above feed costs this year. Returns were much higher on the 2-year-olds than yearlings because of a drop in the market of about \$3.00 per cwt. between September 25 and November 20. A more severe drop occurred the previous year. Such a drop is a common occurrence. The yearlings were not very well finished at the time the 2-year-olds were sold, but the additional dry-lot feeding period of 56 days put them in about the same slaughter condition as the 2-year-olds when they were sold.

3. The 2-year-old grass steers returned \$6.94 more per head than the grass-grain lot. The yearling grass steers returned \$0.60 less per head than the grass-grain lot. On the appraisals September 25, the grass lot showed \$5.99 less profit than the grass-grain lot. Although the yearlings made good gains and improved in finish during the 56 days of dry-lot feeding, the period produced no profit above feed costs.

A COMPARISON OF TWO METHODS OF WINTERING CALVES

On December 31, 1947, a group of stocker calves were placed in a barn with access to an outside lot and fed for 112 days on a daily ration of corn silage, 14.2 pounds; alfalfa-orchard grass hay, 6.2 pounds; and cottonseed meal, .96 pound. A similar group of calves was placed on an orchard grass-alfalfa pasture upon which a considerable growth had accumulated, and fed in addition .93 pound of alfalfa-orchard grass hay and 1 pound of cottonseed meal. The hay was fed for only a few days when snow covered the pasture. A pasture of 1.8 acres per calf was provided. Some of this pasture would have yielded 1200 to 1500 pounds of hay had it been cut in the late fall.

At the end of the winter period the 2 lots of calves were run on the same pasture to July 31. One half of each lot was continued on pasture for only 56 days; the other was full-fed a grain mixture while on pasture. At the conclusion of this period both lots were fed a grain mixture and alfalfa hay in dry lot for an additional period of 56 days and then marketed.

Table 20 shows the performance of these calves as influenced by method of wintering.

Table 20—A comparison of barn-wintered and pasture-wintered stocker calves.

Item	Barn-wintered	Pasture-wintered
Avg. initial wt. Dec. 31, 1947 (lbs.)	542.0	556.8
" gain Dec. 31, 1947, to April 21, 1948 (112 days winter period) (lbs.)	42.1	90.8
" gain 1st pasture period, April 21 to July 31 (101 days) (lbs.)	108.3	128.0
" gain 2nd pasture period, July 31 to Sept. 25 (56 days) (lbs.)	111.5	94.0
" gain dry lot period, Sept. 25 to Nov. 20 (56 days) (lbs.)	129.6	131.3
" gain Dec. 31, 1947, to Nov. 20, 1948 (lbs.)	391.4	444.1
" final weight Nov. 20, 1948 (lbs.)	933.4	1000.9
" initial value per head @ \$19.00 cwt.	\$102.98	\$105.78
" feed charges per head ¹	\$ 99.67	\$ 98.90
" initial and feed cost per head	\$202.65	\$204.68
" returns per head @ \$26.01 and \$26.67 per cwt.	\$242.90	\$267.10
" returns per head over feed and initial cost	\$ 40.25	\$ 62.40
" dressing percentage (final-exp-wt. and warm-carcass-wt. basis)	58.35	58.95
" carcass grade (Federal)	Low Good +	Good

¹ Alfalfa-orchard grass hay, \$40.00; alfalfa hay, \$35.00; silage, \$10.00; cottonseed meal, \$90.00; grain mixture, 7 parts corn-and-cob meal and 1 part CSM, \$60.00 ton. Winter pasture @ 7½c; permanent pasture first period @ 15c and second period @ 11¼c per day.

ANIMAL HUSBANDRY AT GRASSLAND SUBSTATION

Crossville

H. R. Duncan, C. S. Hobbs, and John A. Odom

COW-CALF AND PASTURE-FERTILIZATION PROJECT

Herds of grade beef cows are maintained on pastures on which 2 levels of phosphate had been applied. The annual applications of phosphorus since 1939 have been 12.8 pounds on the "low" area and 41.6 pounds on the "high" area. For several years, 2 lots of cows were run on the low area, one of which had a dicalcium phosphate supplement. This supplement did not appear to be giving any results and was discontinued, but the original grouping of the cows has been maintained. A brief summary of the results for the year 1947-48 is given in table 21. The cows were wintered on 1810 pounds each of medium-grade hay and were run on the pasture practically the entire year. The calves were born after April 1 and were not creep-fed.

Although the 1948 grazing season was unfavorable because of the drouth, a crop of remarkable calves was produced. They were not quite as heavy as those produced in 1947, but were above average in weight, for their age, and in quality. The cows on the "low" area have been lighter than those on the "high" area and have maintained a later calving schedule.

Table 21—Performance of cows at Grassland Station, Crossville.

Item	Lot 1 Low-Phos. area	Lot 2 Low-Phos. area	Lot 3 High-Phos. area
Number of cows starting year per lot	11	11	11
Number of acres pasture provided per cow	3.57	3.57	3.27
Number of calves raised	11	10	11
Average weight of cows in fall, Oct. 31, 1947 (lbs.)	946.5	966.3	1067.0
" gain of cows to Oct. 30, 1948 (lbs.)	17	16.8	— ¹
" birth of calves (lbs.)	69.1	71.6	62.5
" weaned weight of calves, Oct. 30, 1948 (lbs.)	449	405	481
" age at weaning, Oct. 30, 1948 (days)	175.7	153.7	196.1
" daily gain, birth to weaning (lbs.)	2.168	2.152	2.143
" appraised value per head at weaning (lbs.)	\$116.43	\$103.63	\$124.88

¹ One cow lost in calving.

VETERINARY SCIENCE

Dennis Sikes

JOHNE'S DISEASE OF CATTLE

Tests were made with an intradermic johnin on cattle naturally infected with the organism *Mycobacterium paratuberculosis*, which causes Johne's disease. These tests were made at 14-, 16-, 18-, and 20-week intervals in the same injection sites, where the hair had been clipped with extra-fine-tooth clippers (fig. 19). Previous research by the

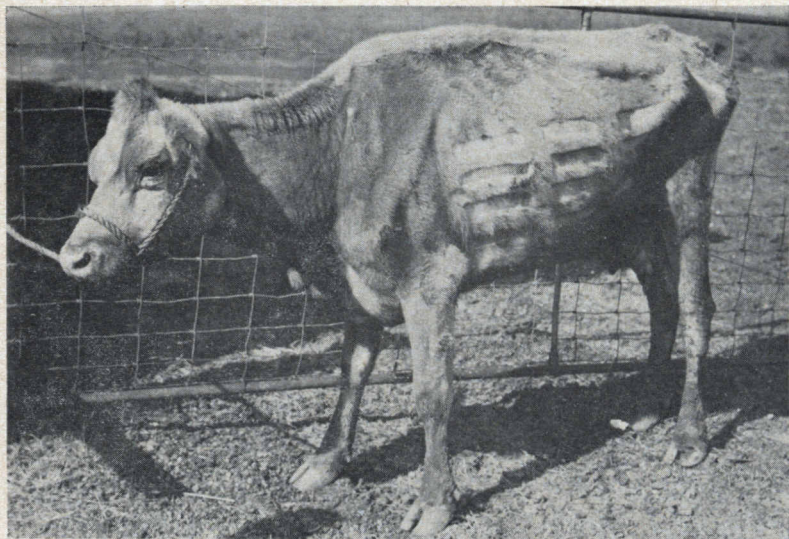


Fig. 19—Advanced clinical case of Johne's disease, with hair clipped from testing sites.

author has suggested that when repeated tests were made in the same site at 12-week intervals the number of positive reactions was irregular, and many tests failed to react at all. A possible explanation is that a local desensitization takes place when repeated injections are made in the same site. Thus, an attempt is being made to find out the length of time that must elapse between tests when a retest is necessary on a herd.

"X DISEASE" OF CATTLE

"X Disease" is new in Tennessee and the United States. During the year, it was diagnosed on 26 farms in the State having a population of 629 cattle, of which 134 died or had to be slaughtered because of their morbid condition. At least as many seem to have recovered. It is conservatively estimated that the loss from death alone is more than \$40,000.00.

Field trips by the author have led to the following observations:

1. The disease seems to be widely scattered in most sections of East and Middle Tennessee.
2. The clinical picture of the progress of the disease in affected herds suggests an infectious agent as the cause.
3. The formation of superficial blisters, which may heal with only a minimum of scar-tissue formation, or which may progress to ulceration, seems to be very important in determining the course of the disease in the affected animal. The blisters or ulcers are located in the buccal cavity, on the tongue, about the lips, on the muzzle, in the trachea, and



Fig. 20—Animal affected with "X-disease," having badly swollen jaw, with large abscess in mouth cavity.

in the upper digestive tract. Often they become infected secondarily and produce large abscesses in the mouth cavity. Note the swollen jaw in figure 20.

4. In the yearlings and adult cattle, a sub-acute or chronic form, with excessive thickening of the skin and a loss of hair, seems to be the more prevalent form (fig. 21).



Fig. 21—Chronic case of "X-disease," with marked thickening of the skin, which formed huge rolls.

Affected animals may linger for many months before recovery or death.

Research should be initiated with the following objectives:

1. To identify the causative agent or agents of the disease.
2. To determine whether the cause is contagious and transmissible.
3. To study its pathogenicity and pathology.

DALLISGRASS POISONING IN CATTLE

During the month of September, 1948, in the Sweetwater Valley section of East Tennessee, Dallisgrass poisoning was diagnosed on 51 farms. This is the first time it has been recognized in the State. The diseased condition is brought about by the animal's consuming Dallisgrass seed heads which are infected with the ergot fungus *Claviceps paspali*. The maximum toxic symptoms seemed to appear when the cattle were eating the infected grass heads in the honey-dew-droplet stage of development. Clinical observations revealed the following symptoms:

1. Hypersensitiveness—animals nervous and fearful.

2. Muscular trembling—so severe in some cases that animals were not able to graze.
3. Incoordination—staggers, lack of muscular control, and, in a few cases, inability to get up.
4. Heart action very rapid.
5. Temperature little affected.
6. Digestive organs—in a few cases, bowels loose, with scours; in others, some constipation.

In all cases, there was prompt recovery when proper medication was administered and the animals were removed from the infected pastures. The disease was controlled by the mowing of the infected pastures.

CHEMISTRY: SOILS, FERTILIZERS, AND FLUORIC EFFLUENTS

W. H. MacIntire, W. M. Shaw, S. H. Winterberg, and L. J. Hardin

EFFECTS OF VARIOUS CALCIC AND MAGNESIC MATERIALS IN A CUMBERLAND CLAY LOAM

The primary objective of this long-time lysimeter experiment was to determine the maximal capacity of the soil for differential absorptions of calcium and magnesium and attendant translocation, absorption, and deposition of the calcium and magnesium carried by the surface drainage waters into acidic clay subsoil along with potassium, sulfur, and nitrogen.

The average percolation volume was 41 percent of the rainfall. The acid control soil maintained a balance between increment and leaching of calcium and yielded some Mg. The mean outgo of Ca from the CaCO_3 and from the limestone additions was equivalent to 550 pounds of CaCO_3 , a third of the outgo being as sulfate and nitrate. As in recent years, nitrogen outgo was only about 5 pounds per acre per annum. The several magnesian materials continued the release basis beyond quantities released by the calcic carbonate. The clay subsoil continued to absorb calcic and magnesian carbonates that had passed from the liming material present in surface soils.

At the end of the past season, ground alfalfa was incorporated at the rate of 4000 pounds per 2,000,000 pounds of soil in all of the limed soils. This treatment was intended to show whether the low nitrate formation in recent years was due to diminution in soil organic matter or to lack of aeration in the compacted soil.

The lysimeter phase of this experiment will be terminated at the

end of the coming 35th year. The soil and subsoil then will be sampled and used in a comprehensive laboratory study as to effects that the various calcic and magnesian additions have exerted upon the chemical and physical properties of the soil.

ECONOMIC ADDITIONS OF LIMING MATERIALS

The lysimeter project cooperative with the Virginia Experiment Station, on the relative effectiveness of 4 liming materials, as influenced by frequency and zone of incorporation, was terminated last year. The 20-year findings have been tabulated and are in preparation for publication as a bulletin of each of the two Experiment Stations.

QUENCHED CALCIUM SILICATE SLAG VERSUS LIMESTONE

The objective of this lysimeter experiment was to compare liming effectiveness of TVA quenched slag and limestone under various comparable conditions as to fineness and rates of incorporation. The materials were incorporated into Hartsells fine sandy loam and a Baxter silt loam at rates of 5 tons of 4-mesh material and 2 tons of the 20- and 100-mesh separates per 2,000,000 pounds of soil at the beginning of the experiment, and also annually in the initial 4 years. Fluorine concentration in the leachate waters from the various incorporations of the TVA slag was of particular concern.

The findings of the 8th year, or the 5th year after the final incorporation, show net outgo of about 120 pounds of CaCO_3 from the 2-ton inputs and 260 pounds from the 5-ton inputs, and without distinction between the effects of limestone and slag. The repetitive slag incorporations of 5 tons of coarse material and of 2 tons of the 20- and 100-mesh slag caused larger leachings of calcium. The outgo of Ca from every incorporation of slag was considerably greater than that from the corresponding input of limestone. The single 2-ton and 5-ton additions of slag induced respective fluorine concentrations of 1 p.p.m. and 3 p.p.m. in the year's leachings, as against a range between 8 and 12 p.p.m. for the repetitive 5- and 2-ton incorporations.

The repetitive additions of slag exerted a distinct repressive effect upon the outgo of nitrogen during the present season, although corresponding incorporations of limestone did not produce such effect.

MAGNESIUM NUTRIENT VALUE OF CERTAIN MAGNESIC MINERALS

Magnesium is recognized as a major plant nutrient. The forsterite minerals that occur in the Blue Ridge Mountains of North Carolina and Georgia have been considered for direct incorporation into magnesium-deficient soils. Very finely divided separates of serpentine and olivine were incorporated into Hartsells fine sandy loam and Claiborne silt loam at the rate of 1000 pounds MgO per 2,000,000 pounds of soil in lysimeters to determine the availability of the added magnesium through analyses of the rainwater leachings. Magnesite and dolomite were included to afford comparative evaluation. Thorough mixing of the additives into the soil was accomplished by means of the device shown in figure 22.

The findings for the initial years are given in table 22 and reveal

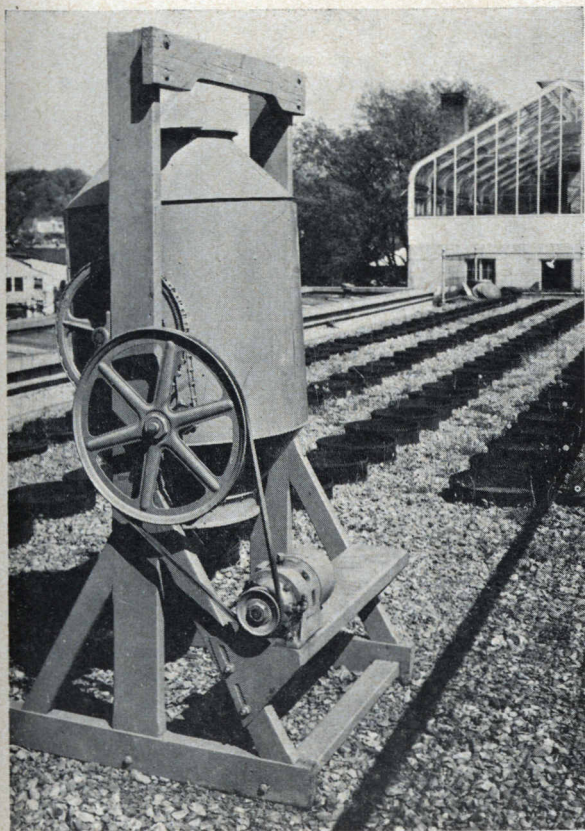


Fig. 22—Motor-driven device for the mixing of fertilizers and liming materials into the soils for lysimeter placements.

the fact that in every instance the jointly incorporated limestone exerted a repressive effect upon outgo of Mg from that native to the soil.

Olivine was the only magnesian incorporation to cause appreciable enhancements in Mg outgo, and that was mainly from the 325 separates. The effectiveness of olivine, and of serpentine coarser than 100-mesh, was registered through the migratory outgo of magnesium from the $-100+200$ -sieve separates. Obviously, the mineral silicates promise little as early sources of nutrient magnesium, when those minerals are incorporated at rational rates and the over-all findings indicate that the magnesite was only slightly more

Table 22—Magnesium outgo¹ during the initial year after the incorporation of magnesian minerals.

Minerals		MgO outgo per 2,000,000 pounds of soil			
		From Hartsells soil ²		From Claiborne soil ²	
		Without limestone	With limestone	Without limestone	With limestone
Type	Particle size	Pounds	Pounds	Pounds	Pounds
Olivine.....	— 100-200	10	—20	1	(lost)
	— 325	92	— 4	31	(lost)
Serpentine.....	— 100-200	4	—18	— 7	— 2
	— 325	21	—16	12	— 5
Magnesite.....	— 100-200	68	— 6	32	— 8
	— 325	97	77	68	41
Dolomite.....	— 100-200	165	104	116	49
	— 325	152	139	119	68
Mg:SO ₄		638	476	393	405

¹ In terms of MgO, equivalent to 1000-pound incorporations of magnesium for 2,000,000 pounds of soil.

² Corrected for MgO outgo in controls: Hartsells soil, 41 pounds; Claiborne soil, 74 pounds.

effective. It also appears that the repressive effects exerted by calcium incorporations upon the outgo of Mg from magnesite were offset by the —325-mesh fineness of that mineral carbonate. The leachings of magnesium from the dolomite treatments were invariably greater than the quantities that passed from any incorporated magnesian mineral, although difference in dolomite fineness did not register differential effects in the outgo from either soil.

The soils retained from 85 to 95 percent of the Mg carried by the inputs of dolomite and, apparently, the two dolomite separates were decomposed completely by the soil within an early stage of the experiment. The soil retained from 36 to 60 percent of the magnesium incorporated through the magnesium sulfate control, the larger retentions being consonant with greater quantities of soil content of calcium, either native or added.

The relative dissolubilities of the several magnesian minerals in saturated CO₂-water extractions were at variance with the values indicated through the lysimeter leachates when 2-gm. charges of the 3 minerals were suspended in 100 ml. of CO₂-charged water during 30 minutes of continuous agitation by means of a bubbling of the gas through the systems. The following results were obtained:

	<u>MgO/100 ml.</u>
	<u>mgm.</u>
Olivine —100+200	.8
Olivine —325	7.2
Serpentine —100+200	3.0
Serpentine —325	14.4
Magnesite —100+200	1.2
Magnesite —325	6.6

Olivine and magnesite registered similar "availability" in CO₂-water. The dissolubility of serpentine, however, was about twice that of the other 2 materials, although the lysimeter leachings had indicated that the serpentine was the least dissoluble of the 3 materials. Upon the basis of similar observations from other CO₂-charged water, and from the use of chemical solvents, it is concluded that the comparative speed of dissolution of carbonate solids in chemical solvents is not a reliable criterion for the relative speed of their disintegration after incorporation into the soil.

COMPARATIVE REACTIVITIES OF INCORPORATIONS OF CALCITE, MARBLE, DOLOMITE, QUENCHED AND UNQUENCHED SLAGS, AND WOLLASTONITE

Under controlled conditions in the laboratory, the rates of dissolution of the calcite separates in CO₂-charged water have shown remarkable correlation with the values computed for surface areas. The findings are being integrated with determinations of reactivities of the several alkaline-earth materials after their incorporation into Hartsells fine sandy loam and Claiborne silt loam in a correlated lysimeter experiment. The lysimeter experiment was expected to register reactivity of the incorporated liming materials:

- (a) Through the enhancements in outgo of Ca + Mg, (b)

through induced elevations in soil pH values, and (c) through the progressive diminution of the carbonate content of the soils that received limestone and dolomite. The net outgo of $\text{Ca} + \text{Mg}$ from the $-18+20$ separates, and that from the $-35+40$ material, indicate that slag No. 1083 was slightly less reactive than the calcite in both soils. The integration of the 4 pH values for the slag and the corresponding values for calcite serve to support the previous conclusion that slag 1083 was less reactive than calcite in the neutralization of soil acidity in the 2 soils. In the comparisons that included Wilson Dam slag No. 1084, Monsanto slag, and wollastonite, it appears that, in the range of sizes used, quenched slag 1084 was decidedly less reactive than the unquenched slag No. 1083, and that Monsanto slag No. 1124 and wollastonite were still less reactive in the 2 soils. If the liming materials had been used either in a finer state of subdivision or at much larger rates of incorporation, the foregoing conclusions would not have been reached.

The carbonate decomposition values enter into evaluations of the reactivities of the carbonate materials. Some 50 percent of the $-18+20$ calcite underwent decomposition in the Claiborne soil as against a 60-percent decomposition of marble, whereas the decompositions for the $-35+40$ separates of calcite and marble were 76 and 85 percent, respectively. The pH values and also the outgo of $\text{Ca} + \text{Mg}$ indicate that the marble separates were slightly more reactive than the corresponding calcite separates.

In general, carbonate decompositions were percentagely higher in the Hartsells soil. The analyses lacked the desired degree of concordance, however, since the dolomite separates were considerably finer than the separates of calcite and marble. Hence, a direct comparison of the effect of particle size upon the extent of carbonate decomposition cannot be made. Since the coarser dolomite separate was only half as fine as the finer calcite and marble separates, only 75 percent of the $-60+70$ dolomite was decomposed, that extent being equal to the decomposition of the $-35+40$ calcite separate. Computations, not given here, indicate that the decomposition of the calcite particles was about twice as rapid as that of the dolomite of like particle size. Hence, the moment a calcite particle suffers complete decomposition, a corresponding particle of dolomite will be decreased to one-half its original size. Under the above conditions, however, the weight, or volume decomposition, will be 82.5 percent for the dolomite at the moment when the calcite particle is completely decomposed. If the comparison between calcite and dolomite decompositions had been upon the basis of identical particle size, choice of particle size, and intervals appropriate for determination of the decomposition of the dolomite, the extent of calcite decomposition would have been too great to admit of a trustworthy comparison as to speed of decomposition.

Comparison of Particle Sizes of Individual Materials.—Liming effectiveness of various separates of the same material cannot be established merely through determined percentages of the decomposition of incorporated carbonates. Through translation of the percentage decompositions of the various separates into particle-size changes, percentage decompositions can be expressed through computed decreases

in the diameter of the mean particle of each separate. Such decreases in particle diameter were calculated for the respective calcite separates, after 1 year of exposure in the 2 soils.

Hartsells	0.195 and 0.280 mm.
Claiborne	0.180 and 0.174 mm.

Outgo of Calcium as Affected by That Added in Soil.—It is important to consider the relationship between calcium absorbed in the soil and that carried in the lysimeter leachings. That relationship is implied in our use of the increased outgo as an indicator of the reactivity of a specific liming material; the decomposition of 2500 pounds of CaCO_3 in the lysimeter induced an increase of only 100 pounds in outgo, whereas a decomposition of 2000 pounds of the finer calcite induced an increase of 1500 to 2000 pounds in CaCO_3 outgo. In contrast, a 1500-pound additional decomposition of the coarser calcite caused an enhancement of only 50 pounds in the CaCO_3 -equivalence of the outgo. The conclusions as to meager hydrolytic disintegration of incorporated calcium silicate are supported by small increases in the outgo of calcium and further by the determined slight effect on the pH of the silicate-treated soils.

PHOSPHATE LEACHING

In this 10-year lysimeter experiment, annual incorporations of various phosphates were made to 2 soils at the per-acre rate of 320 pounds P_2O_5 . Ortho-phosphoric acid and mono- and diammonium phosphates were incorporated separately into neutral Dewey silt loam and H_3PO_4 and mono-, di-, and tricalcium phosphates, and a TVA fused tricalcium phosphate, were incorporated into the acidic Hartsells fine sandy loam.

The 100-pound aggregate outgo of phosphorus from the dicalcium phosphate in the Hartsells soil was 10 times that from the mono- and tricalcium phosphates and 100 times the outgo from the phosphoric acid. The dicalcium and tricalcium phosphates induced significant increases in the outgo of calcium from the Hartsells soil against a small increase from the monocalcium phosphate and a repression by the acid. The secondary and tertiary phosphates caused 150-pound increases in the total outgo of nitrate nitrogen from the Hartsells soil.

The incorporations of H_3PO_4 , and of monoammonium and diammonium phosphates caused appreciable increases in the leachings of phosphates from the initially neutral Dewey silt loam, respective enhancements being 109, 149, and 78 pounds of P_2O_5 from inputs of 2880 pounds per 2,000,000 of soil. Hence, most of the incorporated phosphorus remained in the soils, regardless of type of phosphate used. The lysimeter phase of this experiment has been terminated and soils have been preserved for use in supplemental chemical and plant-growth studies.

POTASSIUM METAPHOSPHATE VERSUS POTASSIUM SULFATE

These 2 potassic fertilizers were compared as to retentions of incorporated K in the 2 soils of distinctive type, with and without an initial incorporation of limestone and of dolomite. Single 1000-pound incorporations of K_2O per acre, were compared with 5 annual 200-pound inputs. The limestone incorporations into the Hartsells fine

sandy loam and into the Fullerton silt loam were at respective rates of 4500 pounds and 2500 pounds.

Retentions of potassium from the five 200-pound inputs of K_2O without limestone were 38 percent for K_2SO_4 and 43 percent for KPO_3 , respectively, by the Hartsells soil and 31 and 38 percent by the Fullerton soil. Upon the basis of 1000-pound input of K_2O , the Hartsells soil effected a retention of 54 percent from K_2SO_4 and only 18 percent from KPO_3 , against corresponding retentions of 62 percent and 23 percent by the Fullerton soil. Agreement between the retentions by the 2 soils is good for the heavy single input, although a reversal in the order of retention was registered by the 2 potassic materials for the annual inputs. The liming of the Hartsells soil invariably caused a substantial increase in the retention of the added K. The liming of the Fullerton soil caused some increase in retention of the potassium supplied by the succession of the 200-pound inputs of K_2O as KPO_3 , and as K_2SO_4 , but the limestone did not increase retentions of potassium for the single 1000-pound inputs of K_2O as either KPO_3 or K_2SO_4 .

NITROGEN RECOVERIES FROM PHOSPHATES AND SULFATE OF AMMONIA

Nitrogen recoveries of 489, 894, and 1540 pounds were obtained from the respective inputs of 568, 1036, and 1704 pounds for the mono- and diammonium phosphate and $(NH_4)_2SO_4$ in the Dewey soil. A large proportion of the outgo of nitrogen from the ammonium sulfate, and to some extent that from the diammonium phosphate, was in the ammoniacal form. That form appeared in the rainwater leachings, however, only after the 7th addition of ammonium sulfate, and coincidentally with a decisive lowering of pH values of the leachings. During the last 3 years, the first 2 or 3 leachate collections showed a pH of about 3.8, but the later leachings showed pH values of 6 to 7 each year. Appearance of NH_4 and low pH values in the leachings coincided with a 10,000-pound depletion of 12,000 pounds of $Ca + Mg$ in the Dewey soil. The net leachings of $Ca + Mg$ from the respective incorporations account for 61 percent of the added NH_4 .

METHOD FOR THE DETERMINATION OF SULFIDE SULFUR CONTENT OF CALCIUM SILICATE SLAG

Since sulfide sulfur is an important component of blast-furnace slags, and to some extent also of the slag from the electric rock-phosphate reduction furnace, a simple method was developed for the determination of that component. The method consists of expulsion of the sulfide sulfur through dissolution of the slag and added zinc dust in dilute hydrochloric acid and absorption of the vapors in a solution of admium sulfate. The experimental work and the method were published in the A.O.A.C. Journal, November 1948.

THE DETERMINATION OF EXCHANGEABLE HYDROGEN IN SOILS

The exchangeable hydrogen content of a soil is the primary cause of low pH and indicates the need for liming. The pH determination is performed easily and simply, but it does not register quantitatively the liming requirement of a soil, and the need of a quantitative method for the determination of exchangeable hydrogen content has been recog-

nized. The values obtained by several proposed procedures were compared with actual CaCO_3 decompositions in soils under controlled conditions. It was found that the exchangeable hydrogen can be determined most effectively through $\text{Ba}(\text{OH})_2$ titrations against the soil when it is suspended in a solution of Ba-acetate, as described in a paper presented at the 1948 meeting of the Association of Official Agricultural Chemists.

EFFECTS OF FLUORIC EFFLUENTS UPON PLANT AND ANIMAL LIFE IN TWO LOCALES

In recent years the Experiment Station has received numerous reports of injurious effects upon plant and animal life in Blount and Maury Counties, in which two of the Station farms are located. The conditions appear to reflect the war-time expansion of the aluminum industry in Blount County and the augmented thermal processing of rock phosphate in Maury County. Both industries emit fluorine to the atmosphere—and emissions of that element have been deemed responsible for numerous instances of deleterious effects upon plant and animal life in this country and abroad. The Experiment Station therefore inaugurated a study to determine how fluorine is imparted to forage crops and to identify the forms that induce fluorosis when the contaminated vegetation is grazed by or fed to livestock. The study was set up as a Research and Marketing project under joint assignment to the Department of Chemistry and the Department of Animal Husbandry and Veterinary Science.

The chemical phase of the problem called for determination of incidence of fluorine in periodic collections of the atmosphere; of waters from streams, ponds, and rain; of green forage and hay; and of soils from the 2 counties and from control areas. Collaborative assistance was to be rendered Animal Husbandry through analyses of crops grazed upon by livestock, of hays and grain fed experimentally, and of bones, urine, and feces derived from experimentally fed small animals and livestock.

Fortunately, the Chemistry Department had a 20-year backlog of findings as to the chemical and biochemical effects induced in soils through inputs of fluorine materials. During the past 15 years, the behavior of incorporations of various carriers of fluorine, and the uptake of that element, have been determined through extensive long-time lysimeter experiments and through pot cultures that have been conducted in collaboration with TVA.

Analytical technics appropriate for the determination of the fluorine content of different types of material were developed. To assure against loss of the fluorine content of the analytical charges of vegetation during the prefatory ignition and against the generation of retentive compounds during such ignition, it was found necessary to fortify those charges with quantities of CaO beyond the amounts added to stabilize the field samples of vegetation. In the incineration prefatory to perchloric acid distillations from the CaO -fortified charges of the organic materials, temperature of 500° to 550°C. was found to be effective and safe against expulsion of fluorine during that step. As had been found in earlier work, full distillation-recovery of fluorine was not obtained when magnesia was used in lieu of CaO in the incinera-

tions. In the perchloric acid distillation, one hour was found essential for complete recovery of the fluorine contained in the calcines of the CaO-fortified analytical charges of materials of organic character. Provision also was made to preclude the interference of chlorine—that native to the vegetation and that added to the experimental feeds.

Analytical charges of soils, bones, urine, and feces were subjected to 1-hour distillation from sulfuric acid at $165^{\circ}\text{C}.$, and resultant distillates were concentrated and distilled from perchloric acid to 200 ml. at $125\text{--}130^{\circ}\text{C}.$, that temperature having been found preferable to the conventional 135° .

The colorimetric procedure was used to determine fluorine in the distillates from materials that contained micro-quantities of that element in range from 0 to 30 ppm. Fluorine content was determined by means of direct titration with thorium nitrate, with resultant analytical rapidity and dependability of analytical values against check analyses on samples of known content of fluorine.

Collection of Field Samples.—A panel truck was equipped with apparatus for the sampling of atmosphere, and for the collection of samples of soils and crops. Rainwater collections were made at several points in the affected localities and at control points, by means of circular metal funnels of 1/10000-acre area. These were supported by means of steel frames and were elevated to minimize contamination from splatterings from soil and vegetation. The rainwaters were collected after each precipitation at Blount County Farm; at the Experiment Station in Knoxville; at 2 points on the Maury County Farm; at the Crossville Farm, on the Cumberland Plateau; and at the Springfield Farm, on the Highland Rim. The collections obtained at the 4 first-named points showed fluorine content in the range between 6.5 and 7 pounds per acre-surface per annum, which was some 7 times the fluorine found in the collections at the 2 control points.

Charges of sodium carbonate were spread over the bottoms of petri dishes, and these were placed at several points under protective coverings that allowed free movement of atmosphere. The exposed charges were found to have acquired significant quantities of fluorine.

The 60-cubic-foot samples of atmosphere were drawn through absorption trains by means of a suction pump that was mounted in the panel truck. Distinction between filterable and solid fluorine materials present was established through analyses of the liquid absorbent and the cotton filter pads. These analyses showed absence of solid forms of fluorine in the sampled atmosphere. The successive samplings of vegetation, comprised of multiple clippings of green vegetation in the designated areas, were put into jars, which were sealed immediately. The jars contained calcium hydroxide and cubes of ammonium carbonate to prevent loss of fluorine during the steps of drying and grinding in preparing the samples for analysis.

The materials analyzed were in the following proportions: vegetation and pastures, 42 percent; bones, feces, and urines, 30 percent; atmosphere, 7 percent; rainwater, 7 percent; experimental feeds and hays, 8 percent; ground waters, soils, and miscellaneous, 6 percent.

Fluorine occurrences were determined on 204 samples of forage

collected on the University's farm in Blount County, some 5 miles distant from the purported source of fluorine effluents, during the interval between July 1947 and December 31, 1948. Of these, 55 samples contained 5-10 ppm of fluorine; 126 samples showed 10-30 ppm; 17 showed 30-40 ppm, and 6 samples were in range between 40 and 100 ppm.

Of the 173 collections of similar forage from the University's farm in Maury County none showed a fluorine content less than 10 ppm; 27 samples showed 10-30 ppm; 25 samples showed 30-40 ppm; 43 samples showed 40-60 ppm; 44 samples contained 60-100 ppm, and 34 samples showed fluorine content beyond 100 ppm. In contrast, of the 38 samples collected in unaffected control areas, 28 samples were in the 1-10 ppm range; 10 samples showed fluorine content of 10-30 ppm, and no content was greater than 30 ppm.

THE UT-TVA COOPERATIVE PROJECTS

Laboratory Studies.—Because of the importance of magnesium as a plant nutrient, and because of the extensive occurrence of mineral silicates of that element in western North Carolina, it seemed desirable to consider further whether inclusions of those minerals would provide available magnesia in fertilizers. The mineral silicates and parallels of magnesite and other carriers of magnesium were mixed into concentrated superphosphate at different rates and the mixtures were "cured." Their contents of available magnesium then were determined by means of an analytical procedure that was developed for that particular objective.

The acidic phosphate content of the superphosphate proved readily reactive upon the in-mixed silicate minerals, and the mixtures acquired substantial percentage contents of dimagnesium phosphate. Contrary to expectations, the mineral silicates were found to be attacked far more readily than either magnesite or dolomite. A brief presentation of the findings was given to the Tennessee Academy of Science and the full presentation will appear in the May 1949 issue of *Industrial and Engineering Chemistry*.

The greater reactivity of the silicates in the phosphatic mixtures is distinctive, since those minerals were found to be relatively inert and of little value as sources of nutrient magnesium in the soil, when incorporations were at rational rates. Findings to that effect were given in a paper that has been accepted for publication in *Soil Science* early in 1949.

Because of the utility of certain organic phosphates for insect control in the greenhouse, those organics were analyzed for phosphorus content by means of the procedure that had been developed and reported at the 1947 meeting of the Association of Official Agricultural Chemists. The values so obtained were applied in a greenhouse study. The plant responses showed specific values for some of the organics and negative utility for others, as reported upon in detail in the October 1948 issue of *Soil Science*.

Greenhouse Studies.—Concentrated superphosphate, dicalcium phosphate, and metaphosphate were compared with fused tricalcium phosphate and rock phosphate through incorporations into Hartsells

fine sandy loam and Fullerton silt loam that had been limestoned or slagged with experimentally quenched fusions of calcium silicate (CaSiO_3) and a mixture of calcium silicate and calcium fluoride ($\text{CaSiO}_3 + \text{CaF}_2$). The input of P_2O_5 supplied through the incorporations of a processed phosphate, at each rate, was only 1/8 of the input carried by the incorporated rock phosphate. Red clover, soybeans, sudan grass, and red clover were grown in that succession.

Dicalcium phosphate induced a significant response over that induced by the other available phosphates on the Hartsells fine sandy loam; and concentrated superphosphate and calcium metaphosphate proved more effective than the fused tricalcium phosphate.

Upon the basis of pounds of P_2O_5 recovered in the crops, dicalcium phosphate, concentrated superphosphate, and calcium metaphosphate also registered superiority over the fused tricalcium phosphate.

Dicalcium phosphate registered greater effectiveness on the Fullerton soil also, through mean dry weight and through recoveries of phosphorus that were significantly greater than the corresponding values found for the other phosphates. Therefore, dicalcium phosphate proved to be the effective carrier of phosphorus to both soils, whereas concentrated superphosphate and calcium metaphosphate showed equal effectiveness, both being superior to the fused tricalcium phosphate.

Although the rock phosphate provided a P_2O_5 input 8 times that provided by the processed phosphates, crop response to rock phosphate was, in general, less than the responses to the processed materials. That relationship also prevailed as to phosphorus recovery in the 4 crops.

Increases in available P_2O_5 inputs from 40 pounds to a maximum of 640 pounds resulted in larger percentages of phosphorus in the crops of red clover, soybeans, and sudan grass, although the larger inputs did not increase greatly the phosphorus in the red clover of crop 4. An input of 80 pounds of P_2O_5 was required to increase the phosphorus content of the red clover (crop 1) over that of the clover grown on the unphosphated limestone controls of both soils, whereas a 40-pound input was sufficient to raise the phosphorus content of the succeeding crops of soybeans and sudan grass.

Measured through crop response and through phosphorus recovery, each combination of phosphate of high availability and slag proved superior to a corresponding combination of phosphate and limestone. The experimentally produced slag that contained fluorine ($\text{CaSiO}_3 + \text{CaF}_2$) proved significantly more effective than the corresponding fluorine-free slag on the Hartsells soil. On the Fullerton soil, where the liming rate was approximately half that on the Hartsells soil, the 2 experimental slags were comparable in effectiveness and both proved superior to the limestone. In general, the combinations of the available phosphates and fluorine-fortified slag imparted to the red clover (crop 1), soybeans, and sudan grass a phosphorus content higher than that obtained on the soils that received either fused CaSiO_3 or limestone. Usually, the phosphorus contents of crops from the limestoned soil were higher than the contents of crops from the soil that received CaSiO_3 . Although the incorporation of the fluorinated CaSiO_3 provided a 131-pound input of fluorine into the Hartsells

soil, and 73 pounds into the Fullerton soil, these inputs caused no increase in fluorine uptake. For a given crop, fluorine content from the incorporated quenched fusions of CaSiO_3 and of $\text{CaSiO}_3 + \text{CaF}_2$ were virtually identical.

The laboratory-prepared mixtures of concentrated superphosphate and olivine, serpentine, and magnesite and their calcines were tested as to their contents of available magnesium by means of pot cultures. These mixtures had been moistened and cured 10 weeks. The pot cultures of red clover and millet on limed Hartsells fine sandy loam received a constant input of 160 pounds of "available" P_2O_5 , and "available" MgO rates between 12 and 174 pounds per acre.

Variation in the input of available magnesium caused no significant difference in the response by either crop, or in P_2O_5 content and uptake. There was, however, a definite and significant difference in the magnesium content and uptake by red clover, and especially by the millet straw, on the limestoned soil. Significant enhancements in magnesium content and uptake were induced through the incorporation of 40 pounds or more of available magnesium to the red clover, and through incorporation of 20 pounds or more to the millet. Hence, crop content and uptake of magnesium afford an evaluation of the amount of available magnesium to be derived from the described mixtures. This is in line with the values indicated by a chemical procedure developed and proposed for the determinations of the available magnesium content in fertilizers. As reported, however, olivine and serpentine were found to be virtually ineffective as liming materials, when those silicates were incorporated as such at rational rates. Although the 2 silicate minerals had proved more reactive than magnesite in the superphosphate mixture, the carbonate mineral proved more effective than the silicates in the soil.

Effect of Additive Soluble Iron Compounds upon Composition of Red Clover.—It had been suggested that an abundance of soluble iron in the soil might induce the transition of additive phosphates to ferrous phosphate, with resultant effect upon plant content of iron and phosphorus. Therefore, superphosphate was incorporated with ferric citrate and with ferrous sulfate into the dolomited Hartsells fine sandy loam and into the Tellico sandy loam at per-acre rates of 200 and 1000 pounds of iron. The objective was to provide crops of high iron content for use in small-animal feeding experiments.

The 200-pound inputs induced no effect upon the response by red clover on either soil, whereas the 1000-pound inputs caused substantial repressions in growth. The analyses of the red clover indicated that the concentrated superphosphate, alone or with iron supplements, caused no significant increases in content of either phosphorus or iron, or of calcium. Soil pH was not altered measurably by the 200-pound input of ferrous sulfate, nor by the ferric citrate at either rate. Hence, there was no indication that the additions of the iron compounds had caused increased incidence of iron in the crops grown on the moderately dolomited Hartsells and Tellico soils.

Fluorine Uptake by Ryegrass, Red Clover, and Alfalfa.—An important aspect of the problem of fluorosis in plant and animal life is

whether plants acquire a toxic level of fluorine through uptake from the soil. Inputs of potassium fluoride (KF), calcium fluoride (CaF_2), and slag were incorporated separately into unlimed and limed Hartsells fine sandy loam and into Clarksville silt loam, at rates to provide 100, 200, and 500 pounds of fluorine per acre. Ryegrass, red clover, and alfalfa then were grown simultaneously.

The ryegrass from the unlimed Hartsells control showed 7 p.p.m. content of fluorine against 38 p.p.m. for 500-pound input of fluorine as CaF_2 ; red clover showed 9 p.p.m. for no input of fluorine against 80 p.p.m. for the 500-pound input of fluorine as KF; alfalfa showed 13 p.p.m. for the no-fluorine control against 38 p.p.m. for the 500-pound input as CaF_2 . On the limed Hartsells soil, the corresponding uptakes of fluorine by ryegrass were 4 and 7 p.p.m. for the controls and 500-pound input, respectively; those by red clover were 10 and 12 p.p.m., respectively, and those by alfalfa were 6 and 12 p.p.m., respectively. On the unlimed Clarksville soil, ryegrass took up 3 p.p.m. for no-fluorine control and 16 p.p.m. for the 500-pound input of fluorine as KF; red clover showed respective contents of 8 and 28 p.p.m. and alfalfa 10 and 11 p.p.m. Grown on the limed Clarksville soil, ryegrass showed fluorine content of 5 and 7 p.p.m.; red clover, 5 and 14 p.p.m., and alfalfa 9 and 11 p.p.m. for the respective controls and fluorine additions. The higher fluorine content in the crops from the unlimed Hartsells soil may be accounted for in part by the decidedly smaller crops of the ryegrass, red clover, and alfalfa. On the Clarksville soil, however, the responses on the limed and unlimed soils were similar, and differences in content of fluorine were much less, such content being virtually the same as that for the no-fluorine controls. There was no increase in the occurrence of fluorine in the crops grown where the 100-, 200-, and 500-pound inputs of fluorine were supplied through incorporations of the slag.

W. M. Shaw continued to serve as Associate Referee on Liming Materials for the Association of Official Agricultural Chemists. W. H. MacIntire served as General Referee on Soils and Liming Materials, and as the Association's designate on the Board of Governors of the Crop Protection Institute.

CHEMISTRY: GENERAL

G. A. Shuey

FROZEN FOODS

The modern home freezer is a relatively recent addition to the ever-increasing number of home electric appliances. It is making an important contribution to the conservation of foods in the home, and to the sale of commercially frozen foods. Freezer cabinets of various storage capacities, equipped to provide proper storage temperature, are available in many different makes. It is predicted that eventually the number of home freezer cabinets will compare favorably to that of

electric kitchen refrigerators now in use. While freezing and storage in 0° F. are important, proper handling of the freshly harvested product prior to freezing is of equal importance. Experiments in freezing-preservation were continued during the year, with a view to further improvement in the quality of frozen foods, and the study of variety suitability of the various kinds of fruits and vegetables.

The following products were prepared, frozen, stored in 0° F., and later examined for quality: Apples, 3 varieties; peaches, 11 varieties; raspberries, 4 varieties; strawberries, 27 varieties; asparagus, 2 varieties; lima beans, 13 varieties; snap beans, 15 varieties; beets, 5 varieties; broccoli, 2 varieties; sweet corn, 14 varieties; okra, 2 varieties; peas, 12 varieties; turnip greens, tomato puree, and pumpkin.

Sugar and Sirup as Packing Media.—Studies were made of sweeteners—dry granulated sugar, sugar sirups, corn sirups, and blends of sugar and corn sirup—in the freezing-preservation of peaches and strawberries. To retard the browning (discoloration) of peaches, small amounts of antioxidants—sulfur dioxide, ascorbic acid, and citric acid—were dissolved in the sirups used as packing media for peaches.

Sixty-Percent Sirup for Peaches.—Experiments during the year have indicated that (1) best protection to frozen peaches is provided by 60-percent sirup; (2) peaches packed in 60-percent sirup containing 200 milligrams of ascorbic acid per pound of packed fruit retained good quality; (3) peaches packed in 60-percent sirup containing .01 percent sodium bisulfite (61 p.p.m. sulfur dioxide-equivalent) were of excellent quality; (4) peaches packed in 60-percent sirup composed of 1/3 corn-sirup solids and 2/3 sugar (sucrose) solids, containing 85 milligrams of ascorbic acid and 35 p.p.m. of sulfur dioxide per pound of packed fruit, were of outstanding quality; and (5) sliced peaches packed in 60-percent sirup in the ratio of 2½ parts of fruit to 1 part of sirup were found to be satisfactory for home use.

Fifty-Percent Sirup for Strawberries.—Experiments on the freezing-preservation of strawberries indicate that (1) sirup packing media are preferable to dry sugar; (2) sirup of 50-percent strength gives better protection to berries than weaker sirups; (3) 50-percent sirup composed of 1/3 corn-sirup solids and 2/3 sugar (sucrose) solids, used with whole berries in the ratio of 3 to 1, and with cut berries in the ratio 2 to 1, gives good protection and a pleasing degree of sweetness to the product; and (4) 50-percent sirup composed of ¼ corn-sirup solids and ¾ sugar (sucrose) solids, used in the ratios given under (3), preserves the quality well, and provides a degree of sweetness that would be generally acceptable.

Pectinates Improve Frozen Strawberries.—Our experiments show that by the use of pectin it is possible to reduce the amount of juice which drains, upon defrosting, from strawberries preserved by freezing. Not only is the drained weight of berries increased, but their appearance and texture are improved. Usually sugar or sirup is added to strawberries prior to freezing. The added sugar draws juice from the fruit and forms a sirup, which covers the fruit and protects it to some extent from the air and retards enzyme activity. In most cases,

juice drawn from strawberries by added sugar amounts to 45 percent of the initial weight of the fruit. It was found that the addition of from .3 to .4 percent of low methoxyl pectin will decrease the quantity of drained juice from 45 to 15 percent. Further experiments are being conducted to determine optimum levels of pectin for the freezing of strawberries.

Keep Vegetables Cold and Moist.—Fruits and vegetables play an important part in the diet. They are referred to as protective foods, and their chief value in the diet is as sources of energy, vitamins, minerals, and trace elements. The retention of nutritive quality in fruits and vegetables depends on the way the products are handled after harvest, and the time elapsing before they are consumed or processed. The temperature and humidity at which such produce is held by the grower, in transit, and at the wholesale and retail stores, and the handling methods of the homemaker, have much to do with the retention of vitamins and other nutritive factors. While wilted vegetables can be freshened by sprinkling with cold water, this treatment will not restore the vitamins lost by careless handling.

Freshly harvested asparagus, green snap beans, and broccoli were exposed to air at room temperature, about 80-85° F.; packed in crushed ice in a tray that permitted draining; and held in the kitchen refrigerator, in open and closed containers, at 45° F. The vegetables were stored under the above conditions for 3 days. Organoleptic observations and vitamin-C determinations were performed immediately after harvest, and repeated daily on the stored products.

While the rate of loss of flavor and vitamin C varied somewhat with the vegetables, it was found that asparagus, green snap beans, and broccoli retained 60, 48, and 55 percent respectively of their original vitamin-C content after being stored in room temperature for 3 days. Vegetables held in the refrigerator at 45° F. showed a higher retention of flavor and vitamin C; and best protection to nutritive qualities was given by the closed container, since loss of moisture from the vegetables was prevented. Generally, vegetables packed in crushed ice lost less vitamin C and retained better over-all quality than those stored in the refrigerator or in a warm room. The effectiveness of crushed ice in maintaining the nearly full nutritive values of freshly harvested vegetables for reasonable periods of time is clearly demonstrated. The liberal use of ice is a practice that should receive the attention of the home processor, the commercial processor, and the marketer of fresh vegetables. It will also prevent moisture loss from vegetables during transportation and holding of such products.

Whole Tomatoes Can Be Frozen.—Formerly, the freezing of whole tomatoes was not recommended. Our recent experiments show that ripe whole tomatoes can be satisfactorily preserved by freezing. The tomatoes are washed, wiped free of water, and placed unwrapped in the zero compartment of the cabinet until solidly frozen, which requires about 5 hours. The freezing must be done as quickly as possible. A freezer equipped with refrigerated plate shelves on which the tomatoes may be quickly frozen (45 to 60 minutes) is best for this purpose. When frozen, the tomatoes are removed from the cabinet, peeled (peel

is easily removed), wrapped in foil or cellophane, or placed in other commonly used moistureproof containers, and returned to the zero storage. When removed for table use, the tomatoes are allowed to defrost slightly, and then may be sliced, quartered, or cut into pieces and mixed with other salad ingredients. Success of this method depends upon rapid freezing of the tomatoes. Home freezers with horizontal freezing plates on which the unwrapped tomatoes can be quickly frozen should be employed. After thawing, tomato tissue becomes somewhat soft, and it is best, therefore, to prepare and use the tomatoes while slightly frosted or very cold.

Monosodium Glutamate (MSG) Improves Flavor of Frozen Vegetables.—Monosodium glutamate, an amino salt, has long been known to have unique ability to enhance the natural flavors of many kinds of foods. It has proved to be effective seasoning with meats, sea foods, soups, gravies, fresh vegetables, and numerous other foods. The taste of foods is definitely sharpened by its presence in proper amounts. Optimum levels of monosodium glutamate had not been established, however, for the different kinds of vegetables preserved by freezing. With a view to ascertaining the most favorable amount for each of several vegetables, the following experiments were conducted:

The study included lima beans, snap beans, broccoli, sweet corn, turnip greens, okra, tomatoes, and tomato juice. All were prepared in the usual way and preserved by freezing, except tomatoes, which were canned and heat-processed. Prior to freezing, monosodium glutamate was added to each kind of vegetable as .15, .20, .25, .30, .35, and .40 percent, respectively, of the product weight. Control packages were prepared containing no monosodium glutamate. To assure the best over-all natural quality, each vegetable was carefully sorted and promptly processed after harvesting. The frozen products were held in 0° F. storage for 2 to 3 months prior to the evaluation of their flavors.

Since there were no perceptible differences in texture and color between samples of each kind of vegetable containing different amounts of monosodium glutamate, only the factors of odor (aroma) and flavor were considered in evaluating the cooked products.

Each series of samples were examined organoleptically. The optimum level of added monosodium glutamate for each of the several kinds of frozen vegetables studied is as follows: Lima beans, .25 percent; snap beans, .3 percent; broccoli, .25 percent; sweet corn, .2 percent; okra, .2 percent; pumpkin, .15 percent; turnip greens, .2 percent; tomato juice, .25 percent; and canned tomatoes, .15 percent.

FRUIT JUICE CONCENTRATES

Juice concentrates were produced from strawberries, raspberries, and blackberries. Juices were pressed from heated berries and from berries after freezing and thawing. The latter method produces juice of better color and flavor. The yield was approximately 10 percent greater. About 10 percent sugar was added to the unclarified juices, after which they were divided into equal parts. One part was frozen rapidly (—25° F.), and the other was frozen slowly (5° F.). The

concentrates were then separated from ice crystals by centrifuging. It was found that slow freezing of juice gives a more concentrated product than rapid freezing, presumably because of the formation of larger ice crystals. The concentration also is favorably influenced by a low temperature during the centrifuging operation. At 20° F., concentrates of about 45° Brix are obtained. As the temperature is reduced, concentrates of higher solids content are produced. Separation of concentrate from ice crystals by centrifuging gives a greater percentage of high-solids product than draining through a screen. Storage tests, and home uses of fruit-juice concentrates are being studied.

SWEETPOTATO UTILIZATION

The Porto Rico variety of sweetpotato was preserved experimentally by canning. Sirups of 50-, 55-, and 60-percent sugar solids were used as packing media. Calcium chloride was added (.1 percent of the product weight) as a firming agent. Prepared sweetpotatoes were neatly placed in the can, covered with the hot sirup, sealed, and processed at 10-pounds steam pressure (240° F.) for 25 and 35 minutes respectively. After 3 months' incubation in 85° F. the products were examined. Experiments show that sweetpotatoes are best preserved in 50-percent sirup containing .1 percent calcium chloride, and heat-processed for 35 minutes at 10-pounds steam pressure. The product was sterile, firm, of excellent texture and good flavor. Experiments in the freezing of sweetpotato pulp were continued, and the frozen products are to be examined as time permits.

DEHYDRATED FOODS

During the past year, experimental work on dehydration of fruits was continued. Studies were made of the use of anti-oxidants, such as dilute solutions of sodium bisulfite, to prevent browning of apples and peaches during the process of dehydration. Again it was found that sliced apples and peaches that were dipped in a 2-percent solution of sodium bisulfite for 2 minutes, prior to dehydration, retained excellent color and flavor. Experiments designed to explore the possibilities of partially dehydrating apples and then freezing, and holding in 0° F. storage, were conducted. The products are in storage and later will be investigated.

NEW FOOD-INDUSTRIES BUILDING

During the past two years the writer served on a committee, appointed by the President of the University, to design a food-industries building. The first unit of the over-all building, containing about 29,000 square feet of floor space and costing \$538,000.00, is under construction (fig. 23). When completed, the building will provide facilities for teaching and the application of research findings in (1) the operation and management of a frozen-food locker plant; (2) slaughtering of animals; (3) chilling, aging, cutting, and curing of meats; (4) preparation of meat specialties; (5) lard-rendering, and utilization of other meat byproducts; (6) poultry processing, egg candling and breaking, packaging, and storage; (7) canning of fruits, vegetables, and flesh foods; (8) freezing-preservation of fruits, vegetables, and

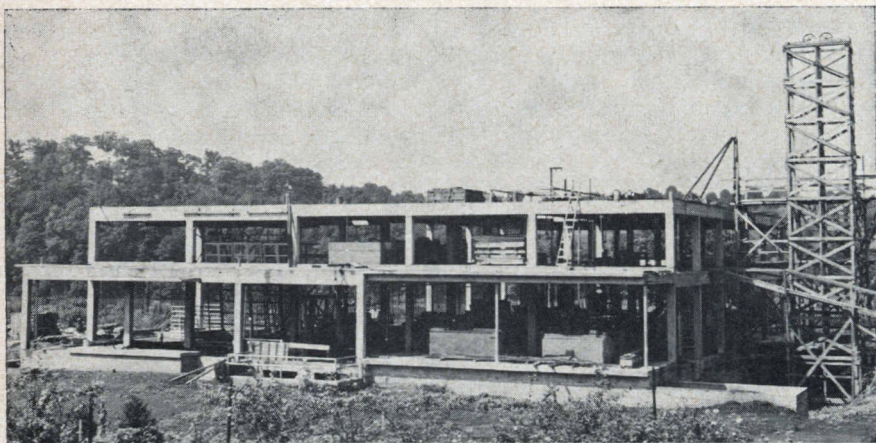


Fig. 23—The Food Industries Building under construction.

flesh foods; (9) freezing-preservation of pre-cooked foods, and leavened goods; (10) cookery and organoleptic technics; (11) preserve- and jelly-making; (12) proper use of various kinds of containers and wrapping papers; (13) utilization of fruits and vegetables in the making of juices, juice concentrates, and vinegar; (14) refrigerated storage of fresh and processed foods; (15) practical operation of refrigerator systems, and freezers; (16) marketing of processed foods; (17) inspection of processed foods according to Federal standards and procedures; (18) practical operation of various pieces of food-processing machinery; (19) quality-control methods; and (20) sanitary requirements of the commercial food-processing plant.

COOPERATIVE INTERDEPARTMENTAL RESEARCH IN FOODS

During the past two decades many outstanding developments have resulted from the application of science to agriculture in general, and to the solving of numerous food-conservation problems. These developments have contributed immeasurably to the public welfare, and have helped both the technologist and the industrialist to visualize the relationship between research and the invested dollar. The accomplishments in the field of food processing are many; yet the surface has barely been scratched. This program begins with the soil and ends in better health and greater comfort for mankind.

The work in foods will eventually include every kind of scientific inquiry that offers any possibility of developing facts which might be applied to the advancement of the food-processing industry, and the assistance of agriculture in the production of fruits, vegetables, cereals, and meat animals of the best quality. Research projects in connection with the growing of food crops and animals will be handled by the departments concerned. It is believed that the combined efforts of the research, teaching, and extension personnel—having common departmental objectives and interests—will be brought to bear in deciding ways and means of producing the best varieties of the different kinds of fruits and vegetables, and animals of quality, for the State's processing industries.

Research projects and problems dealing with all phases of food processing, packing, storage, and byproducts, will be the responsibility of the Department of Food Technology. Marketing studies and consumer-acceptance surveys of various processed foods should be delegated to departments of the University equipped to handle such work. While there will be a division of responsibility in the conduct of this work, there will also be a meeting of minds and interests—co-operative effort.

In planning research in the field of physical science, we should be mindful of its possible beneficial effects in the field of social science. The two branches are interrelated. Future economic conditions—such as changing price levels, lack of employment, and farm surpluses—will call for the technical know-how for all sorts of food-processing operations which are designed to give wider distribution to our farm products in the form of processed food.

Some of the most important objectives to be attained through the foods-research program over a period of time are listed below. Certainly, one would fail in an attempt to name all the important problems in which the methods of research may be employed—they are too varied, too intricate, and too numerous.

RESEARCH OBJECTIVES

Through research—basic and applied—an attempt will be made to improve processes and products, and to search for new uses of agricultural byproducts. It is believed that a well-organized program of food research, together with proper educational efforts, is the key to future success of the frozen-food industry.

The Food Industries Building will be used for experimentally preserving fruits, vegetables, meats, poultry, eggs, and byproducts, by freezing, canning, drying, pickling, brining, and other methods commonly employed or those developed in the course of the work.

The over-all objectives through research are, (1) to determine the quality—under preservation by freezing, canning, and other methods—of fruits, vegetables, meats, and poultry, produced in Tennessee; (2) to ascertain the most suitable varieties and stages of maturity of fruits and vegetables for commercial freezing and canning; (3) to find the best preparatory treatment of fruits, vegetables, meats, and poultry for commercial freezing and canning (other methods of meat curing will receive attention); (4) to study methods of preparing and packaging cooked and leavened foods for freezing-preservation; (5) to explore the possibility of developing new and improved raw- and cooked-food combinations of high nutritive quality, preserved by canning and freezing, with a view to better utilization of future crop surpluses; (6) to develop mechanical equipment that will simplify and improve fruit-, vegetable-, and meat-processing procedures; (7) to study the relative protective qualities of the various wrapping and packaging materials being manufactured and distributed for home and commercial use in the packaging of frozen foods; (8) to subject laboratory developments to pilot-plant processing operations and storage tests; (9) to give further consideration to the production of fruit and vegetable juices (small-scale experiments in the making of concentrated fruit juices

have been conducted); (10) to determine the nutritive values of raw and processed fruits, vegetables, meats, poultry, and other food products; (11) to accumulate information relative to the establishing of definitions and standards of identity and standards of fill of containers, for frozen vegetables and certain frozen fruits, under the Federal Food, Drug and Cosmetic Act; and (12) to study economic phases of the work.

REASONS FOR A WELL-ORGANIZED PROGRAM

In recent years the production of foods in Tennessee has increased greatly. Likewise, there has been rapid expansion of the preservation of foods by freezing and their distribution in the frozen condition. At the present time, there are 125 freezer-locker plants and 12 commercial processors of frozen foods in Tennessee, and others are being planned, all of which require additional information for the improvement of processing methods and quality of products. Freezing and canning of fruits, vegetables, meats, and poultry provide a means of marketing farm produce that has been found to have decided economic advantages to both the farmer and the commercial processor of this State. Food processing in Tennessee can be greatly assisted and further expanded through systematic experimental surveys of fruits, vegetables, meats, and poultry, with reference to (1) variety suitability and methods of preparing fruits and vegetables; (2) relation of foods and breeds of animals and methods of handling (processing) them to the quality of the preserved products; (3) retention of desirable qualities after processing and storing for reasonable periods of time; and (4) processing in sufficient quantity, in a pilot-plant, for a study of marketing problems, such as the determination of consumers' acceptance by distribution through customary marketing channels. Methods employed in this work would eventually be so standardized as to be reproducible in, or adaptable to, (1) the commercial freezing plant, (2) the rented freezer-locker, and (3) the canning and preserving industries.

PREVIOUS WORK

During the past nine years the Agricultural Experiment Station has been conducting experimental work in freezing fruits and vegetables, and some attention has been given to meats. We have accumulated considerable basic information, on a laboratory scale, concerning (1) variety suitability of many kinds of fruits and vegetables; (2) methods of preparing fruits and vegetables for freezing; (3) protective qualities of various wrapping and packaging materials; (4) the use of antioxidants to prevent the browning of light-colored fruits; and (5) the quality as affected by preparatory treatments, packing, and storage in zero-degree F.

EXPANSION OF PROGRAM URGENT

Because of requests from farmers and food processors of this area for additional scientific information relative to food crops best suited to the several methods of preservation, improvement of processing procedures, and the development of new food products, it is necessary that our present research program be enlarged with respect to studies of meats and poultry.

The Food-Industries Building will provide facilities for conducting research in food processing on a semi-commercial (pilot-plant) scale. It is ideal for subjecting our laboratory findings to semi-commercial processing operations, and for conducting marketing studies of the products. In the operation of the plant, opportunities will be provided for the training of students in the fields of food processing, quality-control work, and marketing.

PROTEIN AND MINERALS IN PASTURES

K. B. Sanders

Pasture Fertilization.—Eight hundred forage samples were obtained from 17 newly seeded experimental pasture fields which were well distributed over the State. A uniform mixture of legumes and grasses had been seeded. The phosphate rate had been varied from 0 to 250 pounds P_2O_5 per acre, and the potash rate from 0 to 150 pounds K_2O per acre; and nitrogen at 30 pounds N per acre had been applied in one of the 12 fertilizer treatments. About 400 of these forage samples were analyzed for protein (nitrogen $\times 6.25$), calcium, and phosphorus by the end of 1948. Considerable time was spent in becoming familiar with and standardizing microchemical methods for the rapid determination of calcium and phosphorus.

Seeding Mixtures of Legumes and Grasses.—Approximately 100 forage samples from a seeding-mixture trial at the Plateau Station, Crossville, were harvested. Sixteen grass-legume mixtures were used. The soil in the experimental area had been tested and then uniformly limed and fertilized according to its needs prior to seeding. The forage samples were analyzed for protein content.

Phosphate Rates on Plateau Pastures.—Forage samples were collected at the Grassland Station near Crossville, as part of a beef cattle production study. Woven-wire cages 4 x 4 feet square and $1\frac{1}{2}$ feet high were placed in the pasture fields to prevent the grazing of those portions. Three times during the year the kinds and proportions of grasses and legumes in the forage were estimated; the forage was clipped, and subsequently air-dry yields were determined; and the samples were analyzed for calcium, phosphorus, and protein. Soil samples were collected simultaneously and were analyzed for field soil-moisture percentage, acidity, available phosphate, and available potash. Both forage and soil samples were collected from fields which had been fertilized at different phosphate rates and reseeded in the summer of 1948, from fields which had been similarly treated and reseeded in 1947, and from fields which had been seeded several years previously.

Nitrate on Small Grains.—Numerous samples of small-grain forage from Blount Farm, Knoxville, and from the Middle Tennessee Station, Columbia, were analyzed for calcium, phosphorus, and protein content, to determine the effects of ammonium nitrate and nitrate of soda applications on the chemical composition of the forage.

MISCELLANEOUS

Throughout the year, analytical services on a variety of agricultural materials have been rendered by General Chemistry to the other departments of the Station, the Extension Service, and the College of Agriculture.

About 100 samples of soil from fertility experiments were analyzed for total nitrogen and moisture, in cooperation with the Agronomy Department. Samples of fertilizers, forage, and other materials were analyzed for different departments.

DAIRYING

MASTITIS-CONTROL INVESTIGATION

Eric W. Swanson and B. T. Throop

Studies of the mastitis situation on 6 large dairy farms have been conducted for more than a year. These studies indicate that in any one test an average of 45 to 50 percent of the cows in a herd are carrying detectable numbers of the infectious organisms which produce mastitis. Less than 10 percent of the cows showed gross evidence of the disease. An average of 73 percent were shedding the infectious organisms in the milk during the entire year. Positive bacterial tests disappeared from an average of 37 percent of the cows in 4 of the herds without specific treatment. In 2 herds, in which all quarters shedding infectious bacteria were treated, the recovery rate was 78 percent of the cows and 82 percent of the infected quarters. Of the treated cows which became negative to the tests, 55 percent did so after 1 treatment, 25 percent after 2 treatments, and the remainder after from 3 to 7 treatments. With the exception of one herd, which culled heavily during the year, the clinical mastitis situation did not improve without treatment, whereas improvement was evident in all treated herds. These studies indicate the improbability that mastitis can be controlled by attention to clinical cases only. The wide spread of the infectious organisms throughout the herd in one year indicates the necessity for dealing with the situation on a pre-clinical and a herd-wide basis. In its initial phases, the program followed here has been too costly to recommend for general farm use. The investigation continues.

WINTER GRAZING FOR DAIRY COWS

R. H. Lush, John A. Ewing, J. N. Maddux, and C. E. Wylie

This project was proposed for three locations, starting in the fall of 1947; but because of inadequate facilities at Knoxville and Jackson, only one trial, at the Middle Tennessee Experiment Station, Columbia, was completed. This grazing test with Jersey cows on Balbo rye and crimson clover, from December 1 to April 1, showed 12 percent more milk produced and 32 percent less legume hay consumed than for a

similar group of cows barn-fed. There was approximately 50 percent more vitamin A in the milk from cows on winter pasture than in the milk from the barn-fed cows. Results averaged with a similar test carried on the previous winter, 1946-47, show 21 percent more milk produced and 46 percent less hay consumed by cows on Balbo rye and crimson clover (with about 20 days too cold or wet for desirable grazing) than by cows with no winter pasture.

Three groups of cows will be used during the winter of 1948-49, with one group on pasture continuously, except for milking; one group on pasture for 3 to 5 hours on those days with no precipitation; and the third group barn-fed. Alfalfa hay, silage, and grain are fed all groups. Results through December favor the cows having the most winter grazing.

GRAZING INVESTIGATION WITH DAIRY CATTLE

John A. Ewing, J. N. Maddux, R. H. Lush, and C. E. Wylie

Irrigated permanent pasture from April to October produced, with dairy cows, 67 percent more cow days of grazing, 90 percent more milk, and 130 percent greater returns above feed and irrigation costs per acre, than similar nonirrigated pastures (fig. 24). Cows on irri-

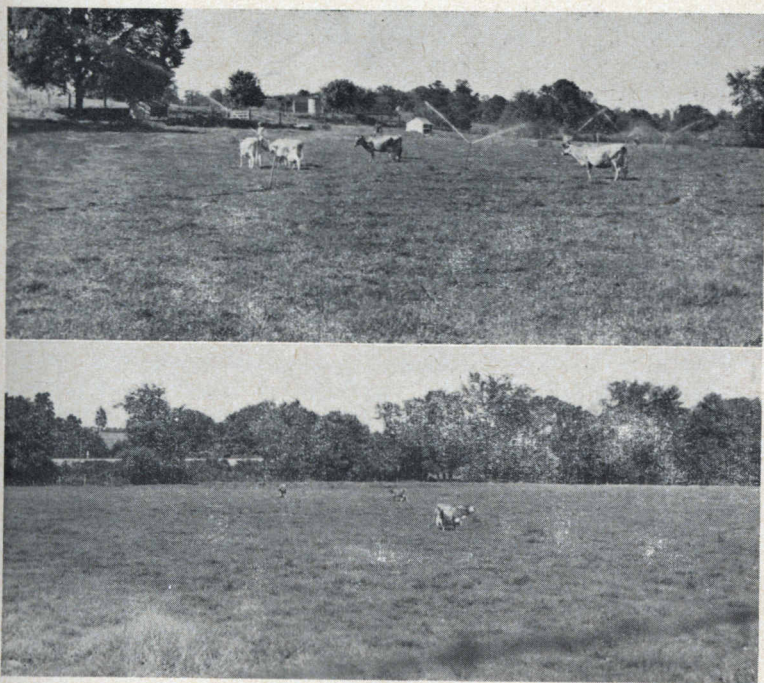


Fig. 24—The irrigated pasture supported more cows, produced more milk, and yielded greater returns per acre than the nonirrigated.

gated pasture also consumed 34 percent less supplemental hay and gained less in weight. About 20 acre-inches of water was applied

during the unusually dry summer, at a total cost of \$25 per acre. The irrigated pasture now contains more white clover and less weeds than the nonirrigated and it is planned to add nitrogen fertilizer to both areas to increase total milk production and lower overhead costs. In 4 comparable tests for 1945-48, irrigation gave 41 percent more cow days of grazing, 43 percent more milk, and 43 percent greater returns, or \$61.30 above all feed and irrigation costs per acre, than nonirrigation.

Rotational grazing of alfalfa-orchard grass hay fields during the late summers of 1947 and 1948 has given more than twice the milk production obtained from bluegrass pasture, has not injured the stand of alfalfa nor caused any bloat difficulties, has saved haying labor, and maintained milk production. Nearly 2 tons of hay per acre was cut each season.

Sweet sudan grazed from June to mid-September 1948 with more than 2 cows per acre, increased and maintained milk production over permanent pasture available and was especially valuable in the dry summers of the past 9 years.

DEVELOPMENT OF STRAINS OF DAIRY CATTLE ESPECIALLY ADAPTED TO SOUTHERN CONDITIONS

R. H. Lush

This long-time project, with Federal support, was proposed in 1948 for four or more locations in the State. The objectives are, (1) to develop superior germ plasm and methods for improving dairy herds, (2) to obtain the highest possible herd production with due regard for low unit cost under southern grazing conditions, and (3) to maintain a system for breeding studies within herds.

INFLUENCE OF PASTURE IN MAINTAINING DAIRY-BULL FERTILITY

Eric W. Swanson

During 1948, one half of the University herd sires at Knoxville were allowed free access to pasture lots and the other half were confined to small paddocks where there was practically no grass. Grain and hay were fed to both bull groups to keep the bulls in good breeding condition. Pasture accounted for less than half of the nutrient intake of the bulls on pasture. Semen was collected about 6 times each month and used in breeding cows artificially. Laboratory tests were also conducted to determine semen quality. No measurable differences in conception rate or semen quality could be ascribed to the type of feed. Figure 25 illustrates the pasture-bull lot and the bare paddock.

PRESERVATION OF LIVABILITY AND FERTILITY OF DAIRY-BULL SEMEN

Eric W. Swanson

The length of time that fertility of dairy-bull semen can be maintained will influence directly the economy of artificial insemination and the increased use of good proved sires by this means. The concentration of sodium citrate in the dilution buffer was found to have a serious



Fig. 25—Bull pasture lot (above), to furnish ample grazing for dairy sires, at the Experiment Station, Knoxville. Bull exercise lot (below), with no grass.

Dairy sires are alternated yearly between the two lots.

effect upon sperm motility. The optimum concentration was 3 percent of $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7 \cdot 2\text{H}_2\text{O}$ and gave a solution nearly isotonic with bull semen. With this buffer solution it was found that very small amounts of egg yolk gave satisfactory storage compared with previously used 50-percent egg-yolk solutions. Collecting semen directly into warm egg-yolk diluter has given slight improvement of motility in some samples but none in others. This method may be useful for bulls whose sperm is hypersensitive to cold shock. Agitation of diluted semen in partially filled test tubes resulted in marked lowering of motility. The effect of agitation is minimized if the test tubes are kept completely filled, but motility is still less than that in non-agitated storage tubes.

RAISING DAIRY CALVES

S. A. Hinton, J. T. Miles, and Homer Patrick

Raising dairy calves without colostrum has been proved possible in feeding trials at the Tennessee Experiment Station. Calves were taken from their dams at birth and given a laxative and a mixture of pure vitamins. They all survived and made normal growth. Other calves were taken from their dams at birth and fed a laxative and vitamin A. Some of these died at an early age, and some have made subnormal growth.

Calves taken off milk as soon as they were consuming as much as a pound of calf meal daily have continued to grow as well as calves fed whole milk. Calves weaned before they were eating calf meal at

a good rate showed a stoppage of growth at the time of the change and were smaller at 4 months of age than those receiving milk. It was found that from 300 to 500 pounds of milk could be saved by the substitution of calf meal for whole milk, without any appreciable sacrifice in gains per calf.

FEEDING THYROIDALLY ACTIVE MATERIAL TO INCREASE MILK PRODUCTION IN LATE LACTATION

Eric W. Swanson

Iodinated casein¹ was fed to 6 cows after they had started definitely to decline in lactation, at an average of 122 days in milk. The drug was fed at the rate of 15 grams daily until the end of lactation. These cows were compared with 6 similar cows not treated. The cows on test increased in milk production for 4 weeks after the iodinated casein was put into their diet, and then gradually declined. Milk production of the control cows declined slowly throughout the trial. During the week of greatest response the treated cows were producing an average of 3.7 pounds more milk daily than the controls. Since the drug increased the feed requirements of the cows, it was necessary to feed an average of 0.54 pound more concentrate daily to each cow on test than to her paired control for the remainder of the lactation. This resulted in an average daily increase for the last 183 days of 0.76 pound of milk. Body weight was maintained satisfactorily. Pulse and respiration were increased slightly for a short time while milk secretion was being stimulated the most. The iodinated casein was fed from February to November. These experiments show that dairy cows in Tennessee can be fed this drug during the summer without harmful effect if they are fed properly throughout the lactation.

RESULTS AT THE DAIRY EXPERIMENT STATION

Lewisburg

A. G. Van Horn, J. N. Maddux, R. H. Lush, and John A. Ewing

Effective October 1, 1948, the 20-year-old Federal Station has been operated as a cooperative dairy experiment station with the Bureau of Dairy Industry. It is the purpose to study problems of dairying in the bluegrass region of the South and demonstrate, as far as possible, the best methods of meeting such problems. At present there are 480 acres of land, 5 proved or partially proved sires, and 97 head of purebred females. The cows in the herd now have a mature-equivalent twice-a-day milking average of 8900 pounds of milk and 475 pounds of butterfat as a result of the use of proved sires over the 20-year period. These breeding investigations will continue with other studies.

Feeding trials involving No. 2 lespedeza and sample grade lespedeza are under way. Work is planned on maintaining Ladino and other clovers, with fertility additions and grazing management, including irrigation. Grazing, silage, and hay cropping of alfalfa-orchard grass and barley-lespedeza fields will be compared for seasonal milk production and costs.

¹ Protamone was furnished for this experiment by Cerophyl Laboratory, Kansas City, Mo.

ECONOMICS AND SOCIOLOGY

C. E. Allred²

AGRICULTURAL ADJUSTMENT

The study of desirable agricultural adjustments in the brown loam area was continued in cooperation with the Bureau of Agricultural Economics. In Haywood County, 150 farm-organization schedules were taken, along with detailed crop-number and livestock-enterprise records, supplemented by tractor and workstock cost studies. Dairy-enterprise schedules were procured in Weakley County. These data will provide a basis for determining the relative profitableness of each enterprise in the area.

Two reports were issued during the year: Monograph No. 238, "Production Practices, Costs, and Returns from Corn, Haywood County, Tennessee, 1947"; and Monograph No. 239, "Production Practices, Costs, and Returns from Cotton, Haywood County, Tennessee, 1947." Another report, containing results of a study of the hay enterprise, is in preparation.

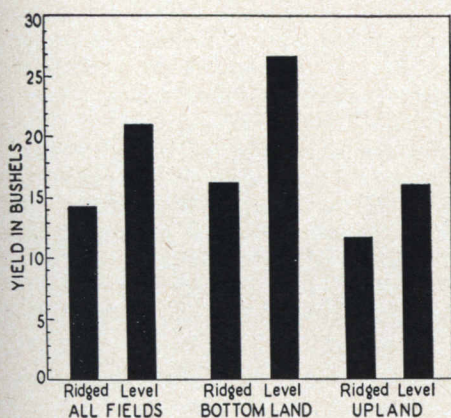


Fig. 26—Ridging compared with level cultivation in the laying by of corn, on fourteen bottom-land and seventeen upland farms.

Significant reduction in yield was found to result from certain practices, as illustrated in figure 26.

Average cost per acre of producing corn was \$29.00, compared with \$74.00 for cotton. Gross returns, however, were \$145.00 per acre for cotton, compared with \$37.98 for corn. On the basis of estimated normal yields, the gross returns from cotton would have been \$178.21, and from corn \$48.74.

Only 6 of the 31 farmers growing corn used hybrid seed, and less than one-third used commercial fertilizer.

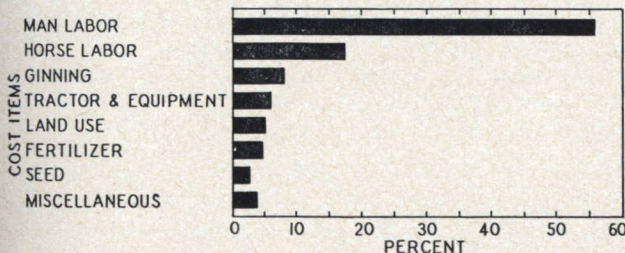


Fig. 27—Relative cost of various items in the production of cotton, 41 fields, Haywood County, 1947.

Sixty-four per cent of the cotton acreage was fertilized. Of 41 fields of cotton, 40 were planted in a strain of DPL, 50 per cent of the seed being certified. The high relative cost of man-labor is shown in figure 27.

² The following persons have participated in the work covered by this report: B. D. Raskopf, H. J. Bonser, B. H. Luebke, T. J. Whatley, M. L. Downen, S. W. Atkins, M. B. Badenhop, J. A. Martin, C. R. Keaton, C. R. Hall, and W. P. Stephens.

A study was made of production practices in each of the major cotton-producing areas of West Tennessee. Two hundred farmers, selected at random from 6 counties, were interviewed. Information was obtained on such items as crop and livestock organization; kind and size of farm equipment and machinery; kind and amounts of fertilizer used in the production of cotton, corn, and hay; and labor, power, and equipment used for each field operation on these crops. These data are now being tabulated.

The growing importance of hay production is an indicator of the adjustment being made in Tennessee agriculture away from cash crops and toward livestock and conservation farming. This trend has been analyzed and is portrayed by years and by type-of-farming areas in Monograph No. 234, "Changing Pattern of Hay Production in Tennessee."

TYPE OF FARMING

A study of farm rental arrangements was made in type-of-farming area 4, in West Tennessee, where dairy cattle and other livestock are being fitted into the old cotton-cash-crop economy. Field work has been done, and analysis of data partially completed. The experience of landlords and tenants who have worked out successful tenure arrangements in connection with dairy and other livestock enterprises will be of value in suggesting improved leasing agreements where a partial shift from cotton is desired.

"Improving Incomes of Small Farms in Area 6, West Tennessee," is the title of Monograph No. 237, covering analysis of a representative 66-acre unit-test demonstration farm in that area. A study of this farm in comparison with the usual situation on farms of similar size showed the feasibility of undertaking significant changes on small farms, and emphasized the importance of soil conservation and reduction in cash costs of living. Some of the changes suggested are as follows:

1. Development of a farm plan based on a soil survey, resulting in better field arrangement and land use.
2. Construction of terraces and drainage outlets to control water run-off and erosion, and facilitate contour farming.
3. Increase in grazing capacity of permanent pastures by clearing land of brush, liming, phosphating, mowing weeds, and controlling grazing.
4. Increase of 50 percent in acreage of crops by conversion of idle land to productive use, and by double-cropping.
5. Protection of land by use of interplanted or cover crops.
6. Introduction of crop rotations which permit some perennial legumes to remain on part of the land more than one year.
7. Increase of 50 percent in purchases of commercial fertilizer.
8. Doubling of yield and production of corn and hay.
9. Decrease in cotton acreage, but increase in yields, by one-half.
10. Increase in number of milk cows from 2 to 3 times, and increase in production per cow by 50 percent.

11. Production of more hogs and laying hens and increase in number of animal units of all livestock by over 50 percent.

12. Production on the farm of 85 percent of the family-food needs.

A report was prepared and published on farming opportunities by types of farming: Monograph No. 235, "Opportunities for Getting Started in Farming in Tennessee." Openings in agriculture in this State are likely to be greater through retirement and death of present operators than from any other source. A limited expansion of part-time farming within reasonable driving distance of some of the 22 larger towns and cities appears feasible. Opportunities for developing farms from lands now publicly owned, from timber tracts, and by drainage, were canvassed. Opportunities in some areas are mostly for those who can be content to farm on a subsistence basis, with a low material level of living. The prospective farmer, if ambitious to succeed in a large way, stands a better chance of success if he locates in a prosperous farming area where the type of farming is suitable for the enterprises he wishes to develop.

MARKETING FARM PRODUCTS

A survey was made of marketing practices of farmers. One hundred farmers interviewed were selected on a block-sample basis in Bradley County, which represents a wide variety of agricultural production. The study is exploratory in nature, the purpose being to throw urgent problems of marketing into relief. Data obtained from each farmer included amount of each product sold, time of marketing, marketing outlets, his share in the marketing process, a statement of special difficulties, marketing methods practiced, and suggestions for improvement. These data are now being analyzed.

A regional egg-marketing project, in cooperation with other southern states and the Bureau of Agricultural Economics, was initiated. The first phase of the study, now in progress, includes a survey of egg production and marketing practices of farmers, marketing practices of first handlers, country prices of eggs, and effect of the foregoing practices on prices received by farmers. Field work was done in the spring of 1948, in 130 sample areas, in 24 counties, in which 1080 rural families and 199 dealers were interviewed. In order to get further reports on seasonal production, mail questionnaires are being sent out monthly to these farmers and dealers.

The Department has participated in a regional study of seasonal costs of producing and marketing milk. In Rutherford County, records were obtained by interview with 72 producers of fluid milk, 68 producers of milk used for manufacturing purposes, and 76 cream producers. It is anticipated that tabulation and analysis of these data will be completed in 1949.

On farms producing fluid milk, it was found that milk production per cow was the most important factor influencing profits, as shown in table 23.

Table 23—Relation of milk production per cow to selected factors on 72 farms producing fluid milk, in Rutherford County, April 1947-March 1948.

Production of 4% milk per cow	Herds	Cows per herd	Gross cost per 100 lbs. 4% milk produced	Net returns per 100 lbs. 4% milk produced
Pounds	Number	Number	Dollars	Dollars
1750-4699.....	18	29	7.21	—1.22
4700-5649.....	18	25	5.12	.51
5650-6549.....	18	26	4.71	.79
6550 and over	18	22	4.81	1.21
All herds	72	26	5.31	.46

With milk production ranging between 2000 and 6000 pounds per cow, each increase of 100 pounds in production per cow reduced costs 10 cents per 100 pounds, as shown in figure 28.

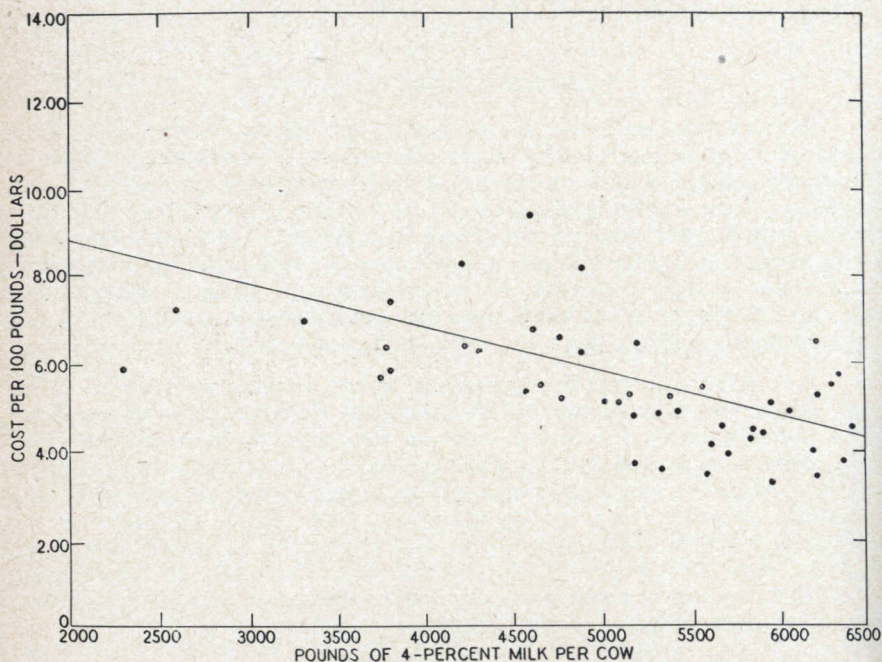


Fig. 28—Relation of cost of producing 100 pounds of fluid milk to pounds of milk produced per cow, Rutherford County, April 1947-March 1948.

In the herds producing fluid milk, net returns varied from a profit of \$1.40 per 100 pounds of milk produced in July, to a loss of \$1.34 during November. For the year as a whole, the net return was a profit of 46 cents per 100 pounds of milk produced, or \$25.62 per cow. Table 24 shows seasonal variation in receipts, costs, and returns per cow.

Table 24—Net returns per cow, in dollars, 72 Rutherford County farms producing fluid milk, April 1947-March 1948.

Item	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Gross receipts	25.73	26.54	25.86	27.69	26.35	24.96	22.32	23.02	27.24	28.51	27.45	30.61	316.28
Gross cost	19.79	19.85	19.60	19.90	20.03	20.70	24.43	28.19	29.27	30.01	29.38	29.51	290.66
Net returns ...	5.94	6.69	6.26	7.79	6.32	4.26	-2.11	-5.17	-2.03	-1.50	-1.93	1.10	25.62

COTTON MARKETING

The principal objectives of this year's phase of the study were to determine the sources of supply and the agencies marketing cottonseed feed products, to determine the importance of Tennessee as a market for cottonseed feed products and the competitive status of soybean and cottonseed meal, to reveal some of the difficulties in marketing cottonseed feed products, and to suggest methods of improving the present system of marketing these products.

Information was obtained from 12 Tennessee cottonseed-oil mills, 127 feed mills, and 180 wholesale and retail feed dealers. A preliminary typewritten manuscript has been prepared. Marketing channels for these products are shown in figure 29.

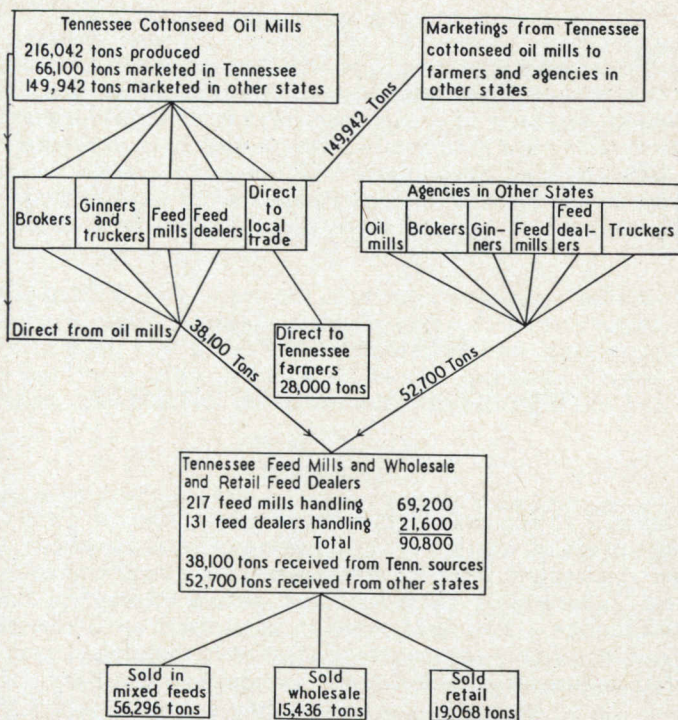


Fig. 29—Marketing channels, and estimated importance of each, in the cottonseed-feed-products industry in Tennessee, crop year 1946-47.

During March and April a field survey was made of cotton-marketing practices of 141 cotton growers, 22 ginnermen, and 43 buyers, in 15 counties. The purpose of this study was to compare the cotton-marketing methods of organized one-variety communities with those of unorganized communities, to measure the effectiveness of the Smith-Doxey program, and to uncover the chief cotton-marketing problems requiring further investigation.

A typewritten report on the preliminary Tennessee findings of this study was prepared for the technical committee in charge of the regional cotton-marketing project. It was found that organized cotton growers, compared with unorganized, are larger producers, contact more buyers before selling their cotton, and have a better knowledge of cotton quality and market conditions. About 83 percent of the organized growers had considerable knowledge of the quality of their cotton before it was sold, compared with 34 percent of the unorganized producers.

Ninety percent of the ginnermen in organized communities reported that the chief value of the one-variety-community program was in improving grade and staple length and in permitting the sale of cotton in larger and more even-running lots.

TOMATO MARKETING

This Department continued cooperation with the Horticulture Department on the regional tomato-marketing project. This was the second season of study of Tennessee tomatoes in the Detroit market. Observations this year emphasized the variation in ripening between fruits in different lugs, particularly with respect to their location in the car. Those in the top tier of lugs ripened more rapidly than those in the middle tier, which ripened more rapidly than those in the bottom tier.

The smaller tomatoes, known to the trade as 6 x 7, appear to be of lower quality than the larger sizes. Greater care in all steps of harvesting, packing, and marketing would result in a product of higher quality. Rough handling should be avoided, only new lugs used for packing, and the lugs properly loaded in the car to avoid breakage.

COOPERATION

In response to requests from managers of cooperative associations, a study was made of cooperative purchasing of farm supplies. Aspects given special attention were organizational structure, trend in volume of business, membership problems, and practices employed in overcoming difficulties. The field work in connection with the gathering of data from the active organizations has been completed, and most of the material is summarized and ready for publication.

Some of the more important difficulties encountered by the associations are, membership education, lack of operating capital, securing competent personnel, inadequate building facilities, and purchasing at

the wholesale level. Significant progress has been made, however. Even after adjustment for the rise in price level, the 1947 business of farmers' purchasing cooperatives in the State was 76 percent above the 1938 volume.

Schedules have been prepared for a study of membership relations of the Dark Tobacco Growers' Cooperative Marketing Association. The Kentucky Experiment Station is cooperating in this study, since the Association covers tobacco areas on both sides of the state line.

FINANCIAL PROBLEMS OF FARMERS

Data have been gathered, and a report is being prepared, to assist farmers in the security aspects of their financial program. Data were obtained on the experiences of 160 farmers with all kinds of insurance and their attitudes toward the different types. The area studied was Greene County, which is predominantly agricultural in its interests and not too greatly influenced by a large urban center. All families were contacted in each of 15-mile-square blocks, spaced as equally as possible throughout the rural sections of the county. The principal objective was to ascertain the factors affecting the insurance program of farmers, and the efficiency of insurance agencies in dealing with farmers and their risks.

Preliminary analysis shows that 80 percent of the families had burial insurance, 24.4 percent life insurance, and less than 10 percent either automobile or hospitalization insurance. Fire insurance was carried by four-fifths of the farm owners, and crop insurance by one-fifth of those growing crops.

ENGINEERING

FARM MACHINERY AND EQUIPMENT

H. A. Arnold

MECHANIZED, OR EJECTOR TYPE, ROUND HAY-CURING BIN³

The mechanized bin is designed to handle quality market hay from the field to the baler mechanically, including curing. Construction details of the hay ejector installed in a round bin ready for trial are described in the 1947 report. Preliminary trials with several tons of hay in one side of the bin for observation gave encouraging results. Succeeding trials included about 35 tons of partially field-cured alfalfa hay in the bin after curing with forced air. Because of the rather long

³The Hay Handling study is carried on in cooperation with the USDA. Self-feeding hay-curing bins is a project cooperative with TVA.

cut of the field chopper and the high moisture content of the hay when put into the bin, the stringy, settled, dense, and compacted hay was difficult to pull out from the bottom. When the electric motor drive was increased from 3 to 5 horsepower, it was difficult to force the teeth into the tightly compacted hay, and, if forced, a number of teeth were bent. It was necessary to redesign the unit for greater strength. Enough hay was ejected out of the bin and delivered mechanically into balers for some chopped-hay baling trials with various machines.

BALING CHOPPED HAY

Attempts to bale chopped hay with standard plunger-type balers were unsuccessful. Unless delivered at a very exacting rate into the baler, the hay settled in the lower part of the baling chamber and was compressed into only about half a bale, leaving the top too loose for tying. The lopsided bales collapsed as they dropped out of the baler.

A commercial roll-type baler making round bales was placed directly under the elevator to receive the hay delivered from the bin. This machine effectively baled the chopped hay and wrapped the tightly compressed bales spirally with twine. One loose end, however, was pressed into the bale by hand to prevent unwrapping as the bale was ejected mechanically. Since the bales were round, they were easily handled, and the rolled bales withstood dropping and handling with little loss from shattering. Except for loading the bales, the entire process, including delivery and feeding of the hay to the machine, was mechanical and continuous. Unlike the process in field-baling, no de-clutching of the tractor power-take-off drive while the bales were being wrapped with twine was necessary. Four out of 8 bales were left outside exposed to the weather for 4 months before being placed in an open shed. The bales turned the rain well, and retained good color, aroma, and quality, except a bleached layer about an inch deep around the outside. One of the exposed bales was used as rabbit feed. For market purposes, hay of such quality should have good possibilities, as the chopped baled hay is easily fed into hammer mills for grinding and mixing with feed; it stores well and handles with little loss of leaves.

SELF-FEEDING HAY-CURING BINS

Although modern farm machinery, such as the field chopper, has effectively mechanized the field harvesting of hay, feeding still requires much manual labor. In total time per ton, it exceeded the savings effected by mechanical field operations. To complete the mechanization of hay handling from the standing crop in the field to delivery in front of the livestock, a self-feeding hay-curing bin was designed. It represents an attempt to combine the desirable features of the self-feeding haystack commonly seen in Tennessee fields some years ago and the duct-type mow drier developed at this Station. The first construction of these bins is described in previous reports. Savings in labor and in losses of quality hay from weather hazards are noted advantages.

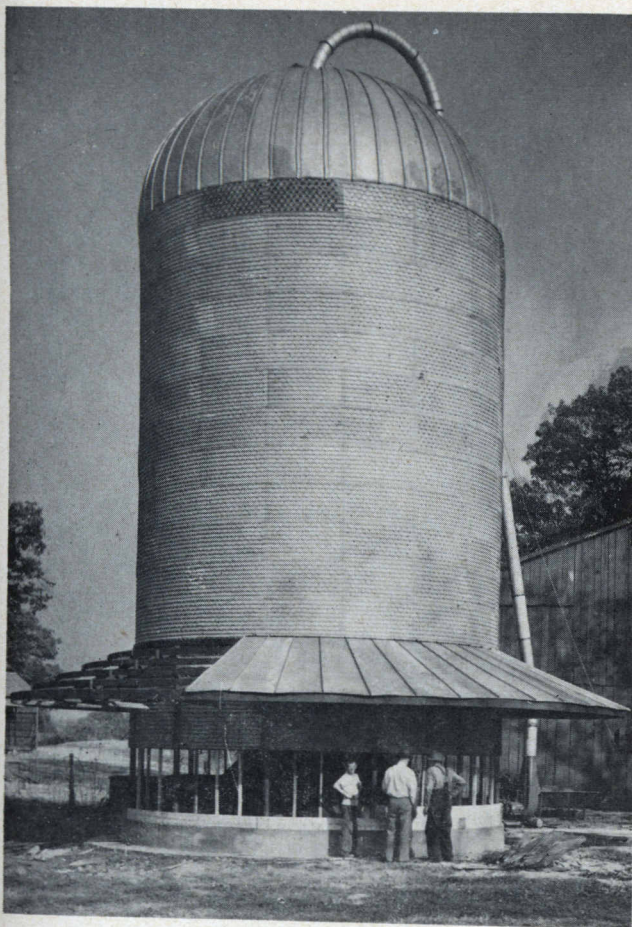


Fig. 30—Self feeding hay-curing bin under construction.

Although the bin was successful from a practical standpoint, the basic principles governing the downward movement of the hay during self-feeding were not clearly discernible. Uneven distribution of the hay while the bin was being filled created faults, or shear lines, which affected the movement. Other factors, such as the increase in diameter of the bin from 18 to 21 feet, or increase in the slope of the conical hay deflector in the center of the bin from 42 degrees to 52 degrees, became important from the design standpoint. The construction of another bin

was decided upon in preference to the making of extensive modifications of a bin operating satisfactorily on a private farm.

The second self-feeding hay-curing bin was designed and constructed as noted in figures 30 to 34. It embodied the following modifications and changes:

1. Diameter increased to 21 feet.
2. Hay deflector slope increased to 52 degrees.
3. Shed roof added around the bottom to protect feeding cattle.
4. Bin bracing modified to permit installation and use of a self-propelled hay distributor developed by this Station.
5. Central vertical duct improved.
6. Removable duct connected to an outside fan instead of a tunnel under the bin.

This bin was constructed on the Strong Stock Farm, near Knoxville. The proprietor of the farm furnished the commercial perforated outer shell with a dome roof, steel and concrete for foundation, stanchion substructure, and lumber for the central vertical duct and conical hay deflector. The Experiment Station furnished minor accessories,



Fig. 32—Stanchion substructure details and the parting of the hay by the hay deflector inside.

such as the safety ladder up the outside, a platform step from the outside of the roof to the top of the inside duct, a self-propelled hay distributor, and angle irons replacing original roof bracing to provide proper clearance for the distributor on top of the duct. The Station furnished plans, assisted in the construction, and loaned a blower and pipe for filling the bin. These arrangements facilitated the experimental work for testing the fundamental principles of design.

For the sake of symmetry and economy, a round-type storage unit was selected. For even air-flow, uniform curing, and good distribution of hay, the symmetrical shape eliminated many problems. Sloping baffles in place of laterals around the main duct placed vertically in the center of the bin symmetrized the mow drying unit. Instead of a V-shaped pole substructure as formerly used under self-feeding hay stacks, a fixed stanchion substructure was placed under the bin and a conical-shaped hay deflector around the bottom of the vertical duct to deflect the downward-moving hay outward to within reach of cattle. Sliding doors on two sides of the duct can be adjusted so as to direct forced air from the duct in the center horizontally outward through the hay. The bin is filled by elevating partially cured chopped hay into a self-propelled hay distributor (lawn-sprinkler type) on the top of the vertical duct in the bin. As the bin is filled from the bottom, the sliding doors between the horizontal baffles on the duct are opened. As the hay is cured from the bottom upward, the sliding doors are successively closed.

Hay-curing trials were made with the mechanized bin on Blount Farm. Self-feeding trials include the new bin on the Strong Stock Farm only.

In the first trial of self-feeding, about 200 head of cattle consumed

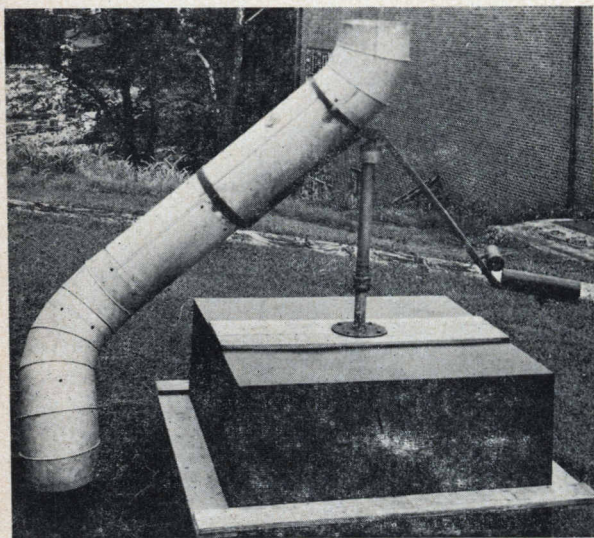


Fig. 33—Self-propelled hay distributor (lawn sprinkler type), mounted on top of duct in the bin.

the lower 8 feet of hay, reaching in about 38 inches from the outside. The entire mass of hay in the bin rested on the conical hay deflector in the center. The tensile strength of the hay plus the frictional resistance between hay and deflector was ample support. Next to the conical deflector the hay was dense and compressed, but around the outside bin wall it remained loose. Apparently only the inner core of hay was under

great stress. At the critical starting stage, the hay tore apart of its own accord, making vertical slits extending from the deflector upward and on a plane extending from the duct corners radially outward to within a few feet of the bin wall. Beyond this stage, the tensile strength was a minor factor, with the strain localized, as in the tearing of a piece of cloth or paper after a rip or tear is started. The hay was torn into 4 parts over the conical deflector, and these 4 pillars of hay supported the overhead mass. With cattle feeding from the bottom, consuming some hay from the pillars, the hay overhead continued to move down uniformly and not in large masses that might have endangered the cattle. Excess wastage at the start and again when the bin was nearly empty was controlled by means of temporary bands placed around the stanchion substructure. Further modifications may eliminate the necessity for such adjustments. In general, the self-feeding trials with this bin demonstrated the basic design principles and provided a sound basis for further improvements, as the movement of the hay clarified the principles of operation. The effectiveness of the curing system had been proved in numerous trials. The problems of elevating partially cured hay into the bin, structural simplification, wastage control, and improved distribution warrant further investigation. Lack of such refinements, however, do not preclude the practicability of the structure. The low initial cost per ton storage, the saving in labor of filling and feeding out, and the quality of hay assured by the efficient curing system seem to assure the practicability of this self-feeding hay-curing bin.

ELEVATING BLOWERS

Although slat and chain carrier-type elevators are more efficient in power requirements, elevating blowers are generally preferred because of greater mobility and simplicity. Farm elevating blowers, including ensilage cutters, are usually of the impact type. Such units

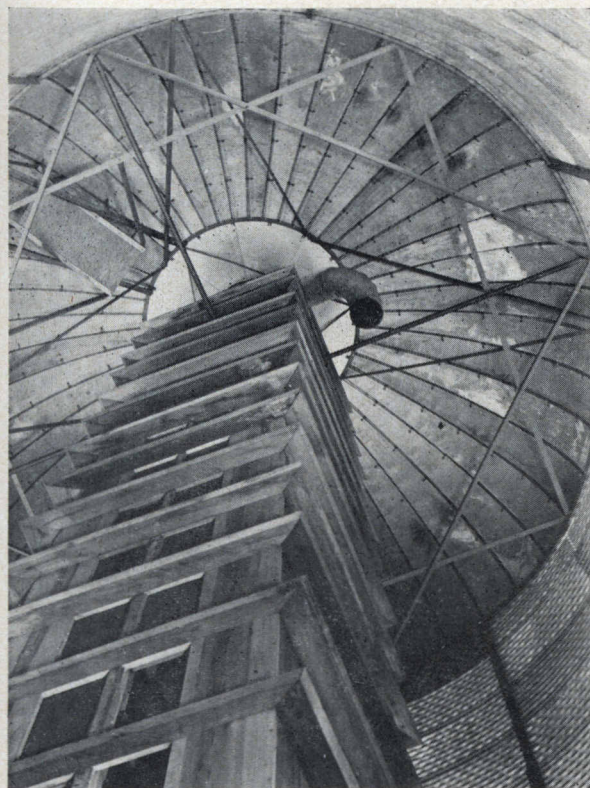


Fig. 34—Construction details of central duct.

elevate by throwing or batting material up a pipe rather than blowing it by high air velocity. Short lengths of heavy, solid cornstalks are efficiently battled up 50 feet of 6-inch straight pipe. The elevating of dry hay does not require a high air velocity. Fresh green chopped forage can be elevated to some extent by impact. Partially cured chopped hay, containing from 30 to 50 percent moisture, could not be satisfactorily elevated up 6-inch pipe into tall hay-curing bins, even when 35 horsepower was applied to the driving belt. Clogging at pipe bends, or wedging of material between the fan blades and blower housing

choked the blower regardless of power application. The air-velocity type of elevating blower was resorted to.

Air velocities of over 4000 feet per minute were required for satisfactory operation. To assure sufficient margin, because of uneven loading, a normal velocity of 6000 feet per minute was necessary for practical operations with the blower used and under the conditions of the trials. Total pressure drop at such a velocity in a 6-inch pipe, due to friction, outlet back-pressure, and weight of material, exceeded the efficient static pressure limits of ordinary blowers. The elevating pipe was increased to 10 inches in diameter and connected to an industrial-type blower. Two single-phase 5-hp. electric motors on a parallel drive but with separate controls furnished the power. About a 2-ton load of partially cured alfalfa hay was elevated in less than 8 minutes, compared with over 20 minutes for impact-type blowers, not including

time loss due to clogging. No difficulties from clogging were experienced with the air-velocity elevating system during the past season in filling the tall self-curing hay bins.

Partially cured or fresh chopped forage as unloaded from a truck is heavy and wadded. Breaking up the wads for efficient handling by the elevating blower is a laborious job. Increasing the speed of standard 10-inch screw feeders from 200 to 900 rpm. improved its operation by tearing up the lumpy hay before delivery into the blower. Balancing of the screws for the higher speed was a problem. A special screw to facilitate balancing was constructed for trial next season.

In principle, the velocity-type elevator blower is similar to thresher stacker blowers, except that the former is of heavier construction, designed for delivery of higher static pressures—and to reduce power requirements, a smaller elevating pipe is used. Better streamlined flow of material through the fan to reduce impact losses, and the use of backward-curved blade to create higher static pressures when loaded, are being investigated as to possibilities of increasing efficiency.

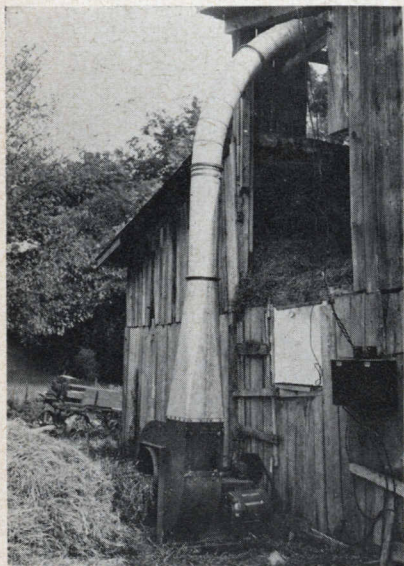


Fig. 35 — Velocity-type blower, with 10-inch-diameter pipe elevating loose long hay, gathered with sweep rake, into a barn mow.

By removing the feeding screw and placing a plywood board around the air-inlet of the blower (figure 35) with the 10-inch pipe extending up into a hay mow, it was possible to elevate long dry hay. The hay included medium-length ryegrass, oats, orchard grass, and alfalfa. A single-phase, 220-volt, 5-hp. electric motor furnished ample power. Loose hay, as from a sweep rake, was fed into the blower at an estimated rate of about a ton in 23 minutes without much physical effort. Compacted

hay, as from a wagon load, had to be torn apart before feeding into the blower, which was a laborious procedure compared with unloading with a power hay hoist. On the other hand, the loose hay from a sweep rake was difficult to handle with the hay hoist without repacking and using a grabble fork or sling, which was time consuming compared with elevating such hay with the blower.

SWEEP RAKES FOR HANDLING HAY

The use of a long-hay blower to handle the loose hay from sweep rakes at the barn mow, modern tractors with speeds of over 10 miles per hour, and hydraulic controls for handling the sweep rakes on tractors greatly extend the possibilities of such equipment. With fair stands, the hay could be gathered directly from the swath as well as

from the windrow (figure 36). As the speed at which a self-dump hay rake can operate is limited to about $3\frac{1}{2}$ miles an hour, and as the



Fig. 36—Tractor-mounted sweep rake with hydraulic control, and a high forward speed, is loaded directly from the mower swath by double piling.

sweep rake works better at a speed of over 8 miles per hour, the hay was gathered and hauled to a nearby hay mow in less time than it took to rake the hay with a dump rake. The bottleneck of the operation was at the blower. Sweep rake loads of about 540 pounds required about 6 minutes to elevate into the mow. With the hydraulic control, the 10-foot-wide sweep rake was easily handled on rather rolling and rough land. Such a combination for handling hay on small farms with tractors and where the haul is short has the advantages of very low labor cost per ton and low initial equipment cost.

The disadvantage of the sweep rake was that when new it would not handle damp or partially cured hay, or even dry hay, unless the teeth and points were filed and sandpapered smooth. The operation of the sweep rake on rough land at high tractor speeds requires experience. Whether tubular steel or alloy aluminum teeth will handle green or partially cured hay for finishing in hay-curing bins is to be determined by further investigations.

IRRIGATION

A. L. Kennedy

Developmental work on irrigation equipment and technics was continued. It consisted largely of tests on the farms of Mr. Ben Clark and Mr. John Carson, near Vonore, Tennessee. Assistance was given these farmers in designing their irrigation systems. Each unit has a 600-g.p.m. war-surplus pump, 1500 feet of 6-inch aluminum pipe, and two types of sprinklers.

These two units were used to irrigate 150 acres of permanent pasture, 20 acres of winter pasture, 20 acres of red clover, 15 acres of alfalfa, 15 acres of corn, 8 acres of cabbage, and 4 acres of tobacco. Mr. Carson's records show that he used 4000 gallons of gasoline in pumping irrigation water. It was estimated that from 4 to 5 gallons of gasoline per hour was used by his pumping unit.

Mr. Carson figures that his returns from irrigation in 1948 not only paid for the gasoline and other operating expenses, but more than paid for the initial cost of the equipment. He was especially pleased with the result of irrigation on Ladino clover pastures. Ladino made a good growth throughout the season and crowded out much of the grass. He had Ladino on 75 acres and was planning to seed 75 more.

SUPER-GIANT SPRINKLER

Four sprinklers were made, two for each of the two systems. The castings and machine work were done at service shops in Knoxville at the regular rate of charge. This and the purchase of materials made the expenditures approximately \$20.00 per sprinkler. The total cost, including assembly work, would probably be about \$40.00. This sprinkler is designed for a capacity of from 300 to 1500 gallons per minute. Its weight is 45 pounds. The methods of attaching it to the end of a length of pipe and moving it to another station are shown in figures 37 and 38.

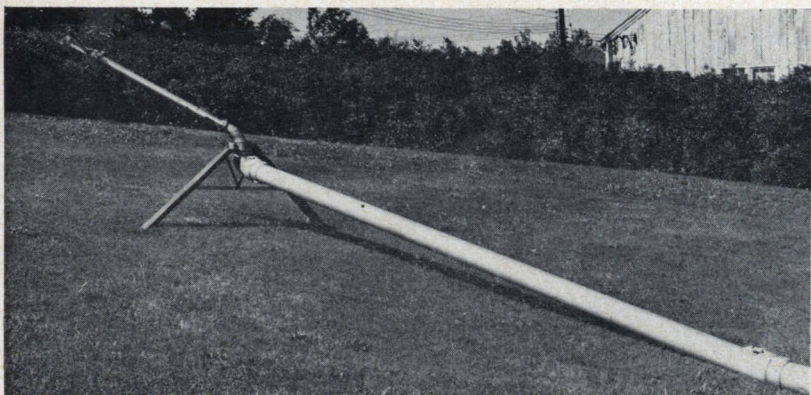


Fig. 37—Super-giant sprinkler attached to the end of the pipe line, ready for irrigating.

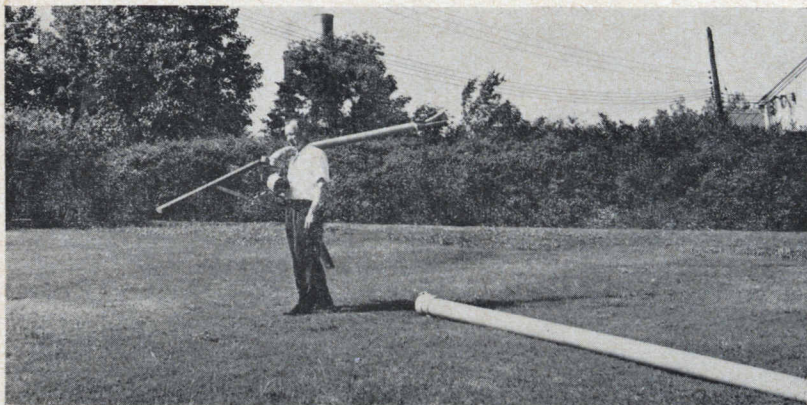


Fig. 38—The 45-pound sprinkler, detached from the end of the line and ready to be carried down the line for another "run."

Mr. Clark and Mr. Carson used both the small sprinklers and the giant sprinklers. They concluded that the giant type of distributor was better for their needs. The four sprinklers made for them were used exclusively after they became available, toward the first of the irrigation season.

DITCHES

Mr. Clark was interested in expanding his irrigation projects so as to include 100 acres of pasture land, most of which is very steep and from 1000 to 3000 feet from the water supply. It appeared that "wild flooding" from ditches would be the best method of distributing the water.

An experimental ditch 750 feet long was made to determine how the ditch method would work. By means of a measuring weir near each end of the ditch, data were secured that made it possible to determine the seepage loss. This loss was found to be 4 percent when the initial flow was 188 gallons per minute, and 8 percent when the initial flow was 690 gallons per minute. The soil type is Cumberland loam, one of the most pervious soils in the State. Figure 39 shows one of the weirs, part of the ditch, and part of the area to be irrigated.



Fig. 39—An experimental irrigation ditch.

IRRIGATION OF WINTER COVER CROPS

The spring and fall drouths of 1948 were hard on winter cover crops. Farmers who attempted to secure full benefit from their spring pastures and soil-building measures by waiting until late in the season to turn and prepare the land for summer crops needed irrigation badly. For an example, see figure 40, which shows Mr. B. M. Elrod's tobacco land at setting time. A green-manure crop of oats and crimson clover was turned under the first week in May. The preparation of a seed-bed was attempted, but the soil remained "open" and dry. The application of 2 inches of water on May 19 enabled him to start a tobacco crop that grew well and made a good yield without further irrigation. The gross income from an acre was \$1447.00.



Fig. 40—Supplying moisture for starting a tobacco crop after turning under a green-manure crop late in the season.

The fall drouth made the establishment of winter cover crops very costly. Mr. R. N. Bacon reported that he spent \$7.00 an acre for gasoline in running his tractor equipment over the land time after time in an effort to break up the clods and prepare a good seedbed. Several farmers reported crop failures.

Mr. Clark spent \$8.00 per acre for city water to save a seeding of alfalfa on a farm near Alcoa. Two $\frac{1}{2}$ -inch applications of water the latter part of August caused about 50 percent more of the seed to germinate and stopped the older plants from dying.

STRAWBERRY CAPPER

A. H. Morgan

A machine that will remove caps and stems from strawberries efficiently and consistently has long been a dream of fruit processors. With the growth of freezing plants throughout the country, calling for the processing of increased tonnages of berries to meet consumer demands, the need for such a machine is greater than ever before.

Devices of many types have been developed for removing stems and appendages from various fruits, such as raisins, cherries, and gooseberries. Some of these devices are fairly successful, but there is no satisfactory method for removing caps and stems from strawberries.

The vertical drum-type capper developed at this Station represents the most nearly successful attempt to solve the problem. Other designs involving different principles are conceivable, and these are being investigated. Another possibility may be the development of varieties of strawberries having loose-fitting caps and stems that can be brushed off during harvesting. This entails a long-time plant-breeding program. Meanwhile a capping machine seems to be the only answer.

Nearly all stemming or capping machines have one point in common—the use of combinations of rolls rotating with other rolls, forming pairs of pinching elements. By providing a large number of such pairs in suitable arrangement, the engineer produces a capping and stemming machine. The arrangement of rolls may be in the form of flat horizontal or inclined tables and horizontal or vertical drums. The manner of presentation of uncapped strawberries differs with each machine. It is believed that the most effective method is the vertical drum. In this method, inclined, angled, circular, stationary runways form troughs around the rotating drum of capping elements. A vigorous spinning action is imparted to the fruit as it passes between the drum and the inclined runways. The amount of spinning may be controlled to some extent by variation in the speed of the vertical drum. This provides the greatest number of cap presentations to the capping elements.

There are many advantages of machine-capping over hand-capping. Some of these are: (1) the fruit keeps better if the caps are left on until a few minutes before packing; (2) losses from leakage, shrinkage, and mold infestation are less; and (3) labor cost is lower.

The characteristics of a good strawberry capper are:

1. Consistent efficiency above 90 percent and ability to perform well on most of the commercial varieties.
2. High capacity and ability to operate continuously without breakdowns or serious damage to the fruit.

IMPROVEMENTS

A larger capper was constructed for the 1948 season, embodying a number of improvements over last year's machine. The new capper is similar to the old machine, but was constructed of better materials and has a better arrangement of parts. In trials at a processing plant in Michigan, 35 crates of Premier and Robinson strawberries were passed through the machine. Capping was good to excellent. It was most efficient on ripe berries and poorest on immature fruit, which includes the misshapen and partially ripened. The size of berries had some relation to capping efficiency, berries up to $1\frac{1}{4}$ inches capping better than larger ones. As improvements in the rolls are made, capping on the larger sizes improves. At present, capping is best on Blakemore, but with further refinements, it can be made as good on other varieties.

The most notable improvement in the new machine is the replacement of the straight-fluted metal rolls with sharp, spirally fluted serrated rolls. With this change it is possible to increase the cutting and pinching action.

The 1948 machine is approximately two and one-half times the size of the previous machine, standing approximately 6 feet high and occupying a floor space of about 5 by 10 feet. The diameter of the vertical drum of rolls is 28 inches, with 16 runways suitably spaced around the drum from top to bottom. Water sprays are placed at regular intervals around the machine for the removal of loose caps through a trash outlet. (See fig. 41.)

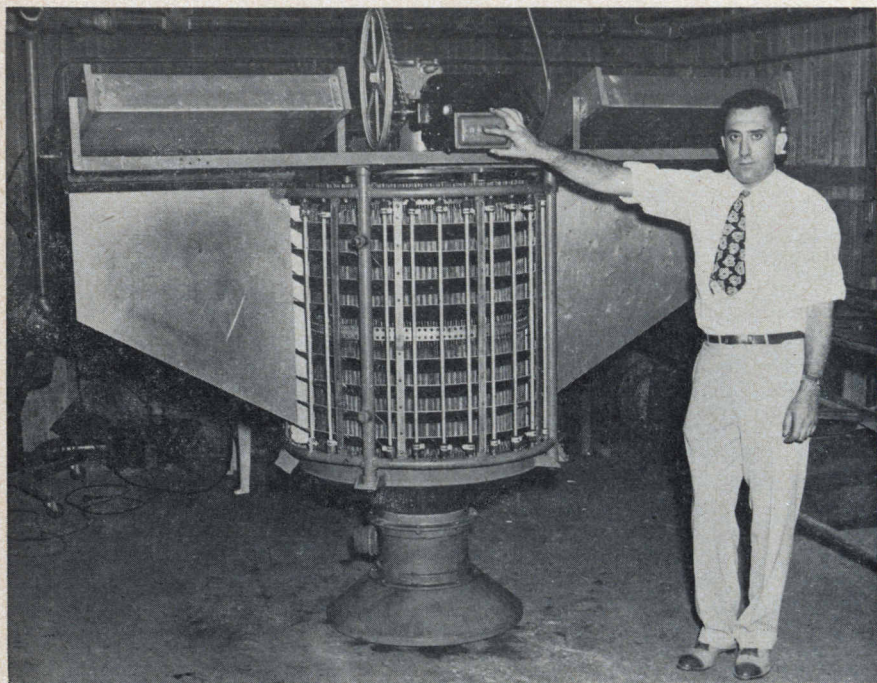


Fig. 41—Front view of the 1948 strawberry capper.

Feeding chutes are shown on left and right sides; capping drum at center. Strawberries are fed at both sides simultaneously onto sixteen horizontal runways, eight of which are shown in photograph. The vertical pipes are water sprays. The speed reducer is at top center. Capped berries are discharged from both sides of capper and below feeding chutes.

The operation during the 1948 season indicated a fine future for this type of machine; with further slight improvements, machine capping can be an established fact for all processors.

ENTOMOLOGY

SWEETPOTATO INSECTS

S. Marcovitch

The Elongate Fleabeetle.—Studies of life history and feeding habits of *Systema elongata* were continued. On August 7, narrow-leaved plantain was found growing abundantly on Cherokee Boulevard in Knoxville. Upon digging around and under the weeds the writer found several half-grown larvae, two nearly full-grown larvae, and one prepupa. The larvae were brought into the laboratory and given several types of plant roots to feed on. They appeared to feed well and burrowed into sweetpotato stems and roots, Irish potatoes, narrow-

leaved plantain, broad-leaved plantain, strawberry, wild lettuce, bean sprouts, and corn sprouts. They did not feed on lambs-quarters, pig-weed, Jimson weed, or dandelion.

Insecticide Tests.—To provide material for insecticide tests on the larvae, a number of adult beetles were collected July 9 by sweeping on Cherokee Boulevard. These were placed in cheesecloth cages over sweetpotato plants, where they deposited eggs. On July 21, the cheesecloth was removed. In this particular plot, 2 rows of sweetpotatoes were treated with DDT, prior to planting, at the rate of 25 pounds to the acre. On August 23, the potatoes in the untreated row showed numerous holes. Eighteen larvae and 7 prepupae were found in the dirt about the potatoes. In the row treated with DDT, the potatoes were clean and no larvae were found. These potatoes, however, were smaller.

On October 8, all of the potatoes in the experimental plot were dug up and the following results noted:

Row	Treatment	Percent infested	Yield per acre in bushels
1	No treatment	45	180
2	DDT	1	90
3	No treatment	15	120
4	DDT	0	60

These figures indicate a decided lowering of the yield caused by the DDT.

SOIL TESTS WITH CRYOLITE AND ARSENIC

S. Marcovitch

Previous work with cryolite indicated that this material added to the soil did not cause injury to plants. Further investigation showed that dosage and soil type are important factors. In the tests here reported an acid Hartsells soil with a pH of 4.5 was used. The dosages and the effects on the bean plants are shown below.

Material	Tons per acre	Height of bean plants in inches
None	0	8
Cryolite	1	8
"	2	5
"	3	2
"	5	0
Cryolite	5	8
Lime	7½	
Calcium fluoride	5	

These data show that cryolite at 2 tons or more per acre will interfere with the growth of beans. The addition of lime tends to prevent the injury. Calcium fluoride at 5 tons produced no injury.

Sodium fluosilicate is more toxic than cryolite and was found to interfere with growth at 1 ton to the acre.

As with cryolite, soil type is an important factor in the injury from lead arsenate. On Hartsells sandy loam, 4000 pounds to the acre interfered somewhat with growth, and on a Knoxville garden soil it prevented germination. Presumably lead arsenate is less soluble in acid media.

In a study of antidotes for arsenical soil poisoning, the best results were obtained with dicalcium phosphate, as shown in the following table:

Material	Tons per acre	Height of bean plants in inches	Arsenic p.p.m.
Check	0	10	2
Lead arsenate	$\frac{1}{4}$	10	7
Lead arsenate	2	4	31
Lead arsenate	2	7	20
Calcium carbonate	$7\frac{1}{2}$		
Lead arsenate	2	9	7
Dicalcium phosphate	$7\frac{1}{2}$		

NEW INSECTICIDES

W. W. Stanley

The testing of new insecticides continues to produce results of immeasurable value. New chemicals are giving control which was considered impossible a short time ago. The practical use of these new insecticides will result in increased crop yields and larger incomes for the farmers. Other advantages are the benefits to the livestock industry through control, and in many cases eradication, of animal pests. The control of household pests has brought about a great saving in food and clothing. The elimination of annoying insects around the home and the barn lot also is important. The new insecticides were used on the following crops in an effort to increase yields by controlling the various pests:

Irish Potato.—For the third consecutive year, spraying and dusting tests have been carried out at the Plateau Station, at Crossville, for the control of potato insects and diseases. Previous tests have shown that DDT is by far the best insecticide. It controls all the pests attacking potatoes, and in addition appears to stimulate plant growth. Yields in 1948 were very low because of unfavorable conditions. It is of interest, however, to note that the highest yield obtained the past two years was on plants sprayed with extra-large amounts of DDT. There were no differences in yield that could be attributed to the use of the various fungicides.

Peanuts.—Tests continue to show an increase in yield of peanuts due to dusting with DDT. Four dustings, with a total of 120 pounds of dust per acre, containing 3 percent DDT and 94 percent sulfur, gave a 25-percent increase in green weight of vines and nuts over plants dusted with 100 percent sulfur. A general recommendation is the combination of DDT and sulfur. Disease was not a factor in the tests.

Squash and Cucumber.—Continuing the dusting of squash, it was found again that benzene hexachloride gave best control of pickle worm. The data also indicate that this chemical is stimulating to the plants—the yield was much higher where it was used. Parathion gave about the same control as benzene hexachloride, but did not increase the yield. Chlordane gave poor control.

In cooperation with R. E. Ogle, of the Horticulture Department, a plot of cucumbers grown for variety trials was dusted with two insecticides—80 percent cryolite and 1 percent gamma benzene hexachloride prepared from high-gamma material. Three applications of dust were made before harvest and two during harvest. The cryolite dust was applied at the average rate of 26 pounds per acre and benzene hexachloride at 29 pounds. Mr. Ogle harvested and graded the fruit. The data are summarized in table 25.

Table 25.—Summary of data on cucumber grown by Horticulture Department, 1948.

Treatment	Total fruits	Wormy fruit	Weight			
			U.S. No. 1	U.S. No. 2	Culls	Total
	Number	Percent	Pounds	Pounds	Pounds	Pounds
1% gamma benzene hexachloride ...	8765	.3	1071	569	¹ 8	1648
80% cryolite	7285	4.5	836	406	² 62	1304

¹ Total of 38 fruits.

² Total of 340 fruits.

It is of interest to notice the beneficial results from the use of benzene hexachloride, but further testing must be done to prove the plant stimulations. Taste tests on both squash and cucumbers, by about a dozen families, indicate that benzene hexachloride as used in these trials does not affect the flavor of either cucumbers or squash.

Bean.—Six new insecticides were tried on the Mexican bean beetle and only one, parathion, was outstanding. Last year .25-percent parathion was used, and gave little control; but this season, when 1-percent strength was used, the control was very good. Until more is known about the hazards from this very poisonous insecticide, no recommendation for its use on beans will be made.

Tomato.—Four years' data on the trial of DDT for control of the tomato fruit worm show no consistent results in regard to decreased yield. A 3-percent DDT dust, when applied at about 30 to 35 pounds per acre, has given very good control, and is recommended for this pest.

Peach.—The new insecticides have not been as successful on the plum curculio as on other pests. The data obtained in 1948 show that lead arsenate gave about the same control as the new insecticides. Their only apparent advantage is safety on foliage. During the past season, 6 sprays of these new insecticides were applied on Early Elberta and Georgia Belle trees without any visible foliage injury.

The timing of peach sprays has always been difficult. The increasing use of legume and cover crops in and around peach orchards

appears to have resulted in greater injury from such insects as the tarnished plant bug. This injury is generally known as catfacing and is caused by the insect's sucking on the very small peach. In an orchard in Knox County, catfacing on Mikado variety was found to range from 56 to 98 percent. There was practically no loss, however, since the fruit was all sold on a roadside market. The loss would have been heavy if the peaches had been graded. Snapp⁴ has shown that catfacing can be largely controlled by spraying at petal fall. This will greatly help in control of curculio, which is present in the orchards at the same time.

In 1947, samples of peach pulp, no skin included, were obtained for fluorine analysis. The object was to secure further data as to why cryolite sprays cause premature ripening of the fruit. It was found that fruit sprayed 3 times with lead arsenate 2-100 (check) had .24 p.p.m. of fluorine; fruit sprayed 4 times with cryolite $2\frac{1}{2}$ -100 had .64 p.p.m. of fluorine; 2 late sprays of cryolite $2\frac{1}{2}$ -100 left .48 p.p.m. of fluorine on the fruit; and 2 early sprays of cryolite $2\frac{1}{2}$ -100, .38 p.p.m.

Soil Insecticides—The new insecticides offer great possibilities for the control of soil insects, which heretofore have been comparatively immune from chemical control. Reports from other sections of the country indicate that DDT, benzene hexachloride, chlordane, and parathion may have good chances of killing the southern corn rootworm, wireworms, sod webworms, cutworms, white grubs, root lice, and other soil insects.

In 1948, several tests were conducted to determine the effect of insecticides on the plants, as none of the various insects listed were available for toxicity tests. The following insecticides were used:

Chlordane, $2\frac{1}{2}$ lbs. to $7\frac{1}{2}$ lbs. per acre.

Benzene hexachloride, $\frac{3}{4}$ lb. gamma to $1\frac{1}{2}$ lbs. per acre.

DDT, 10 lbs. to 25 lbs. per acre.

Parathion, 2 lbs. to 10 lbs. per acre.

Seeds of peanuts and cotton were planted. First a small furrow was made with a wheel plow. The insecticide, in dust form, was then applied in the furrow and covered with dirt by the wheel plow, which left a furrow. The seeds were dropped into the furrow and covered. Good stands were obtained of both crops. Other tests were made with sweet corn. (1) Chlordane and benzene hexachloride were mixed with fertilizer (4-10-4); (2) seeds were dropped into the insecticides in the furrow; (3) insecticides were applied in the form of spray to soil and covered; and (4) parathion was applied at 10 pounds per acre and covered with dirt, and the row seeded. There was no apparent effect from the insecticides.

The following test was made with tobacco and sweetpotato plants: The insecticides were applied in furrows and covered with the wheel plow, leaving a small ridge. With the aid of a wide dibble, the plants were set in the poison. After transplanting, the plants were watered, since the ground was dry. The stand of tobacco was as good in the treated area as in the untreated. The stand of sweetpotatoes also was

⁴ Control of Sucking Bugs That Cause Deformed Peaches, Jour. Econ. Ent. Vol. 41 (4): 555-557. 1948.

unaffected. The yield of sweetpotatoes from the section of the row treated with $1\frac{1}{2}$ pounds gamma benzene hexachloride per acre was 30 percent more than that of the adjoining areas, indicating a stimulation similar to that obtained with cucurbits. No bad flavor could be detected in the sweetpotatoes grown in soil treated with benzene hexachloride.

MISCELLANEOUS INSECT PESTS

W. W. Stanley

Green June Beetle.—About August 20, a heavy infestation of green June beetle larvae was reported near Jonesboro. The larvae were damaging newly seeded alfalfa and pasture fields which had been planted for early fall grazing. The infested fields were in either alfalfa or pasture at time of flight of beetles. As a preliminary test, several of the new insecticides were applied on August 28 to a small area. The materials, in dust form, were scattered by hand; then the ground was disked once with a garden tractor to work the insecticides into the soil.

Observations 7 days later revealed an excellent kill from parathion (10 pounds per acre) and benzene hexachloride ($1\frac{1}{2}$ pounds gamma per acre). Chlordane at 5 pounds per acre gave a fair kill; DDT at 25 pounds was less effective. A mixture of sodium fluosilicate and bran, as recommended for use in tobacco beds for this pest, showed practically no reduction in number of larvae.

Another treatment consisted in the use of pills or capsules containing ethylene dibromide. The capsules were dropped into holes about 2 to 3 feet apart, made with an iron bar. The kill at the end of the first week was excellent, but larvae moving into the plot later were not affected.

On September 13 another test was conducted in a pasture field that was being reseeded. The insecticides used were:

Parathion, at 8, 4, and 2 lbs. per acre

Benzene hexachloride, at $1\frac{1}{2}$, 1, and $\frac{1}{2}$ lb. gamma per acre

Chlordane, at 10 and 5 lbs. per acre

The chemicals were distributed as evenly as possible by hand and worked into the soil by the grain drill as the field was seeded. Observations September 16 showed excellent kill with parathion at all rates. Benzene hexachloride also gave excellent kill at $1\frac{1}{2}$ - and 1-pound rates; the $\frac{1}{2}$ -pound rate seemed to be much poorer. Poor control was obtained from chlordane. The infestation of larvae was very large—counts before treating ranged from about 5 to 25 per square foot. After treating, the counts were often over 30 per square foot, as the dying larvae collected in small depressions. There was a strong odor from the decaying larvae.

Since both parathion and benzene hexachloride worked extremely well, the problem of large-scale applications is important. Each chemical was mixed with a commercial fertilizer (0-12-12 plus 5% borax) and applied with a grain drill. Excellent kills were obtained with parathion at rates of 2 and 3 pounds per acre and with $1\frac{1}{2}$ and $2\frac{1}{2}$ pounds gamma of benzene hexachloride per acre.

Another small test, October 7, showed that parathion at $\frac{1}{2}$ - and

1-pound rates was not as effective at at 1½ pounds; also that DDT at 25 pounds per acre and ½-pound-gamma benzene hexachloride were ineffective. However, observations October 7 on the stand of grass in plots treated September 13 showed that ½-pound-gamma benzene hexachloride was as good as on plots which gave a higher kill.

Although the control with these new insecticides was good, the cost is high, about \$20.00 per acre. Under the conditions in one field the owner might well have spent \$20.00, since about \$35.00 was already invested in seed, labor, and fertilizer. It is hoped that further testing and studies on this pest will bring the cost of treatment much lower.

Cotton Insects.⁵—At the Jackson Station, 6 weekly applications of a dust containing 20 percent toxaphene and 40 percent sulfur was applied to a small area of cotton. The dusting was started while the cotton was in the seedling stage. Although the dusting did not increase the total yield, it did increase the yield of the first picking as much as 20 percent with some varieties.

Housefly.—As in other sections of the country, reports were received that DDT was not giving satisfactory control of the housefly. Other workers have proved that houseflies have become resistant to DDT; hence, the control of this pest is again a major problem. This is believed to be the only case in which DDT has failed to produce expected results.

In most cases the housefly problem is aggravated by the failure of farmers to remove the manure which is the breeding place of the maggots. In the past, borax has been used on manure to prevent the development of the fly. The new insecticides were tried for the same purpose. Although the results were not consistent, the maggots were killed by all three materials—chlordane, benzene hexachloride, and parathion.

Cattle Grubs.—Grubs, or wolves, in the backs of cattle during the winter months are the larvae of a species of fly commonly known as the "heel fly." The pest causes great loss to farmers by damaging hides and meat and reducing milk flow. There are two distinct species, *Hypoderma lineatum* (De Vill.), or the "common cattle grub," and *H. bovis* (De Geer), or the "northern cattle grub." Until 1947 it was thought that only the "common" species occurred in Tennessee. On April 18, 1947, grubs found in cattle that had been on the University Farm, at Knoxville, for more than one year were identified as the northern species.

In 1948, the third week in April, grubs of the northern species were collected in Knox, Blount, and Grainger Counties. W. P. Tyrrell, Extension Animal Husbandman, reported finding grubs in cattle in Henry County on May 21.

The significance in the appearance of the northern cattle grub is that our cattle growers are going to suffer more losses and that control programs will have to be extended to cover the months of December, January, February, March, April, and May.

⁵ In cooperation with N. I. Hancock.

Reports from other workers indicate that this pest is generally spreading southward.

European Corn Borer.—The European corn borer is another foreign pest that has finally established itself in our State. It had been found in a few Middle Tennessee counties, close to the Kentucky border, for several years, and this year it has been reported as appearing in 10 counties.

This pest is a serious threat to corn production, particularly to hybrid seed corn. Insecticide control can be obtained with either DDT or ryania powder. Cultural control consists in complete destruction of all corn stalks.

Up to the present time no direct loss has been reported from the insect, but farmers should be on the lookout for it and be prepared to combat it.

White-Fringed Beetle.—The white-fringed beetle was found in Shelby County this year. It was first found in Florida in 1936 and has now spread to most of the southern states. It is a serious pest, as the larvae, which live in the soil, attack almost all plants. The adult beetle feeds on a large variety of plants, but does not cause much economic damage. The white-fringed beetle is parthenogenetic; no males are known, and each female is potentially capable of producing viable eggs. Therefore, any egg, larva, or adult may establish a new infestation.

HOME ECONOMICS

FOOD-CONSUMPTION STUDY

Josephine Staab, Florence L. MacLeod,
and Dorothy Stockburger

A study of the food consumption of open-country farm families in certain types of farming areas in the Southern Region is being made in cooperation with the Agricultural Experiment Stations of Arkansas, North Carolina, Mississippi, South Carolina, and Virginia and the Bureau of Human Nutrition and Home Economics. The regional sample of mountain farm families, selected with the assistance of the Institute of Statistics at North Carolina State College, consists of 182 Tennessee open-country farm families living in Cocke, Hancock, Johnson, and Unicoi Counties.

Schedules were collected by interviewers from 122 families in these 4 counties from the middle of January to the first of May, 1948. Climatic and topographic conditions made certain sample areas inaccessible during the winter and early spring. When travel conditions improved, a partial schedule was taken from 60 eligible families in the remaining sample areas.

An analysis of the data collected is in progress. The first regional

report on the study of food consumption by farm families living in typical cotton-farming areas of Arkansas and Mississippi, in typical tobacco areas of South Carolina and Virginia, and in typical mountain communities of Tennessee will probably be made about July, 1949.

A preliminary tabulation of income data for the Tennessee sample indicates the importance of non-farm income as a source of money income to mountain farm families. Of the 122 Food Record families, 118 gave complete income data. Non-farm income from off-farm work or from self-employment in non-farm enterprises was a significant source of money income to 58 percent of these families. In each of the income classes, except the \$1000-\$1499 net money income class, the average amount of money derived from non-farm employment in 1947 was greater than that derived from farm operations.

The estimated average net money income per family in 1947, of those families reporting income, was \$1509, and the average income per person was \$280. However, 63 percent of these families had a net money income of less than \$1500.

The preliminary tabulations also show the importance of the home-produced food to the well-being of mountain farm families. The average value of the home-produced food used in 1947 by the 121 families reporting was \$781. The farm-furnished produce was valued at farm prices. Seventy-five percent of these families consumed, in 1947, home-produced food valued at \$600 or more. The average expense of purchased food for the families was \$357 per family per year, and the average cash expenditure for food per person per year was \$64. Fifty-five percent of these families spent less than \$300 per family per year for food.

HOUSING STUDY

Josephine Staab, Elisabeth L. Speer, and Dorothy Stockburger

A study of household activities as a guide to housing needs is being made in selected areas of the South as a basis for the development of functional farm-house plans. Data on open-country farm families living in the Coastal Plains, Piedmont, and Mountain areas of the Southern Region were collected in the spring of 1948 through the cooperative efforts of research workers in the Agricultural Experiment Stations of Georgia, Mississippi, South Carolina, Virginia, and Tennessee and the Bureau of Human Nutrition and Home Economics. In the Tennessee Mountain sample, selected with the assistance of the Institute of Statistics at North Carolina State College, 182 schedules were secured from farm families living in Coffee, Fentress, Hawkins, Knox, Macon, Meigs, Sevier, Sullivan, and Washington Counties.

In the fall of 1948 the regional sample was extended to include open-country farm families living in the Plateau, Interior Plain, and Alluvial Plain areas of the South. The Experiment Stations of Alabama, Arkansas, and Tennessee were designated to collect these data. The Interior Plain sample, selected with the cooperation of the Institute of Statistics, consists of 4 Tennessee counties. Seventy-seven schedules were obtained from families living in Bedford, Davidson, Lincoln, and Smith Counties.

Tabulation and analysis of these data are in progress.

SERVICEABILITY OF TENNESSEE COTTON IN CONSUMER FABRICS

Mary P. Shelton, Ida A. Anders, and Jean Gibson

Cotton has long been one of the major commodities produced in the southern part of the United States. The emphasis in the production of this fiber has been placed on the annual yield per acre and price per pound rather than on its properties or behavior in consumer fabrics. With the increased production and sales of manufactured fibers, such as rayons, cellulose acetate, and nylons, it has become necessary to make a more thorough study of the properties of the cotton fiber and their effects on the serviceability of consumer fabrics.

There are very few published studies in which known varieties of cotton have been analyzed from both laboratory and consumer-use, or serviceability, aspects. No records of the properties of Tennessee cotton other than length, strength, and density have been published except as units of studies made in other parts of the country. The Fifty-Eighth Annual Report (1945) of the Tennessee Experiment Station gives some records on the physical properties of certain varieties of fiber grown in the State as related to crop improvement. That report also gives a review of the work completed on the methods of measuring the fiber as developed by the Physics Department of the Experiment Station.

The present study has been undertaken to determine as nearly as possible what can be expected of certain of the cottons grown in the state of Tennessee. It is hoped that the results will point out some types of cotton which might be in greater demand than some now being produced.

Materials and Methods.—The fibers selected for this study were chosen because they represented some of the more popular varieties grown in the State. The cotton was purchased in every instance from the gin nearest the farm on which it was produced. Approximately 25 pounds of each type was obtained so that there would be enough for samples for laboratory tests and for spinning and weaving tests. Each lot of cotton was sub-sampled for length, strength, maturity, and total extractable impurities. Following the sub-sampling, the remainder of the cotton was shipped to the Clemson Laboratory, Research and Testing Division, Cotton Branch, Clemson, South Carolina, where further grading and testing preceded the actual spinning and yarn tests.

In every instance the methods used for measuring and testing the properties of the fibers are the accepted standards for this type of work.

The first part of 1948 was spent in setting up the methods and procedure to be followed. A sample lot of cotton was obtained from the Plant Pathology Department and a preliminary study was run to check the accuracy of the methods selected for this study.

Results.—The work on the physical measurements of the fibers studied has been completed, with the exception of certain check tests. The results of these tests are given in table 26. An analysis of this

Table 26—Physical measurements of Tennessee cotton fibers.

Fiber sample	Location of farm	Approximate maturity ¹	Length ² (mean)	Length ³ (upper half)	Fineness ⁴	Strength ⁵
		Percent	Inch	Inch	Cm ² /mg	1000 lbs./sq. in.
Delta Pine 15	Ripley	88.8	.87	1.17	2.93	73
Delta Pine 15	Brownsville	92.8	.74	1.02	2.86	74
Tenn. 241	Ridgeley	78.0	.80	1.13	2.95	75
Delta Pine 15	Memphis	94.2	.74	1.05	2.62	75
Stoneville 2B	Rossville	72.0	.86	1.15	2.41	74

¹ Approximate maturity—Cotton fiber does not always develop or fully mature uniformly in the field. This figure represents the approximate amount of fully developed fiber in the test lot.

² Length (mean)—average length of the cotton fiber.

³ Length (upper half)—average length of the fiber above the mean length.

⁴ Fineness—density of the fibers, measured in sq. cm. per mg.

⁵ Pressley Index—of the fiber as measured in thousands of lbs. per sq. in.

table will show that there are definite differences between the cottons, not only of different varieties, but of the same varieties grown in different locations. This fact has been established by workers in other parts of the country with different varieties of cotton. Figure 42 shows an apparatus for extracting impurities from cotton.

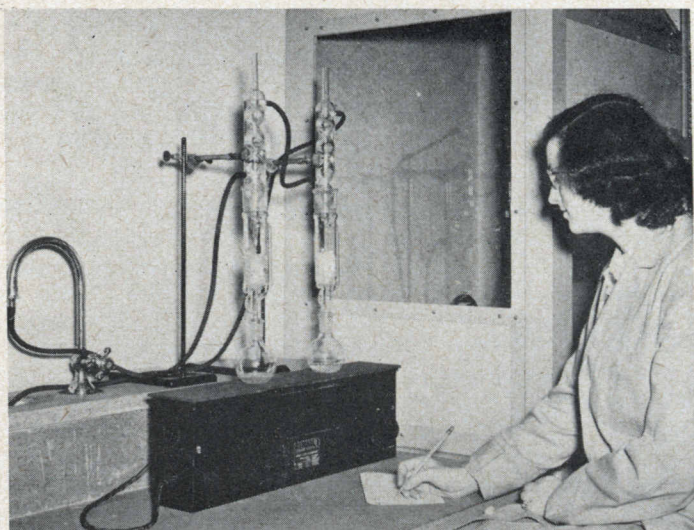


Fig. 42—Extracting impurities from raw cotton.

The physical measurements completed for this study represent approximately 4 months' work. Spinning is now in progress. Therefore, no comparison can yet be made of the properties of the yarn as related to the measurements made on the raw fiber. Since the major purpose of this investigation is to study the raw fiber in relation to the serviceability of the finished yarn and fabric, no conclusions can be drawn at the present time as to what can be expected of this fiber.

Proposed Work.—Work on the study should be completed within the next year. This will include the weaving of swatches of material for use in determining serviceability. A report of the findings will be submitted to a journal for publication.

PRECOOKED AND READY-TO-COOK FROZEN-FOOD PRODUCTS

Bernadine Meyer, Ruth Buckley, and Ruth Moore

The work on precooked and ready-to-cook frozen-food products was continued during 1948. The products tested included fruit pies, cakes, pastry, and yeast rolls. The over-all purpose has been to evaluate these products from the standpoint of consumer acceptability. This has been done by means of palatability ratings, using a panel of 3 to 5 judges for each product tested. In addition, objective measurements of quality factors, such as planimeter measurements for volume of cakes and shortometer measurements for tenderness of pastries, have been used whenever practicable.

The specific objectives were: (1) to compare the effects of freezing, before and after baking, on the quality of the products; (2) to compare the performance of an all-purpose soft-wheat flour, used extensively in Tennessee, with the performance of a nationally distributed brand of all-purpose (hard-wheat) flour; and (3) to determine the probable freezer-storage life of each type of product.

Fruit Pies.—Palatability ratings were made on 42 pies stored during the 1947 season, to complete the freezer-storage tests for that year. Results of these additional tests substantiated those reported last year and are not repeated here.

Tennessee-grown Hale Haven and Elberta peaches were used to process 2 new series of peach pies. One series was to compare the suitability of these varieties for use in prebaked and ready-to-bake pies. In the other series, various pretreatments to prevent discoloration of the peaches during freezer storage were tested.

At each test period, through 6 months of freezer storage, pies made with Elberta peaches scored higher than pies made with Hale Haven. Elberta peaches held their color better during freezer storage and were superior in flavor and texture. While the frozen ready-to-bake pies of both varieties of peaches scored slightly higher than pre-baked pies, the differences seemed to be too slight to be of any practical importance.

The addition of 0.05 percent ascorbic acid in combination with 0.1 percent citric acid to either variety of peach was effective in preserving the color and flavor of the fruit through 5 months of freezer storage. Ascorbic acid when used alone was almost as effective as when used in combination with citric acid. Dipping the fruit in 0.15 percent sodium bisulfite for 1 minute tended to bleach the fruit slightly, but was very effective in the prevention of browning. The flavor of the sulfite-dipped peaches was considered flat by most of the judges.

A slight deterioration in general acceptability with increased freezer-storage time was noted in all pies.

Butter Cakes.—A series of 78 butter cakes, 39 each of soft-wheat and hard-wheat flour, were processed. In each group, one-third of the cakes were baked before freezing, one-third were frozen ready-to-bake without thawing, and one-third were frozen and thawed before baking. The cakes were judged after 2 weeks of freezer storage and then at monthly intervals up to 9 months of storage. A freshly baked cake also was judged at each test period. All samples were coded to conceal their identity.

No marked differences were observed in cakes made with the 2 types of flour. Those baked before freezing were practically equivalent to the freshly baked cakes throughout the entire storage period, except that they seemed slightly drier than the fresh cakes. However, the moisture loss during freezer storage was less than 1.0 percent at all test periods. Of the cakes frozen in the batter state, those which were thawed before baking were also equivalent to freshly baked cakes in volume, texture, and grain. Those baked without thawing were smaller, tended to hump in the center, and were more compact in texture. These differences may be observed in figure 43. After 6 months of freezer storage, the cakes that had been frozen in the batter state developed a slight "off" flavor, which became more pronounced with longer storage.

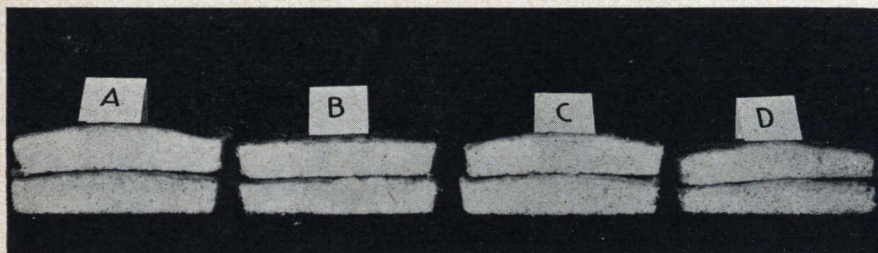


Fig. 43—Butter cakes. Showing effect of freezing on volume and texture after nine months of freezer storage.

A. Freshly baked cake (not frozen). B. Batter baked before freezing; cake thawed to room temperature. C. Frozen batter thawed to room temperature before baking. D. Frozen batter baked without thawing.

Sponge Cakes.—A series of 39 soft-wheat-flour and 33 hard-wheat-flour sponge cakes were processed exactly as the series of butter cakes just described. An equal weight of hard-wheat flour was substituted for soft-wheat flour in a plain sponge-cake formula. The cakes were judged after 2 weeks of freezer storage and then at monthly intervals through 7 months of storage.

In general, the soft-wheat-flour sponge cakes were slightly superior to the hard-wheat-flour cakes, though the differences were not marked.

The sponge cakes which were baked before freezing were practically equivalent to the freshly baked cakes throughout the entire test period. The slight dryness observed in the frozen cakes did not seem to be related to moisture loss during freezer storage.

Frozen sponge-cake batters were not as satisfactory as frozen butter-cake batters, especially when they were thawed before baking.

The foam broke during thawing, producing heavy, soggy cakes of poor volume. When the batters were baked without thawing, the cakes were satisfactory, although they were coarser-grained and somewhat smaller than fresh sponge cakes. These differences may be observed in figure 44.

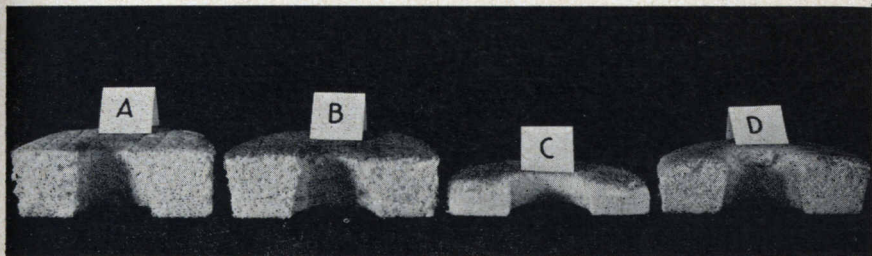


Fig. 44—Sponge cakes. Showing effect of freezing on volume and texture after six months of freezer storage.

A. Freshly baked cake (not frozen). B. Batter baked before freezing; cake thawed to room temperature. C. Frozen batter thawed to room temperature before baking. D. Frozen batter baked without thawing.

Another important difference between the butter cakes and sponge cakes frozen in the batter state was in the development of an "off" flavor. While the butter cakes did not show any deterioration in flavor until after 6 months of freezer storage, the sponge cakes had an objectionable flavor after 1 month of freezer storage, and after 4 months had deteriorated to such an extent that they were no longer edible. Subsequent tests indicated that this deterioration in flavor was probably not due to bacteriological decomposition, but to oxidative deterioration of the egg-yolk lipids. Investigations to clarify this point are under way.

Chocolate Cakes.—A series of 18 chocolate cakes containing baking powder and 18 chocolate cakes containing baking soda were processed to determine whether the hydrogen-ion concentration of the batter affected the suitability of cakes for freezer storage. The cakes were frozen before and after baking and were judged at monthly intervals through 5 months of freezer storage. The cake batters containing baking powder had an average pH of 6.7; the pH of those containing baking soda averaged 7.2. No change in these values was obtained as a result of freezer storage. Baking, however, increased the acidity of the cakes containing baking powder to pH 6.2, while the cakes containing baking soda became more alkaline after baking, with an average pH of 8.0.

The 2 types of cake were found to be equally satisfactory for freezing. Cakes baked before freezing and those baked from thawed batters were equivalent to fresh cakes at all test periods through 5 months of freezer storage. No changes in volume, texture, color, odor, or flavor were noted as a result of freezing. Some of the judges preferred the color and flavor of the cakes containing soda, while others preferred the flavor of cakes containing baking powder.

Pastry.—Shortometer tests for tenderness were made on 14 lots

each of hard-wheat- and soft-wheat-flour pastry. One-half of each lot was frozen ready-to-bake; the other half was baked before freezing. The mixing, rolling, cutting, and baking of the test wafers were done under carefully controlled conditions. All samples were brought to standard condition by being placed in a constant-temperature and -humidity room for approximately 12 hours before the shortometer tests were made.

Shortometer tests indicated that soft-wheat-flour pastries were definitely more tender than hard-wheat-flour pastries. There was no evidence that the freezing process per se had any effect upon the tenderness of either soft- or hard-wheat-flour pastry held in freezer storage through 6 months, whether frozen before or after baking.

Yeast Doughs.—Work has been started on yeast doughs in an effort to determine causes for the rapid loss in quality which these products exhibit when frozen in the dough state. The following tests are being used: (1) palatability ratings; (2) measurement of carbon dioxide evolved from aliquots of the dough under standardized conditions after intervals of freezer storage; (3) measurements of the swelling capacity of the gluten before and after freezing of the dough; and (4) measurements, by seed displacement, of the volume of rolls baked before and after intervals of freezer storage.

This work is incomplete, but the data indicate that neither loss of viability of the yeast nor change in the swelling capacity of the gluten is the chief cause for the loss of quality in frozen-yeast doughs.

CALCIUM AND PHOSPHORUS METABOLISM

Dorothy E. Williams, Florence L. MacLeod,
Elise Morrell, and Echo L. Price

CALCIUM METABOLISM STUDIES ON HUMANS

Investigations on calcium requirements of humans, by means of balance studies and determinations of the utilization of calcium from different sources, have led the National Research Council to increase the recommended daily allowance for adults from 0.8 to 1.0 gram. In view of the wide range of individual differences found in calcium retentions, probably due in part to differences in utilization of calcium, it appears desirable to find a method of measuring calcium retention based on the storage of calcium in the bones. Since the bones are the physiological storehouse for calcium, it seems reasonable to expect that lowered calcium intakes, which result over a period of time in adaptive equilibria as shown by blood analyses and total balance experiments, would result in decreased density of bone. It is therefore the aim of this study to attempt to obtain an objective quantitative measure of bone densities and to correlate this measure with calcium intakes and calcium balance data. Previous studies of bone-density measurements have been made by Dr. Pauline Beery Mack, of Pennsylvania State College.

In May 1948, a group of 13 subjects—3 men and 10 women—volunteered to keep a careful dietary record for one week. They also received, at the University Hospital, a physical examination which included a series of X-rays of hand and foot. Analysis of the diets

indicated that 1 man and 3 women received on the average 1 gram or more of dietary calcium per day during the week studied. The rest ranged from 0.4 to 0.9 gram. Riboflavin values were below recommended allowances in 8 cases. Protein and ascorbic acid tended to be below recommended values in some cases.

Efforts to obtain access to an instrument to determine bone densities from the X-rays have progressed slowly. In cooperation with the Physics Department, and utilizing the basic principles used by Dr. Mack, an instrument has been designed for this purpose. Lack of workshop time and facilities in the Physics Department have delayed the building of the instrument. The purchase price of a microphotometer has been considered prohibitive. Through the Physics Department a microphotometer was made available for a sample determination of 2 X-rays: one from a subject with a high calcium intake, the other from one with a relatively low intake. The subjects were women, of approximately the same height and weight. The density of bone observed, based on the amount of light absorbed by the X-ray photograph of a corresponding portion of the heel bone (calcaneum), was notably greater in the subject with the high-calcium intake than in the other. The encouraging result obtained in this sample case has led us to request the use of the same instrument for obtaining bone-density measurements in the other subjects for whom we have dietary records.

A set of X-rays for each of the 13 subjects has also been sent to Dr. Mack, who has offered to make measurements with her apparatus. Examination of the X-rays by a radiologist at the University Hospital reveals no differences that can be detected by the human eye.

Plans are now under way to carry through a balance study on 8 individuals for whom we have dietary records. One subject was chosen who reported an average calcium intake above the recommended allowance of 1 gram per day; the others had average intakes of 0.4, 0.5, 0.6, or 0.8 gram. Balances for calcium, phosphorus, nitrogen, and riboflavin will be obtained during a period of 5 days when the subjects are on a dietary regime as nearly identical with their usual one as possible. At the end of this period the 7 subjects with records of previous low calcium intakes will increase their milk consumption for a period of 4 months, so that 2 will be receiving a total of 2 cups of milk each per day; 2 others, 3 cups; the remaining 3, 4 cups. X-rays of the heel bone will be made every month, and at the end of 4 months another balance experiment will be carried through on a dietary regime similar to the first, except for the addition of the individual milk supplements. Data from the dietary records, balance studies, and bone-density measurements will be compared. Figure 45 shows a worker making an analysis of food.

Methods of determining vitamin A and carotene have been investigated with a view to future work in the field of interrelationships of the various nutrients involved when increased milk consumption furnishes the increase in calcium intake.

CALCIUM AND PHOSPHORUS METABOLISM STUDIES ON RATS

Preliminary studies of experimental diets for rats have been car-

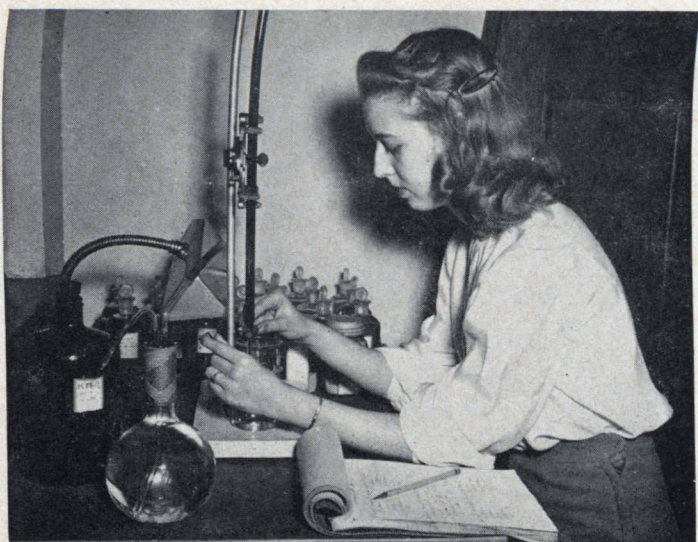


Fig. 45—Chemical analyses are made on diets.

ried on. It is hoped that a diet can be developed to serve as a standard for comparison with experimental diets that will be as nearly as possible optimum for growth, reproduction, and lactation. Such a diet seems to be that reported by Anderson and Smith in 1932. In addition, an attempt has been made to develop a synthetic diet which also will be optimum for growth, reproduction, and lactation, in order that there may be available a purified diet which can be modified by the omission of particular nutrients but be adequate in all other respects.

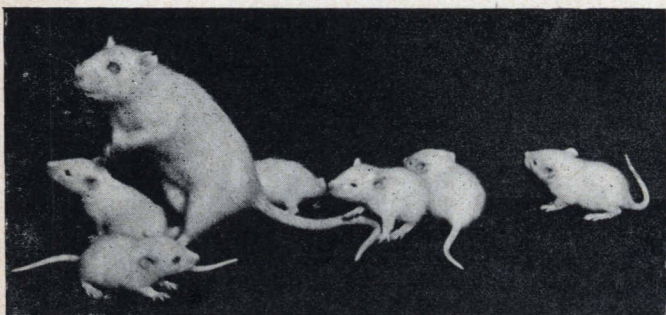


Fig. 46—Parent rat and offspring.

have been raised on the synthetic diet. Carefully matched control breeding lots have been fed our stock ration by way of comparison. Figure 46 shows a typical female rat and her young.

Parent rats and offspring down to the 3rd generation have been raised on the Anderson and Smith diet, and rats to the 2nd generation

AVAILABILITY OF PHOSPHORUS IN FEEDS

The experiment in feeding Dutch rabbits red clover hay grown on plots receiving different phosphate applications, as described in the

1947 Annual Report, was terminated. The original plan to compare the availability of phosphorus in a low- and a high-phosphorus hay was abandoned, since the effort to produce hay high in phosphorus resulted in a better grade of hay and a higher yield, but no substantial increase in phosphorus content. The results of feeding the 3 red-clover hays grown on soils with different phosphate applications are of sufficient interest, however, to report in some detail.

The procedure of placing a mother and young on the experimental diet was followed in an attempt to get results on growth of young and lactation in the mother simultaneously. All litters were reduced to 5 animals.

Four different diets were fed. The control diet consisted of 35 percent rabbit chow and 65 percent good-grade alfalfa hay. The experimental diets consisted of the following parts per 100: hay 65 (fed separately), lactalbumin 12, starch 9, Osborne and Mendel salt mixture 4, Crisco 4, cod-liver oil 2, "Vitab" plus a mixture of B vitamins 4. The B vitamins added per 2 kg. of diet were riboflavin 9 mg., calcium pantothenate 31 mg., choline 1.7 mg., niacin 160 mg., inositol 100 mg. The experimental diets differed in the types of red clover hay fed, which were: (1) hay (0.09% P content) grown on soil which received no phosphate, (2) hay (0.10% P content) grown on soil which received 40 lbs. P_2O_5 per acre, and (3) hay (0.12% P content) grown on soil which received 80 lbs. P_2O_5 per acre. These hays have already been described.

A mother with a litter of 5 young was put on each diet ad libitum 2 to 3 days after birth of the young for the duration of the lactation period. The young were weaned at the end of 8 weeks and were continued for 2 weeks longer on the experimental diet. The young were killed and the right femur removed for ashing; the rest of the body was then ashed to determine total phosphorus content.

The criteria used for judging results were the weight records of the mother during lactation, the weight of the young 2 weeks after weaning, weight of total ash, weight of femur ash, and total phosphorus content. Table 27 gives the results.

DISCUSSION OF RESULTS

No consistent information was gained regarding the weight loss of the mother during lactation.

Food consumptions, although only approximate, since complete recovery of scattered food was impossible, indicate that the differences in results on these red clover hays, all of low-phosphorus content, might be explained on the basis of palatability of the hay. The relation of palatability of forage to the fertilization of the soil on which it was grown can only be conjectured; nevertheless, it is true that in this experiment the only difference in the diets came from the difference in the treatment of the soil on which the red clover hays were grown.

Averages in weight gain of young, weight of total ash, weight of

femur ash, and total phosphorus content vary directly with food consumption, as shown in table 27. Upon the assumption that the lack of phosphate on the one plot was an important factor in the small yield and poor growth of the red clover grown on that plot, in contrast with the good yield and sturdy growth of the clover grown on the other 2 plots, it is reasonable to postulate that the poorly grown hay was not so palatable to either mother or young. Lack of food consumption would restrict the amounts of both phosphorus and nitrogen, among other nutrients, taken by the animal. Phosphorus, like nitrogen, when utilized by growing organisms, plant or animal, is converted to living tissue and becomes a part of the organic body. Because of this fact, phosphorus or nitrogen uptake tends to be accompanied by growth, so that percentage composition is not greatly influenced. Then, with well-balanced nutrition, and consequent greater growth, the percentage of these elements tends to decline through dilution.

Table 27—Comparison of rabbits raised on diets containing hays grown on soils receiving different phosphate treatments.

Diet	Mother		Mother & young	Young							
	No.	Gain in wt.	Food consumed (10 wks.)	Avg. gain in wt.	Avg. wt. of total ash	Wt. of femur	Wt. of femur ash	Pct. femur ash	P in rabbit	P in terms total ash	P in terms body wt.
Rabbit chow and alfalfa	8	Ozs. -1	Gms. 11,415	Gms. 730	Gms. 23.5	Gms. 1.40	Gms. 0.80	Pct. 57	Gms. 4.28	Pct. 18	Pct. 0.75
Synthetic diet and red clover (no P_2O_5 on soil)	8	-10	9,608	408	15.6	0.98	0.54	55	2.88	19	0.68
Synthetic diet and red clover (40 lbs. P_2O_5 per acre).	11	-1	13,480	846	25.6	1.75	0.97	55	4.52	18	0.65
Synthetic diet and red clover (80 lbs. P_2O_5 per acre)	11	-14	16,055	950	28.5	1.80	1.06	59	5.14	18	0.61

From table 27 it can be seen that on the basis of percentage (percent femur ash to femur weight, percent total phosphorus to total ash, and percent total phosphorus to total body weight) the differences between rabbits fed the different diets tend to disappear. In fact, there is a tendency for the percent phosphorus as related to body weight to decrease with increased growth in the rabbits fed the experimental diets. An analogous situation in the realm of plant growth is described by Stubblefield and De Turk⁶ in an article, "The Composition of Corn, Oats, and Wheat as Influenced by Soil, Soil Treatment, Seasonal Condition, and Growth."

⁶ Soil Sci. Soc. Amer. Proc. 5, 120-124. 1940.

The original aim in comparing the availability to rabbits of phosphorus from a low-phosphorus and a high-phosphorus hay was not achieved. The marked differences in food consumption and growth and total phosphorus utilization of rabbits fed red-clover hays grown on soils receiving different phosphate treatments seem worth recording. A great deal more work needs to be done on this problem of the interrelationships of soil, plant, and animals.

HORTICULTURE

N. D. Peacock

Chairman Horticulture Section

Investigational work in horticulture has been conducted at the main Station located at Knoxville, the West Tennessee Station at Jackson, the Highland Rim Station at Springfield, the Plateau Station at Crossville, and a temporary location in the Douglas watershed area at Dandridge. Progress has been made in coordinating the research, resident instruction, and extension programs in horticulture. New projects are reviewed by the staff before they are formally presented for official approval.

EXPERIMENTS AT KNOXVILLE

VEGETABLE CROPS

R. E. Ogle, Brooks D. Drain, and Arthur Meyer

Snap Beans (Ogle and Drain).—Studies were continued on the Urd garden bean project. A green strain of the Urd bean was requested and received from the Indian Agricultural Research Institute of New Delhi, India. Urd hybrids were secured from a previous worker, and crosses were made with these.

A snap bean trial was conducted in cooperation with other southern stations and the U. S. Vegetable Breeding Laboratory at Charleston, South Carolina. Zaumeyer No. 1, an unnamed variety developed by the U.S.D.A. at Beltsville, Maryland, was the outstanding variety for yield and general appearance. Other promising varieties were 1625-17, B1801-7, B1515-1-7-1-5 (all U.S.D.A. entries), and Rival, a recent U.S.D.A. introduction. Cherokee was the leading wax bean.

Tomatoes (Ogle and Drain).—Tucker S-6-17 (an unnamed Missouri variety) produced the highest total yield of 10 tons per acre. STEP 57 (a U.S.D.A. line) was second with a yield of $9\frac{1}{2}$ tons per acre. It was early, produced a high percent of marketable fruit, and showed less blossom end rot than most varieties. These two varieties look promising for Tennessee.

Sweet Corn (Ogle and Drain).—Cooperation in the Southern Sweet Corn Testing Program was continued. Golden Security, Ioana Hybrid, Oto, and M.C.76 were outstanding for yield, quality, earworm resistance, and general appearance, with Golden Cross Bantam being used as the standard. Two years' data indicate that there are now varieties of sweet corn available on the market which out-yield Golden Cross Bantam and have equal or better quality and general appearance. Earworm damage is an important factor in producing sweet corn in Tennessee and should be considered in selecting a desirable variety.

Cucumbers (Ogle and Drain).—The Station participated in the Southern Cooperative Cucumber Trials, in which 10 varieties were tested, including some disease-resistant lines of the South Carolina Truck Experiment Station. Standard varieties such as Marketeer, White Spine, and Colorado were the higher-yielding sorts. Cubit, S.C.6, and S.C.7 were outstanding for color and shape and produced large yields of fancy fruit.

English Peas (Ogle and Drain).—It was interesting to note that of the 20 varieties tested none of our commonly grown varieties, which were placed in the trial as checks, ranked in the first 5. P17-B-5M, Dark Skinned Perfection, Confidence, Dwarf Pea No. 10, and Wando were the top 5, ranking in that order. Tests of previous years and of other stations also rank these high. Three of these varieties, Dark Skinned Perfection (a freezer type), Confidence and Wando (home garden and freezer types) are available on the market.

Okra (Ogle and Drain).—Clemson Spineless has been the most productive of the varieties tested both this year and in previous years. It also ranks high in ease of picking, quality and general appearance.

Other Vegetables (Ogle and Drain).—Asparagus, beet, broccoli, lima bean, mustard, Irish potato, and sweetpotato trials also were conducted. All vegetables were supplied to the General Chemistry Department for processing studies.

Sweetpotato Root Studies (Meyer).—Three years of field trials with the Porto Rico sweetpotato plant indicate that the larger the number of nodes set in the ground, the higher the yield will be. Numbers of nodes used in the study were 2, 4, and 6. The earlier recommendation of large plants with 4 to 6 nodes still stands.

There is strong indication that unrooted cuttings produce higher yields and better quality than the customary rooted plants. Most of the roots that enlarge into "potatoes" have their origin at the nodes. It appears that if these roots are injured, as in pulling and transplanting, they do not recover and develop. The smaller roots coming from internodes, and the lateral roots from the strong roots arising at the nodes, do not seem to have the ability to enlarge into potatoes.

Sweetpotato Improvement (Meyer).—Open-pollinated sweetpotato seed was obtained from the Louisiana Experiment Station and grown

in 1948. Detailed examination was made of all seedlings, 520 in number, and not one was retained as having desirable market characteristics.

Selections made in 1947 were propagated and grown. They too were discarded because of lack of flesh color which the markets demand.

Several selections of Unit No. 1 Porto Rico were increased with a view to making further tests on shape of root and yielding capacity. This phase of the work is being studied in an effort to establish facts relative to seed selection and crop improvement.

Tomato Marketing (Meyer).—This was the second season of study of Tennessee tomatoes in the Detroit market. Observations emphasized the variation in ripening between fruits in different lugs, particularly with respect to their location in the car. Those in the top tier of lugs ripened more rapidly than those in the middle tier, which in turn ripened more rapidly than those in the bottom tier.

The smaller tomatoes, known in the trade as 6 x 7, appear to be of lower quality than the larger sizes.

Greater care in all steps of harvesting, packing, and marketing doubtless would result in a product of higher quality. Rough handling should be avoided, only new lugs should be used for packing, and the lugs should be properly loaded in the car to avoid breakage.

SMALL FRUITS

Brooks D. Drain, R. E. Ogle, and Troy Jones

Strawberry Improvement (Drain and Ogle).—A severe drouth reduced both size of fruit and yield in the strawberry plots. New varieties from the West Tennessee Experiment Station were hard to evaluate. Processing trials were made in cooperation with the Department of General Chemistry of a few of the more promising. These plots were renovated and will be fruited in 1949.

Raspberry Breeding (Drain and Ogle).—A good germination of hybrid black raspberry seed was secured, using shredded sphagnum. About 1500 progenies made an excellent growth in the field and many will fruit in 1949. A small population fruited this past season and a few selections were made. Raspberry seed from various parts of the world were secured and some are germinating well. These raspberry species will be sorted in the hope of locating better parents. A considerable quantity of seed of known parentage was secured and stratified and is now germinating in flats.

A promising new variety from the red raspberry breeding work was propagated and will be available for limited distribution in 1949.

Grape Variety Trials (Jones).—Five additional bunch-grape varieties and 6 new muscadine varieties were set out in February, 1948, at Knoxville. The latter include most of the perfect-flowering kinds of muscadine.

The variety trials were initiated at the Plateau Station with the

planting of 17 varieties of bunch grapes and 4 of muscadine. The young vines did not grow as well as expected, because of the dry season.

Both old and new vines grew under adverse conditions during the year. Dry weather slowed down growth, and just before harvest a wet spell caused serious cracking of most of the Niagara, Portland, Delaware, and Golden Muscat berries. An unprecedented outbreak of grape berry moth took a heavy toll of all varieties that fruited.

Under our current management practices, Fredonia is not bearing to its full potential. Pruning technic is being altered, in the hope of correcting the unbalanced fruit to vegetative ratio. Concord is still reliable in spite of uneven ripening. Of the newer varieties, Athens and Van Buren appear promising. This was their second fruiting season, and production was very light. Golden Muscat, which closely resembles the California grapes in shape, texture, and size, is too capricious when grown in this region. It is readily susceptible to black rot and fruit cracking.

The young muscadine vines laid down satisfactory growth in spite of the dry season.

Breeding and Selecting of Blackberries and Dewberries (Jones).—Nineteen selections of blackberries and dewberries previously considered promising were increased by means of root cuttings, and 10 of each were set out in a separate range for further examination.

Ten new parent-stock varieties were set out for future hybridizing work. Numerous borderline, single-plant selections were discarded at the close of the fruiting season.

One hundred and sixty-seven young seedlings, obtained from crosses in 1947, were transferred from the greenhouse to the field. In the absence of irrigation facilities, growth was poor. A few of the vines will fruit to a limited extent in 1949.

Negotiations were completed too late for a supply of pollen from the Giant Blackberry, *Rubus macrocarpus*, of Columbia, South America, to reach us in time for our blooming season. Pollen did arrive, however, from Bogata, Columbia, in time for crosses to be made on native species in the Great Smoky Mountains National Park, but it is almost certain that the pollen was rendered nonviable during shipment. Mold had formed when the tube was opened. Only one seed was formed, which seems to substantiate the belief that the pollen had deteriorated.

Approximately 1500 hand pollinations were made during the flowering season in 1948, with Alfred, Eldorado, Ozark Beauty, Crossville Selection No. 3, Lavacaberry, and thornless Boysenberry being used as parents. Several of these varieties were allowed to self-pollinate. About 1000 seeds (both cross and self) were collected and dried. In August these seeds were stratified in sphagnum moss in flats and placed in cold storage for after-ripening.

Strawberry Rotation Studies (Jones).—In March, 1948, all 18 plots in the strawberry rotation experiment were set to Blakemore. The

plots had been handled for 2 years under 6 different rotations in 3 replicates each. Very accurate records were taken on man-hours required in hand weeding, hoeing, and cultivating to keep the plots free of weeds. Weed population was sampled periodically throughout the growing season. Plant stand on each plot at the end of the growing season was tabulated. Soil samples taken prior to setting of strawberry plants were analyzed in the laboratory for pH, phosphate, potash, and organic-matter content. Many of the plants died during the hot, dry summer, especially from plots that tended to be more fouled up with weeds.

Mulching and Winter-Injury Studies with Strawberries (Jones).—During the harvest season, all strawberry plots were recorded separately. The field was picked over 7 times. It was very dry up to and during most of the harvest season; hence, the number of dirty berries was not serious on even the unmulched plots. Apparently $1\frac{1}{2}$ tons of straw per acre was not sufficient to affect the moisture level appreciably. The mulched plants seemed to be in as much distress as the unmulched, and berries were about the same size under the two treatments. Plant crowns were sectioned throughout the dormant season, but no winter injury could be detected on any plant that had established itself in the soil. Late-developed runners that were scarcely anchored in the soil were damaged badly. As efficient fruiting plants, these were worthless anyway.

Immediately following harvest, the entire block of plants was renovated. Subsequent management was similar to that of the previous summer and fall. The block was divided into 40-foot plots, and replicated 5 times. Presprouted wheat straw is being applied and plants will be pulled at random for examination every two weeks, beginning December 1, rather than each week as practiced last season. In view of last year's work, it appears that 2-week intervals will be quite adequate.

TREE FRUITS

Brooks D. Drain, R. E. Ogle, and Troy Jones

New Pears for the South (Drain and Ogle).—About 70 new pears, more or less fire-blight resistant, have been developed at Knoxville during the past 25 years. A tree or part of a tree of each has fruited at the Mericourt Station. Trials of many of these new pears were started in 1944 at many experiment stations in Southeastern United States. A summary of these trials indicates that a number are worthy of more extensive planting.

Many progenies in nursery rows were sorted for fire-blight resistance and the more promising set in the orchard. Over 2000 progenies from 1947 crosses are now growing in nursery rows. A large number of new crosses were made and a good set of fruit was secured, but low temperatures caused the fruit to drop.

Apples and Plums (Drain and Ogle).—Low temperatures destroyed the plum crop this year. Pilfering made yield records of little value in the apple orchard. Premature dropping has long been serious with certain apple varieties that ripen in warm weather. If premature drop-

ping is prevented by chemical sprays, varieties like Early McIntosh make a much better showing.

Peach Variety Test (Jones).—During 1948, 31 new varieties and numbered seedlings were added to the peach variety test plot. Pertinent records were taken throughout the season on all varieties that bloomed and fruited. The freeze of March 29 killed the blooms on several varieties that were ready to bear their first crop. Curculio and oriental fruit moth infestations were serious in the orchard and, as usual, aggravated brown rot. The ripening season was short for all varieties. Twelve varieties were frozen by the General Chemistry Department for observation at a later date.

Twelve yellow-fleshed and 3 white-fleshed kinds were frozen in 1947 and sampled by a tasting panel in 1948. The top varieties as judged by the group were Redhaven, Fair Beauty, J. H. Hale, Elberta, and Fertile Hale. Cumberland was the outstanding white-fleshed variety.

A peach variety test was established at the Highland Rim Station with Mr. Latham as co-leader. Four trees each, of 11 promising varieties, both old and recent in origin, were set in early spring. Fifteen additional varieties were used as guard trees. This gives a good assortment of varieties for both detailed study and observation. The trees were planted on the contour and did well, considering the adverse growing season. The site was under special management for a year prior to setting.

MISCELLANEOUS

Brooks D. Drain and R. E. Ogle

Insecticidal Crops.—*Wilfordii*, from Asia, has been grown for some years at Knoxville. The roots are used in making insecticides. Preliminary assays have shown some promise. A quantity of roots were dug and dried for shipment to the Division of Tobacco, Medicinal and Special Crops, U.S.D.A. This plant appears adapted to the soil and climate of Tennessee. We do not know whether it can be grown economically here.

A nursery planting of Tennessee high-assaying clonal strains of pyrethrum was continued.

Nut Crops.—A nursery planting of blight-resistant chestnuts, *Castanea mollissima*, was made and a good stand secured. A part of these seedlings were distributed to growers.

Garden Sage.—European competition has reduced the price of dried sage leaves and further work on this crop will be limited at this time.

Nematode Control.—'Two years' work with ethylene dibromide (see fig. 47) indicates that recommended dosages do not give satisfactory control of the root-knot nematode in our heavy soils. Increasing the rate of application of a material containing 10 percent (by volume) from 20 to 30 gallons per acre gave satisfactory control but not eradication of nematodes. Further observations are needed to determine residual control.



Fig. 47—Applying ethylene dibromide to truck land to control nematodes.

The applicator and method of applying by hand are shown. There is mechanical equipment for large-scale operations.

Weed Control.—A preliminary experiment in the use of 2, 4-dichloro-phenoxyacetic acid on strawberries indicates that it may play an important role in weed control in strawberries.

An application of Dow Selective Weedkiller on English peas gave good control of winter mint, smart weed, narrow leaf plantain, and morning glory, but did not affect Bermuda and Johnson grass. There was some burning on the lower leaves of the peas.

Irrigation.—Irrigation water applied to 12 varieties of lima beans, 14 varieties of snap beans, and 4 varieties of broccoli increased the average yields 23, 37, and 40 percent respectively.

TREES, SHRUBS, AND FLOWERING PLANTS

Brooks D. Drain

The Preziosa variety of torch lily, *Liriope graminifolia*, a ground cover plant, and 2 varieties of hybrid pinks were propagated and a limited number of plants distributed through garden clubs. A collection of day lilies and breeder varieties of chrysanthemum have recovered from being moved in July 1947. There were no new acquisitions, as these plantings are limited to nursery rows. Plantings of roses for roadside bank covers along the airport highway made moderate growth.

The time of blooming of plants varies with season. There are probably a number of undetermined factors causing this, but temperature and moisture are important. Table 28 presents 2 years' data on the time of blooming of day lilies at Knoxville. Most plants started to blossom somewhat early in 1948, and this was true for day lilies. This planting was moved in July 1947, and some plants may not have become fully established.

Table 28—Time of blooming of day lilies.

Variety	First blossoms 1948	Full bloom 1944
Gold Dust.....	Late April	May 7
Amur.....	May 11	
Mikado.....	May 29	June 7
Mrs. J. R. Mann.....	May 27	June 7
F. Rosea.....	May 27	
Bagdad.....		June 7
Sachem.....	June 2	
Flava Major.....		June 22
Bijou.....	June 10	June 22
J. A. Crawford.....	June 2	June 29
J. R. Mann.....	June 4	June 22
Mr. W. H. Wyman.....	June 16	July 2
The Gem.....	June 14	June 22
D. D. Wyman.....	June 12	June 22
Radiant.....		June 29
Patricia.....	June 5	July 1
Caballero.....	June 10	
Mrs. A. H. Austin.....	June 10	June 29
Ophir.....	June 10	July 1
Golden West.....	June 14	
The Gem.....	June 14	June 22
Gypsy.....	June 21	June 29
Dauntless.....	June 21	July 9
Imperator.....	June 21	July 1
Hyperion.....	June 28	July 9
Margaret Perry.....	July 13	July 9
Bouffonniere.....	July 23	July 20

HORTICULTURE AT CLARKSVILLE

Brooks D. Drain

Nut Crops.—A Chinese pistachio (*Pistacia chinensis*) tree planted in 1933 on land that is now owned by the city of Clarksville, is making excellent growth and shows no cold injury.

Blight-resistant chestnuts set on soil of low fertility made good growth where mulched and given an annual application of mineral fertilizers. Those set on soil of high fertility produced an excellent crop of nuts.

Breeding for Fire Blight Resistance.—Sixty promising selections of blight-resistant pears have been made to date from a population of over 700 seedlings set in the pear orchard. What appear to be the best of these have been placed on yield tests in other parts of Tennessee and in surrounding experiment stations. A few new selections were made this past season. Propagating wood was cut of all remaining trees preparatory to discarding this orchard.

HORTICULTURE AT HIGHLAND RIM STATION

Springfield

Brooks D. Drain

Yield Tests of Blight-Resistant Pears.—Twelve selections from the Mericourt Station have been set in 3 plots of 3 trees each with random arrangement. A few missing trees were replanted and the remaining guard trees set out. This orchard is making excellent growth, but it will be some years before significant yield data can be secured.

HORTICULTURE AT PLATEAU STATION

Crossville

T. R. Gilmore

GRAPES

A planting of grape varieties was made at the Plateau Station in the spring of 1948. Three replicates were set of 2 plants each of the following varieties: Concord, Fredonia, Athens, Dunkirk, Golden Muscat, Kendaia, Seneca, Sheridan, Van Buren, Urbana, Eden, Seibel No. 1000, Buffalo, Yates, Hector, and Ruby.

The greatest vigor was shown by Niagara, Athens, Buffalo, Van Buren, Sheridan, and Fredonia. The varieties showing the least vigor were Hector, Urbana, and Ruby.

STRAWBERRIES

Variety Tests.—A root rot which developed in this range during the test destroyed the value of the planting for variety comparison. C. D. Sherbakoff, of the Plant Pathology Department, believed the rot to be due primarily to *Rhizoctonia*.

Fertilization on New Land.—Blakemore strawberries were set on newly cleared land in 1947. Eight fertilizer treatments were applied both on limed and on unlimed soil. A 3-9-6 fertilizer was used at the rates of 500 pounds, 1000 pounds, 1500 pounds, and 2000 pounds per acre. Other treatments were at the rate of 2000 pounds per acre with one or more elements omitted.

Yield records taken in 1948 showed, in general, a substantial increase on the limed plots over the unlimed. Increases in yields also were obtained by the use of greater amounts of 3-9-6. Each 500-pound step produced an increase.

Strawberry Rotation Study.—Plantings of certain crops were made in 1946 and 1947 on plots to be set to strawberries in 1948, to determine the influence of preceding crops on the yield of berries and upon the cost of controlling weeds in a plantation.

The cultural practices used for each crop were those recommended for the area. A winter cover was grown between the crops on each plot except No. 2.

Cropping Sequence

1946	Corn	Lespedeza	Snap beans	Snap beans	Tobacco	Corn
1947	Corn	Lespedeza	Soybeans	Snap beans	Tobacco	Sweetpotatoes

The treatments were replicated 3 times on plots 20' x 60'.

Blakemore strawberries were set in 1948. Eight hundred pounds per acre of 3-9-6 was applied in the row. A dry season reduced weed growth to such a point that little trouble was experienced in weed control.

Records were kept on weed population and plant stand. All plots except the lespedeza developed a uniform row.

COLE CROPS

Because of interest in cauliflower, broccoli, and brussels sprouts for processing, certain tests were undertaken in 1948 with the fall crop.

The 3 crops were grown in the same block and received the same cultural treatments. The plantings were made July 22 on land from which a crop of wheat had been harvested. The ground had been limed. The cole crops received a 5-15-5 fertilizer applied $\frac{2}{3}$ broadcast and $\frac{1}{3}$ in the row. Boron was mixed with the fertilizer to give a rate of 30 pounds per acre.

Part of the area was irrigated, receiving a total of 7 inches of water. Plots consisting of 20 plants each, spaced 2 feet in rows 3 feet apart, were replicated 6 times on both the irrigated and nonirrigated areas.

Broccoli.—Nonirrigated broccoli plots averaged 4356 pounds per acre and the irrigated plots averaged 5517 pounds, an increase of 26.6 percent. A temperature of 18 degrees on October 19 damaged the crop to such an extent that harvesting was discontinued.

Brussels Sprouts.—There was little increase due to irrigation. Many heads were very loose and were not harvested. The yields were disappointing, being around 4400 pounds.

Cauliflower.—Four varieties were grown with and without irrigation. These varieties were Early Snowball, Super Danamerica, Snowdrift, and Super Snowball. The following table shows comparative yields of the varieties on irrigated and nonirrigated plots:

Variety	Irrigated Pounds	Nonirrigated Pounds
Snowdrift	49.46	35.70
Super Snowball	47.07	33.70
Early Snowball	46.30	26.60
Super Danamerica	41.03	32.69

The irrigated plots matured earlier than the nonirrigated. Super Snowball was decidedly earlier than the other varieties. The low of 18 degrees on October 19 injured some of the curds, but a harvest on November 11 was free from injury.

Mottling occurred on many cauliflower plants in these tests. The veins remained green while the areas between became more or less yellow. The condition is believed to be due to a deficiency of magnesium in the soil.

VEGETABLES

Cantaloups.—A variety test of Hales Best, Fordhook, Burrells Gem, Iroquois, and Market King was conducted in 4 replicates of 5 hills each. Good yields were obtained from Fordhook, Hales Best, and Burrells Gem. The yields of Iroquois and Market King were too low to be practical.

Irish Potatoes.—Four replicates each of 12 varieties were grown under standard cultural practices for the area. Sequoia, Earlane No. 2, Erie, and Kennebec gave the highest yields. Sebago and Mohawk gave the lowest yields.

The Station cooperated in spraying tests of new insecticides and fungicides, and in certain phases of the Southeastern potato breeding program. This work will be reported elsewhere.

Snap Bean Fertilization.—The bean-fertilization tests were continued on soil of a higher fertility level than that used in the 2 preceding years. Particularly, the phosphorus level was higher. The yields of the no-phosphorus plots were about as high as those with any other treatment. Yields of different replicates of a given treatment, as in the past, have varied rather widely.

HORTICULTURE AT WEST TENNESSEE STATION

Jackson

W. E. Roever and Brooks D. Drain

SMALL FRUITS

Strawberry Breeding and Inheritance.—Six new crosses were made with the objective of obtaining better combinations of shipping, processing, and red-stele resistance. A total of 1841 seedlings were set in the field. Parent plants were moved to the greenhouse for further crosses. Germination trials of strawberry seed, in soil, sphagnum, and vermiculite over soil, showed best results from sphagnum.

Seven hundred and fifty-five seedling clons were fruited and fruit characters noted. Forty-four selections were made and saved for further trial. Thirty-four new selections and 90 selections that had produced berries in previous years were fruited and notes on commercial quality taken.

These plots were 28 by 4 feet, and included from 1 to 7 replica-



Fig. 48—A planting of Tennessee 965 strawberry—second-year planting on the left; first-year on the right.

This variety is being propagated with a view to its being named and introduced.

tions. Nine selections compared favorably with Blakemore and gave larger 2-year-average yields—1947 and 1948. Tennessee 441 averaged 376 crates per acre, Tennessee 654, 364 crates; Tennessee 866, 352 crates; Tennessee 586, 350 crates; Tennessee 846, 345 crates; Tennessee 998, 344 crates; Tennessee 906, 336 crates; Tennessee 938, 332 crates; Tennessee 862, 330 crates—compared with 312 crates for Blakemore. A planting of Tennessee 965, as shown in figure 48, was used for propagation purposes.

Boysenberry Pruning Test.—This is a trial of two methods of pruning, and is in 6 replications. It was started in 1946. Plots having all canes removed after harvest produced 42 percent more fruit than those where fruiting canes only were pruned off. As the trial continues, observations will be made on the cumulative effects of the two types of pruning.

TREE FRUITS

Peach Variety Trials.—The crop was considerably reduced by heavy spring frosts March 11 and 12. Average yields per tree were as follows: Summercrest, 78 pounds; Raritan Rose, 65; Fisher, 62; Polly, 54; Mikado, 23; Early-Red-Fre, 20; Georgia Belle, 19; Fair Beauty, 14; and Golden East, 7.2. A new variety orchard set in 1946 is in excellent condition.

Pear Selection Trials.—Selections from the Knoxville breeding work, set in 1946 for comparison with standard varieties, are making good growth.

VEGETABLES

English Peas.—Eighteen varieties were tested for adaptation at the West Tennessee Station as a part of the Southern Cooperative Pea Trials. The best-yielding variety of a freezing and canning type was Dark Skinned Perfection. Confidence gave the highest yield of varieties considered suitable for market. Among the first 10 lines, Early Alderman produced the best type of pod for market purposes. Confidence and Wando would be desirable home-garden peas. Plots were 3 ft. by 60 ft. and not replicated. Dark Skinned Perfection yielded at the rate of 2760 pounds of pods per acre; Confidence, 2520; Green Bayou, 2448; Wando, 2088; Thomas Laxton, 1968; and Early Alderman, 1872.

Early Cabbage.—Three early shipping varieties were tested for yield, earliness, and head size. Copenhagen Market gave the largest

Table 29—Yields, earliness, and size of heads of cabbage.

Variety	Average weight of head			Yield per acre	
	1st & 2nd cuttings	3rd & 4th cuttings	Season 1948	1st & 2nd	Total
	Pounds	Pounds	Pounds	Pounds	Pounds
Copenhagen Market ..	2.30	2.02	2.18	9,490	15,738
Golden Acre	2.27	1.78	2.09	9,347	13,726
Early Round Dutch ...	3.05	2.08	2.15	1,575	15,003

total yield and Golden Acre produced the highest percentage of its crop in the first and second cuttings. The early cuttings of Early Round Dutch produced the heaviest heads, but the yield of the first two cuttings was small. The color of this variety was good. Weighings are shown in table 29. Copenhagen Market and Golden Acre are considered the best varieties for the early cabbage market in West Tennessee.

Lima Beans.—Eleven varieties or strains of lima beans were tested as part of the National Lima Bean Cooperative Yield Trials. A small-seeded strain, Oklahoma 8-2, was outstanding, yielding at the rate of 3,203 pounds of shelled beans per acre. This seedling is not yet available from seedsmen. Clark's Bush produced 2,484 pounds; Henderson Bush, 2,427 pounds; Early Thorogreen, 2,376 pounds; U. S. No. 147, 1,542 pounds; Triumph, 1,505 pounds; Peerless, 1,407 pounds; and four U.S.D.A. seedlings, smaller amounts.

The effect of irrigation on the yield of a small-seeded lima bean, Early Thorogreen, was tried. Four plots were used, and 3 applications of water were made, as follows: June 8, 17/32 inch; June 11, 20/32; and July 15, 23/32. The plots were planted May 21 and harvested August 3 and 20. The irrigated plots produced at the rate of 4,363 pounds per acre of usable green shelled beans after blanching and grading out the light-colored ones; the nonirrigated produced 3,892 pounds.

The effect of lime on the yield of lima beans was tried, with the Fordhook 242 variety. A Lintonia soil of pH 4.9 was used. Two plots were treated with lime at the rate of 4,000 pounds per acre and 2 left untreated. Half of the lime was plowed under and half disked in, one month before planting. One thousand pounds of a 4-8-8 NPK fertilizer was broadcast and disked in one week before planting. The soil in the treated plots was found to have a pH of 7.9 after treatment.

The seed was treated with Spergon. Plants were thinned to 1 per foot. Each plot consisted of 6 rows 28 feet long, 3 feet apart, and data were taken on 2 pickings. The total shelled-bean yield was slightly in favor of the unlimed area. The usable green shelled beans averaged 21.1 percent more on the limed plots. Since food processors are interested in the usable green shelled bean, this difference may be significant. Further trials are planned.

Spinach.—Neutral or somewhat alkaline soils are generally preferred for spinach. Limed and unlimed plots were laid out as described above. Rows were 28 feet long, and plots were in 12 replicates. A mineral fertilizer, 4-8-6 NPK, was applied at the rate of 1000 pounds per acre. The limed plots (fig. 49) yielded at the rate of 6,711 pounds per acre, compared with 1,538 pounds for the unlimed (fig. 50). The spinach from the limed plots was of U. S. No. 1 marketable grade, while that from the unlimed area was dwarfish, yellowish-green in color, and did not make grade. These yield differences were very consistent, and clearly indicate the importance of liming acid soils before trying to grow this crop.



Fig. 49—A fall crop of spinach on limed plot. Note vigor, stand, and depth of color as compared with unlimed plot.



Fig. 50—A fall crop of spinach on unlimed soil that had a pH of 4.8-4.9. Note the poor stand and lack of vigor.

Hybrid Sweet Corn Tests.—Twenty-two yellow hybrid varieties and strains of sweet corn were tested for adaptability, yield, and market qualities. Four-row plots were used and records taken from the center

rows. Heaviest yielders, in pounds of ears per acre, were Tristate, Gold Rush, Erie, Golden Cross Bantam, Tendermost, and Golden Hybrid No. 2439, in that order. Highest yielders of marketable ears (less than $1\frac{1}{2}$ inches of tip damage by earworm) were: KVF-45, Erie, KVF 46-3601, Goldengrain, Golden Cross Bantam (49 x 56), and Tristate, in that order. Earworm control was purposely omitted. The largest number of ears was produced by North Star, Erie, Tristate, Tendermost, Golden Cross Bantam, Golden Cross Bantam (49 x 56), and Gold Rush. Tristate, Aristogold Bantam Evergreen, Goldengrain, KVF-45, Golden Hybrid 2439, and Gold Rush developed the largest ears. The last appears to be an outstanding second-early market type, with exceptional ear size for its maturity class, and is of good quality. Earworm damage was heaviest in the early varieties. Seneca Chief, a high-quality corn, suffered heavily from smut. Tendermost lived up to its name. Golden Cross Bantam was still the standard for quality, though Gold Rush, Golden Hybrid No. 2439, and Topflight and Ioana also were good. Goldengrain produces a beautiful and large ear, but lacks quality. Tristate also produces a large ear. It is widely adapted, but of only fair quality. On the basis of these tests, the following varieties merit trial: Gold Rush for early market or home garden; KVF-45, Erie, KVF-46, and Golden Cross Bantam for home or market garden where quality is important. Where size and quantity of kernel take precedence over tenderness and quality, Tristate, Goldengrain, and Bantam Hybrid No. 57 are recommended.

Tomato Breeding.—One hundred and thirteen varieties, strains, and F_1 hybrids were grown and studied, with the object of selecting adapted lines for a breeding program, aimed primarily at the production of an early greenwrap tomato. Several selections were saved, as well as F_2 seed from some of the most promising hybrids. Several crosses were made, but the hybridizing program was mainly reserved for the greenhouse during the fall and winter.

Chemically Induced Fruit Set in Tomatoes.—High summer temperatures often cause poor fruit set of tomatoes in West Tennessee. *p*-chlorophenoxyacetic acid was sprayed on blossom clusters to test the effect on fruit setting during the hot periods of midsummer. Triplicate plots of 15 plants each were transplanted to the field on June 6. Marglobe variety was used. Clusters were sprayed when the first flowers of the inflorescence opened. Tomatoes ripened 7 to 14 days earlier in the treated plots. These fruits were seedless and fleshy. The first 2 pickings yielded at the rate of 1736 pounds of marketable fruit (U. S. No. 1 and No. 2 combined), compared with 625 pounds for the untreated plants, an increase of 177 percent. However, the total yield for the season was greater from the untreated plots. Leaf surface was reduced on the treated plants; the result was more exposed fruit and less vigor for sustaining prolonged production.

The value of *p*-chlorophenoxyacetic acid (Dow's Sure-Set) in improving hot-weather fruit set was not demonstrated, but the material appeared to induce greater earliness. This may be of value for early-market production.

Tomato Mutant for Use in Hybrid Seed Production.—A new kind

of mutant tomato, discovered by the senior author on a visit to the Pennsylvania Station, and kindly supplied by that Station, was increased by hand-selfing. Its character of non-dehiscing anthers is also being incorporated in other desirable varieties. The special value of the mutant is that it makes emasculation unnecessary in producing hybrid tomato seed, while the mutant itself can be maintained by means of selfing. The character is believed to be unique. The plant has elicited considerable interest among breeders and seedsmen and geneticists. Requests for seed have been received from Europe, South America, Australia, and Canada, as well as from various sections of the United States.

Field Hybridizing of Tomato Without Emasculation: Pollen Prepotency.—Crosses of the potato-leaved, long-styled variety Red Jacket by John Baer were made in the field without emasculating the female parent to test whether the outcross would dominate over any self-pollinations that occurred. Since the potato-leaf character is recessive, determinations were easily made in the seedling stage. A count of 1739 seedlings showed that 542, or 31 percent, were hybrids, the remainder being selfs.

These results indicate that crossing on a long-styled tomato, such as Red Jacket, in the field and without emasculation will yield about one-third hybrids and two-thirds selfs.

When the F₁ seed is grown, the hybrid seedlings can easily be determined if the female has a recessive character, such as potato-leaf foliage.

Tests will be made to determine percentage hybrids from crosses made in a greenhouse, where sibbing by insects is eliminated.

Southern Tomato Exchange Program Yield Trials.—Eleven selections were grown in randomized duplicate in cooperation with other southern states and the Regional Vegetable Breeding Laboratory at Charleston, South Carolina. STEP 68 showed up as a particularly promising medium-early, high-yielding type that was free from Fusarium wilt. STEP 14, 42, and 57 also were promising (table 30).

Table 30—STEP replicated yield trial of tomatoes.

Variety or strain	U. S. Numbers 1 and 2				Yield rating	Increase over Rutgers
	Replications			Acre yield		
	1	2	Avg.			
	Pounds	Pounds	Pounds	Pounds		Percent
Rutgers	20.0	28.3	24.2	10,953	10	-----
STEP 10	27.9	35.6	31.8	14,393	6	31
STEP 11	31.7	28.7	30.2	13,669	8	25
STEP 22	29.7	31.4	30.6	13,850	7	27
STEP 24	33.4	32.1	32.8	14,848	5	36
Grothen's Globe	32.6	29.0	29.8	13,487	9	23
STEP 42	24.8	44.6	34.7	15,705	3	44
STEP 54	18.8	15.6	17.2	7,785	11	29
STEP 57	29.6	38.5	34.1	15,434	4	41
STEP 68	39.0	42.5	40.8	18,466	1	69
STEP 14	31.5	41.7	36.6	16,565	2	52

The new *Fusarium*-resistant variety Southland was introduced this year by the Regional Laboratory in cooperation with the collaborating stations. This variety was STEP 22.

Southern Tomato Exchange Program Observation Trials.—Thirty-two strains and varieties were grown for preliminary evaluation. Of the lines suitable for greenwrap tomatoes, none appeared outstanding. The most noteworthy lines were STEP 101, 103, 80, and 53.

Eggplant.—Some breeding work with eggplant was started and some promising progenies were secured. Three standard varieties were used as parents.

Peppers.—The following yields per plant were obtained in a duplicated randomized pepper trial: California Wonder, 3.3 pounds; Early Pimento, 3.3; California Wonder selection, 3.2; Early Pimento x Anaheim Chili, 3.0; Windsor A., 2.9; Square Worldbeater No. 1, 2.0; Square Worldbeater No. 2, 2.86; Illinois No. 5, 2.66; and Georgia Pimento, .86. California Wonder lines showed themselves to be the best market strains in the trial. Early Pimento was high-yielding but thin-walled for a pimento type. Windsor A. was prolific and fairly thick-walled for an early pepper.

Sweetpotatoes.—Thirty hill selections were made from a certified planting of Unit No. 1 Porto Rico sweetpotato. Selection was made on the basis of shape, smoothness, color, and uniformity of size. Re-selections are planned from the 1949 plantings of these primary selections.

HERBS

Sage.—Desirable clons from previous selections were increased by cuttings. Interest in this crop has lagged with the return of cheap European sage to our domestic market, and no further work is planned.

FLOWERS

Zinnias.—A comparative trial containing most of the standard varieties from two of the largest zinnia-seed growers showed that varieties of zinnias are in need of greater trueness to type and freedom from rogues. Thirty-four lines were tested.

The most satisfactory lines, on the basis of uniformity of color, trueness to type, freedom from rogues, and color range in mixtures, were Fantasy Finest Mixed, Dahlia Flowered Crimson Monarch, California Giants Cherry Queen, Lavender Queen and Orange Queen, Super Giants Mixed, Luther Burbank, Super Crown O'Gold Pastel Tints, Primula Sunshine Tints, and Cut and Come Again Mixed.

All scabiosa-flowered lines were highly variable and unsatisfactory, having a low percentage of crested flowers and numerous flowers with coarse disks.

DOUGLAS TRUCK-CROP PROJECT

Dandridge

Cooperative with Tennessee Valley Authority

A. B. Strand

The 1948 season at Dandridge was unfavorable for vegetable production, being marked by extremes in temperature and rainfall. A

deficiency of rainfall may be met to some extent by the use of strains of vegetables that have lower water requirements.

A study of rainfall data indicates that irrigation would be beneficial in parts of Tennessee every year. The lower Douglas watershed is a deficient-rainfall area. Although the annual precipitation furnishes more water than is required for the production of vegetable crops, there are dry periods that injure the shallow-rooted or less drouth-tolerant vegetables, such as beans, cabbage, broccoli, and similar plants. When there is a shortage of rainfall, timely irrigation, properly applied, will give profitable increases in yield.

Tomatoes, hominy corn, cabbage, and turnip greens are the only vegetables now being grown in this area for the canneries. Strawberries and asparagus have a definite place in our plan for crops on upland soils. All information gathered indicates that many other vegetables can be profitable on terrace soils, provided irrigation is available.

BROCCOLI

Sprouting broccoli, *Brassica oleracea* var. *italica*—commonly called Italian Sprouting or Asparagus broccoli, and listed in seed catalogs as Calabrese, Sprouting, or Italian—is the type of broccoli that is being grown in Tennessee for the frozen-food industry. Calabrese—early, medium, late—and De Cicco form compact heads of bluish-green flower buds resembling a head of cauliflower. After the main head has been harvested, side shoots with small heads develop.

De Cicco is a new variety. It is productive but is very much inclined to "bolt," or bloom. The Early Strain is the best for this locality. Freezers' Sprouting is a new variety that forms individual sprouts with small heads, which are convenient for processing. Home-grown plants surpassed the southern-grown in quality and yield.

Owing to the extreme drouth in the spring, the yields on the nonirrigated plots were practically a failure—only one harvest was necessary. The curds were small and bitter.

CABBAGE

Cabbage generally requires abundant supplies of plant food and moisture. Without these, the plants are likely to make few, poor, or no heads. Cabbage varieties display wide variations. Early varieties, such as Resistant Detroit, Ferry's Round Dutch, and Racine Market, have comparatively low water requirements and can produce fair crops under adverse weather conditions. Cabbage yields this year were low, especially those produced without irrigation. Premium Late Flat Dutch produced very large, leafy, loose heads under irrigation, and worthless heads without irrigation. Resistant Detroit (Resistant Golden Acre) and Ferry's Round Dutch produced good crops without irrigation and excellent crops when water was added. They were cut 10 days before any other variety. They remain in the field as hard heads for a considerable time.

STRAWBERRIES

This is the third season that strawberries have been tried at Dandridge. They can be grown successfully on terrace soils without irrigation. Tennessee Beauty appears to withstand drouth better than

other varieties. Under adverse conditions the Tennessee Supreme produced a poor-quality berry. Blakemore was satisfactory under all conditions. Goddard's Early, a local variety, produced an early crop similar to that of Blakemore. It appears that a good combination would be, Goddard's Early, Blakemore for midseason, and Tennessee Beauty for late crop.

ASPARAGUS

This year's crop of asparagus is the second that has been harvested. Cutting of spears started March 25, and continued until early May. Yields were high and the quality was excellent. Irrigation appears to be unnecessary. Commercial fertilizer at the rate of 2000 pounds per acre was as effective as 8 tons of manure supplemented with 1000 pounds of 5-10-5 fertilizer. Future cuttings may show injury from lack of organic matter in the soil.

TOMATOES

Plant-Production Studies.—Tomato plants were grown in manure-heated hotbeds with and without glass. It is the aim to determine whether quality, disease-free tomato plants can be grown cheaply enough to compete with the plants that are being shipped in from the southern states.

The first hotbed was prepared and planted to Marglobe March 15. Low temperatures and cold winds necessitated the use of glass. Clay pots, 2½-inch size, were filled with a sterilized compost. The seeds were planted in the pots. No transplanting from hotbeds to coldframes was made this year, since it had been found that such practice is costly. The plants were set in the field April 28. The soil was cold and moist and the plants did not require much water for transplanting.

Another hotbed was sown in a similar manner March 31. Plants from this bed were small, having been in the pots only 28 days. The pulled plants were gathered from one end of the hotbed. They were "stocky," with good root systems. They were kept moist until set in the field, and were watered after being set. These plants were handled more carefully than is customary. One set was grown in aluminum dirt bands. The bands were difficult to remove. Three randomized plots consisting of 33 plants, or 1/110 of an acre, were used for each treatment. Plants were protected from cutworms by a heavy application of poison bait. It was necessary to do some replanting in each plot because of cutworm damage.

The yields were lower from the planting of April 28 than from that of May 21, and the loss from rots was almost twice as high where the plants were set out at an early date. The results show the advantage of potted plants over pulled plants. Blocking gives a better stand of plants than pulling. An early-seeded or large plant is better for field planting than a small plant. Tomatoes seeded about April 1 did not need expensive glass sash for covering; and the late seeding produced a larger crop than the earlier seeding. All studies show that well-grown and carefully transplanted plants are necessary for successful tomato production.

Variety Studies.—A consideration of varieties and strains of tomatoes is important. Tucker S-6-17 is a recent introduction in Tennessee and bids fair to become one of the leading varieties, provided it continues to perform as it has done in trials during the last two years. Rots and waste, due to adverse weather conditions, were low in this variety as compared with others in the trials. Landreth Marglobe and Tucker S-6-17 were highest in yields of large tomatoes and in total yield for the 1948 season. Rutgers is somewhat later than Marglobe and less productive. P. P. 47-25 was the best strain tried from the Plant Pathology Department. It produced large, early fruit, but was not equal in total yield to strains of Marglobe originated at other experiment stations. Pearl Harbor, a determinate variety from the Burrell Seed Company, was very productive early in the season, but the fruit was poor in both size and color, compared with that of Marglobe.

Average acre yields of varieties from 4 replications were as follows:

Variety	Tons	Variety	Tons	Variety	Tons
Landreth	8.02	Rutgers	6.32	P. P. 47-35.....	4.24
Tucker S-6-17	8.01	Greater Baltimore.....	6.27	P. P. 47-21.....	4.10
B. Marglobe	7.48	Marglobe	5.75	P. P. 47-23.....	3.98
Pearl Harbor	6.95	Essary	5.62	P. P. 47-20.....	3.31
STEP 68	6.45	P. P. 47-25.....	5.36		

Rotation, Soils, and Soil Preparation.—The fertility of many fields in the Douglas and Cherokee watershed is rapidly declining. Very little attention is given to the maintenance of the organic matter in the soil. With these facts in mind, a rotation was laid out on a level area. The aim was to learn how other crops affect the yield and quality of tomatoes, and how tomatoes affect other crops.

Three sets of rotation areas were arranged. The whole area was planted to Jackson No. 1 barley during the fall of 1944. The various grasses and legumes were planted in their respective plots in the spring of 1945. The barley was harvested the first summer and produced a very low yield. The first rotation area was plowed in the winter of 1945. Tomatoes were planted in the spring of 1946. Yields were fair, averaging about 9 tons per acre.

The second area was set in tomatoes May 4, 1947. The yields from these plots were high, averaging slightly under 13 tons per acre, and the quality was fine.

The third rotation area was set to tomatoes in 1948.

There was very little difference in yield between the treatments. Soil high in organic matter gives large yields of large fruits. According to the records, the large fruits are produced during the first 2 weeks of harvest. As the season advances the fruits become smaller. It appears that no great difference results from the different treatments. The essential thing is to incorporate vegetable matter in the soil. Planned rotation will conserve the soil and improve the tilth.

BUSH-BEAN VARIETIES

The quality of beans is closely related to yield and optimum growth. Any unfavorable condition, such as drouth, high temperature, or mechanical injury, that depresses yield will impair quality. Tender-green and Giant Stringless varieties have been losing in popularity

because of the large number of flat and "greasy" pods that are being brought to the canning factories. The records show that they are rather poor yielders in comparison with recently introduced varieties. Local canners look with favor upon these new varieties because they grade out well and produce fine-flavored canned products. They can be considered as drouth-tolerant. Data accumulated during past years substantiate this statement—a factor which is well worth considering where irrigation is not available.

Two inches of irrigation water applied when pods were forming almost doubled the yield of all varieties. This shows the bean plant's need for water at one of the critical stages in its growth. The following table gives comparative acre yields of grade-A beans, by varieties, under irrigation and nonirrigation:

B1801-7	373	177	Logan	197	109
1625-17	303	153	Dixie Bell	186	106
Topcrop	289	176	B1515-1-7-1-5	179	109
Rival	265	125	Black Valentine	175	103
Cherokee	233	110	Tendergreen	131	78
Supergreen	215	110	B1661-7	117	69

CLIMATIC CONDITIONS

The main factors responsible for low yields in 1948 were lack of rainfall for long periods and excessive rainfall for short periods. The 1948 total rainfall for the months of May, June, July, August, September, and October was 16 inches, which compares favorably with that of 1944 (17 inches) and of 1946 (13 inches). There were 8 drouth periods in 1948, which included 112 days without rain. In April and May, rains were two weeks apart and severe drouth was experienced. Sufficient moisture was supplied by rain in June, July, and August, the total rainfall during this period being 10.50 inches. Diseases, related to adverse weather, were largely responsible for low yields and low-quality products in 1948.

With the exception of 1945, each of the past 5 years had drouth periods during which irrigation was needed.

A study of rainfall records from Jefferson County indicates that irrigation is a "must" for vegetable production on upland soils in the Dandridge area.

PLANT PATHOLOGY

C. D. Sherbakoff

WHEAT BREEDING FOR RUST RESISTANCE

Our wheat-breeding work aims at developing rust-resistant varieties suitable for culture in Tennessee. The 3 new varieties — Tenn. 47:13, Tenn. 47:1-20, and Tenn. 46:1—previously selected for rust resistance and for apparently acceptable yielding ability, became available for regular yield tests, and in the fall of 1947 were submitted to the Agronomy Department. The new wheats, together with Fulcaster 612, Thorne, Vigo, and Carala, were tested at 6 stations located in

different parts of the State. The 3 new Tennessee wheats were the highest-yielding varieties in the test. More detailed information is given in Bulletin No. 208, from the Agronomy Department.

There were 154 blocks, consisting of 6 rod rows each, of wheats selected from the preceding season's head rows. Nearly half of these selections were from 1946 head-row selections of Tenn. 46:1. In 1947-48 these were grown on the river-bottom land, at Knoxville, where conditions for rust development are very favorable and where wheat has been grown continuously since 1921. Of these wheats, 30 were selected for their disease and lodging resistance and their apparent ability to produce good yields of good kernels. In October, 30 of these wheats were planted, with an 8-row grain drill, each of them one drill across the range⁷, on land having good air drainage. Then 9 of those that were available in sufficient amounts were again repeated 4 times with Vigo and Tenn. 2 as checks. There was no damaging rust or any other disease in this test. The average yields per acre, of 5 plots each, were: Tenn. 2—47.9 bu.; 48:8—40.5 bu.; 48:7—40.3 bu.; 48:6—39.9 bu.; 48:5—39.8 bu.; 48:9—39.2 bu.; 48:4—38.6 bu.; Vigo—37.6 bu.; Tenn. 46:13—37.1 bu.; 48:1—36.8 bu.; and Tenn. 47:1-20—36.1 bu. This yield test showed (1) that under usual Tennessee conditions, and in the absence of damaging rust attack, Tenn. 2 is still the highest-yielding wheat; (2) that several of our new rust-resistant wheats appear to be as high-yielding as the best rust-susceptible ones with the exception of Tenn. 2, even in the absence of damaging rust; and (3) that some of the rust-resistant wheats of better kernel quality and resistance to lodging may soon be recommended for culture in the State. It is necessary first to increase the more promising wheats sufficiently for tests not only of their yields and resistance to disease and lodging in various parts of the State, but also of their suitability for different flour-mill requirements.

Hence, in October, the following wheats were planted for increase: the 9 which were included in the 1947-48 Plant Pathology yield test reported above, each on about an acre plot, at Greeneville Tobacco Station; 13 of the selections from those grown in the 1947-48 season in plots of one grain drill, and 2 of bulked head-row selections of certain lines, each on plots from 1/10 to 3/10 acre, on Blount Farm; and 32 selections from rod-row blocks of the 1947-48 season on plots of 1/60 acre each at Knoxville.

The 2294 head selections planted in the 1947-48 season gave over 600 selections segregating for awned and awnless heads and other characters, and over 300 nonsegregating head-row selections. These were made on the basis of freedom from disease, resistance to lodging, and apparent vigor. After the selected nonsegregating heads were threshed, 125 head rows were saved and planted in October, at Knoxville, in 3-row plots across the range. The 600 segregating head-row selections were all threshed by hand, individual heads separately. Of these, 3264 heads were saved and planted, in 7-foot rows, with individual kernels spaced about 6 inches apart. Each of the best-looking 651 heads was repeated in the same manner, only half the kernels of each head being used each time. These wheats were planted on river-

⁷ The range is 60½ feet wide, unless otherwise stated.

bottom land where wheat had been grown continuously since 1921 and where rust and other diseases, as well as lodging, usually occur in more severe forms than on other ranges.

The study of segregations occurring in progenies of the complex hybrids produced for rust resistance has shown that some of the desirable characters seem to be recessive. Softness of head, for example, may appear first not in an entire rod row, but in a single plant, and even in a single head, and hence may be easily overlooked, especially in fair-sized lots. Therefore, in addition to head and head-row, selections have been made of individual kernels from all breeding lots of rod-row size or larger. Usually from 30 to 100 or more kernels are selected from each lot, depending on the number and attractiveness of the kernels found. From the wheats harvested in June 1948, at Knoxville, the following selections were made: 4 lots of 30 kernels each, 42 lots of 50 kernels each, and 92 lots of 100 kernels each. The kernels were planted in October 1948, at Knoxville, from 5 to 7 inches apart.

Because of the high-yielding capacity of Tenn. 2, efforts to improve this wheat were continued, by means of head-row selections. During the 1947-48 season there were 124 head rows of this wheat. One of the rows appeared to be earlier-maturing and several were definitely more uniform in the kernel characters. These were planted in spaced kernel head rows, in October 1948, at Knoxville.

One of our oldest rust-resistant selections appeared to be generally a good wheat, but it was too hard for this section. About 100 head-row selections of this wheat were grown in 1947-48. Of these, 3 head rows were planted with uniformly soft and very attractive kernels. For rapid increase, each of the head rows was diluted about 4 times with dead kernels (autoclaved and dried) and drilled with a Planet Jr., each in 24 rows across the range.

COTTON BREEDING FOR WILT⁸ RESISTANCE

In the cotton-breeding work, 147 selfed and 20 open-pollinated lines were grown at Knoxville. Through the cooperation of Dr. A. L. Smith, small lots of the open-pollinated lines were grown also at Tallassee, Alabama, on land where cotton is severely attacked by wilt. In the Alabama test, 4 of the lines were entirely free from wilt; 7 were more or less resistant or tolerant; and 9 were severely affected.

At Knoxville, a number of individual plants were selected in the field before the first picking; all the selfed and open-pollinated bolls were saved. The latter were used to determine lint percent and boll size. The lint samples, of acceptable lint percent and boll size, were submitted to the Physics Department for determination of the staple length, strength, and fineness. The characters of 308 individual selections from the lines selfed in 1947, and of 72 samples of bulk lots of lines open-pollinated in 1947, were thus evaluated. The characteristics of the 9 most interesting individual plant selections of 1948 are given in table 31.

The staple length and strength of a number of bulked open-pollinated seed lots indicate that we already have some cottons with about $1\frac{1}{4}$ -inch staple of 7.50 or better strength. However, at present

⁸ Caused by *Fusarium vasinfectum*.

Table 31—*Main characteristics of the more promising single-plant selections of cotton from wilt-resistant lines, compared with Coker 100 Wilt.*

Breeding line in 1948	Turnout	Length	Strength	Fineness	Bolls per pound
Number	Percent	Inch	Lbs./Mg.	Cm. ² /Mg.	Number
35	37.6	1.25	8.45	3.57	66
44	39.2	1.22	6.87	3.25	45
46	37.5	1.24	8.52	3.32	64
54	35.8	1.17	8.74	3.04	67
72	36.6	1.43	6.94	3.04	60
84	55.0	1.31	7.40	3.36	49
115	43.0	1.20	7.83	2.86	63
116	39.1	1.25	8.21	3.01	63
140	37.9	1.42	7.18	2.85	54
Coker 100 Wilt (Avg. 3 samples)	38.1	1.12	6.75	2.68	63

the yield of these wilt-resistant cottons is definitely not on a par with that of the best-yielding varieties—DPL, Stoneville 2B, and others—and therefore the yielding capacity of the resistant cottons has to be increased before they can be introduced to Tennessee growers.

TOMATO WILT AND EARLY BLIGHT

The search for better-performing, wilt-resistant varieties of tomatoes and for varieties less affected with early blight was continued.

Field tests and artificial inoculations with the wilt fungus⁹ show that at present there are several varieties entirely resistant to wilt and high in total and early fruit yield. The field tests were conducted by the Plant Pathology Department at Knoxville, Jackson, and Springfield. The Horticulture Department conducted a yield test which included a number of the same varieties. The artificial inoculation tests were conducted at Jackson and Knoxville. At Springfield, the test was ruined by dry weather. The data show that Tucker's S-6-17 and Beltsville 46CS24 (STEP 57), which are highly resistant to wilt, appear to be best in both total and early yields. There are other tomatoes—for example, Southland, CrW 194-1, some crosses of Pl. Path. 57, and several new tomatoes tested at Jackson—that are not significantly lower in yield than the 2 varieties named above. Some of these have a distinct advantage in being resistant to certain other diseases as well as wilt. Of these, Southland deserves special mention because of its resistance to stem canker and late blight. At present it is impossible to say which of the tomatoes is best under all the conditions found in the State. Moreover, it is necessary to determine the suitability of the different tomatoes for canning and for greenwrap. In the tests of the coming season these factors will be given attention.

At present, Tucker's S-6-17, Beltsville 46CS24, and Southland seem to be the best of the highly wilt-resistant varieties for canning and greenwrap in Tennessee. Southland is not on the market. Still more promising varieties are in the making.

There are other factors essential to success in tomato culture. The most important of these are suitable soil, its timely preparation, the

⁹ *Fusarium lycopersici*.

right kinds and amounts of fertilizer, early planting—as soon as the danger of late freeze is past—and use of disease-free, sturdy, well-rooted plants. During the last several years late blight has been very destructive in some fields, so that dusting or spraying with fixed copper or other suitable fungicides appears to be indispensable.

Tests are being conducted for control of fruit rot on unstaked tomatoes, through resistant varieties, effective fungicides, and cultural practices. Rot in some cases destroys more than half of the total fruit produced on the plants. Indications are that certain cultural methods and the use of fungicides may be helpful in reducing the damage.

RED CLOVER BREEDING

The hay-yield test of 3 varieties of red clover—Cumberland, Tennessee Resistant, and our new Purple Seeded—at Jackson, was discontinued during the second season, after the first cutting, because of the poor stand of the first 2 varieties and the heavy weed growth. There was still a good stand of healthy plants of Purple Seeded. The first cutting gave the following hay yields in tons per acre: Tenn. Resistant, 0.66; Cumberland, 0.88; and Purple Seeded, 1.03.

Approximately 2 acres were sown to Purple Seeded clover, with seed saved from the best lines, for increase and further testing and selection.

The selection of more vigorous individual plants of the Purple Seeded clover has been continued. Seed saved from the individual plants are grown in the greenhouse and seedlings set out in the field, 1 foot apart, in double rows. The off-type and weak plants are discarded before open-pollinated seed from the saved plants is harvested, for increase and further testing.

All of the work with red clover reported above was performed by James M. Epps, at the West Tennessee Station, Jackson.

Uniform nursery tests are carried on at Knoxville, in which 7 clovers from other experiment stations are compared with the Purple Seeded variety. So far, Cumberland and Kenred, the latter especially, appear to be more vigorous at the beginning of the season; however, in later cuttings, and especially during the next season, the Purple Seeded appears to be at least on a par with the other two.

STRAWBERRY BREEDING FOR RESISTANCE TO BLACK ROOT

From the many strawberry crosses made and grown, in an effort to find black root-resistant strawberries, only 3 appeared to be worth further testing and breeding: 48-18, Sport, and W5 x D25.

The strawberry 48-18 is definitely worth trying in home gardens. It would be a desirable companion to Blakemore but for its dark-red color when fully ripe. In yield it is about equal to Blakemore, but from 5 to 7 days later, with good-sized berries of mild flavor to the end of the season. It is free from yellows and is a good plant producer.

Sport is so named because it came up as a sport in the earlier planting of a series of hybrids. The berry is large, cone-shaped, very solid, without a hard core, and of attractive medium-light-red color. It is close to Blakemore in yield, but the berries have very thin skin.

The selection W5 x D25 is one from our earliest crosses. It was originally saved because of the uniform size and attractive shape of the berry—somewhat similar to 48-18, described above.

Because of the threat to Tennessee strawberry culture from red stele disease, it was considered worth the effort to use these 2 strawberries and Temple, a red stele-resistant strawberry that gave a fair performance in our preceding tests, for crossing in all possible combinations. The crosses were made by E. L. Felix in the spring of 1947. The seedlings were grown during the winter of 1947-48, and 1170 of the potted plants were set out in the field, April 1, 1948, at Knoxville. At present the stand and condition of growth are good. A large number of additional crosses were made in 1948 and the seedlings are now growing in the greenhouse, to be planted in the field next spring.

NEW FUNGICIDES

Fermate spraying of red raspberries at Jackson, in 1948, again gave significant increase in yield, and definite control of leaf spot, without injury to foliage or berry flavor.

At the West Tennessee Station, spraying of apple trees, including varieties very susceptible to scab, such as Ben Davis and Red Delicious, with fermate, 2 pounds to 100 gallons, in all cover sprays, gave thorough control of scab.

Spargon, 4 ounces to 100 pounds, appeared to give increased stand when used for treatment of soybean seed affected with purple spot (*Cercospora*).

"Soil rot" of tomato fruit on unstaked plants at Knoxville, caused mainly by *Phytophthora* and *Rhizoctonia*, seemed to be reduced by copper oxychloride sulfate, 90 pounds to an acre. Spraying with bordeaux, fixed coppers, and several dithiocarbamates showed no significant differences in tomato yield, at Knoxville and Jackson, in the absence of late blight and with moderate infection with early blight. Copper chromate and dithane D-14 plus zinc sulfate gave the highest tomato yield at Knoxville. The last-named fungicide, plus a large amount of DDT, gave the highest yield of potatoes at Crossville, though none of the treatments gave yields significantly different from the check. Several fungicides were tested on cantaloups. In the absence of sufficient damage from the diseases, even on the checks, no conclusions can be reached as to the value of these chemicals. Certain stickers, acting also as spreaders, appear to be good for use with fungicides.

PLANT PATHOLOGY AT WEST TENNESSEE STATION

Jackson

James M. Epps

TOMATOES

The breeding of *Fusarium* wilt-resistant tomatoes and the testing of the various lines were continued in 1948. During the previous year, crosses were made between 9 commercial varieties and 3 wilt-resistant varieties. The resulting 27 crosses were then crossed with the Bonny Best, Stone, and Greater Baltimore varieties. These crosses were made

in the greenhouse in the early spring. Seeds of all of them were planted and the plants set in the field.

Several wilt-resistant lines that have shown promise in the past were planted in a variety test to compare them as to yield, quality, and disease resistance with some commercial varieties. Some of these gave a considerably higher yield than Marglobe and were earlier. Essary gave the highest yield for the first two pickings and ranked 5th in total yield of marketable fruits. Three of the Station's lines were among the highest yielders in the test. Marglobe ranked 8th.

Forty-eight lines were tested for wilt resistance and yield. From these, 36 were selected for further studies because they were completely free of wilt and had other desirable characters. Some of these have been selected for 5 generations and are uniform for some of their plant and fruit characters.

A preliminary test of certain methods of control of tomato fruit rot, caused by soil fungi, principally *Rhizoctonia solani*, on unstaked plants, was made in 1947. Because of the very dry season, there was not enough fruit rot to show the effectiveness of any of the treatments. In a repetition of the test this year, the yield of sound fruit on plots of tomatoes unstaked but mulched with straw on ground treated with bordeaux, was as good as that on the plots with staked tomatoes.

As new tomatoes are introduced into this country seed are sent to experiment stations for observational plantings. Eighty-three new lines have been received and some of these may have value in the tomato-breeding program.

Several fungicides were evaluated for the control of tomato diseases. These fungicides were used in both spray and dust forms. Of the sprays tested, parzate gave the highest yield, followed by bordeaux, copper zinc chromate, and tri-basic copper. The dithane-sprayed plot had the lowest yield of marketable fruits. Of the materials tested as dusts, the tri-basic copper gave the highest yield, followed closely by dithane. The other fungicides used as dusts did not increase the yield over that of the untreated plot.

RED CLOVER

Attempts at further improvement of the anthracnose- and mildew-resistant purple-seeded red clovers were made. The variety test was discontinued after one cutting because many of the plants of Tennessee Resistant and Cumberland died the previous year. The plots of these two varieties had heavy weed growth in comparison with that of the Purple Seeded plot, which had maintained a good stand of healthy clover plants. The first cutting, in spite of the weeds in the two varieties, gave the following yields of hay per acre: Cumberland .88 ton, Tennessee Resistant .66 ton; and purple seeded 1.03 tons per acre.

Approximately 2 acres was seeded with seed saved from the best Purple Seeded line. Seed from this acreage will be used for further increase and testing.

WATERMELONS

The breeding of Fusarium wilt-resistant watermelons was continued, with the improvement of some of the present breeding lines as



Fig. 51—A high-quality wilt-resistant watermelon.

the objective. Crosses were made between the new Miles variety and several tough-rind varieties. Some of the best breeding lines were grown in soil infested with wilt, and crosses were made to improve their resistance and quality. Miles (fig. 51) continues to be one of the highest-quality va-

rieties in the test and has been free of wilt when planted in heavily infested soil. Arrangements were made with the Associated Seed Company to produce seed of the new Miles variety. These seed will be available to the public for planting in 1949. This variety is recommended because of its resistance to wilt and its good quality.

STRAWBERRIES

A test is under way to evaluate the use of green-manure crops in strawberry root-rot control. A study is being made on the amount of root rot in strawberries following the turning under of one crop and of two crops of soybeans as green manure. The strawberries resulting from these practices will be compared with those grown where no soybeans were turned under. This test was started in 1947 and will run for at least 3 more years.

COTTON

Samples of seed cotton were collected from 8 varieties and sent to the Southern Regional Cotton Research Laboratory for chemical analysis. Unweathered and weathered samples of seed cotton were sent to the U. S. Department of Agriculture for viscosity, fiber deterioration, and wax-analysis studies.

POULTRY

O. E. Goff, H. Patrick, B. J. McSpadden,
D. E. Cooperrider, and J. T. Tumlin

QUALITY OF TENNESSEE-PRODUCED CHICKS

The quality of Tennessee-produced chicks was measured during the hatching season of 1948 through the cooperation of 10 Tennessee hatcherymen and 352 flock owners.

The 352 chick buyers started 60,118 baby chicks. Total mortality from all causes, including accidents, loss from rats, chilling, overheating, and diseases, through the first 21 days of brooding was 1305 chicks, a loss of 2.15 percent of all chicks started. The chick livability

of 97.85 percent through 21 days is an indication that Tennessee hatcherymen are following a good selection and pullorum disease control program. A greater percent of the Pullorum Passed chicks were alive at the end of the 21-day period than of the Pullorum Controlled chicks.

A few buyers started 5000 chicks; the majority, however, started 50 to 200. The average number of chicks started per brood was 171. Greater efficiency of production should result if the number of chicks started per farm and per brood were increased. Under farm conditions, 300 baby chicks in one colony-type brooder house, under one brooder stove, makes a more desirable unit.

THE ANIMAL-PROTEIN FACTOR (VITAMIN B₁₂)

Data on the growth-promoting activity found in fish solubles and fish meal, used to supplement poultry rations containing soybean-oil meal as the principal protein concentrate reported in 1947, demonstrated the vitamin-like nature of this substance. The experimental procedure employed during 1948 was similar to that described in last year's report.

These data indicate that the growth-promoting substance in fish solubles, the animal-protein factor (both natural and synthetic), and vitamin B₁₂ are the same nutrient. The interrelationship of this nutrient and methionine also is indicated.

Perosis, poor growth, and abnormal pigmentation were associated with a deficiency of vitamin B₁₂.

CONTROL OF INTERNAL PARASITES

The problem of parasite control and prevention under farm conditions has not been solved. In a trial to secure information regarding this problem, pullets were allowed to range on yards planted to alfalfa, spring oats, and lespedeza and spring oats, and a yard scraped bare of green feed.

At maturity, the birds were confined for one laying year. At the time of confinement, the lots were divided into 2 principal groups. Group 1 consisted of 47 pullets, each of which was given one commercially prepared phenothiazine-nicotine capsule. Autopsy reports at the end of the trial revealed the fact that of the 47 pullets in the treated group, 37 were infested with *Ascarid* (the common round worm), while all of them were infested with *Heterakis* (cecal worm). Of the 54 control birds, 33 were infested with *Ascarid*, while 49 were infested with *Heterakis*.

Little difference in egg production, efficiency of feed utilization, and body weight was observed between the treated and untreated groups. Additional data will be required for proper evaluation of the promiscuous treatment of farm flocks.

INCIDENCE OF INTERNAL PARASITES

One hundred and one pullets were autopsied after confinement in laying houses for from 6 to 13 months. The incidence of the internal parasites infecting these birds, grown under various range conditions and later maintained in confinement, is presented in table 32.

Table 32—Incidence of internal poultry parasites.

Type of range	Total birds	Ascaridia galli (Roundworm)				Heterakis gallinae (Cecal worms)				Capillaria sp.				Cestodes (Tapeworms)	
		Birds parasitized		Parasites		Birds parasitized		Parasites		Birds parasitized		Parasites		Birds parasitized	
		Num-ber	Per-cent	Num-ber	Avg. per bird	Num-ber	Per-cent	Num-ber	Avg. per bird	Num-ber	Per-cent	Num-ber	Avg. per bird	Num-ber	Per-cent
Bare lot	27	13	48.1	243	18.6	27	100.0	1576	58.3	414	40.7	11	37.6	15	55.5
Spring oats	25	23	92.0	244	10.6	24	96.0	2110	8.0	198	44.0	11	18.0	15	55.5
Spring oats and lespedeza	21	15	71.4	177	11.8	19	90.4	1757	92.4	39	26.3	5	7.8	9	36.0
Alfalfa	28	19	67.8	343	18.0	26	92.8	1844	70.9	151	32.1	9	16.7	7	25.0

RESISTANCE OF INBRED CHICKENS TO COCCIDIOSIS

Under a cooperative agreement between the Regional Poultry Research Laboratory, East Lansing, Michigan, and the Poultry Department of the University of Tennessee, a study is being made of the possibilities of resistance of Single Comb White Leghorns to internal parasites.

A total of 228 inbred Single Comb White Leghorn cockerels were secured from the Regional Poultry Research Laboratory and inoculated with *Eimeria tenella* in doses varying from 2500 to 15,000 sporulated oocysts. After inoculation, each bird was weighed daily for 10 days. At the end of each trial, all birds were sacrificed to observe degree of infection. Incidence of lesions related to avian lymphomatosis (lesions of fowl paralysis complex) was secured. All cockerels were divided into 2 groups according to their breeding for resistance or susceptibility to avian lymphomatosis. Little difference in resistance to coccidiosis was noted between the groups, when resistance was measured in terms of weight variations.

IMPROVEMENT OF POULTRY THROUGH BREEDING

The improvement of poultry through breeding involves egg production, hatchability, fertility, livability, and resistance to diseases and parasites. In 1947-48, the study involved 10 pens of Barred Plymouth Rocks. Matings consisted of brother x sister, son x dam, half-brother x half-sister. Approximately 2500 baby chicks were hatched from these inbred lines. Each line has been selected for vigor, rate of growth, degree of feathering at 8 and 12 weeks of age, body conformation, hatchability, egg production, and egg size. Many families have been discarded because of low vigor or poor egg production, hatchability, feathering, rate of growth, or meat quality. In general, those lines

possessing a high degree of meat quality have produced fewer eggs. Data on hatchability reveal marked differences between lines and families. The hatchability of all fertile eggs ranged from 11.4 percent

in one inbred line to 73.7 percent in another. Hatchability for individual hens ranged from 0 to 100 percent. Hatchability is inherited.

It is necessary that inbred stock be rigorously selected for hatchability if the lines are to persist. Only lines with a hatchability of

over 65 percent and families with a hatchability over 85 percent of all fertile eggs set have been placed in breeding pens. From a hatchability standpoint, lines R-7, R-8, R-9, and R-10 are inferior. These lines have eliminated themselves.

Percent fertility ranged from a low of 35.9 for line R-9 to a high of 82.5 for line C-5. The pens with the highest hatchability of all eggs set did not necessarily have the highest percent of fertility. Many fertile eggs failed to hatch. In these studies it was found that 7 hens failed to produce a single fertile egg, while 30 hens produced eggs of which less than 50 percent were fertile.

It is reported that fertility is a physiological condition varying in individuals and not to be attributed to inheritance. On the basis of the data accumulated at this Station, it is evident that the problem of fertility in chickens needs additional study.

All incubated eggs

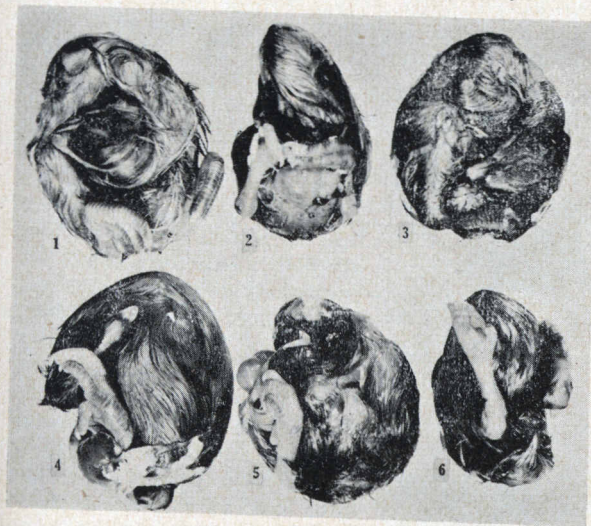


Fig. 52—Malpositions.

1. "Normal" embryo, with head in large end of egg and under right wing. 2. Head in large end of egg but under left wing. 3. Head in small end. 4. Head in large end, but over left wing. 5. Head in large end, but twisted away from air cell. 6. Head in small end of egg, covered with both feet.

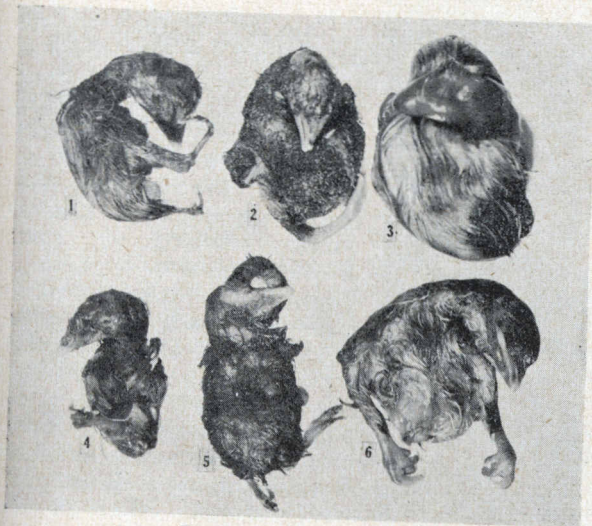


Fig. 53—Malformations.

1. Thin, undeveloped embryo. 2. Thin, undeveloped, showing a creeper condition of shanks and a cranial hernia. 3. Strangled with yolk stalk. 4. Thin, undeveloped, showing cranial hernia. 5. Thin, undeveloped, exhibiting a parrot beak. 6. Creeper condition in the shanks.

that failed to hatch were broken out and the embryos examined for malformations, malpositions, and age at death. The majority of embryos classified as dead germs or dead in the shell, failed to survive the 18- to 21-day critical incubation period, although well developed for their respective ages. All unhatched eggs from several hens contained embryos in malposition. The most common malpositions and malformations observed are shown in figures 52 and 53. The most common

malpositions encountered were those with the head of the embryo in the small end of the egg, head covered with one or both feet, and head in large end of the egg but turned away from the air cell. Malformations encountered included "parrot" beak, short shank, imperfect closure of the cranial cavity, double-bodied embryos, and thin, undeveloped embryos. Several of the hens produced these abnormalities at a rather high rate. From the data collected in these studies, it appears that many of the malpositions and malformations are characteristic of the individual hen and may be hereditary.

Rate of feathering was determined for each chick at 1 day, 2 weeks, 8 weeks, and 12 weeks of age. When chicks were 8 and 12 weeks of age, each was placed in one of the 3 arbitrary feather-development grades, which consisted of rapid, medium, and slow feathering. Figure 54 shows a typical example of each group. No chicks were found exhibiting sex-linked rapid feathering, but many did exhibit complete feathering at 8 weeks of age. Other birds exhibited slow feathering well after 12 weeks of age. Many of the medium-feathered birds at 8 weeks of age were found to be completely feathered at 12 weeks.

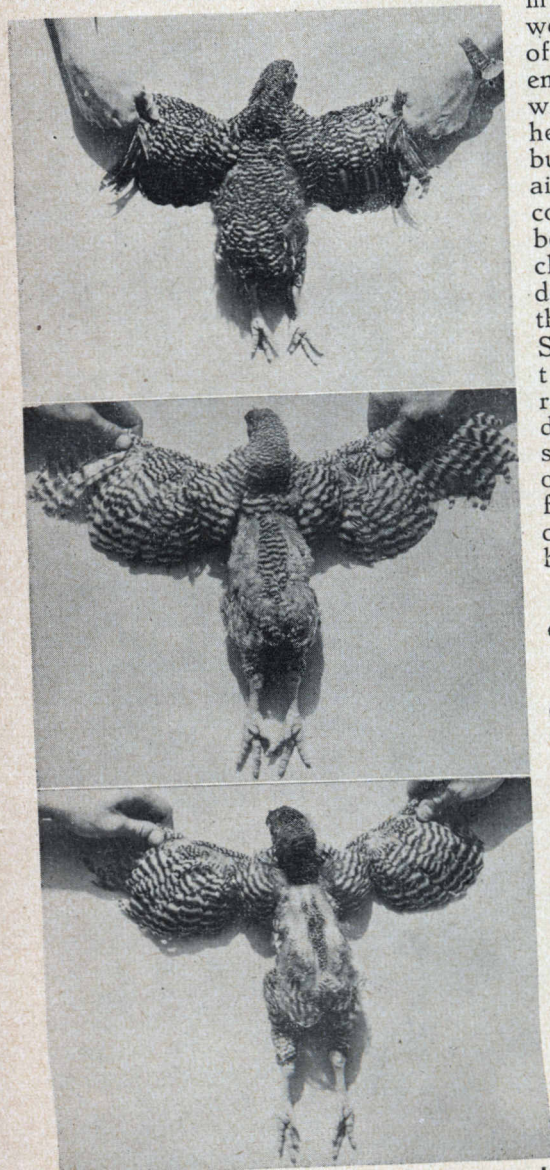


Fig. 54—Top to bottom: Rapid-, medium-, and slow-feathered Barred Plymouth Rock pullets at eight weeks of age.

BREED RESISTANCE TO COCCIDIOSIS

Considerable individual differences in susceptibility to the ravages of coccidiosis have been observed. It appears highly desirable to identify and establish a strain of chickens resistant to this disease. To identify possible individuals or families of inbred Barred Plymouth Rocks, 509 chicks were individually inoculated with varying doses of sporulated oocysts of *Eimeria tenella*. These chicks were weighed daily for a 10-day period immediately following inoculation. At the end of this period, all chicks were sacrificed to determine the effects of the disease upon the individual.

When resistance was measured in terms of weight variation and rapidity of recovery, certain individuals and lines appeared to possess different degrees of resistance to this disease.

Individuals from families possessing high and low degrees of resistance to coccidiosis will be selected and matings made in an effort to establish resistance and susceptible lines.

SOLVENT-EXTRACTED COOKED COTTONSEED MEATS IN CHICK FEEDING¹⁰

This project was conducted cooperatively by the Engineering Experiment Station and the Agricultural Experiment Station. The object was to determine the effect of various fat solvents on the biological value of cooked cottonseed meats.

Cottonseed meal, for many years considered to be of questionable value as a poultry feed, has recently shown promise as a protein supplement for poultry. This improvement was produced by the development of solvent methods for removing the oil and toxic substance in the meats. Many such methods are described in the literature. The value of cottonseed meal in the chick ration after treatment with given fat solvents was studied during the year.

The solvents used included methanol, iso-heptane, iso-octane, ethanol, iso-propanol, benzene, n-pentane, n-heptane, skellysolve B, iso-hexane, and trichlorethylene.

Measured in terms of chick gain, the cottonseed meal extracted with iso-octane was superior to the meats extracted with other solvents utilized.

GROWTH VALUE OF PROTEIN CONCENTRATES

The biological value of several common protein feedstuffs used in Tennessee feeds was determined. The rat-growth assay-test procedure was followed, which involved the use of a simplified basal ration calculated to be adequate in all known nutrients except protein. The protein supplement supplied each group with 12 percent protein in the completed ration.

The ranges in weekly gain per rat fed the various protein supplements in the basal ration were: meat scraps, 2 to 9 grams; meat meal (So. American), 11 grams; Menhaden fish meal, 14 to 28 grams; herring fish meal, 16 grams; expeller-processed soybean-oil meal, 12 to 18 grams; solvent-extracted soybean-oil meal, 14 to 18 grams; hydraulic-extracted soybean meal, 12 grams; hydraulic-extracted cottonseed meal,

¹⁰ J. W. West and J. A. Glass, graduate students, assisted in conducting these tests.

12 to 13 grams; solvent-extracted cottonseed meal, 12 to 14 grams; corn-gluten meal, 5 grams; and milk casein, 18 to 23 grams.

PASTURES FOR GROWING STOCK

Maximum use of green feed for growing poultry would be expected to reduce the cost of flock replacements. In an effort to secure maximum utilization of a range consisting of bluegrass, crabgrass, lespedeza, and white Dutch clover, 108 New Hampshires were divided into 2 lots and pastured on this range from 13 weeks of age to maturity. Lot 1 received mash and grain free choice. Lot 2 received a grain mixture and a mineral mixture, available to them early in the morning and late each afternoon.

The pullets receiving grain and mash were 10 percent heavier at 24 weeks of age than the grain-fed pullets. The cockerels were 6 percent heavier. The pullets receiving mash and grain came into production at 22 weeks of age, one month earlier than the grain-fed birds. The pullets receiving grain and mineral mixture developed good frames, but were thin and undeveloped when compared with the better-fed group.

In the second trial, 113 White Plymouth Rocks were divided into 2 groups and placed in separate range shelters on the same type of pasture used for the New Hampshires. Lot 3 had mash and grain available at all times. Lot 4 received this same ration early each morning and late each afternoon, but received only pasture daily from 9 a.m. to 4 p.m.

After a range period of 10 weeks the average weight of the full-fed White Plymouth Rock pullets was 4.5 pounds, compared with 4.1 pounds for those receiving a restricted ration. A ration consisting of mash and grain, available to growing stock at all times, while on range, was superior to the other combinations used.

INFLUENCE OF PASTURE ON EGG QUALITY

Two lots of pullets fed a balanced ration but having access to different green feeds were used in a study involving egg quality as influenced by type of green feed. Lot 1 was permitted to range on a pasture planted to ryegrass, wheat, and oats, each crop being planted in a separate area. Lot 2 was allowed a range planted to ryegrass, barley, and rye. No preference was shown by the hens for any of the green feed while the plants were young and tender. In May, they preferred the ryegrass.

Over a 5-month period, 194 eggs were candled and broken out for examination from pen 1, and 161 eggs from pen 2. The Van Wagenen index was used in evaluating the quality of broken-out eggs. A score of 1 indicates the highest quality in eggs; a score of 4, low quality. The Hyman Carver Color Rotor was used in determining yolk color. The lower the score the lighter the yolk color. Essentially, no differences in yolk color or range in yolk color existed between these lots.

Individual hens were a factor in the occurrence of blood and meat spots. Thirteen hens in lot 1 produced one or more eggs showing meat or blood spots; 4 hens were responsible for 48.8 percent of all

eggs containing blood spots. In lot 1 a total of 9 hens produced eggs with meat and blood spots; 3 hens produced 65.2 percent of the eggs showing this defect. Of the eggs produced in lot 1, 22.1 percent contained meat and blood spots, while 14.3 percent of all eggs produced in lot 2 exhibited this undesirable feature.

A second trial involving 2 pens and the same type of pasture gave similar results. It appears that no significant differences existed in the influence of pasture on yolk color or egg quality.

HIGHLAND RIM EXPERIMENT STATION

Springfield

Dennis H. Latham

LAND, BUILDINGS, EQUIPMENT

The remainder of the Mericourt Farm, at Clarksville, was sold in 1948. The Station still has access to the pear orchard, however, and is continuing the work on blight-resistant pears.

A 100-acre tract of land adjacent to the Highland Rim Station was purchased during the year, with right of possession January 1, 1949. This new addition is designated as the Russell Farm. It contains about 85 acres of cultivable land and 15 acres of woodland. All merchantable timber was cut about three years ago. There are a number of acres suitable for plot work, the major portion being either Dickson or Sango silt loam. The buildings and other improvements are of little value.

A 36-foot addition to the machinery shed was built during the year, part of which will be used primarily for fertilizer storage.

A garden-type Gravely tractor and mower, a seeding cultipacker, and a grader blade for use on a farm-type tractor are the only pieces of equipment purchased.

A deep-well pump was installed in well No. 3 during the summer. Additional facilities for watering livestock on the Simmons Farm were made available by enlargement of the small pond.

About one mile of 47-inch woven-wire fence was constructed during the year. Where practicable, electric fencing was used to provide additional space for temporary pasture.

WEATHER

The year 1948 was characterized by variable weather. The total precipitation was 47.90 inches, only 1.76 inches below the average annual rainfall for the State. During the last 5 years a total monthly precipitation greater than 7 inches has been recorded at the Station only 4 times, and 3 of them occurred in 1948. The rainfall for August measured only .31 inch.

TOBACCO

Dark Fire-Cured, Type 22.—Breeding and selection for resistance to tobacco mosaic were continued. Ten lines, including Ky. 160, a mosaic-resistant dark air-cured tobacco, were field-tested for yield and quality. Several of the mosaic-resistant tobaccos appear promising, in comparison with Madole No. 1, the standard variety used as a check.

In testing several commercial lines or varieties of dark tobacco, grown on Dickson silt loam, it was found, from a 2-year average, that Madole No. 1 had an acre value more than \$50.00 above that of Ozark, the second highest in acre value.

Because of the dry weather during the month of August, the fourth deep plowings, in the cultivation tests, were not made in these plots. In general, the 1948 data agree with those of earlier tests in that more than two deep plowings cut the acre value of the tobacco. The plots worked with only a 14-tooth harrow gave the highest average value in the 1947 and 1948 tests.

The tobacco fertilization and rotation study, initiated in 1946, was continued. Madole No. 1 was used in all plots. All fertilizers were applied at the rate of 600 pounds per acre and all manure at 10 tons per acre. The data from the 1948 crop agree with those of 1946 and 1947. A substantial increase in acre value is shown by all treatments in which manure was used.

A replicated test of the effect of height of topping on yield and value of dark tobacco was started this year. The tobacco was grown on Dickson silt loam soil. Fertilization consisted of 3-9-6 fertilizer at 1000 pounds per acre plus stable manure at about 4 tons per acre. The manure and about 750 pounds of the fertilizer were applied broadcast and worked into the soil. The remainder was put into the rows.

The lower leaves on the plants that ordinarily would not be harvested were removed and the plants were topped to the desired number of leaves. From this first test it appears that the height of topping has a direct bearing on the yield and acre value. The tobacco topped with 10 leaves to harvest had an acre value of \$526.00, and that with 14 leaves had a value of \$637.00.

In a spacing test with dark tobacco, the plants were set 30, 36, 42, and 48 inches apart in the row. The preliminary results indicate that closer spacing than the customary 42 inches would be profitable. The test will be repeated.

The breeding program aimed at developing varieties of dark fire-cured tobacco that will be resistant to such diseases as black root rot, wildfire, and black shank is still under way; but neither black root rot nor wildfire was sufficiently prevalent this year to furnish worth-while data. The black shank project is conducted off the Station. None of these projects is far enough advanced to be discussed at this time.

The spraying of tobacco plantbeds for control of wildfire and downy mildew gave about the same results as in previous tests; no wildfire developed on either the sprayed or unsprayed portions of the beds, nor did it develop in the fields set with plants from the test beds.

In addition to all beds at the Station, approximately 1200 square yards of plantbeds on 10 farms was sprayed.

Burley, Type 31.—The dry weather in August severely damaged the burley crop. It had to be cut in mid-August because of the burning of the lower leaves. It was not mature, and consequently both yield and value were reduced. The topping test was abandoned and all plots were harvested as one lot. Data showing the 4-year average, 1945-1948, for 10 lines or varieties of burley are given in table 33.

Table 33—Results of burley tobacco variety test, 1945-1948.

Four-year average, 3 replications each year.

Varie'y or line	Stand	Acre yield	Value per 100 pounds	Acre value
	Percent	Pounds	Dollars	Dollars
Greeneville 6	93	1535	42.08	660.73
Kentucky 16	98	1562	40.50	654.43
Greeneville 14	93	1656	38.61	645.24
Barnett	93	1582	39.98	640.63
Greeneville 7	94	1538	40.40	625.83
Kentucky 41A	91	1529	39.74	618.86
Greeneville 15	92	1360	41.31	568.73
Greeneville 10	88	1385	39.98	566.59
Greeneville 13	94	1284	42.76	555.25
Judy's Pride	88	1241	35.83	443.87

In this table, Kentucky 16 is surpassed only by Greeneville 6 in value per acre. In the 1948 test, where a total of 23 lines and varieties were grown, some of them for the first time, Kentucky 16 ranked 13 and Kentucky 41A ranked 15 in value per acre.

CORN

Yields in the Uniform Corn Variety Test fell far below the yields of the past 2 years at this Station. They were well below the averages for comparable tests at the other 5 locations in the State. The poor corn yields probably resulted from insufficient moisture, especially during August.

SWEETPOTATO

In the sweetpotato fertilization study the results were about the same as in 1947. The yield of number 1 potatoes was poor, varying from a low of 32 bushels per acre to a high of 70 bushels.

TOMATO

A tomato variety test, with 10 varieties and 5 replications, was established on Dickson silt loam soil May 5, 1948. Yields were disappointing, varying approximately from 3 to 8 tons per acre. The yields of number 1 fruits varied from less than 1 ton per acre to a maximum of 3.25 tons.

SMALL GRAINS

In the Uniform Variety Test of small grains, 8 barleys, 7 oats, and 7 wheats were grown in replicated plots. The barley yields averaged from 31 to 50 bushels per acre. The oat yields ranged from 97 to 117 bushels. The varieties of wheat susceptible to leaf rust were notice-

ably affected by this disease, and all varieties were affected by stem rust. Leaf and stem rusts combined were the most serious observed on wheat in Robertson County during the last 10 years. The average yield of wheat, in the variety test, ranged from 29 to 35 bushels per acre.

In the experiment with nitrogen on Thorne wheat, as in previous years, Dickson silt loam soil was used and the nitrogen was applied March 1. Data from the 4-year test are given in table 34.

Table 34—Results from nitrogen applications on Thorne wheat, four years, 1945-1948.

Nitrogen application	Per acre	Average yield per acre				4-year average
		1945	1946	1947	1948	
Ammonium nitrate (32.5% N)	Pounds	Bushels	Bushels	Bushels	Bushels	Bushels
	None ¹	10.00	20.64	23.19	29.30	20.78
	50	16.90	31.46	28.08	32.26	27.17
	100	19.29	33.16	29.56	35.32	29.33
	150	20.22	36.34	29.16	38.01	30.93
	250	19.71	39.34	30.08	43.37	33.12
Sodium nitrate (16% N)	None ¹	10.00	20.64	23.19	29.30	20.78
	100	15.35	28.98	27.53	34.76	26.65
	200	17.01	33.12	29.21	36.35	28.92
	300	19.39	35.04	28.27	35.87	29.64
	500	18.26	31.96	25.80	38.62	28.66

¹ The check-plot yields represent an average for 6 plots each year; all other yields are an average of 3 plots each year.

BLIGHT-RESISTANT PEARS

Studies are continuing, in cooperation with the Department of Horticulture, in an attempt to develop a desirable variety of pear that will be resistant to fire blight. A majority of the trees that were set at this Station in March 1947 are making fair growth. Some failed to survive, but most of these have been replaced. The few vacancies will be filled in the spring of 1949. Barley and crimson clover are being used as a winter cover crop.

PEACH VARIETIES

A study of peach varieties adapted to the Highland Rim was started this year. A planting of 200 trees, representing 26 varieties, was made in March. Most of the trees made excellent growth during the year. Because of rough terrain, this orchard was set on the contour. The trees were spaced at intervals of 20 feet on terraces 25 feet apart. The area, except the terraces, is planted to barley and crimson clover as a winter cover crop.

PASTURE STUDIES

The grasses in the pasture fertilization and management study, seeded in August 1947, failed to become well established. A second seeding with the full amount of all grasses, was made on March 10, 1948. The original seeding of legumes made a fair showing and was not reseeded. Only 2 hay cuttings, followed by 2 periods of concentrated grazing, were made on these plots in 1948. This was due primarily to the relatively dry summer months.

The pasture-species test, seeded in 1947, did not become established well enough to furnish reliable data. This test was reseeded, in a new location, September 9, 1948.

ALFALFA

On the alfalfa seed-production plots, all early growth was cut for hay. On some plots subsequent growth was allowed to reach maturity for seed production; on the other plots it was removed for hay. Both hay and seed production was low. Because of poor late growth, no further harvests were attempted.

NEW PROJECTS

The following additional projects were started: Source of phosphate used in a 3-year rotation for growing corn, wheat, and red clover; a pasture species study; alfalfa and red clover variety tests; a permanent-pasture study involving methods of seeding; and a grass- and legume-species study.

MIDDLE TENNESSEE EXPERIMENT STATION

Columbia

John A. Ewing, Superintendent

EFFLUENCE

The effluence from the local phosphate chemical industry has injured the livestock and crops at the Middle Tennessee Experiment Station. Under existing conditions it is not practicable to raise replacement dairy cattle, beef cattle, and sheep. It is impossible to determine the extent to which individual animals in the experiment are affected. Crops when analyzed prove to be high in fluorine, but only corn and sorghum show symptoms of injury. Yields have been fairly satisfactory. However, the interpretation of data obtained under these conditions is difficult.

Work is under way to determine the toxic levels, the effect, extent and amount of damage due to fluorine in the effluence from these plants. The Chemistry and Animal Husbandry Departments are co-operating, and their findings are presented elsewhere in this report.

Because of the injury to livestock and crops at the Middle Tennessee Station, steps are being taken at the phosphate plants to eliminate fluorine from their effluence. It is hoped that by the beginning of another crop year the condition will be corrected. (See fig. 55.)

WEATHER CONDITIONS

Middle Tennessee suffered from one of its worst summer drouths. The summer rainfall, from April 1 to October 31, totaled 13.28 inches, consisting of small showers with not one rain amounting to as much as an inch. The total rainfall for the year was 51.80 inches. After

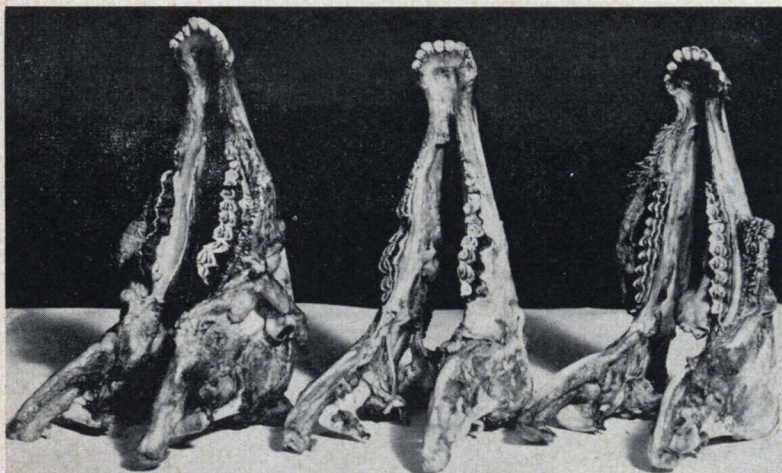


Fig. 55—Lower jaw bones of 5-year-old ewes—left to right: Western, Native, and Cumberland Plateau—showing the effect of fluorine damage.

Note the striking difference between the Native ewe, produced at the Columbia Station, and the Western and Plateau ewes brought in as yearlings.

June, it was necessary to feed hay to all the cattle, except the beef-cow herd, or to graze them on short alfalfa. The beef-cow herd of 38 cows, calves, and bull, was on a 50-acre bluegrass-bermuda pasture, which supplied sufficient grazing. The bermuda was grazed very short, but continued to produce some grazing while other pastures were so dry that they were set afire by sparks from trains. Feed production was greatly reduced, and considerable quantities of hay were fed before winter, making it necessary to import hay and silage. Corn and Hodo sorghum on well-manured bottom land produced 15 tons of silage per acre. However, silage was hauled by trailer trucks 125 miles from the West Tennessee Experiment Station and ensiled for less than \$7.00 per ton. During August and September, alfalfa and orchard grass mixture furnished good pasture for dairy cows and beef steers.

IRRIGATION

The irrigated pasture for dairy cows during the summer drouth was a decided contrast to the nonirrigated pasture and aroused the interest of farmers. Results of this test are given in the report of the Dairy Department. Several sets of the irrigating system were purchased and put into operation in Middle Tennessee.

During the extreme dry weather the system was used 18 hours a day, and other crops—sudan grass, tobacco, alfalfa, and orchard grass, corn, and winter pasture—were irrigated. The water helped to make a good stand of sudan grass, which was ready to graze in approximately 6 weeks from seeding. After the sudan grass was grazed close, additional water was applied, making rapid recovery of the grass possible. Following the sudan grass, balbo rye and crimson clover were sown and irrigated, and were being grazed in 6 weeks. Winter pasture seeded on fallow land the same day was ready to graze in 10 weeks.

Tobacco variety plots were beginning to fire badly from drouth when they were thoroughly wet with 3 inches of water (see fig. 56), and the tobacco made a rapid recovery from the drouth injury, producing yields of over 2500 pounds per acre, as reported under Tobacco. The results on alfalfa and orchard grass also were very satisfactory. Irrigation corn variety plots produced from 70 to over 100 bushels per acre. The midsummer drouths in Middle Tennessee offer real opportunities for irrigation where a source of water is available. Additional studies on this subject are needed.

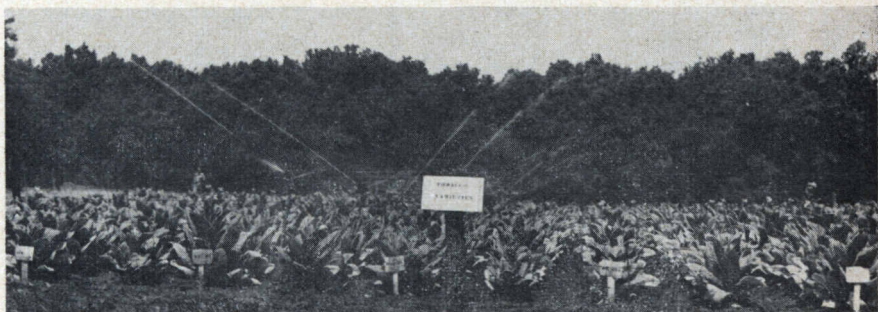


Fig. 56—Irrigating tobacco variety test.

MEETINGS

The Station was host to a large number of visitors during 1948. The Farmers' and Homemakers' Institute on May 19 was attended by 3000 farm people (fig. 57); and over 500 attended the Negro Institute on May 20. An important feature on each of these days was a tour of the Station to study the various projects under way. Over 2500 4-H Club boys and girls attended the District 4-H Club Camp during July and August. Agricultural leaders—Farm Bureau Presidents, Farm Bureau Women, Co-Op Managers, and others—attended state-wide meetings at the Station. Other visitors included county and



Fig. 57—Institute attendants looking over Animal Husbandry work.

community groups of farmers, and veterans on the farm training program.

PASTURE-RENOVATION STUDY

In the late winter of 1947 a study was initiated in the renovation of unproductive broom sedge-infested pasture on Maury silt loam, a high-phosphatic soil, to determine the effects of different cultural treatments, reseeding practices, and the addition of soil amendments. The cultural treatments were as follows: Subsoiled and disked, bush-and-bog harrowed, and kept mowed. Reseedings of bluegrass, Ladino clover, red clover, and mixtures of the same legumes with Kentucky 31 fescue were made.

Fertility treatments of 2 tons of lime, 2 tons of lime and 600 pounds of 20-percent superphosphate, 2 tons of lime and 12 tons of manure, and 2 tons of lime and 100 pounds of ammonium nitrate were used. The seedings and soil amendments each crossed the different cultural treatments. A second series, using the same practices, was established in the fall of 1948.

The results of these studies to date indicate that the use of the bush-and-bog harrow, along with 2 tons of lime, 12 tons of manure, and reseeding gave the best results. Good stands of grasses and legumes were established and practically all of the plots were cultivated; however, only scattered plants were established on the undisturbed plots, with the exception of the lime-manure plots. As a result of these trials, 50 acres of heavily infested broomsedge pasture were worked during the late summer several times with a bush-and-bog harrow, followed by a "soil surgeon," limed, and reseeded to orchard grass and Ladino clover in the fall. Seventy-five pounds of ammonium nitrate was applied, and excellent stands have been secured. Practically 100 percent of the broomsedge was eliminated.

LEGUMES

All new seedings of red clover, white clover, and lespedeza made in the spring were complete failures because of the drouth.

Alfalfa.—Spring-seeded alfalfa on land turned early and well prepared survived the summer drouth, but did not produce hay. Alfalfa varieties and strains seeded September 11, 1945, and harvested 4 times produced the following acre yields: Buffalo, 3.24 tons; Oklahoma N.W., 3.12 tons; Oklahoma S.W., 3.11 tons; Kansas Common, 3.03 tons; Grimm, 2.95 tons; Ranger, 2.76 tons; Utah, 2.62 tons; and Argentine, 2.48 tons.

Argentine, Ranger, and Utah Common are gradually weakening, and all yields were low because of weather conditions.

Alfalfa, with different grasses seeded in the fall of 1946, was harvested 4 times, and very low yields were obtained. The alfalfa plants in the mixture with Kentucky 31 fescue are being reduced by this vigorous-growing grass. The grass grown with alfalfa, which added nitrogen to the soil, showed marked contrast in growth and color with the grass grown alone on the other half of each plot.

The alfalfa and orchard grass mixture was rotationally grazed with dairy cows for the second year without apparent injury to the stand.

Three cuttings of hay were harvested. The field was then divided into 4 equal parts and was grazed twice during August, September, and early October. It was irrigated during this period.

Button Clover.—Excellent volunteer stands of button clover have been obtained for 9 years in the north kudzu field. This field has been grazed with sheep from early winter until the middle of June. Some plants have produced seed annually. The land has been disked from 2 to 4 times after the first of July and the clover has volunteered each year. On range 10-W, 4 good crops have volunteered from one seed crop turned under the first year. The following years the clover was turned before producing seed. Button clover is one of the most palatable winter legumes and has a longer spring grazing season than crimson clover or bur-clover. One of the major problems has been the saving of seed. A number of methods have been employed. The most successful has been to equip a combine with a pick-up reel and set the reel at an angle similar to that used in a side-delivery rake (fig. 58). The button clover matures and dies and is picked up and threshed with a combine.



Fig. 58—Harvesting button clover with combine equipped with a Hume reel.

Ladino Clover.—Ladino clover plots seeded with different grasses (strains of smooth brome, strains of orchard grass, fescue, and blue-grass) in the spring of 1947 looked very good in the early spring and summer, but much of the clover was killed by the summer drouth. The

plots were seeded to grass, and the clover was seeded with the grass on only one half of the plot. The grass alone produced very little forage, and was lighter in color than that grown with the clover.

GRASSES

A number of tests with various permanent grasses seeded alone and in combinations, and also with various legumes, are under way, but owing to weather conditions results show only slight differences. Spring and fall applications of ammonium nitrate were made at different rates on Kentucky bluegrass pasture and Kentucky fescue 31 pasture.

A pasture fertilizer experiment showed no response to phosphate or potash on a high-phosphate soil. All treatments without nitrogen averaged 3200 pounds of air-dry forage per acre. One hundred pounds of ammonium nitrate was responsible for a gain of 950 pounds of forage.

SMALL GRAINS

Nitrogen Studies.—Studies to determine the value of nitrate of soda at various rates on winter oats, barley, wheat, and rye have been carried on for a number of years, and the results of these trials are shown in table 35.

Table 35—*Effects of nitrate of soda, applied at different rates, on acre yields of small grains.*

Small grains	Nitrate of soda in pounds per acre							
	0	50	Incr.	100	Incr.	150	Incr.	200
	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels
Oats ¹	34.3	45.9	11.6	57.1	22.8	60.8	26.5	70.0
Barley ²	25.8	33.8	8.0	38.6	12.8	44.4	18.6	47.3
Wheat ²	18.7	25.0	6.3	27.6	8.9	29.6	10.9	31.5
Rye ¹	20.4	25.6	5.2	29.0	8.6	30.8	10.4	34.1

¹ 9-year average.

² 10-year average.

A comparison of ammonium nitrate and nitrate of soda as sources of nitrogen for winter oats showed that all plots treated with 50 pounds of ammonium nitrate produced 84.5 bushels, and that all plots treated with 100 pounds of nitrate of soda produced 84.5 bushels. The untreated plots averaged 70.7 bushels.

Effects of Grazing on Grain Yield of Winter Oats, Barley, Wheat, and Rye.—In this test nitrate of soda was applied at time of seeding at acre rates of 0, 100, and 200 pounds. In addition, there was one treatment which received 100 pounds of nitrate of soda at time of seeding plus 100 pounds after each of 2 grazings. One half of each plot was grazed on December 30 and again on March 18. The amount of forage provided was determined by means of a 4 x 4 pasture cage. The other half of each plot was left ungrazed. It is shown that late grazing seriously reduces grain yields. This reduction in yields can be kept at a minimum by application of part of the nitrogen at seeding time followed by an application after each grazing.

SORGHUM

Grain Sorghum.—Grain sorghum, even under extreme drouth conditions, made good yields and produced more pounds of grain than Tennessee No. 10 hybrid corn. Since it seems practicable to produce grain sorghum in Middle Tennessee, trials were made with varieties, dates of planting, rates of planting, and spacing. The results of these tests are shown in tables 36, 37, and 38.

Table 36—Yields of varieties of grain sorghum planted early and late.

Acre yields, averages of four replications			
Variety	Early (May)	Late (June)	Average
	Bushels	Bushels	Bushels
Caprock	34.9	44.7	39.8
Texas Double Dwarf	41.1	36.4	38.8
Imperial Kafir	38.3	37.3	37.8
Early Hegari	37.4	37.1	37.3
Wheatland Milo	36.8	36.6	36.7
Double Dwarf White Sooner	32.3	38.0	35.1
Oklahoma Darso	29.9	38.0	33.9
Bonita	29.4	37.9	33.6
Club	36.1	29.9	38.0
Martin	33.7	31.6	32.6
Westland	35.8	28.7	32.2
Plainsman	31.1	29.5	30.3
Texas Blackhull Kafir	30.2	30.2	30.2
Hegari	26.1	21.1	23.6
Kafirita 811	20.9	20.2	20.5
Dwarf Shallu	24.9	9.0	16.9
Tenn. 10 Corn ¹	31.4	35.9	33.7

¹ Corn, 56 pounds per bushel; sorghum, 50 pounds per bushel.

Table 37—Spacing test with Plainsman sorghum.

Spacing	Yield per acre	Rate of planting per acre
	Bushels	Pounds
36-inch rows, cultivated	30.6	6
14-inch rows, drilled	22.6	12
7-inch rows, drilled	24.0	12

Table 38—Rate-of planting test with Plainsman and Early Hegari sorghum.

Rate per acre	Plainsman ¹	Early Hegari
Pounds	Bushels	Bushels
4	30.9	32.3
6	33.2	30.9
8	38.3	27.1

¹ Plainsman seed used was larger than Early Hegari.

Sweet Sorghum.—Hodo variety, planted at the rate of 4 pounds per acre, with Hastings Prolific corn spaced at 2 feet, produced, on bottom land, over 15 tons of silage per acre under favorable conditions. The yields in a variety test on McAfee silt loam treated with 12 tons of manure, were: Sumac, 13.09 tons; Hodo, 13.00; Texas Seeded Ribbon, 12.76; Hodo and corn, 11.23; Orange, 11.06; Blue Ribbon, 10.72; Sugar Drip, 10.51; Honey, 10.33; and corn alone, 5.65 tons. All

sorghum plots were seeded at the rate of 4.5 pounds per acre; corn with Hodo, at 2-foot spacing; and corn alone, at 15 inches.

TOBACCO

Varieties.—A test of varieties of burley tobacco was carried on in cooperation with the Greenville Station (fig. 59). The plots received



Fig. 59—New variety of burley tobacco.

500 pounds of 4-8-8 fertilizer and 12 tons of manure per acre, and once, at a critical stage, were irrigated. This treatment resulted in very high yields, as shown in table 39.

Table 39—Comparative yields and value per acre of varieties of burley tobacco.

Variety	Yield per acre	Value per acre	
		Dollars	Price per 100 lbs.
	Pounds		Dollars
Greenville 21C	2704	1438.13	53.18
Greenville 24	2591	1431.51	55.24
Greenville 21B	2586	1397.75	54.05
Greenville 21A	2497	1393.53	55.80
Kentucky 16	2660	1340.72	50.40
Greenville 6	2457	1318.89	53.68
Kentucky 41A	2277	1163.71	51.10

Average prices by U. S. grader, 1948-49 sales.

Fertilizer and Manure.—Tobacco following alfalfa on McAfee silt loam (high-phosphate soil) was of poor quality. Heavy applications

of complete fertilizer and manure increased the yields and improved the quality somewhat. The results of this test are shown in table 40.

Table 40—Results of applications of fertilizer and manure to burley tobacco following alfalfa.

Treatment	Yield per acre	Value per acre	Price per 100 lbs.
	Pounds	Dollars	Dollars
40-80-150	1865	790.89	42.40
12 tons manure plus			
40-80-75	1924	784.19	40.75
40-0-150	1791	745.30	41.61
12 tons manure	1569	740.25	47.18
6 tons manure plus			
40-80-75	1795	728.91	40.60
6 tons manure	1768	720.92	40.77
40-80-75	1730	704.76	40.73
40-80-0	1818	686.06	37.74
0-80-150	1671	648.87	38.83
0-0-0	1634	633.38	38.79

Average prices by U. S. grader, 1948-49 sales.

OTHER CROPS

Corn, soybean, and small-grain variety tests conducted at the Middle Tennessee Station are included in the report of the Agronomy Department.

LIVESTOCK AND DAIRYING

Detailed reports of the pasture and feeding work with beef cattle, sheep, and dairy cattle may be found in the Animal Husbandry and Dairy sections of this report. Also will be found the report of the work being done on the Jack and Jennet Breeding Farm.

PLATEAU EXPERIMENT STATION

Crossville

John A. Odom, Superintendent

LAND CLEARING

Thirty-five acres of land at Grassland Farm were cleared, treated with lime and phosphate, and seeded to temporary pasture in late summer. Further clearing of small plots of land areas was done at the Plateau Station, and a site for orchard studies was partially cleared.

BUILDING AND EQUIPMENT

Dwelling No. 6 was completed; drives to several of the newer dwellings were improved; lawns were prepared and seeded; and shrubbery was set. A combination garage, storage room, and coal house was built for one dwelling, and the water line extended to another, a distance of 1000 feet. A well to supply the two dwellings and livestock lots at Grassland Farm was drilled and a good supply of water obtained.

Further work was done on 4 farm ponds, begun last year. A concrete core was poured in the base of pond No. 1, which had been drained by crawfish, preventing its use for irrigation of cole crops in the fall season. Pond No. 2 was used successfully for this purpose. The stocking of these reservoirs with fish was begun by the introduction of small bream in the fall season.

A medium-sized tractor, with mower, 2-row planter, and 2-row cultivator, was purchased.

FIELD CROPS

Tobacco variety trials were continued with 14 varieties, in cooperation with the Tobacco Station at Greeneville. New strains from that Station continue to show promise in comparison with the standard varieties used in the trial.

The Uniform Tests of small grains, corn, and soybeans; tests with fertilizers and liming materials; trials of grasses and legumes in pasture and hay mixtures; and the beginning of a grass garden at the Plateau Station, are covered in reports from the Agronomy Department.

LIVESTOCK

Work on various livestock projects at the Grassland Farm is reported by the Animal Husbandry Department.

SOIL SURVEY

A detailed soil survey, under the direction of Lester Odom, was made on Grassland Farm, composed of 1380 acres, of which approximately 1200 acres was in woodland. The survey showed a total of approximately 900 acres of the total farm area potentially suitable for pasture.

FORESTRY

A timber cruise of the 1200 acres of timberland on Grassland Farm was made in cooperation with the TVA. The report showed only a small amount of marketable timber, mostly of species used principally for crossties. Annual burning of the area had developed this condition.

Studies in underplanting cut-over timberland with nursery seedlings of desirable species were continued, in cooperation with TVA, on the Station farm, with additional plantings of one-year seedlings of 4 species, including white pine and poplar. Other underplanting with white pine was done for future windbreaks and timber growing in small areas not suitable for crop use.

HORTICULTURE

Horticultural work at the Plateau Station is discussed in the Horticulture section of this report.

TOBACCO EXPERIMENT STATION¹¹

Greeneville

J. Hugh Felts, Superintendent

IMPROVEMENTS

Buildings.—Much time was spent during 1948 on the building of the District V 4-H Club Camp and the Administration Building for the Station at Greeneville. Early in March, construction of the Camp was started on a 23-acre tract adjoining the Station on the west. The Camp consists of two dormitories and a large main building with recreation room, dining room, and kitchen. It should be ready for use by the first of June, next year (fig. 60).

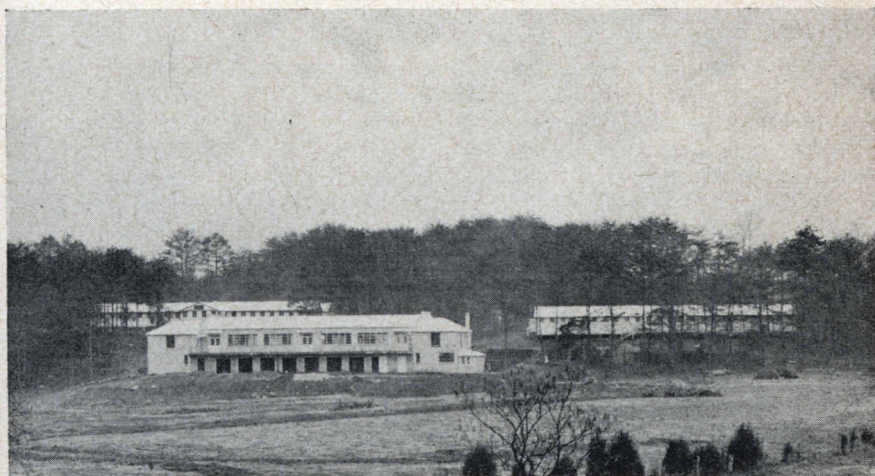


Fig. 60—District 4H-Club camp, November 26, 1948.

In October, work was started on the Administration Building—a 40-by-80-ft. brick structure, with a main floor and complete basement. It should be completed by June first of next year.

In addition to helping with these two jobs, the farm labor painted three of the Station buildings and completed the farm shop.

Road.—The 3.6 miles of gravel road from the city limits of Greeneville to the Station were surfaced in November. This improvement makes the Station more accessible to the public.

LIVESTOCK

The following livestock projects conducted at the Station are discussed in the Animal Husbandry section of the Annual Report: (1) A study of the time of calving, with straight- and cross-bred calves, using a cow-calf herd of 48 cows and 2 bulls. (All steer calves are used in other tests.) (2) Comparison of grass-finished steers with

¹¹ Tobacco work in cooperation with U.S.D.A.

steers finished on grass supplemented with grain. This test was conducted on 2 age groups, one to be marketed at 18 months of age, the other at 30 months. Both lots of steers were wintered in a test comparing barn feeding with winter grazing. (3) A native ewe-improvement project.

The Station produces all feed for the livestock, except cottonseed meal for experimental use.

AGRONOMY

In addition to tobacco work, tests were run on corn, wheat, oats, and barley varieties; one series on experimental corn varieties; two tests on pasture fertilization; and one test on pasture varieties.

WEATHER

The spring was very early, with a dry April and May. The shortage of 2.72 inches of rain during these months made conditions unfavorable for turning winter cover crops for tobacco. The pasture and hay growth suffered from spring drouth. The rainfall for August was normal, producing a good late summer growth for corn and tobacco. The dry September and October provided very little fall pasture and created a poor season for seeding winter legumes. High temperature and a rainfall 5.42 inches above normal made November and December unfavorable for handling tobacco.

VISITORS

The Field Days on Tobacco were well-attended, with 350 present at the annual meeting. Over 2000 attended two special days held for G. I. Farm Trainees.

BURLEY TOBACCO-BREEDING PROGRAM

H. E. Heggestad

Varieties.—Continued progress was made in the development of varieties with more disease resistance and with improved quality and yielding ability. The main objective of the variety-improvement program is to combine in a single variety resistance to the more important burley diseases; namely, black root rot, tobacco mosaic, and wildfire.

The advanced lines of burleys at Greeneville were compared with Kentucky 16, the most popular commercial variety, at 10 locations in the State. The variety trials were located in 6 East Tennessee counties and also at the branch experiment stations at Crossville, Greeneville, and Columbia. Plants for these tests, except at Columbia, were produced at the Greeneville Station. No attempt was made to vary the cultural practice of the different growers, except that all plots were set with the same spacing—3½ feet between rows and 15 inches between plants in the row—approximately 10,000 plants per acre. The graded tobacco was brought to the Station to furnish yield data and for the appraisal of quality by experienced tobacco graders from the Production Marketing Administration.

Results from the 10 locations are summarized in table 41.

Table 41—Summary of results on seven varieties of burley tobacco at ten locations in Tennessee.

Variety	Yield per acre	Smoking tobacco ¹		Quality index	Crop index
		Percent	Yield per acre		
	Pounds		Pounds		
Greeneville 6	2411	72.4	1738	.592	1426
Greeneville 17A	2416	78.6 *	1919 *	.632	1531
Greeneville 18	2531 *	67.1	1687	.606	1526
Greeneville 21B	2520	78.5 *	2004 **	.642	1615 *
Greeneville 21C	2480	82.4 **	2059 **	.670 **	1664 **
Greeneville 23B	2592 **	78.6 *	2031 **	.631	1620 **
Kentucky 16 (check)	2422	72.0	1752	.619	1504

¹ Includes X, C, and BF grades.

* Significant increase over Kentucky 16.

** Highly significant increase over Kentucky 16.

Greeneville 21C, having a high degree of resistance to black root rot, showed outstanding quality improvement in these tests. Statistical analysis of the data shows that the differences between Greeneville 21C and Kentucky 16, in percent and pounds of smoking tobacco, in quality index (price), and in crop index (value) were highly significant in favor of the new variety. Greeneville 21B, Greeneville 17A, and Greeneville 23B also produced significantly more smoking tobacco than Kentucky 16. Two of the varieties, Greeneville 18 and Greeneville 23B, yielded significantly more tobacco per acre than Kentucky 16.

Variety Released.—The best line of Greeneville 21 was released to the Tennessee Crop Improvement Association for seed increase during 1949. The new variety when released will be known commercially as Burley No. 1. Very favorable results during 1948 and 1947, from several locations in Tennessee and also from similar variety tests reported from other state experiment stations, indicate that the production of high-quality cigarette smoking tobacco may be substantially increased by use of the new variety. Some of the hazards associated with burley production will be reduced because the variety possesses a high degree of resistance to black root rot, and the tobacco cures well under variable curing conditions. It normally produces about 25 percent more leaves than Kentucky 16. However, the variety appears to be very similar to Kentucky 16 in sucker production, in time required for maturity, and in nicotine content.

Resistance to Black Root Rot.—Control of black root rot is possible with resistant varieties even on the more heavily infested soils. Judy's Pride, an old susceptible variety, is grown each year with resistant varieties for yield and quality evaluation, as shown in figure 61.

In 1948, Judy's Pride produced 846 pounds per acre on root rot-infested soil; whereas, the average yield for the 15 advanced lines and varieties included in the test was 2269 pounds per acre. There was no significant difference in yield between the best 13 lines and varieties, which included Kentucky 16. However, there were 5 lines significantly better in quality than Kentucky 16. In descending order of quality indexes, they were: Greeneville 21C, Greeneville 17A, Kentucky 22, Greeneville 24, and Greeneville 17B, with index values of .821, .809,

.792, and .790 respectively. Greeneville 21C produced the highest-percentage smoking tobacco, being 18 percent more than that produced by Kentucky 16.



Fig. 61—Judy's Pride, a susceptible variety of burley, grown in comparison with resistant varieties on black rot-infested soil.

Resistance to Tobacco Mosaic.—Results of 1948 replicated tests at the Station showed that 2 available mosaic-resistant varieties produced yields and quality comparable to those of Kentucky 16 (table 42).

Table 42—Comparison of Kentucky 16 with two mosaic-resistant varieties of tobacco.

Variety	Yield per acre	Smoking tobacco	Quality index	Crop index
	Pounds	Percent		
Kentucky 16	2066	78	.612	1266
Kentucky 56 ¹	1998	90	.650	1308
F17A46 ²	2195	79	.616	1351

¹ Resistant to tobacco mosaic.

² Resistant to tobacco mosaic and Fusarium wilt.

Kentucky 56 was also grown at the Station in 1947 and gave promising results. It is highly resistant to black root rot and very similar in field appearance to Kentucky 16. F17A46 is a new variety from the Kentucky Experiment Station which has resistance to Fusarium wilt as well as to black root rot and mosaic.

The above disease-resistant varieties were superior to the older mosaic-resistant varieties, Kentucky 50, 52, and 54, and the Fusarium-resistant varieties, Kentucky 33 and 34, in tests at this Station.

Resistance to Wildfire.—An intensified variety-improvement program is in progress for the development of wildfire-resistant burley

tobacco. The original resistant material was provided by Dr. E. E. Clayton (U.S.D.A.). Continued selection for wildfire resistance is made in the plantbeds and fields, where all the susceptible segregates are eliminated by artificial inoculation with bacteria which cause the disease. Some lines show a very high degree of resistance to wildfire and also good resistance to black root rot. The yield and quality of most breeding lines were equal to or better than Kentucky 16.

Weed and Disease Control.—Weed and disease control in tobacco plantbeds by chemical means is being investigated. Rates of cyanamid and uramon, singly and in combination, were tried on Dunmore cherty silt loam. Good weed control was secured with most treatments. It is believed that a combination treatment will prove most satisfactory, although cyanamid alone has given good results for many growers. Further investigation will be required to determine the most desirable rates of application. Early fall application of chemical, with good soil moisture at the time of the treatment or soon afterward, is of vital importance with these materials. The unmulched treatments were as good as mulched treatments or better.

Of several new chemicals tested, allyl alcohol with water as a soil drench was most promising. It gave excellent weed control and permitted good stand and growth of plants. Combination treatments of allyl alcohol (weedicide) and formaldehyde (fungicide) also gave excellent results. These treatments may be made from 7 to 10 days prior to seeding in the spring. Continued tests with these and other materials are in progress.

FERTILITY AND CULTURAL EXPERIMENTS WITH BURLEY TOBACCO

B. C. Nichols

Agronomic experiments with burley tobacco in 1948 included testing the effects of (a) rates and sources of various fertilizer materials, (b) spacing and topping practices, and (c) preceding crops.

Rates and Sources of Fertilizer Materials.—In one test, the effects of 4 rates of sulfate of potash, varying from 0 to 540 pounds K_2O per acre, with and without manure, were compared on Ooltewah silty clay loam soil. Muriate of potash and sulfate of potash at the rate of 60 pounds K_2O also were evaluated in this experiment. The 540 pounds per acre K_2O produced 1968 pounds of tobacco leaf, compared with 1823 pounds where no potash was used. This increase in yield was significant, but smaller rates of K_2O failed to give measurable gains in yield. Tobacco quality tended to improve with increasing amounts of sulfate of potash—grade indexes for 0, 60, 300, and 525 pounds per acre K_2O being 0.345, 0.450, 0.561, and 0.615 respectively. Ten tons of manure per acre improved quality, but showed little tendency to increase yield. Muriate and sulfate at the specified rate produced tobacco of similar yield and grade index. Although none of the tobacco in this particular test burned satisfactorily, the average burning time for the smoking grades (flying, cutter, and tan leaf) was 2.2 seconds where sulfate of potash was used, and 1.0 second for muriate of potash. Fire-holding capacity tended to improve as K_2O in the

fertilizer was increased. The average burn for 0, 60, 300, and 525 pounds per square acre K_2O was 0.2, 0.5, 3.4, and 3.6 seconds respectively. Manure showed some tendency to repress burn.

The effects of 20 percent superphosphate, 48 percent treble superphosphate, and 27 percent fused tricalcium phosphate were compared at different rates on Etowah silt loam soil. No significant improvement in tobacco quality was obtained with any rate or source of phosphate in this experiment. The 750-pounds-per-acre rate of 3-18-6 gave 1761 pounds per acre tobacco leaf, compared with 1596 pounds produced by 750 pounds per acre 3-0-6, which was the only increase in yield that approached significance.

The effects of 4 rates of sulfate of potash, ranging from 0 to 525 pounds K_2O per acre, with and without manure, were compared on Cumberland silt loam soil. Also muriate as a source of potash for tobacco was compared with sulfate at the 45-pound-per-acre K_2O rate. Only the highest rate of K_2O (525 lbs.) gave a significant increase in yield over the 0 rate—yields being 1980 and 1773 pounds per acre respectively. Quality tended to improve according to the amount of potash added—grade indexes being respectively 0.458, 0.566, 0.541, and 0.636 for K_2O rates of 0, 45, 285, and 525 pounds per acre. Ten tons barnyard manure per acre gave slight but non-significant increases in yield and quality of tobacco leaf. The average time of burn tended to increase with the amount of potash added. Smoking grades of tobacco held fire for an average of 6.4 seconds at the 0 rate of potash and for 12.0 seconds at the highest rate of potash. At the 45-pounds-per-acre K_2O rate, tobacco grown with sulfate of potash burned for an average of 7.1 seconds, compared with 4.2 seconds where muriate was used. Manure tended to repress the burning time, the mean burn of tobacco produced on manured plots being 6.2 seconds, as compared with 9.5 seconds where no manure was applied.

Spacing and Topping Tests.—A factorial experiment involving 2 fertilizer rates, 3 topping practices, and 2 spacings was set up on Nolichucky silt loam soil.

An application of 1500 pounds per acre of 3-9-6 fertilizer, plus 100 pounds of ammonium nitrate applied as a side dressing, produced tobacco of slightly higher yield and quality than was produced by 600 pounds per acre of 3-9-6 fertilizer. The number of suckers per plant was about the same for the two treatments, but the high fertilizer rate gave 3061 pounds per acre (green weight) of suckers as compared with 2683 pounds for the low fertilizer application. Heavy fertilization tended to repress the burn of the smoking grades—the average time of holding fire being 7.8 seconds for the high fertilizer rate and 10.4 seconds for the low rate.

Five leaves topped out with all suckers pulled gave a higher crop value than either 5 leaves topped out with the 2 top suckers left or 2 leaves removed and all suckers pulled. Table 43 summarizes these results.

The green weight per acre of suckers was highest where 5 leaves were removed and the 2 top suckers left. This topping practice, however, produced about 3 fewer suckers per plant than either of the two

Table 43—Comparison of three topping practices.

Topping practice	Yield per acre	Grade index	Crop index
	Pounds		
5 leaves out, suckers pulled	2231	0.671	1502
5 leaves out, 2 suckers left	2056	0.674	1385
2 leaves out, suckers pulled	2196	0.651	1430

treatments in which all suckers were pulled. Since the plant population was about 10,000 per acre in this experiment, the saving in labor necessary to remove 30,000 suckers per acre is an item to be considered.

Tobacco from plants having 2 leaves topped out burned slightly longer than tobacco from plants having 5 leaves removed, regardless of whether suckers were taken out or left.

Spacing plants 15 x 42 inches and 21 x 30 inches gave about the same yield and quality of tobacco leaf.

Effect of Preceding Crops.— In testing the effects of green-manure crops in a one-year rotation, crimson clover, vetch, and fallow treatments produced tobacco of similar yield and quality. Tobacco following barley was decidedly inferior in both yield and quality.

WEST TENNESSEE EXPERIMENT STATION

Jackson

Ben P. Hazlewood, Superintendent

VISITATION

The two annual meetings at the West Tennessee Station—the Spring Field Day and the Farmers' and Home Makers' Institute—were well attended, although the numbers were slightly smaller than usual. On the other hand, the visitation by groups showed an increase. This was due largely to visits by teachers of Veterans. The facilities of the Station were used by many groups for meetings not related to Experiment Station work.

SEED PRODUCTION AND DISTRIBUTION

The Station continues to grow pure seed of certain crops developed by Station workers. The income from seed sales represents a major part of our operating funds. Seed of Jellicorse corn, Forkeddeer oats, Jackson No. 1 barley, Ogden soybeans, and Tennessee 241 cotton were available. A field of LeConte oats was planted for 1949 distribution.

DRAINAGE

The system of ditches completed in 1942, through the cooperation of the Soil Conservation Service, for the drainage of the Station bottom-land area, has been resurveyed by the Conservation Service

biennially. The 1944 survey indicated that silting had not reached the point of impairing the efficiency of the ditches. In 1946, the silting in the main ditch was such that drainage was not efficient. Following this survey, the main ditch was "cleaned out" to the original grade, requiring the removal of 5000 cubic yards of silt.

The 1948 survey did not show enough silting to necessitate another "clean-out." The source of the silt has been largely the channel of the ditch just above the bottom-land area, but this channel now is becoming well stabilized with vegetation. Silting has been the principal hazard to the many miles of farm ditches in West Tennessee. The Station's drainage work is giving many factual data relating to this problem.

WEATHER

Total rainfall for the year was 61.64 inches. Each month, excepting January, April, May, and July, had above-normal rainfall. The 11.43 inches in November was very detrimental to the fall harvest. The low temperature for the year was -10° F., occurring in January; the high of 98° F. occurred in both July and August.

PROPERTY MAINTENANCE

Such funds as were available for property maintenance were used to rebuild fences. Approximately 25 percent of the urgent work of this kind was completed. The new fences are being placed on lines conforming with the rearrangement of the Station fields, taking in the new property purchased in 1941, 1942, and 1943.

LIVESTOCK

Beef Cattle.—Sixty weanling beef calves were purchased to continue the 4 projects under way. These projects are treated more fully in the Animal Husbandry section of this Report.

Dairy Cattle.—A purebred Jersey herd is maintained, with complete records of breeding and production performance. Cooperation with the Dairy Department in the project, "Controlling mastitis in specialized dairy herds," was continued.

Swine.—The project for comparing protein supplements, when growing and finishing hogs, was completed in March. This project was conducted for three consecutive years. The different protein supplements were fed with corn when hogs had access to crimson clover pasture during the months of December, January, February, and March.

Work Stock.—In the Station's operations the use of work stock is declining each year, according to summaries of the daily labor report cards. This trend is less pronounced in the horticultural work than in other projects.

DEPARTMENTAL PROJECTS

Projects of the Departments of Agronomy, Plant Pathology, and Horticulture being conducted at the West Tennessee Station are discussed in the reports of those departments.

LIBRARY

Sarah C. Currell

Volumes in agricultural library, 1947	22,979
Experiment Station.....	12,990
College	9,989
Additions, 1948	720
Experiment Station	232
College	488
Total volumes	23,699
Periodicals received, 1948	
	Purchase Gift Exchange Total
Experiment Station	60 53 35 148
College	117 185 11 313
Volumes bound, 1948	165
Books and pamphlets circulated	29,948
Reference questions answered	1,726

CHANGES IN STAFF

APPOINTMENTS

L. J. HARDIN, Asst. Chemist, Jan. 16
W. E. ROEVER, Assoc. Hort., Feb. 9
DONALD E. COOPERRIDER, Assoc.
Parasitologist, Mar. 16
GERALDINE C. COLEMAN, Asst. Gen.
Chem., April 1
H. C. KINCER, Asst. Agron., April 1
JOHN R. OWEN, Herdsman (Dairy),
June 1
J. W. COLE, Assoc. An. Husb., July 1
W. N. DUDNEY, Asst. Editor-Photographer,
July 1
HOWARD E. REED, Assoc. Pl. Path., July 1
A. J. STERGES, Asst. Soil Chemist, July 1
BEN T. THROOP, Bact. Tech., July 1
J. T. TUMLIN, Asst. Poultry Husb., July 1

C. L. COMAR, Biophysicist, Sept. 1
MARY D. EVANS, Asst. Chemist, Sept. 1
E. R. BARRICK, Assoc. An. Husb., Sept. 15
A. G. VAN HORN, Assoc. Dairy Husb.,
Oct. 4

DOROTHY E. WILLIAMS*

* On leave.

RESIGNATIONS

LESTER E. ODOM, Assoc. Agron., Mar. 31
ADDIE RULE WISE, Asst. Gen. Chemist,
March 31
Q. L. HUMBERD, Bact. Tech., April 30
J. T. MILES, Herdsman (Dairy), June 30
KATHLEEN MCCOOK, Asst. Gen. Chem.,
Nov. 30

PUBLICATIONS, 1948

BULLETINS

	Title	Authors	Publication	Pages
205	Worm Parasites of Tennessee Chickens	A. C. Todd	January	20
206	Variety Performance Trials of Oats, Barley, Wheat, Corn, and Soybeans	O. H. Long S. F. McMurray	January	16
207	All-Year Pasturing With and Without Concentrates for Dairy Cows	Ben P. Hazlewood	May	16

CIRCULARS

98	Korean Lespedeza		January	2
99	A Select List of Varieties of Farm Crops (revision of Cir. 10)		February	4
100	Effects of Several Winter Cover Crops on the Yield of Cotton	Ben P. Hazlewood E. J. Chapman	November	4
101	Tennessee Prolific Red Raspberry	Brooks D. Drain	December	4
102	Raspberry Disease Control	J. M. Epps C. D. Sherbakoff	December	2
103	The Miles Watermelon	J. M. Epps C. D. Sherbakoff	December	4

MONOGRAPHS

Mimeographed

234, 235, 237-239	(Listed in Economics and Sociology report)	201
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REPORT

Fifty-Ninth Annual Report, 1946	136
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ARTICLES AND PAPERS

AGRONOMY

The Lay of the Corn-Huckster	F. D. Richey	Jour. Heredity 39: 11-17, Jan., 1948	7
A Survey of the Possibilities and Methods of Breeding High-Niacin Corn (Maize).	F. D. Richey R. F. Dawson	Plant Phys. 23: 238-254, April, 1948	17
The Correlation of Certain Characters with Yield in Barley Strains.	J. K. Leasure E. E. Down H. M. Brown	Jour. Amer. Soc. Agron. 40: 370-373, April, 1948	4
Hybrid Vigor from Natural Crossing for Improving Cotton Production.	D. M. Simpson	Jour. Amer. Soc. Agron. 40: 970-979, Nov., 1948	10

Title	Authors	Publication	Pages
Burley Tobacco Disease Situation in Tennessee—1948.	H. E. Heggstad	Plant Disease Reporter 32: 507-508, Dec., 1948	2
A Comparison of Two Soil-Test Methods as Correlated with Wheat and Cotton Response to Fertilizers.	O. H. Long	Soil Sci. Soc. Amer. Proc. 1947, 12: 255-261, 1948	7

CHEMISTRY

Differential Effects of Various Calcium Carriers Upon Transitions in Phosphate Mixtures	W. H. MacIntire W. M. Shaw L. J. Hardin S. H. Winterberg	Soil Science 65: 27-34. Jan., 1948	8
Disparity in the Leachability of Fluorine from Incorporations in Phosphated and Slagged Soils	W. H. MacIntire W. M. Shaw B. Robinson A. J. Sterges	Soil Science 65: 321-339. April, 1948	19
Procedure for the Determination of the "Available" Magnesium Engendered in Mixtures of Superphosphate with Olivine, Serpentine, Magnesite, and Their Calcines	L. J. Hardin W. H. MacIntire H. S. Johnson, Jr.	Jour. A.O.A.C. 31: 405-419. May, 1948	15
Procedure for the Determination of the Phosphorus Content of Hexaethyl Tetraphosphate and of Certain Other Organic Phosphates.	L. J. Hardin W. H. MacIntire	Jour. A.O.A.C. 31: 400-405. May, 1948	6
The Comparative Effectiveness of Blast-Furnace and Electric-Furnace Slags in Greenhouse Experiments	W. H. MacIntire S. H. Winterberg L. J. Hardin A. J. Sterges L. B. Clements	Soil Sci. Soc. Amer. Proc. 1947, 12: 145-152. 1948	8
Phosphate Migration in Limestoned and Dolomited Soils as Registered by Plant Response	W. H. MacIntire S. H. Winterberg L. B. Clements A. J. Sterges	Soil Sci. Soc. Amer. Proc. 1947, 12: 359-363, 1948	5
The Determination of Fluorine Attributable to Soil Incorporations of Calcium Fluoride	W. H. MacIntire George Palmer	Jour. A.O.A.C. 31: 419-426. May, 1948	8
The Forsterite Olivine Formations of North Carolina as a Source of Magnesium for Fertilizers	L. J. Hardin W. H. MacIntire	Jour. Tenn. Acad. Science 23: 180-186. May, 1948	7
Report on Soils and Liming Materials	W. H. MacIntire	Jour. A.O.A.C. 31: 359-360. May, 1948	2
Analytical Evaluation of Certain Synthetic Organic Phosphates in Relation to Their Fertilizer Effectiveness in Pot Cultures	W. H. MacIntire S. H. Winterberg L. J. Hardin A. J. Sterges L. B. Clements	Soil Science 66: 249-257. Oct., 1948	9
The Determination of the Sulfide-Sulfur Content of Calcium Silicate Slags in Relation to The Neutralization Value	W. M. Shaw	Jour. A.O.A.C. 31: 715-728. Nov., 1948	14

DAIRYING

No.	Title	Authors	Date	Pages
Raising Dairy Calves Without Colostrum		J. T. Miles S. A. Hinton H. Patrick	Jour. Dairy Sci. 31: 674. Aug., 1948	1
Varying the Proportion of Egg Yolk in Diluters for Bull Semen		E. W. Swanson	Jour. Dairy Sci. 31: 680. Aug., 1948	1
Comparison of Early-Cut and Late-Cut Lespedeza Hay for Milk Production		C. E. Wylie J. A. Ewing E. W. Swanson J. N. Maddux	Jour. Dairy Sci. 31: 690. Aug., 1948	1
Wintering Dairy Heifers on Legume Hay		S. A. Hinton J. T. Miles C. E. Wylie	Jour. Dairy Sci. 31: 692. Aug., 1948	1
Silage or Winter Pasture for Dairy Cows		C. E. Wylie S. A. Hinton L. R. Neel	Jour. Dairy Sci. 31: 695. Aug., 1948	1
Pastures in Relation to Dairy Development in the South		R. H. Lush	Jour. Dairy Sci. 31: 696. Aug., 1948	1
Irrigated Pastures for Dairy Cows		J. A. Ewing J. N. Maddux C. E. Wylie R. H. Lush	Jour. Dairy Sci. 31: 696. Aug., 1948	1

HOME ECONOMICS

Comparison of Three Methods for Ascorbic Acid Determination Using the Sweetpotato	Mary L. Dodds Echo L. Price Ruth Moore	Jour. Amer. Dietetic Assoc. 24: 582-585. July, 1948	4
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HORTICULTURE

A Promising Type of Male Sterility for Use in Hybrid Tomato Seed Production	W. E. Roever	Science 107: 506	1
New Plants for Tennessee	B. D. Drain	Volunteer Gardener, Oct., Nov., Dec.: 2, 14, 1948	