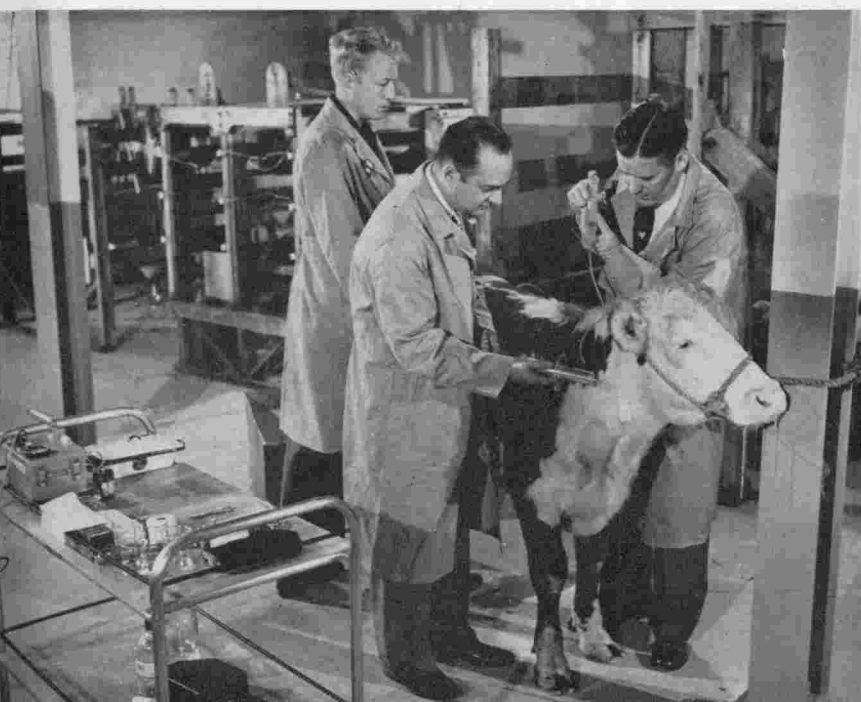


THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

SIXTY-THIRD ANNUAL REPORT 1950



A solution of radioactive phosphorus is being injected intravenously into a Hereford steer in the U.T.-A.E.C. research program.

KNOXVILLE, TENNESSEE

LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 1, 1951

To His Excellency, Gordon Browning, Governor of Tennessee:

Sir: I have the honor to transmit herewith, on behalf of the Board of Trustees of the University of Tennessee, a report of the work and expenditures of the Agricultural Experiment Station for the year 1950. 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, and Bankhead-Jones Acts,
and Non-Federal Funds, 1949-50

	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	\$89,992.09	\$114,147.40	\$565,932.10
From Other Sources						
Expenditures						
Personal Services	14,990.81	14,736.03	57,323.49	71,475.96	83,564.69	321,383.15
Travel			66.64	1,167.73	3,970.43	10,147.04
Transportation of Things	9.19	2.37	90.40	143.62	176.75	4,676.33
Communication Service		3.61	7.00	33.18	41.20	3,629.60
Rents and Utility Services		24.97	30.94	145.09	32.81	6,981.32
Printing and Binding					17.00	7,666.46
Other Contractual Services		125.00	62.87	707.73	1,006.76	24,123.45
Supplies and Materials			1,641.06	6,591.29	4,585.52	119,374.49
Equipment		108.02	448.54	5,502.95	8,431.53	52,923.60
Land and Structures (Contractual)			329.06	4,224.54		15,026.66
Total Expenditures	\$15,000.00	\$15,000.00	\$60,000.00	\$89,992.09	\$101,826.69	\$565,932.10

CONTENTS

	Page		Page
Letter of Transmittal	2	U.T.—A.E.C. Projects	55
Financial Statement	2	Chemistry	56
Introduction	4	Soils, Effluents, Fertilizers	56
Agricultural Economics and		U.T.-T.V.A. Cooperative	
Rural Sociology	5	Projects	65
Adjustments in Reservoir Areas	6	Chemistry: Food Processing	68
Cotton Production Practices	6	Fertilization and Protein	
Type of Farming	7	Studies	70
Farm Electrification	8	Dairying	72
Milk Marketing	8	Artificial Insemination	73
Egg Marketing	11	Mastitis Investigations	73
Marketing Practices of		Thyroid Metabolism	74
Feed Mills	11	Thyroprotein Feeding	75
Cotton Marketing	12	Dairy Manufacturing	75
Tomato Marketing	13	Dairy Experiment Station,	
Agricultural Engineering	14	Lewistown	76
Small Grain Plot Combine	14	Cool Weather Grazing	77
Mechanical Harvesting of		Grass Silage	80
Hybrid Corn	15	Dairy Cattle Breeding	80
High-Clearance Cotton Sprayer	16	Entomology	81
Irrigation	19	Cotton Insect Control	81
House Construction Studies	21	Woolly Apple Aphid Control	82
Curing Dark-Fired Tobacco	21	Tomato Fruit Worm Injury	82
Agronomy	22	Vegetable Weevil	83
Corn Breeding	23	European Corn Borer	83
Grass Breeding	24	Sodium Fluosilicate Studies	83
Chemical Weed Control	25	Home Economics	84
Crop Fertilization Studies	26	Home Management	84
Zinc and Magnesium Studies	28	Housing Survey	85
Sulfur Studies	28	Southern Rural Home Studies	86
Comparison of Phosphate		Textiles and Clothing	87
Fertilizers	29	Consumer Preferences	89
State Soil Survey	29	Foods	90
Fiber Research	29	Nutrition	92
Crop Improvement	31	Horticulture	93
Animal Husbandry and		Tree Fruits	93
Veterinary Science	34	Vegetables	97
Effects of Atmospheric		Cultural Studies	98
Effluents	34	Breeding	99
Winter Pastures and Dry Lot		Plant Pathology	100
Rations	36	Cotton Verticillium Wilt	100
Pasture Investigations with		Alfalfa and Clover Crown Rot	101
Swine	37	Root Diseases of Small Cereals	101
Producing Ability of Beef		Strawberry Root Rots	103
Cattle	39	Disease-Resistant Tomatoes	103
Carcass Evaluations with		New Fungicides	103
Pork and Lamb	41	Poultry	105
Effects of Hormones, Ewes and		Poultry Nutrition	105
Lambs	42	Poultry Parasitology	106
Effects of Hormones on Swine	43	Breeding and Physiology	107
Jackstock and Mule Breeding	43	Influence of Hormones	108
"X Disease" of Cattle	44	Calcium Metabolism	109
Johne's Disease of Cattle	46	Poultry Processing	110
Finishing Yearlings, Jackson	47	Forestry Experiment Station	110
Orchard Grass and Tall Fescue		Highland Rim Experiment	
Pastures, Columbia	48	Station	113
Spring Lambs, Flock		Middle Tennessee Experiment	
Comparisons, Greeneville	49	Station	116
Cow-Calf Production Studies,		Plateau Experiment Station	119
Greeneville	50	Tobacco Experiment Station	121
Finishing Two-Year-Olds	51	U.T.-A.E.C. Research	130
Cow-Calf and Pasture		West Tennessee Experiment	
Fertilization, Crossville	53	Station	141

INTRODUCTION

How valuable is the Tennessee Agricultural Experiment Station to the people of Tennessee?

This question is frequently asked, although it cannot be completely or accurately answered. It is parallel with asking how valuable is penicillin to mankind. Too many intangibles are involved to permit arrival at a figure approximating accuracy. Certain indications of the Station's value, however, are available.

During the year 1950, county agents of Tennessee, who extend to farms the information available from the Experiment Station, reported changed practices on 139,787 farms. It is inherent that many of these practices were adapted because of their value proved by research and actual experience at the Agricultural Experiment Station.

The Experiment Station is concerned with whatever problems confront farm people of Tennessee. Some of the quickly evident results of this concern are the development of higher-yielding crop varieties, improvement of existing varieties of grass, grain, fruit, vegetable, and other crops; the testing of insecticides and herbicides under Tennessee conditions; investigations into all fields of livestock production.

The Station has received valuable support from other agencies, such as the Atomic Energy Commission, the Tennessee Valley Authority, the U. S. Department of Agriculture, and industrial grants, in addition to the State appropriation.

Some indication of the Station's monetary value to the State is available. The financial statement in this report shows what funds were available during the year. The amount scarcely compares with the approximately 10 million dollars derived from improved Burley tobacco varieties, and improved practices; the 15 to 20 million dollars added to the State's corn crop due to improved seed and better use of fertilizers. A similar sum has been added to the wealth of farmers by the use of higher-yielding varieties of soybeans, oats, rye, and barley developed by the Experiment Station. Some eight or 10 million dollars may be obtained or saved each year by livestock farmers through feeding and management practices proved at the Station.

It is, of course, impossible to describe all research at the Agricultural Experiment Station in a bulletin report of this size.

Currently, the Nation faces another emergency, and much of the work at the Station for some years will of necessity be directed toward making it possible to meet food, feed, and fiber requirements through employment of practices compatible with good land use.

J. H. McLEOD
Dean and Director

F. S. CHANCE
Vice Director

SIXTY-THIRD ANNUAL REPORT

1950

AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

AGRICULTURAL ADJUSTMENTS

Unit-Test Demonstration Farms

Analysis of 45 farm records of unit-test demonstration farms over a 12-year period reveals that the following factors are conducive to increased farm income: increases in numbers of livestock, especially roughage-consuming animals; shifts in land use from crops to pasture; shifts from low-producing hay crops to higher producing hay crops of clover and alfalfa; reduction in corn acreage; and increases in livestock returns per animal.

These facts are useful to county agricultural agents and farm management specialists in assisting farmers in planning improvements in their farm businesses. Results were published in a Report, "Farm Adjustments Related to Changes in Farm Returns, East Tennessee, 1937-1948," Tennessee Agricultural Experiment Station Monograph 261, June 28, 1950. The Agricultural Extension Service and the Tennessee Valley Authority furnished the farm records.

Further study of unit-test demonstration farms is under way in a selected watershed. Farmers will be offered intensive guidance and assistance in management problems. Progress of these farmers will be measured against that of other farmers in the watershed to determine applicability on similar farms in other areas.

FARMS SELLING MILK FOR MANUFACTURING PURPOSES

From 147 farms selling milk in Greene County, preliminary analysis of data indicates: that most farmers, especially the larger ones, now selling milk can profitably expand their dairy enterprise. It appears that the factor most directly influencing incomes on the very small farms is the size of the tobacco enterprise, which is limited by acreage allotments.

Costs of and Returns from Dairying

Major emphasis was placed on a study of alternative farming opportunities available in the Southern Brown Loam Area of West Tennessee. The dairy enterprise was analyzed on 40 farms in Weakley County. Results of the study were published in a report, "Costs and Returns from Dairying on 40 Farms Producing Milk

for Processing, Weakley County, Tennessee, 1947-1948," Tennessee Agricultural Experiment Station Monograph 256, June 15, 1950, in cooperation with the Bureau of Agricultural Economics, U. S. D. A.

With home-grown feed charged at market price and labor at 50 cents per hour, cost of production averaged \$243, and gross receipts averaged \$217 per cow. However, farmers paid an average of only \$1 in cash for every \$4 of total cost. After paying all direct cash expenses on the dairy enterprise, the average net cash income amounted to \$125 per cow. The market furnished for home-grown feed and pasture, and the use of surplus or under-employed family labor have added to the importance of the dairy enterprise on farms in this area. Basic data from this study have been used by county agents and agricultural workers in group discussions with farmers in making production adjustments and improving farming opportunities. The study of alternative systems of farming in the Brown Loam Area is being continued.

ADJUSTMENTS IN RESERVOIR AREAS

In cooperation with the Tennessee Valley Authority, a survey is being made of economic adjustments in areas adjacent to the Douglas Reservoir in Jefferson, Sevier, and Cocke Counties. The purpose of the study is to determine the special needs of the area, and outline research and extension plans for rational economic development.

ECONOMIC SIGNIFICANCE OF COTTON PRODUCTION PRACTICES

In cooperation with the Bureau of Agricultural Economics, U. S. D. A., as part of a belt-wide survey, the study of production practices for cotton was completed and the following publications were issued: "Cotton Production Practices in Type-of-Farming Area 6, Western Tennessee, 1947," and "Cotton Production Practices in Type-of-Farming Area 3, Southwestern Tennessee, 1947," Monographs 257 and 258, June, 1950.

Among the cotton practices described in the major cotton-producing areas are those relating to planting seed, fertilization, insect poisoning, harvesting, and field operations using horse and tractor-drawn equipment. Use of commercial fertilizer in Southwest Tennessee was at a relatively low level. About 60 percent of the cotton acreage was fertilized at an average rate of 200 pounds per acre. In contrast, 98 percent of the cotton acreage in the southeastern part of West Tennessee was fertilized at the rate of 300 pounds per acre.

Tractor power was used to perform some or all of the machine operations on an average of two of every five farms in both areas. On farms using tractor power alone for machine work, seven hours of man labor were required, compared to 30 hours needed to perform

similar work with horse-drawn equipment. These data provide a bench-mark of cotton production practices from which future changes in practices may be measured. They also show levels of practices actually in use compared with those recommended. The information is being used in teaching at high school, college, and extension levels.

The investigation of costs and methods of hay harvesting, completed last year in cooperation with the Bureau of Agricultural Economics, U. S. D. A., was published in a report, "Usual Requirements, Practices, and Costs in Hay Harvesting, Central Basin of Tennessee, 1945," Monograph 251, January 20, 1950.

TYPE OF FARMING

Analysis of farm leases considered to be successful by 55 farmers in Type-of-Farming Area 3, West Tennessee, was completed and the results were published in a report, "Some Factors in Farm Organization and Returns to Tenants and Landlords by Type of Leasing Arrangements, West Tennessee, 1947," Experiment Station Bulletin 217, June, 1950. This report was also designated as Publication No. 7, "Southwest Land Tenure," as it was part of a regional project. The bulletin provides basic information on new leasing arrangements for cash-crop farmers who contemplate adding dairy or livestock enterprises.

Changes Occurring on Farms, 1916 to 1948

The study last year of changes in farming in type-of-farming Area 15 over a 31-year period was completed. The more pronounced changes included: (1) proportion of non-farm families on these farms increased from 12 to 50 percent; (2) farm land values increased over 50 percent; (3) many small farms were divided and sold as non-farm building sites; (4) there was a decided shift away from row crop to livestock farming and most of the land taken out of crops was turned into pasture; (5) crop production shifted principally from row crops to hay crops and small grains; (6) there were substantial increases in crop yields, the percentage increases being 66 for corn, 100 for barley, 96 for wheat, and 47 for tobacco; (7) there was a tendency to change from owner-operated to cropper and tenant-operated farms; (8) there was a significant shift toward mechanization; (9) the most important change in the sale of farm products was increased sales of milk; (10) income from the sale of livestock and livestock products increased from 52 to 70 percent of the gross income.

Because agricultural trends point to urban growth and industrial development, other areas may undergo changes similar to those of the area studied. They may use the experience of this area to advantage.

FARM ELECTRIFICATION

In cooperation with the Bureau of Agricultural Economics, U. S. D. A.; and the Tennessee Valley Authority, the study started last year of the costs and use of electricity on 479 farms, and consumption of electricity by 79 rural non-farm families, was continued and a preliminary report summarized the results. The amount of kilowatt-hours of electricity used per farm increased from an average of 654 in 1939, to 2,139 in 1948. Non-farm families used an average of 1,851 kilowatt-hours in 1948. Consumption of electricity was highest for the larger farms, those with the highest incomes, livestock farms, and owner-operated units. About 11 percent of electricity used on farms was for farm production purposes. The remainder was used in the home. Of the farms having running water systems, 89 percent used electricity for pumping. Cost of electricity in 1948 averaged \$42.63 per farm or 1.993 cents per kilowatt-hour. The cost per non-farm resident unit in 1948 averaged \$35.09.

Considerable increase in consumption of electricity is likely because of the extension of power lines, increased appliance density on farms and in homes already electrified, increased numbers of rural non-farm and part-time farm families, and shifts in farming toward more livestock, dairy cattle, and poultry.

LIVESTOCK MARKETING

In cooperation with the Agricultural Experiment Stations of 10 other Southern States, the Bureau of Agricultural Economics of the U. S. D. A., and various State Departments of Agriculture, a Regional Study, SM-7, was started on "Marketing Livestock and Livestock Products in the South." Present plans call for work on the evaluation of price-grade differentials among various classes of livestock.

MILK MARKETING

Seasonality of Supply and Utilization of Milk

In cooperation with the Agricultural Experiment Stations of five other Southern States and the Bureau of Agricultural Economics, U. S. D. A., a study was made of the seasonality of milk supply and its utilization by 211 milk plants operating in Tennessee in 1949. The first phase of this study was to obtain information concerning the quantities of milk and cream received by the milk plants and variation in the use of these receipts with reference to geographic location and type of plant.

Seasonal variation of milk production creates a serious problem for fluid milk plants (Fig. 1). Increased receipts of milk from producers in the summer creates a problem of utilizing this surplus. Some seasonal pricing of milk to help control the wide seasonal

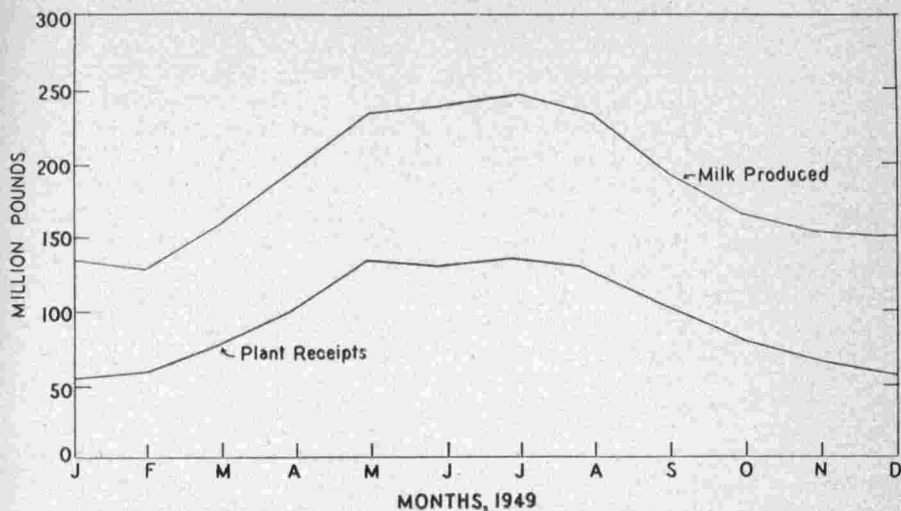


Figure 1—Seasonality of milk produced in Tennessee, and receipts of milk by 211 plants in Tennessee in 1949.

variation in production is needed. Many different pricing methods are being used in paying farmers for milk. A study is under way to evaluate these alternative pricing plans.

Costs and Margins of Milk Distributors

The study of milk distribution costs in Memphis, conducted in cooperation with the Bureau of Agricultural Economics, U. S. D. A., was completed and published by the Bureau in a report, "Costs and Margins of Milk Distributors in Memphis, Tennessee, 1948," Mimeographed, 1950.

Summarized results of this study show that the milk distributors' spread in Memphis in 1948 was one of the lowest among large cities in the United States. A quart of milk was delivered to the Memphis consumers' doorstep for an average price of 18.8 cents, of which the producer received 12.8 cents. Salaries made up more than half the cost of distribution.

Wide distribution was given to the published results. The development of standards of operation by various milk distributors provides a means whereby dealers can rate their own operations and find ways to reduce costs. This study also serves as a source from which consumers can obtain information on the costs of milk distribution.

Seasonal Costs of Producing and Marketing Fluid Milk in the Memphis Milkshed

As part of the Regional Dairy Marketing Project, SM-2, a study was made of the costs of producing and marketing milk by

185 dairymen in the Memphis milkshed. Summarized results of the records gathered were published in two reports: "Seasonal Costs of Producing and Marketing Fluid Milk in the Memphis Milkshed, 1948-49," Monograph 252, February 22, 1950; and "Seasonal Costs of Producing and Marketing Milk for Manufacturing Purposes in the Memphis Milkshed, 1948-49," Monograph 255, June 13, 1950. It was found that the most important factor influencing production cost was the production average per cow. Costs could have been reduced by increased feeding of cows on about half of the farms, by increasing the total digestible nutrients obtained from pasture, and by better adjustment of size of herd to labor and feed available. A study of the costs of producing and marketing milk in the Chattanooga milkshed is in progress.

Fall Season Milk Production Incentive Plan

A report "Operation of the Fall Season Production Incentive Plan in the Nashville, Tennessee, Milk Marketing Area, 1949," Monograph 253, April 28, 1950, was published. It was found that about 85 percent of increased milk deliveries to the market was due to new producers, and the remaining 15 percent to increased production per unit. The operation of the incentive plan increased the price of milk in the Fall by \$1.02 per hundredweight over the Spring period. In addition, the blend price was increased by \$1.01 per hundredweight during the Fall. The operation of this plan for 1950 is being analyzed.

Seasonal Costs of Producing and Marketing Fluid Milk in the Knoxville Milkshed

A study of the cost of producing and marketing milk in the Knoxville milkshed as part of the Regional Dairy Marketing Project SM-2, was completed. Net returns from fluid milk produced on 135 farms in the Knoxville milkshed for the year ending July 31, 1949, ranged from a loss of \$6.83 per cow in December, to a profit of \$12.36 in May.

Milk production averaged 5,878 pounds per cow for all herds. Net return per 100 pounds of milk produced was highest in the range of production of 6,000 to 6,999 pounds per cow. However, net return per cow was highest in the group with a production of over 7,000 pounds. The most important factor determining the cost of producing 100 pounds of milk was production level per cow, the cost decreasing rapidly as production per cow increased to 7,000 pounds.

A report on the findings of this study, "Seasonal Costs of Producing and Marketing Fluid Milk in the Knoxville, Tennessee, Milkshed, August 1948-July 1949," was published in Monograph 260, June 28, 1950. Reports were distributed to members of the Knoxville Milk Producers' Association, milk dealers, and agricultural workers.

EGG MARKETING

In cooperation with eight other States and the Bureau of Agricultural Economics, U. S. D. A., work was continued on Regional Research Project SM-6, Marketing Poultry and Poultry Products. Analysis was completed on data obtained on 170 market egg producers and the distributive functions of 197 egg dealers or primary buyers of eggs. A typewritten report was prepared on "The Relation of Size of Flock of 170 Market Egg Producers to Market Egg Production in Tennessee, 1947-48." The use of practices to maintain egg quality and provide for more uniform distribution of eggs throughout the year is directly associated with the size of flock kept by market egg producers. As the size of flock increases, there is an increase in the proportion of producers who provide better housing facilities and controlled range, eggs are gathered more often and are held under conditions conducive to quality maintenance, eggs are marketed more frequently and those sold are cleaner and better packaged. Market egg producers with large flocks receive higher average prices for eggs than do producers with small units.

A report, "Distributive Functions of Primary Egg Buyers in Tennessee," Monograph 254, May 5, 1950, was published and widely distributed in the industry and to agricultural workers. This report has been of value to the industry and educational agencies in increasing the effectiveness of their programs and cutting down unit operating costs by focusing attention on increasing size of flock, concentrating egg production, and eliminating waste.

Tennessee, Alabama, and Mississippi are cooperating on a regional project, "Egg Marketing by and Through Agencies Beyond the First Buyer."

MARKETING PRACTICES OF FEED MILLS

The study of feed mills in six Southeastern States, begun in 1949 on contract with the Commodity Research Division, Grain Branch, Production and Marketing Administration, U. S. D. A., was completed. Results of the study, with those of other regions, were published in a national report, "Inventory and Hedging Policies of Commercial Mixed-Feed Manufacturers in the United States," U. S. D. A., Agriculture Information Bulletin No. 24, September 1950.

It was found that many of the feed manufacturers built up substantial stocks of ingredients such as soybean meal, fish meal, alfalfa meal, and sometimes grains, with resultant risk of losses through price declines. Manufacturers usually carried these risks rather than transfer them to others. Hedging was practiced by 7 of 47 mills contacted in six Southeastern States, compared with 36 of 194 mills included in the national survey.

Many feed manufacturers who accumulated large ingredient inventories expressed interest in ways to obtain protection against price risks. They were keenly interested in the grain futures mar-

kets as indicators of market values. Although few feed manufacturers hedged directly, they benefitted indirectly from the hedging operations of grain merchants.

In general, feed mills are tied to a milling-in-transit privilege which favors purchase of ingredients from the North, and distribution of mixed feed deep into Southern territory. This often results in neglect of the farmers in the local trade area, both as a source of ingredients and as an outlet for mixed feeds. Procurement policies of feed manufacturers play a vital role in the economy of livestock production of the South.

COTTON MARKETING

In cooperation with the Agricultural Experiment Stations of 11 other cotton-producing States and the U. S. Department of Agriculture, the cotton marketing studies as part of the Regional Project SM-1, "Regional Marketing of Cotton Including Cottonseed and Other Products," were continued.

The study of adjusting cotton production and marketing to provide mills with the qualities of cotton best suited to their requirements and to provide for the movement of cotton from farms to mills in the most efficient manner is reported in: "Improvements Needed in Tennessee Cotton Quality and Marketing Practices to meet Mill Requirements," Monograph 259, June 25, 1950.

Analysis was completed of the cotton marketing practices of 141 growers, 22 ginners, and 41 buyers, and summaries were published in a report: "Cotton Marketing Practices of Growers, Ginners, and Buyers in Tennessee," Monograph 262, November 16, 1950. In improving cotton marketing conditions in the cotton-producing areas of Tennessee this study points out the following questions for consideration:

1. Would the bargaining position of growers be improved if they sold their cotton in the larger markets, sold in several bale lots, and secured prices from more than one buyer?
2. Could cotton buyers and ginners aid in improving local cotton market conditions by buying no cotton in the seed with the exception of less than bale lots, paying prices for cotton based on the quality of each bale, and encouraging farmers to sell in several bale lots in the larger markets?
3. To secure cotton price and quality information from unbiased sources, should all growers assume a more active role in marketing by becoming members of cotton improvement associations and receiving the benefits of free Government cotton classification and market news services?

A study is in progress to determine the extent to which merchants who sell cotton to spinning mills are buying on the basis of growth, variety, price and cotton quality. Data secured from 290 farmers who feed cottonseed meal and hulls to livestock in West Tennessee are being analyzed and a report is being prepared on the possibilities of extending the market for cottonseed feed products.

A study is under way of methods of improving the marketing of cottonseed for planting purposes and of enhancing the commercial and agricultural value of cottonseed for planting by use of better methods of preparation, storage, and distribution.

TOMATO MARKETING

This was the fourth season of investigation of practices affecting the quality of tomatoes marketed by farmers. Work on this project was conducted in cooperation with four other Southern States; the U. S. Department of Agriculture, Bureau of Plant Industry; Production and Marketing Administration; and Bureau of Agricultural Economics. The study completed this year covered 130 commercial tomato producers and 19 packer-buyers in West Tennessee during 1949. There was a direct relationship between certain production and marketing practices and the marketable yield and quality of tomatoes. Based upon technical advice from the professional horticulturist and upon data available from the study, various weights were assigned to specific practices, namely: weight of 26.5 to use of insecticides and fungicides; 4.0 to quality standard in harvesting; and 4.5 to handling practices. Table I indicates the results of the arbitrary application of assigned weights to specified practices and shows that the marketable yield increases in direct proportion to the effective performance of the practices considered.

TABLE 1—*Distribution of Marketable Yield to Aggregate Valuation of Production and Marketing Practices, 100 Producers, Humboldt Area, 1949.*

Number Points	Percent of Growers	Average Marketable Yield (Bushels)
0—4.9	12	52
5—9.9	16	54
10—14.9	14	68
15—19.9	14	97
20—25	44	208
TOTAL	100	479

A report was prepared on the "Practices Affecting the Marketable Yield and Quality of Tomatoes in West Tennessee, 1949." Results of this study are available to producers and the industry from the Horticulture Department and Extension Service of the College of Agriculture. This project is being continued and a study is being made of the competitive status of Tennessee tomatoes in relation to the trade and consumer acceptance. Data have been obtained from 23 wholesale agencies and 57 retailers handling tomatoes, and from 100 consumers.

COOPERATION

The analysis of data secured on 224 members of the Dark-Fired Tobacco Associations in Tennessee is nearing completion and a report is being prepared. Preliminary data indicate that news-

papers are the most used medium in disseminating information about the association. Farmers had a better knowledge of association activities dealing with the actual sale of tobacco than they had of other association affairs. Tenant arrangement had little effect on the time that tobacco was sold on the market. In general, members with higher educational attainment were more favorable toward the activities of the association than those with a lower level of education.

A study is being made of the efficiency of operation of 55 purchasing cooperatives in Tennessee. Principal objectives of this study are to determine the influence of volume of sales on operating costs and any financial ratios which may be applicable in establishing the comparative efficiency of different associations.

AGRICULTURAL ENGINEERING

SMALL GRAIN PLOT COMBINE

Small grain breeding work at the University of Tennessee has been limited in the past by equipment for harvesting the plots. Until 1950 the plots had been harvested by hand, requiring a large amount of labor.

A combined harvester-thresher was needed for harvesting plots because: (1) it would enable plant breeders to evaluate the field harvesting characteristics of the small grain varieties as they were developed; (2) it would greatly reduce the amount of hand labor required. Commercially built combines are unsatisfactory for plot work because of their size and difficulty to clean.

Design of Plot Combine

The plot combine shown in Figure 2 was assembled from four basic units, namely: (1) an Allis-Chalmers 40-inch combine; (2) an Allis-Chalmers "G" tractor minus front end and rear wheels; (3) an 8.4 HP air-cooled engine; (4) a small air compressor. The combine was stripped of the original wheels, bagging attachment, and frame. The inside of the combine was streamlined with sheet metal, solder and plastic wood to prevent lodging of grain. A frame was made to mount the tractor on top of the combine and two drive wheels were added to the front of the combine, driven by roller chains from the tractor. Two steerable wheels were added to the rear, controlled by cables from the tractor seat. A small engine was mounted on the right side to drive the separating and threshing parts. An air compressor was attached to the belt pulley of the tractor to speed cleaning of the combine after each grain variety harvest.

The plot combine was ready for use in June, 1950. It was used to harvest most of the breeding plots at Knoxville. Results were satisfactory. Harvesting time was reduced by 90 per cent as com-



Figure 2—Front view of plot combine in action.

pared to hand harvesting. The machine was stable on slopes up to 35 per cent, but to allow a safety margin it was not driven on slopes greater than 15 per cent. Since all plots were on slopes of less than 10 per cent, comparative instability of the combine was not a problem.

MECHANICAL HARVESTING OF HYBRID CORN IN TENNESSEE

A new project was started in 1950 at the Knoxville station to investigate the mechanical harvesting characteristics of hybrid corn in Tennessee.

There were 1,200 corn pickers in Tennessee in 1950; there were none in the State in 1936. This comparatively rapid increase has caused some complaints about the efficiency of corn pickers when

used on Southern hybrids. Corn pickers have been designed to pick hybrids developed in the corn belt. Compared to corn belt plants, the Southern hybrids are more prolific, have smaller ears, have tighter husks and are taller.

Ten hybrid corn varieties, including four from the corn belt, were tested. All picking was done with a Dearborn-Wood Bros. model 16-27 corn snapper furnished by the Monarch Equipment Company of Louisville, Kentucky.

Results of these tests are shown in Figure 3. The white part of the bar represents the corn lost by shelling at the snapping rolls. This corn is almost a complete loss to the average farmer since few

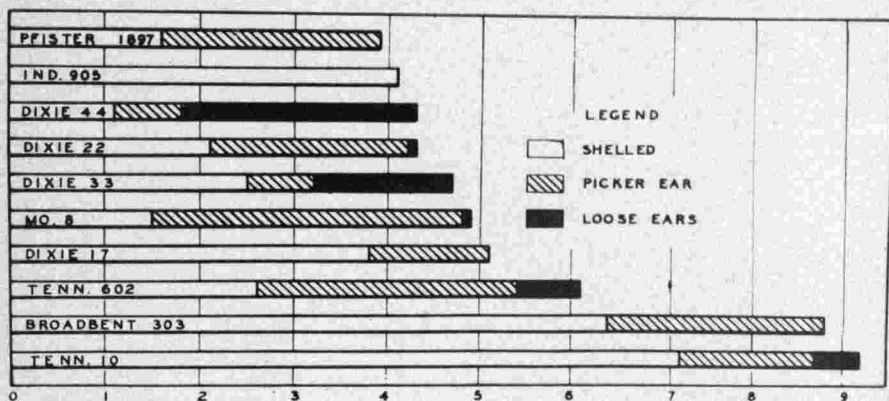


Figure 3—Summary of corn picking losses in tests with corn picker in 1950. Numbers at bottom of graph represent bushels of corn lost per acre.

farm animals will pick it up. The cross-hatched (diagonal lines) bar represents the ears of corn knocked from the stalk to the ground by the picker. This is usually caused by leaning and broken stalks. The black part of the bar represents the loose ears on the ground before the picker passed. This loss cannot be attributed to the picker, but is a characteristic of that particular corn variety.

Corn missed by the picker is not a complete loss since swine and beef cattle salvage a large percentage of it. In total loss, Tennessee 602 and Tennessee 10 were significantly higher than the others, except Broadbent 303. There was no significant difference in the other seven, which means that Dixie 17, 22, 33 and 44 compared favorably with the corn belt varieties—Missouri 8, Indiana 905, and Pfister 1897.

A HIGH-CLEARANCE COTTON SPRAYER

A cotton sprayer (Fig. 4) was designed and built for the West Tennessee Experiment Station at Jackson. While the sprayer was designed primarily for use on experimental plots, this machine has some advantages over a tractor-mounted rig, making it useful to cotton farmers. Some advantages are:



Figure 4—A high-clearance cotton sprayer developed at the Experiment Station.

(1) because of its high clearance it does less damage to cotton; (2) the cotton grower who does not own a tractor can afford to own this machine; (3) it makes possible a regular spraying schedule regardless of the field conditions; (4) the rig will release the tractor for other jobs during the busy season.

Information on this sprayer is given in Experiment Station Circular of Information No. 88, entitled "Construction and Use of a High-Clearance Cotton Sprayer."

WATER MANAGEMENT AND IRRIGATION

Engineering work on water management and irrigation has been in progress at this station since 1936. This work has consisted of: (1) development of apparatus and techniques for experimental studies; (2) obtaining information; (3) development of practical equipment and techniques for farmers, and (4) determination of the reliability of the experimental data secured and the practicability of the equipment and techniques developed. This is a report on the latter phase of the work.

Conclusions on Data Obtained Relative to Infiltration, Runoff, and Erosion

Data obtained by this Station in 1940 and 1941 indicated that loss of water by surface runoff was not as serious in Tennessee as generally believed, and that for some of Tennessee's more important soils, surface runoff could be prevented without the use of contour furrows or other mechanical devices. This was difficult to believe at that time and definite conclusions were not made. The data were filed and the personnel put the irrigation equipment for rain simulation to use in the food production program soon after the National emergency arose.

Fortunately, runoff measurements on 12 of the 1/20-acre permanent plots were continued by personnel of the General Chemistry Department. The Station now has data on actual runoff on a long-time basis for two soil types and infiltration and erosion data on a comparative basis for 27 soil types. As supplementary investigations, the Station has studied simulated flow of water, gully erosion, puddling of soils, soil moisture and records of rainfall.

Supporting data are still limited but the value of the data secured is greatly increased by the absence of conflicting and erratic results. The data from the permanent plots are in line with information secured from the temporary plots. In testing the accuracy of the rain simulation method it was found that the results from duplicate plots were very close. Duplicate 1/20-acre plots were set up on undisturbed sod land at 16 different places. The greatest difference in the rate of infiltration for two plots side by side and tested simultaneously by means of controlled simulated rain was 24 per cent. The average difference for the 16 different sets was 8 percent.

This was found to be a small difference in comparison with that due to variation in soil type, treatment and condition. For example, a 1/20-acre plot on a Cumberland silty clay loam soil with a 16 percent slope and with a 95 percent cover of bluegrass and other grasses for pasture absorbed all of the 1.85 inches of water applied in 30 minutes. This plot and duplicate plots continued to absorb water at the rate of one inch per hour after the soil and subsoil were completely saturated.

For a similar set-up on a Memphis silt loam soil with a 41/2 percent slope and with a 90 percent cover of bluegrass for pasture only, .59 inch of the first application of 1.85 inches in 30 minutes was retained. Toward the latter part of this application the soil was retaining and absorbing water at the rate of only .24 inch per hour. For the first application on a Hagerstown silt loam soil with a trashy seedbed practically all the water was retained and for a second application 30 minutes later, .98 inch was retained. This plot continued to retain water at the rate of .84 inch per hour. For a similar set-up the same day on the same farm, another plot on Hagerstown silt loam soil in a seedbed condition absorbed only .84 inch of the first application and .08 inch of the second. The rate of absorption at the end of the second application was zero. The comparative low infiltration rate on the second plot and other plots with a clean pulverized soil was explained later by findings on soil puddling by raindrop impact.

The occasional severe erosion by a single rain was explained by findings on gully erosion and erosion by simulated flow of water. It was found that water will not flow over a clean, pulverized unpacked soil with a slope of 3 percent or more without concentrating and cutting channels and carrying off an enormous amount of soil. When the simulated flow was applied to soils that had first been

rained on, the water spread and did not cut down into the soil so easily.

These results indicate that most rains stop before much runoff occurs on clean, loose pulverized soils and that resistance to severe erosion is built up by the time the runoff starts. If only the surface is compacted and runoff is severe, enough channels will be cut down into the unpacked soil to permit the concentration of eroding water. The amount and rate of rainfall and other conditions are frequently favorable for severe gully or rill erosion in East Tennessee. Indications are that conditions favor such erosion in West Tennessee nearly every winter on soils that are completely bare or unprotected and in a condition to be pulverized by freezing and thawing. Figure 5 shows what happened in a Knox County wheat field in one week of February, 1939. Detailed measurement showed that erosion on this field caused loss of more than an inch of soil from the steep convex slope.

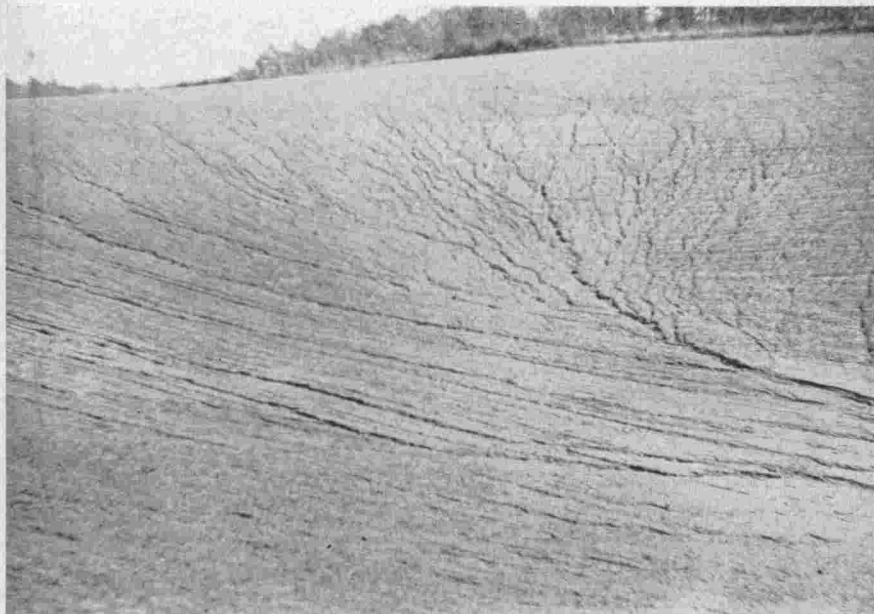


Figure 5—This severe gully or rill erosion, which occurred on a wheat field in East Tennessee, shows what may be expected on a clean-cultivated slope during heavy or prolonged rainfall.

IRRIGATION

Work at this Station on low-pressure giant sprinklers has been based on the assumption that as long as irrigation involves a great amount of pipe and other equipment to be set up and moved frequently by hand, Tennessee farmers would not be interested in providing moisture for their crops on an intensive basis and that

equipment purchased for this purpose would not be used very much. Irrigation needs in Tennessee are not now known, but it is known that farmers who have portable irrigation systems have not used them very much. Most irrigation systems in the State were not used at all this year and have been used very little within the last two years. Even during years with less favorable moisture conditions, many farmers have waited until the crops showed signs of drought damage before using their irrigation systems.

The objectives of the work on giant sprinklers by this Station are: (1) to develop for farmers a less expensive and more compact and more flexible irrigation system for occasional use in emergency irrigation; (2) to make more frequent irrigation less difficult by eliminating much of the labor involved; and (3) to provide techniques for using irrigation equipment for other uses, such as applying fertilizers in solution. The giant sprinkler is considered essential for all three objectives.

Suction Strainer

A perforated pipe strainer made by this Station and lent to co-operating farmers has been found to be less expensive and more satisfactory than the standard compact deep water type strainers.

Suction Pipe

The customary way of conducting water from its source to an irrigation pump is through a heavy reinforced rubber hose. For large pumps this requires a heavy, expensive suction hose. This Station has substituted a light, inexpensive pipe. Both the pipe and the quick-acting rubber cushioned coupling to the pump have proved satisfactory.

Pressure Pipe

Two co-operating farmers have found dragging a satisfactory method of moving the irrigation line to a new location within a field. Tractors were used on pastures to drag long lines of 6" aluminum pipe. For corn, a mule was used to drag the line to an adjacent field where the line could be maneuvered in position to be taken back into the corn field at a new location. The pipe shows signs of wear and it is not now known how much dragging it will withstand.

It has been established that in pipe for this section, the coupling should have a positive latch so that when a line is laid the pipe will remain coupled until the latch is released.

Mounting a Pump on a Tractor

After several unsatisfactory mountings, this Station devised a method of swinging the pump under the tractor pulley to utilize the weight of the pump to provide proper belt tension automatically. This mounting has proved satisfactory.

Priming a Centrifugal Pump

The old standard foot valve method adds considerably to the weight of the intake pipe and holds the pipe full of water when the operator wants to move it. The pitcher pump method, like the foot valve method, requires a lot of work especially if there is a leak. An experience of accidental bursting the piston heads of a gasoline engine, caused by water in the cylinders, has discouraged the recommendation of the intake-manifold suction method. The exhaust-ejector type works well for certain types of gas engines, but has been found not so good with tractors with old exhaust pipes.

Progress has been made by this Station in making a high pressure pump self-priming. This involves external circulation of a small quantity of water and a small tank for liberating trapped air pulled out of the intake pipe. Water can be lifted about five feet without the tank. It may prove practical to provide for a tank and pump connections for the three-fold purpose of priming the pump, and mixing and feeding fertilizers into the irrigation system.

HOUSE CONSTRUCTION STUDIES

The study of low cost housing has been continued and the materials to be used have been selected. After careful study of work done in other States, and of materials available, it appears that recently developed light-weight aggregates for concrete offer the most promising possibilities. Tests are being made and design has been essentially completed for construction of an all-masonry house. This structure will be well insulated and electrically heated.

Electric Radiant Heating Panel

In connection with the housing studies it seemed desirable to develop a more efficient method of using electric heat than is now available. A project involving the development of panels has been progressing very well, three types of panels having been developed. These have not been completely tested, but all of them function well. During 1951 these panels will be placed under severe test conditions and recommendations can be made by the close of the year.

In the same study it is necessary to determine what types of insulation and how much is necessary for economical use of electricity. Tests are under way using different types and amounts of standard insulating products and reliable data have been obtained. Results will be available in 1951.

CURING DARK-FIRED TOBACCO

A project on curing dark-fired tobacco was started in the fall of 1949 at the Highland Rim Experiment Station, Springfield. This project is cooperative with the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. D. A.

Observations of the curing process by customary methods were made and plans prepared for future developments. Some preliminary tests were made in 1949. During 1950 barns were constructed or remodeled, furnaces were installed, and tests of equipment were made before harvest. Humidity controls were added and provisions were made for depositing smoke by the electrostatic method. A new plywood-sheathed barn was constructed for studies of gas-fired furnaces for initial curing. Douglas Fir Plywood Association co-operated in the construction of this barn.

Three barns are in use to facilitate obtaining data. Wood-burning furnaces are used to generate the smoke rather than burning the sawdust in open piles as is customary. These barns are so arranged that closely controlled curing conditions may be obtained and studies are being made to determine the best rate of initial drying, the rate of application of smoke, the type of smoke that gives best results, the desired temperature and humidity conditions, and length of curing time. Based on information obtained in the 1950 curing season, alterations in the equipment are being made for the 1951 season.

AGRONOMY

Research in agronomy continues to be varied in nature and broad in scope. Portions of the work relate primarily to crops and soils; but many studies necessarily join crop and soil problems.

Plant breeding projects are under way in connection with the major field crops to develop superior new varieties. An integral part of the plant-breeding program is the variety trial project in which the most promising selections from all sources are tested at various locations across the State. Pasture studies are under way to determine the most suitable types of pasture mixtures for Tennessee conditions, optimum rates of seeding, and the best grazing management. Weed control studies include cultural as well as chemical methods of killing weeds in the major field crops under various conditions. Crop fertilization studies are being continued with most of the important field crops including pastures. A study is being made of the comparative value of different phosphate materials for the more important crops grown separately and in rotation. Attention is being given to some of the less common elements, including magnesium, zinc, and sulfur as to their influence on plant growth and crop yields in Tennessee. Laboratory studies are being made to determine the best methods for measuring soil fertility levels. This year soil permeability studies were initiated to determine the rate at which water may be expected to penetrate the various soils. Tennessee has one of the larger soil-survey programs in the country and is making rapid progress toward completing an inventory of the soil resources in the State.

Work in these major activities is carried on both in the laboratory and in the field. Most of the laboratory activity is concentrated at Knoxville, though the soil permeability laboratory is located at Jackson. Field work is done at Knoxville, Greeneville, Crossville, Springfield, Columbia, and Jackson. In addition, some field work is done on lands of individual farmers. Some of the projects are sponsored cooperatively with other agencies, particularly the U. S. D. A. and the T. V. A. Because of these cooperative arrangements the Agronomy Department is able to undertake a broader and more adequate research program than would be possible with the support of State funds and personnel alone.

CORN BREEDING

The best evidence of the value of the Tennessee corn breeding program in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture, is the year-to-year increase in superiority and the growing popularity of the newer hybrids being developed. The acreage of Dixie 22 certified in 1950 was 1,009 against 166 in 1949. There were 558 acres of Dixie 33, being certified for the first time; 256 acres of Tennessee 602, and 860 acres of Dixie 17. The acreage in the production of Tennessee 10 on the other hand, had decreased from 4,192 in 1949 to 794 in 1950. That these shifts are in the right direction is clearly shown by the results of the State yield test, in which the newer hybrids are superior both in yield and standing ability.

Other new hybrids are on the way. One of these, Experimental T0120 (Fig. 6), a double cross with white cobs and grain, led the official State corn yield test with an average of 123 bushels per acre.

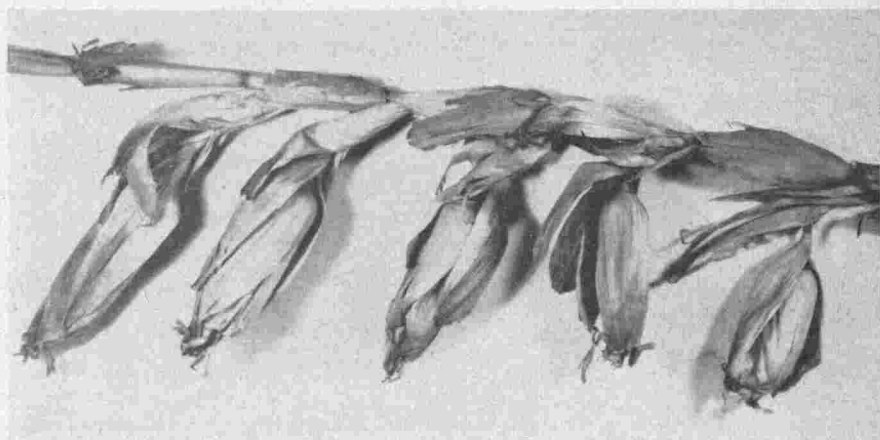


Figure 6—A five-eared plant of experimental hybrid T0120, which led the 1950 Tennessee corn yield test with an average yield of 123 bushels per acre and an average of two ears per stalk. Putting on occasional extra ears indicates a desirable ability to respond to very favorable conditions, even though two ears per stalk is a desirable average.

This compares with acre yields of 119 and 118 bushels for the next best entries, Dixie 33 and Dixie 17, which were developed previously in the program. Another all-white double cross, Experimental T0114, also tested for the first time in 1950, yielded 113 bushels per acre in the State test and had 93% erect plants, more than any other entry. An experimental yellow double cross, T9002, had 90% erect plants and yielded 117 bushels per acre, 4 bushels more than Dixie 22, the next highest yielding yellow hybrid.

Including T0120 and 70114, six of our white experimentals were tested at three locations in North Carolina and three in Tennessee. They all averaged about the same or more than Dixie 17 in yield. All six had excellent records for lodging resistance. They have other characteristics that give them promise of much value for the State within the next few years. Stocks for all of these new hybrids are being increased with a view to making them available to farmers of the State just as quickly as their potentialities can be proved.

GRASS BREEDING

Work is being done with Kentucky bluegrass, tall fescue, smooth brome, Harding grass, orchard grass, and little canary grass to breed and select strains that show improvement in yield, resistance to diseases and insects, and greater longevity. A strain of Kentucky bluegrass, which has short rhizomes and therefore gives a dense turf, seems to offer some promise. Harding grass has given exceptionally high yields of hay. Harding grass is somewhat like tall fescue, being a relatively coarse bunch grass and requiring high level fertility. The increasing interest of farmers in pasture and forage crops for livestock feeding points to the importance of the grass-breeding program to develop better varieties.

Pasture Mixtures and Seeding Rates

Over a three-year period mixtures of orchard grass and Ladino clover, and tall fescue with Ladino clover, produced high yields of forage. Either orchard grass or tall fescue may be seeded successfully with alfalfa for hay or for a combination of hay and grazing.

At Crossville, plots were seeded to mixtures of orchard grass and Ladino clover, and tall fescue with Ladino clover at various rates, starting with as little as five pounds of grass seed and one-half pound of clover seed per acre. Heavier rates of seeding gave somewhat higher yields the first season, but the stand was about equally good from all rates of seeding in the second year. The rate-of-seeding test was planted again in the fall of 1950.

Lespedeza

Tests of lespedeza varieties were made at Knoxville and Jackson, in cooperation with the U. S. D. A. Climax was the outstanding variety in yield. It probably will be necessary to purchase

fresh seed of the Climax variety every two or three years since seed of ordinary Korean lespedeza is present in most of the fields throughout Tennessee, and it will mix with the Climax variety.

Variety Trials

Variety performance experiments were conducted this year on eight of our major crops, including corn, cotton, oats, wheat, barley, soybeans, alfalfa, and red clover. These crops were tested for the most part at the six Experiment Stations across the state. Results of these experiments form the basis for the recommendation by the Experiment Station of varieties of the above crops. Detailed results of the variety performance experiments are given in Experiment Station Bulletin 218.

CHEMICAL WEED CONTROL

Chemical weed control experiments were conducted this year on corn (double cross and inbred lines), cotton, soybeans, peanuts, and Johnson grass. Many of the available herbicides have been tested for the past three years under varied conditions in Tennessee. Some of them have been found to be very effective as selective weed killers which can be used safely in many crops.

Corn—It was stated in the last Experiment Station report that 2, 4-D is an effective weed killer on corn when used as either a pre-emergence or a post-emergence spray. An experiment was conducted at the West Tennessee Experiment Station this year that showed how 2, 4-D reacts on corn during an unusually wet season and added to present information on chemical weed control in corn. When using 2, 4-D as a pre-emergence spray, the amine formulation has been most effective. The spray should be applied to the soil 3 to 4 days after planting, or just before the corn emerges. The rate of application should be $1\frac{1}{2}$ to 2 pounds of 2, 4-D acid per acre. The pre-emergence method of spraying should not be used on light-textured sandy soils or in areas that have poor internal drainage. On the heavier well-drained soils this method of spraying will control most of the annual broad leaf weeds and annual grasses.

2, 4-D may be used as a post-emergence spray on corn to control broad leaf weeds at any stage of growth in which the corn can be cultivated. The grasses will not be killed by this method of spraying. The rate of application should be $\frac{1}{2}$ to $\frac{3}{4}$ pound of 2, 4-D acid per acre. Chances of injury will be reduced if the spray is directed from the sides of the plants toward the base and never from over the top.

A test on 13 inbred lines of corn, using 2, 4-D as a pre-emergence spray, was conducted at the Knoxville Station. This test showed that there is a difference in the resistance of 2, 4-D of some of the inbred lines. More work must be done to determine the sensitivity to 2, 4-D of the inbreds that go into the make-up of the "Tennessee" and "Dixie" hybrids.

Cotton—Tests on chemical weed control in cotton were conducted this year on the U. S. Cotton Field Station at Knoxville and the West Tennessee Experiment Station at Jackson. Very good results were obtained with the dinitro compounds again this year and tentative recommendations and directions for use have been outlined by the Experiment Station in Circular of Information No. 87. Cotton farmers facing a labor shortage should try a small acreage, using chemicals to eliminate or reduce chopping, to see whether this method of weed control would be practical under their conditions.

Soybeans—A test at the Jackson station shows six pounds of dinitro per acre applied as a pre-emergence spray to be an effective weed killer in soybeans. It can be applied in the same manner as it is used in cotton, on the row area only or as a blanket coverage of row and middle.

Peanuts—A test was conducted on peanuts this year at Jackson, but more work must be done before herbicides can be recommended for use on this crop. However, dinitro looks promising.

Johnson Grass—Two tests have shown very effective control of Johnson grass with 250 pounds of sodium chlorate per acre. T. C. A., a relatively new chemical, gave excellent kill at 75 pounds per acre. Both of these chemicals are rather expensive but should be considered for use by farmers who have only a small area infested by this grass.

Bulletin No. 213, "Some Common Weeds and Their Control," was released in January, 1950.

CROP FERTILIZATION STUDIES

Pastures—Pasture fertilization and forage quality studies, initiated in 1947, were continued. Twelve experiments were conducted in 1950 at the various stations as well as on private farms. Moisture conditions throughout the year generally were quite favorable for pasture production. Yields of air dry forage were as high as four and one-half tons per acre on one of the highly-fertilized treatments at one location.

In cooperation with the Dairy Department and the T. V. A., nitrogen was applied at different rates and at different times to a pasture field at Columbia. The field was irrigated and was grazed by dairy cattle. Where no nitrogen was used, forage production was 1,500 pounds per acre; where nitrogen was applied at the rate of thirty pounds per acre per month for eight months the total production was about 3,500 pounds per acre.

Peanuts—Two peanut experiments, involving both fertilization and dusting to control insects and diseases, were carried out in Humphreys County in 1950. The work was made possible by a grant from the Growers Peanut Cooperative, Franklin, Virginia. In one experiment there was a significant response to a complete fertilizer treatment. The data for the two experiments are given in Table 2.

TABLE 2—*Acre yields of peanuts in shell and shelling percentage (average 4 replications).*

Treatment	Virginia White peanuts Jim Forrest farm (Hustburg)		Tennessee Red peanuts N. L. Binkley farm, (McEwen)	
	Acre Yields	Shelling percent ¹	Acre yields	Shelling percent ¹
No treatment (check)	Lbs. 408	66.5	Lbs. 451	72.5
Gypsum ²	505	64.0	373	71.5
Gypsum, dusting ³	389	62.5	605	72.5
Potash, gypsum, dusting.	489	64.5	570	72.0
Complete fertilizer, gypsum, dusting ⁴	680	62.5	605	71.5
L.s.d. (5%)	123		193	
(1%)	173		271	

¹Shelling percent determined on 2-lb. composite sample.²Gypsum (calcium sulphate) applied at the rate of 400 pounds per acre by dusting on plants August 8, 1950.³Dusting was at the rate of 25 pounds per acre, applied June 20, 1950.

Dust contained 5% copper, 80% sulfur, and 5% DDT, (furnished by Tennessee Corporation, College Park, Ga).

⁴Fertilization was equivalent to 400 pounds per acre of 2-12-12.

Where potash was used alone it was applied at the same rate as was applied in the complete fertilizer.

The Forrest test was on Paden silt loam; the Binkley test on Ennis silt loam.

Corn—Nitrogen was applied to corn at rates from 60 to 120 pounds per acre with variations from 8,000 to 16,000 plants per acre. The experiment was conducted at each of the substations as well as the Main Station at Knoxville. All of these plot areas were located on soils very well adapted to corn. Two varieties were used: Dixie 17 and Kentucky 103. Averages of yields obtained at all locations at the different plant rates and nitrogen rates are given in Table 3. Dixie 17 was consistently higher in yield than Kentucky 103. Optimum yields were obtained under these experimental conditions at 12,000 plants per acre with nitrogen at 90 pounds per acre. It should be emphasized that these plots were on soils well adapted to corn. Lodging was most severe at the highest plant rate—16,000 plants per acre.

TABLE 3—*Acre yields of dry-shelled corn (corrected to 15.5 percent moisture) at different plant populations and at different rates of nitrogen.*

(Average 6 locations, 4 replications at each location)

Plants per acre	8,000			12,000			16,000		
	60	90	120	60	90	120	60	90	120
Dixie 17									
Bu. per acre	103.2	113.5	111.4	112.5	119.5	118.4	110.7	116.6	119.5
Kentucky 103									
Bu. per acre	85.7	84.4	86.7	93.5	97.2	98.8	94.6	98.9	99.8

Crop Rotation Studies. Experiments were set up in Lawrence County in 1950 testing response of a rotation to fertilization. The rotation consists of corn, cotton, wheat, and alfalfa. It is planned that the experiment will continue for at least two rotation periods in order to give some measure of the residual effects of the fertilization on the succeeding crops.

ZINC AND MAGNESIUM STUDIES

Corn showed an unusual degree of stunting and yellowing in certain areas of the State early in 1950. The symptoms were most pronounced in the region of high phosphate soils in Middle Tennessee. Similar appearance of corn in previous seasons had been observed, but the difficulty was much less pronounced and much less common. Certain of the severely affected fields were treated with salts of zinc and magnesium. Zinc sulfate, at the rate of about twenty-five pounds per acre in the row, seemed to eliminate the difficulty. Magnesium had little or no influence on the behavior of the corn. Further studies of the response of the corn and other crops to zinc, magnesium, and certain other less common elements will be continued in 1951.

SOIL TESTING METHODS

Work has been done this year on the development of new solutions to be used in extracting the available phosphate and potash from Tennessee soil samples. Attempts were made to develop a solution which could be used successfully in a flame photometer, since a flame photometer permits more accurate and rapid determination of potassium than other current methods permit. The most promising solutions studied are tenth normal hydrochloride acid containing one per cent ammonium chloride, and .05 normal sulfuric acid containing one percent ammonium sulfate.

SULFUR STUDIES

High analysis fertilizers are being used more widely in Tennessee; and, since these materials contain little or no sulfur, the question arises of a possible deficiency of sulfur for the production of certain crops. Field and laboratory studies of an exploratory nature were started on this problem in 1950.

Sulfur Content of Tennessee Surface Soils—Twenty-four samples of representative surface soils from various places in Tennessee were analyzed for total sulfur. The sulfur content was, in general, quite low; ranging from .007 percent to .03 percent S. There was a significant correlation between the sulfur and nitrogen percentages in the samples analyzed, the coefficient of correlation being .64. These low values for total sulfur in Tennessee soils suggest that deficiencies of this element might occur, particularly in areas where the population density is low and little sulfur gets into the atmosphere through the burning of coal and wood.

Crop Response to Sulfur—Six field experiments to determine the response of crops to sulfur were conducted in 1950, two in Cumberland County and four in Lewis County. Alfalfa was the test crop in five experiments and red clover in one. Calcium sulfate at 200 pounds per acre was the source of sulfur. A significant response to sulfur was obtained at one location only. Further work is planned on this problem.

COMPARISON OF PHOSPHATE FERTILIZERS

Corn, cotton, wheat, and oats were used as test crops to determine the relative efficiency of the phosphorus in dicalcium nitrophosphate, triple superphosphate, diammonium phosphate, and commercial fertilizer mixtures. Somewhat similar experiments were carried out last year. The results thus far indicate that all of these phosphate sources have very similar effects in terms of crop response. A more exact evaluation will be possible after the experiments have been continued for a longer period.

STATE SOIL SURVEY

The State soil survey is being made with the assistance and cooperation of the Tennessee Valley Authority and the Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. D. A.

A detailed soil survey of 412,992 acres was completed in 1950, bringing the total to 9,420,527 acres. Field work has now been completed for 30 counties, parts of two counties and six special areas. Field work continues in three counties.

One report—Cumberland—was made available, bringing the total of available published reports to 11. Manuscripts for three 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 five counties in 1950.

FIBER RESEARCH

Testing Division

The laboratory this year tested 4,374 samples, of which 67.4 percent were for the Tennessee Experiment Station; 5.9 percent were commercial samples; and 26.7 percent for the United States Department of Agriculture. Length of these samples was measured on the fibrograph, strength on the Pressley breaker, and fineness on the arealometer.

Fiber Properties

The quality and usefulness of a quantity of lint cotton are affected by, among other things, the average dimensions of cross-sections of the fibers. Several properties of cotton connected with cross-section dimensions have been measured and used in the past, such as immaturity, perimeter, wall-thickness, weight per inch and specific area. If any two of these quantities are known, the others may be calculated. This follows from the fact that a cross-section is two-dimensional.

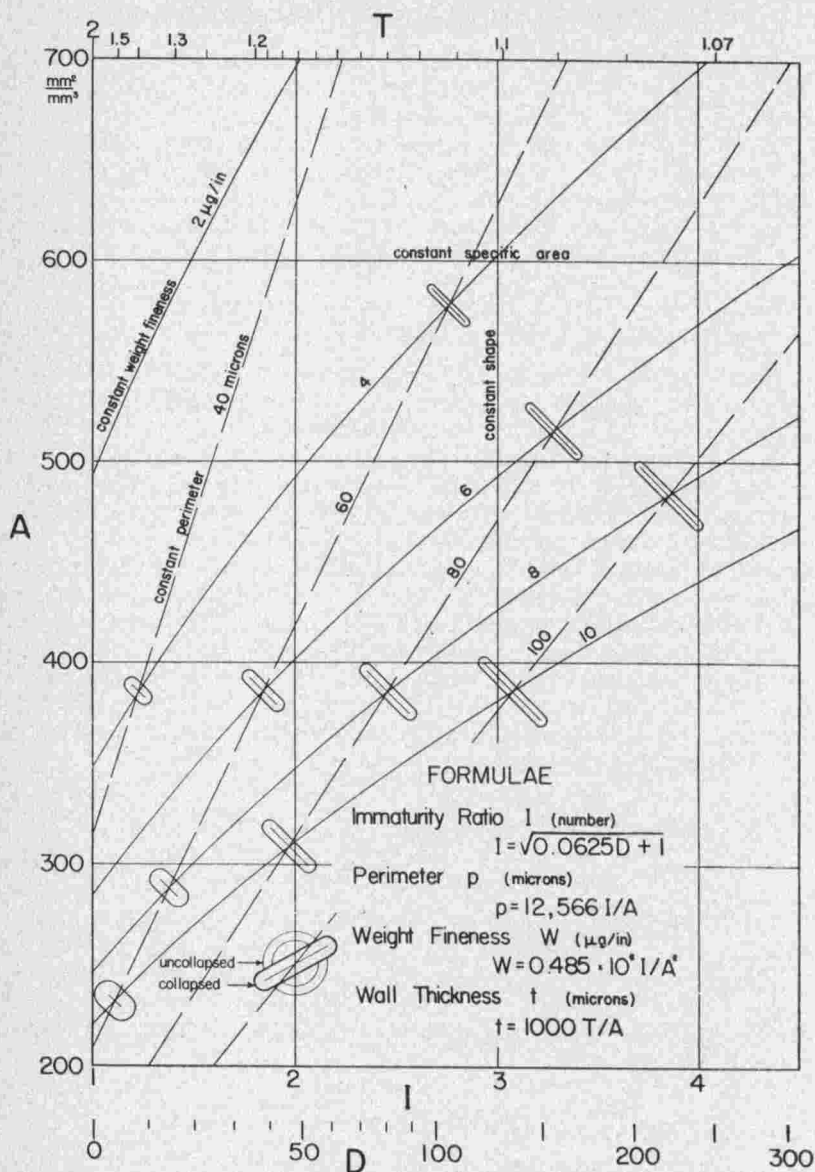


Figure 7—Specific area, A , versus immaturity ratio, I , for idealized fiber cross-sections indicating the relations between these and other cross-section properties.

The arealometer was originally designed to measure specific area or "fineness" of cotton. It has been modified to measure another of the above properties, immaturity. This is accomplished by taking two readings of specific area at different compressions

and interpreting the apparent change of specific areas in terms of orientation of the more ribbon-like fibers under increasing compression. The fiber property to which this test is sensitive seems to be the ratio of the area of a circle having the same perimeter as an average fiber to the actual cross-section area of the fiber. This relation is taken as a definition of "immaturity ratio."

The relations between various parameters connected with size and shape of fiber cross-sections are exhibited by Figure 7. The horizontal and vertical axes represent values of immaturity ratio and specific area measured by the arealometer. Idealized sections of fibers which, when collapsed, would have corresponding values of these two variables are sketched. Fibers having constant perimeter but varying in other respects would lie on a slanting straight line. Four such lines are represented in the figure. Fibers having constant weight per inch would arrange themselves along a parabola. Five of these parabolas are also shown.

The modified arealometer has a direct-reading scale which eliminates the use of conversion tables, and a mirror has been installed behind the monometer to permit more accurate setting of the instrument. An adjustable capillary resistance has been designed which greatly facilitates the manufacture of standard resistances for the arealometer.

Compression Studies—A study of the behavior of cotton and other fibers under varying compression, which was started last year, has been continued. Cottons at various stages in the mill processing compress differently. It is thought that compression may be a method of measuring the crimp or kinkiness of fiber.

New Instrument—A new instrument, mentioned in last year's report, for rapid measurement of fineness has been completed. Only a limited number of samples have been tested, but they show good correlation with the present arealometer. The instrument does not give as accurate measurements as the arealometer since the weighing of the sample is not necessary, but it will meet the need in a mill where rapid measurements are essential and where approximate classification of fineness is all that is necessary. About fifteen seconds are required to make a single fineness reading on a sample.

Sampling Technique for the Fibrograph—Preliminary work has been started on developing a new sampling technique for the fibrograph. It would be desirable to have a sampling technique which would eliminate the operator difference inherent in the present method of sampling preparation.

CROP IMPROVEMENT

Cotton

The 1950 season at the Jackson Station resulted in the latest maturity of cotton varieties ever recorded. Rainfall continued throughout the summer and fall months causing vigorous growth of

plants. A fairly heavy infestation of boll weevils appeared for the first time in the history of this Station. However, a spraying schedule was followed and yields of around a bale and a half were obtained from most varieties. White Gold Wilt, Tenn. 818, Empire Wilt, Coker 100 Staple, and Stoneville 2B were the leading varieties in the order given. Staple length, strength, and fineness were above average, although late bolls in another test showed some weakness of fibers where the plants had been defoliated.

In the new strains test, D.P.L. Fox, Tenn. 12 and Tenn. 19, all early maturing cottons, give indications of being high yielders. The Fox variety is not as vigorous and not as long in staple length as Deltapine 15, but its other characteristics such as leaf and boll size are similar to those of Deltapine 15 to which it is very superior in earliness.

Tenn. 818 is being released for production. This variety has ranked among the first four in yield of lint cotton for the past three years at the Jackson Station. It is out of a cross of Stoneville x Coker 100-6. This variety is earlier and has larger bolls than Coker 100-6. Its staple length is about the same as that of Coker 100-6 and is longer than Tenn. 241. It has a stiff center stalk and does not fall over in a storm when heavily balled, as much as Tenn. 241.

Four other strain tests containing 36 new Tennessee strains were compared with commercial checks. These strains came out of crosses or combinations of various Tennessee inbred lines.

There were five Progeny tests containing 45 Progenies compared with commercial checks. In each of the six New Strains tests and the five Progeny tests there were 10 entries with five replications of two row plots.

Selfing and establishment of inbred lines were continued at Jackson and Knoxville. A total of 500 lines were selfed and 300 crosses were made at Knoxville between the most promising lines. In species crossing between the hexaploid Coker 100 x Arboreum and the hirsutum inbred lines, the pollen of hirsutum was sterile on the hexaploid female.

A spraying test for the control of cotton insects was continued with the Entomology department. Results of this test will be found in the report of that department.

Barley

Temperatures during the past winter were so high that small grains made abnormal growth of plants. In fact, it was necessary to mow the plots in December and again in February. Thus the data on winter hardiness were of no value. In the case of barley, fairly high yields were obtained: around 45 to 60 bushels per acre in the various tests.

Selections from the cross of (Wong x Jackson No. 1) x Missouri Beardless and (Wong x Awnless) x (Jackson No. 1 x Kentucky No. 1) continue to give promising yields. Stiff strawed types

resembling these parents are being tested against the check, Jackson No. 1. Three of these selections are being carried in the Uniform Variety tests at 6 stations.

Barley is subject to many diseases. Crosses have been made using as parents resistant varieties and the native adapted ones. But most of the resistant varieties are of the spring types, a fact which complicates the problem. The Pathology department is cooperating in this research. The Pathology department inoculated over 300 heads of the second generation segregates with loose smut, a disease that is controlled only by the hot water method; and 150 strains of barley were inoculated with scald, a disease which kills the plants completely in some seasons. Spot blotch is another serious disease on barley; it attacks the small seedling plants in the fall, especially in the case of early plantings. Crosses to disease resistant parents have been made.

Hooded barleys have continued to be very popular in Tennessee. Over 100 strains of hooded barleys are being tested in nurseries. All of these strains have Wong as one of the parents, so that they possess shorter and stiffer straw than the old varieties of hooded barleys.

A new outfit for the hot-water treatment of barley was completed by the T.V.A. Agricultural Engineering department. In cooperation with the T.V.A., the Belgian and Swedish methods were tried. These two methods require only 45 minutes for soaking the seed, against the American method of four hours. The seed of the three different kinds of treatments were planted last fall, and the results will be known in the coming year.

Oats

Small infections of crown rust on winter oats appeared in the past season, although the winter months were abnormally warm. In the past fall, crown rust, however, was prevalent on early seedlings of Forkedeer; whereas LeConte showed considerable resistance. It should be recalled that LeConte is out of a cross of Tennex x Bond, and that Bond is resistant to most races of rust. Bond, however, is susceptible to race 45, a new race of rust which has not reached this state thus far. It is resistant to *Helminthosporium victorae* which has damaged oats considerably in States south of Tennessee. Fulgrain St. 6 has been used on the Tennessee x Bond selections for early maturity, and shorter and stiffer straw. Winter hardy selections of these crosses are now in the fifth generation and appear promising.

Disease resistant material was received this year from Florida, Minnesota, and the U. S. Division at Washington. Such varieties as Santa Fe, Clinton, Landhafer, (Anthony x Bond x Boone) (Hajira x Joenette) have been crossed on our Tennessee winter varieties. But all these disease resistant varieties are of the spring type so that winter types must be selected before they will be of any value in our state. Some of these varieties, such as Landhafer

have weak straw, and it will take time to find selections having the good characters of our present varieties with added disease resistance.

The Agricultural Engineering department has cooperated in building a small self-propelled combine. This small combine enables the breeder to permit small plots to stand up under the same weather conditions as encountered in the large fields. Thus, many selections can be eliminated in the early stages of breeding, thereby saving time and money. The combine operates successfully and our small plots were cut and threshed in one-fifth of the time formerly consumed.

Crimson Clover

Six hard-seeded crimson clover varieties were tested against the common Tennessee crimson clover varieties. There were five replications of each variety in single rows 24 feet long. These varieties were Dixie, Cantauga, Thorton, Allen, Talladega, and Hardy. They were infected heavily with sclerotina during the winter. None of them showed any resistance to this disease. On March 17, three feet of each row was cut and weighed for forage comparisons. Both Tennessee varieties led in this respect by around 15 percent. The variety Hardy excelled the other hard seeded varieties by around 9 percent.

Selfing crimson clover was continued by tying small bags made of tobacco cloth over the heads when the florets were in the pink state. Inbreeding considerably depresses the vigor and vitality of crimson clover.

ANIMAL HUSBANDRY AND VETERINARY SCIENCE

THE EFFECTS OF CERTAIN ATMOSPHERIC EFFLUENTS UPON THE GROWTH AND COMPOSITION OF PLANTS AND UPON ANIMAL LIFE AT LOCALES IN EAST AND CENTRAL TENNESSEE

Knoxville and Columbia

Cattle—At the Knoxville station the original cows on individual and pasture levels were continued. Gross examination of the teeth was made every month and color pictures were taken every third month. The teeth show progressive changes on about the same levels as reported last year. All of the calves produced from the flourine cows at Knoxville and the cows on the Columbia high and low hay levels were slaughtered. Samples of jaw, leg and rib were taken from these animals for chemical analysis and pathological study. Rib biopsies were performed on one group of the individually fed cows. These samples were obtained for two purposes:

1. A chemical analysis of the amount of F in the bone.
2. A pathological study.

Intensive pathological studies are being made to determine any changes that may occur due to fluorosis. Urine collections were continued to further test urine as a diagnostic means.

Forty-five new heifers were started on the project. Thirty of these were put on individual feeding test with $\text{Al}_2(\text{S04})_3$ being fed as an alleviator.

The remaining fifteen head were divided and placed on normal and high pasture with $\text{Al}_2(\text{S04})_3$ being fed as an alleviator. These heifers started the test with no permanent teeth erupted and were bred to calve at 24 to 30 months of age.

At Columbia the cows on individual feed and pasture were carried on and bred to calve in the early spring of 1951. Mature cows from the Columbia Station herd were sold for slaughter; and, as at Knoxville, samples were taken for chemical analysis and pathological studies. Also at least one quarter of the animal was boned out and studied for bone changes. A survey of the Columbia area was made in the same manner as last year. Special emphasis was put on a study of the young cattle that had permanent teeth which had erupted within the last two years. In cooperation with the Agricultural Chemistry department, the forage sampling and analyzing work was continued.

Expansion of the cattle studies at Knoxville, using various salt and feed mixtures to study their possibilities in alleviating or preventing fluorosis, was planned and initiated.

Sheep—Studies with Western feeder lambs were conducted to determine the effects of various levels of fluorine intake, and the effect of various alleviators.

Studies of growth, feed consumption, digestibilities of feed constituents, mineral balance studies, (calcium, phosphorous and fluorine), rumen micro-organisms, blood constituents, and possible pathological conditions were undertaken.

The lots of ewes fed at the Columbia Station are being continued.

Small Animal Studies—Albino rats have been used to test a number of substances for their alleviation effect as determined by bone storage, feed data, etc.

Various levels of fluorine intake from 50 ppm to 400 ppm, and various possible alleviators—boric acid, iodinated casein, $\text{Al}_2(\text{S04})_3$, and Al Cl_3 , among others, have been studied. The aluminum salts have shown the most promise as possible alleviators as measured by fluorine storage in the leg bone tissues. However, they failed to show any beneficial effects when added to the ration after high levels of fluorine intake as measured by fluorine analysis of leg bone tissue. This would tend to indicate that the fluorine must be held in the gastro-intestinal tract in the rat.

Due to the large volume of analyses and determinations the summaries are not yet complete. Animals fed $\text{Al}_2(\text{S04})_3$ at 0.5%

and Al Cl_3 at 0.1% with 100 ppm of fluorine added as NaF showed lower concentration of fluorine in both the leg and jaw bones than those given 100 ppm of fluorine but no alleviator.

WINTER PASTURES AND DRY LOT RATIONS FOR FINISHING CALVES FOR THE LATE SPRING MARKET

Projects, which were similar in a general way, were set up at the Greeneville, Knoxville, Columbia and Jackson stations to study this subject. In each case, some form of winter pasture such as crimson clover, rye grass, oats, or orchard grass was used. All of the projects had lots receiving either hay or silage in the barn as a main part of the ration. The amount of concentrates varied from none to 5 pounds daily. During the winter of 1949-50 conditions for winter pasture were most favorable and provided a good source of feed, an exception being at Columbia where it seemed necessary to remove the calves from the pasture several times due to a soft and muddy condition of the fields. This condition resulted in unsatisfactory gains. These projects were started about the middle of November and ran until the latter part of May.

Summary of Results

Excellent gains were secured in most winter pasture lots. At Greeneville, heifer calves made 1.7 pounds daily gain with only 2.84 pounds hay on pasture and produced carcasses grading good plus. Gains on the pasture lots varied from .99 pounds at Columbia on pasture and hay to 2.05 pounds at Knoxville where the calves received 2.6 pounds hay and 5 pounds of concentrates. The orchard-bluegrass winter pasture was 85 percent as efficient in producing gains as crimson clover-rye grass pasture.

The dry-lot rations of silage and hay also produced good gains of 1.46 to 1.66 pounds at Columbia; .87 to 1.53 at Jackson; and 1.63 pounds at Greeneville. The silage-fed calves gained somewhat faster than the hay-fed calves. The gains were satisfactory considering the fact that no more than 5 pounds of concentrates (1.25 pounds being cottonseed meal) was fed.

Fairly heavy calves were used in these projects and very satisfactory slaughter records were made from them. Carcass grade varied from medium to high good—and dressing percentages varied from 53 to 59 percent on a selling weight and chilled carcass weight basis. These cattle, selling at a time when market receipts were low for this area, were found to be very satisfactory for Tennessee markets. They were light, young, tender and had sufficient cover to make good beef. Heavy calves, particularly heifers, are much more satisfactory for such production than light calves.

Cost of gain on these young cattle so handled was low, averaging less than \$15 per cwt. with feed at current prices.

With selling prices above \$25 per cwt., and some up to \$28, these calves would have been very profitable without any feeding margins. Since from \$3 to \$6 margins were secured on them they were very profitable.

Winter pastures in this project seemed to open up a new field for their use. At Jackson the pasture was worth 22½ cents per day and at Greeneville pasture was worth \$6.38 to \$42.76 per head, depending upon the kind and way it was used. At Columbia, however, where the pasture was used at intervals, it proved of no value in producing profits over silage or hay and concentrates fed in the barn.

PASTURE INVESTIGATIONS WITH SWINE

Limited Vs. Full Feeding of Growing and Fattening Hogs on Pasture—Knoxville and Columbia

The project to study the optimum use of high-quality pasture in swine production was continued during 1950 at the Knoxville and Columbia Stations. Summaries of the data on rate and economy of gain and of carcass data at the various levels of feed intake are shown in Tables 4 and 5.

TABLE 4—Rate and Economy of Gain of Swine Fed at Different Levels of Feed Intake*

Items Compared	Level of Feed Intake			
	Full-feed in drylot	Full-feed on pasture	80% full feed on pasture	60% full feed on pasture
No. of pigs	33	39	39	40
Av. no. of animal days	87	85	94	108
Av. initial wt., lbs.	76.9	76.9	77.1	77.7
Av. final wt., lbs.	215.4	214.6	214.8	210.6
Av. daily gain, lbs.	1.59	1.61	1.46	1.23
Av. daily feed consumed, lbs.	6.63	6.04	4.71	3.59
Feed required per 100 lbs. gain exclusive of pasture, lbs.	415.7	374.4	322.7	291.3

*Combined summary of data from four replicated experiments conducted at the Knoxville and Columbia Stations of the University of Tennessee Agricultural Experiment Station in the summer of 1949 and winter of 1950.

Summary and Observations

Considerable use can be made of good, high-quality pasture as a substitute for concentrates in the rations of growing-fattening pigs. Savings in feed consumed per 100 pounds of gain of 41.3; 93.0; and 124.4 pounds over full-feed in drylot resulted when pigs were fed at 100; 80; and 60% full-feed on pasture.

Savings of 10-30% in the amount of feed consumed per 100 pounds of gain at 60-100% levels of feed intake on good high-quality pasture were obtained.

TABLE 5—Carcass data on swine fed at different levels of feed intake—summer 1949 and winter 1950 experiments

Level of feed intake	Items compared																
	No. of pigs	Kill Weight	Chilled Carcass Weight	Dressing Pct. 1	Percentage of Primal Cuts 2		Length of Carcass in. 5	Depth of Carcass in. 6	Width of Carcass in. 6	Back-fat Thick in. 7	Firmness	Color of Lean	Carcass Grade	Percentage Lean Trim		Percentage Fat Trim	
					L.W.3	C.W.4								L.W.3	C.W.4	L.W.3	C.W.4
Full feed in dry lot	30	213.7	147.4	69.	46.1	67.2	29.5	13.5	10.6	1.60	Hard—	Good	Ch. No. 1	5.8	8.3	14.7	21.1
Full feed on pasture	36	213.6	148.4	69.5	46.3	67.2	29.5	13.4	10.7	1.64	Hard—	Good	Ch. No. 1	6.3	9.0	14.0	20.0
80% full feed on pasture	37	216.5	146.9	67.8	46.0	67.8	29.9	13.1	10.7	1.50	Medium Hard+	Good	Ch. No. 1	6.0	8.8	13.3	18.8
60% full feed on pasture	37	211.2	140.2	66.4	45.5	68.5	29.9	13.1	10.4	1.39	Medium Hard	Slightly Shady	Med.+	6.3	9.5	11.3	17.1

1. Dressed packed style—head off, hams faced, leaf fat removed.
2. Regular ham, loin, belly and skinned shoulder.
3. Based on live weight.
4. Based on chilled carcass weight.
5. Measured from the anterior edge of the first rib to the anterior edge of the aitch bone.
6. Measured at the 7th rib.
7. Average of three measurements including the skin at the 1st rib, last rib and the last lumbar vertebra.

Similar average daily gains and feed requirements were observed on the different kinds of pastures within any season. Of the summer pastures, Ladino clover was slightly superior to alfalfa and Louisiana white clover. Crimson clover and button clover were equally good as winter pastures for swine.

More differences were obtained between pastures of different seasons than between pastures within the same season. Slightly higher average daily gains and more economical utilization of feed were obtained on winter pastures. Average feed consumed per 100 pounds of gain for all levels of feeding on all summer pastures was 344 pounds, as compared to 311 for all winter pastures, or a difference of 33 pounds or 9.6% in favor of winter pasture.

Carcasses of pigs fed at an 80% level of feed intake on pasture were acceptable in quality and may be more desirable than carcasses from full-fed pigs because of the favorable lean-to-fat ratio. (Figure 8.)

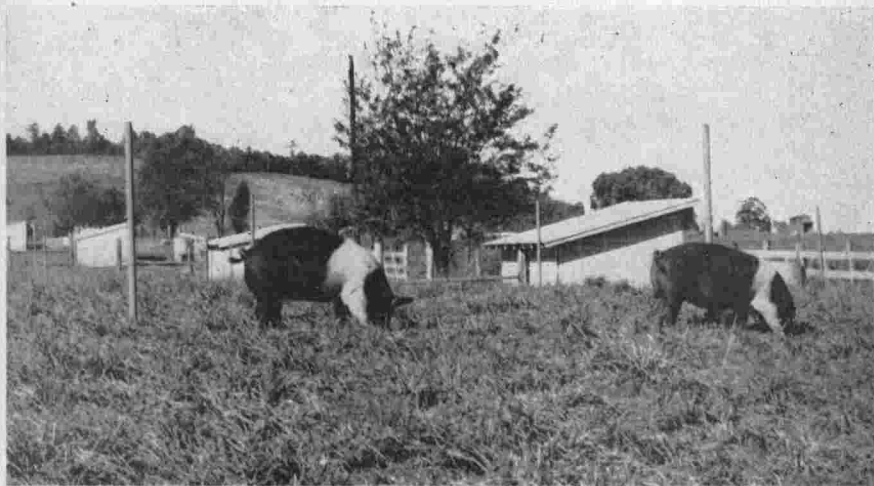


Figure 8—Pigs fed 80 percent of a full feed on pasture.

Carcasses of pigs fed at a level of 60% full feed on pasture were lacking somewhat in quality (firmness and color) but yielded the highest percentage of primal cuts and least backfat and fat trim.

IMPROVEMENT OF THE PRODUCING ABILITY OF BEEF CATTLE

Work in this project has progressed as set forth in the station project at Knoxville, Greeneville, Crossville, Springfield, Columbia, Oak Ridge and Jackson.

A portable photographic chute (Figure 9) for obtaining linear measurements was built and tested. It has been shown that meas-

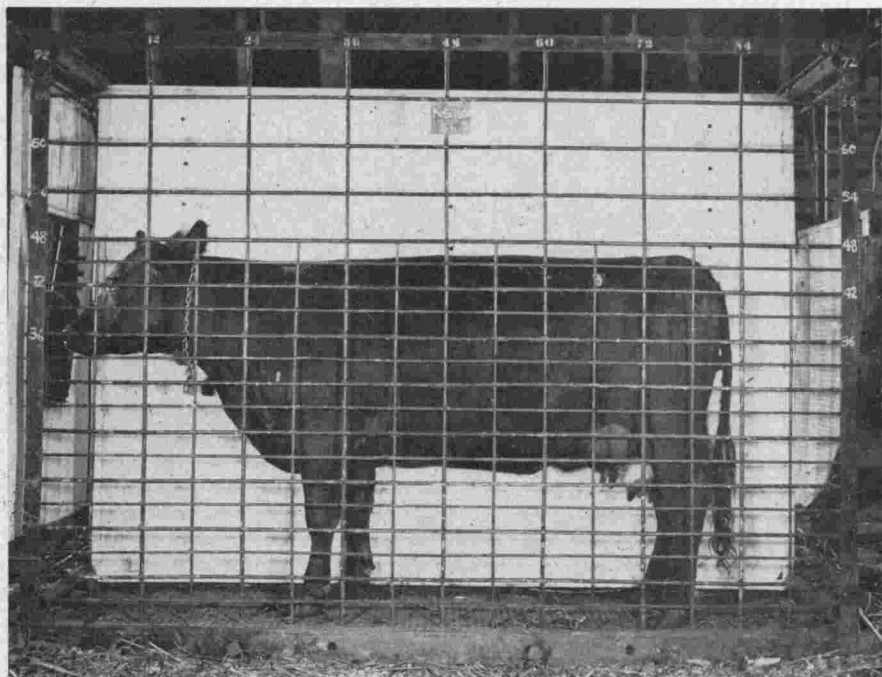


Figure 9—Cow in photographic chute.

urements can be made more accurately and satisfactorily from photographs taken of animals in this chute than from actual measurements of the live animals.

New barns and facilities were provided at Springfield, Jackson, and Knoxville.

The weaned weights of the calves at the Crossville and Greeneville stations were studied to determine the best method of adjusting the weights of the steer and heifer calves to a standard age so that calves from projects could be more accurately compared. It was found that average adjustment based on the prorated gain between the two period weights bracketing the desired standard age was most accurate when periodic weights were taken.

It was also found necessary to develop different factors for different stations to use in adjusting weights.

A project was initiated to study the effect on the development of bull, heifer and steer calves of the following planes of nutrition:

1. Nurse cow with full feeding of concentrates.
2. Full feeding of concentrates.
3. Customary feeding practices for commercial production.

Five sets of three calves were started in 1950. These will be carried on the project until the steers reach 900 pounds and the bull and heifer calves are 18 months of age. The heifers will be



Figure 10—Three Hereford heifers used in test. Respective feeding of the calves was: left to right, 1, nurse cow with full feeding of concentrates; 2, full feeding of concentrates; 3, customary feeding practices for good commercial production.

carried in the breeding herd for at least two years. Detailed records and observations will be made. (Figure 10.)

The first generation calves of an Angus inbred line at Knoxville averaged 61.4 pounds at birth and 431 pounds at 226 days of age. The calves from the outcross Angus herd at Knoxville averaged 54.8 pounds at birth and 454 pounds at 231 days of age. Purebred and grade Angus calves at the Crossville station averaged 368.8 and 393.2 pounds at 180 days respectively. The progeny of two Hereford bulls used at Crossville showed adjusted weights at 180 days of 479 and 462 pounds respectively. There was no difference in the adjusted weaned weights at 210 days' age of calves by an Angus and by a Hereford bull when used on grade Hereford cows at the Greeneville Station. The weaning weights of the calves by the Angus and Hereford bulls were 451 and 448 pounds respectively.

CARCASS EVALUATIONS WITH PORK AND LAMB

Knoxville

In the initial phase of this project, carried on cooperatively with the State Department of Agriculture, a detailed study of the bacon from 179 pork carcasses of the four proposed grades was made. The standard measurements, along with carcass width and depth and belly thickness, were noted. In addition the percentage of No. 1, No. 2, No. 3 sliced bacon and ends, as well as waste and shrink, was determined for each of the 358 cured pork sides. The two most important observations that can be made are:

1. The data show a sex difference which might be of economic importance.
2. Bacon produced by the medium grade, so-called underfinished hogs, is more valuable than bacon from overfinished hogs.

In this study, medium hogs produced a higher percentage of No. 1 grade bacon with a resulting higher value per hundredweight of green bellies. The choice No. 1 carcasses produced more valuable bellies than the overfinished choice No. 2 and choice No. 3 carcasses. The measurement data presents a regular pattern from Medium to Choice No. 3 as to backfat thickness, carcass width, and belly thickness.

The lamb grading phase consisted of grading small bands of lambs (20-50) on the hoof, ear tagging them and following through with carcass grades. Such factors as castration, docking, and breeding were noted to determine the influence, if any, of these factors on the carcass grade. More detailed work is needed on this phase.

A STUDY OF THE EFFECTS OF HORMONES ON THE GROWTH RATE AND CARCASS CHARACTERISTICS OF EWE AND WETHER LAMBS

Knoxville

Ewe Lambs—Ten ewe lambs, four pairs of twins and two singles all approximately one month of age, were used in this study. One member of each pair of twins, selected at random, and one single lamb were given one 12 mg. pellet of stilbestrol, implanted subcutaneously.

All lambs remained with their dams on pasture during the study. The average initial weights for control and treated groups were 34 and 36.5 pounds respectively. Fifty-one days after treatment the average weight for the controls was 72 pounds; and 88 pounds for the treated group. One lamb died and three were slaughtered because of rectal prolapse.

Wether Lambs—Eleven wether lambs were divided into two groups. A 12 mg. pellet of stilbestrol was implanted subcutaneously in each treated animal. The average initial weight of the control group (five animals) was 81 pounds and for the treated group (six animals), 78 pounds.

Both groups ran together on pasture with no supplemental feed. Forty-two days after treatment the average weight was 89 and 96 pounds for the control and treated groups, respectively. Fourteen days later, or 56 days after treatment the average weight for the respective groups was 91.5 and 94.5 pounds. It should be noted that, despite the fact that the treated group lost weight during the last 14 days, the average daily gain for the 56-day period for the control group was 0.19 pounds and for the treated group 0.30 pounds.

A STUDY OF THE EFFECTS OF HORMONES ON THE GROWTH RATE, FEED UTILIZATION AND CARCASS CHARACTERISTICS IN SWINE

Sixteen pigs were divided into two comparable groups, treated and control, on the basis of age, weight and sex. Each pig in the treated group received one 12-mg. pellet of stilbestrol implanted subcutaneously at the beginning of the study. Each group was self-fed tankage and ground barley free-choice on alfalfa pasture. The average initial weight of both groups was 80 pounds. Seventy-two days after treatment the treated group averaged 16 pounds heavier than the control group. However, 27 days later, or 99 days after treatment, this difference was only 6.5 pounds. The treated animals consumed slightly less protein supplement than did the control group.

JACKSTOCK AND MULE BREEDING

Knoxville and Columbia

Matings were made with 21 mature jennets principally to Rowdy I, Marvel and Rowdy II. Fourteen jack and jennet foals were dropped and raised within the calendar year, from 19 mature jennets. Nine mule colts were weaned from ten mares. Most of the colts by Rowdy I looked promising.

Eight performance tests were run on each of seven mules, from three to six years of age, at the station. Pulse and respiration rates were taken on the mules immediately after completing a road test hitched to a dynamometer regulated to a load of 25 percent of live weight. The counts were made at five-minute intervals for thirty minutes after completing test. These tests continued to show that height or rate of recovery in respiration seems to be more valuable than the behavior of the pulse in determining working ability or stamina.

Semen studies have been continued during the past year. In the last report it was indicated that thiamine and ascorbic acid when added to the semen appeared to have a stimulating effect upon sperm survival in storage. In addition, the effects of riboflavin and pyridoxine were also studied. Variable amounts of the several different vitamins were added to the stored semen. It was found that five mg. of thiamine, riboflavin or pyridoxine and three mg. of ascorbic acid to 10 cc's of diluted semen appeared to be the optimum amounts for maintenance of motility. It was indicated in the previous report that the addition of minute amounts of potassium permanganate stimulated the maintenance of sperm motility during storage. It has been found that addition of the potassium permanganate at the rate of 1 to 50,000 dilution to the semen along with ascorbic acid and thiamine further increased survival of motility in storage.

Due to the small number of mares available for insemination, it has not been possible to test the fertility of semen diluted with the various compounds. Nineteen mares and one jennet were inseminated in the Knoxville area during the past spring and summer with semen diluted with a diluter containing three mg. of ascorbic acid per 10 cc's of semen to which a 1 to 50,000 dilution of potassium permanganate was added. Pregnancy tests, using young immature female rats, were made on these mares 60 to 120 days after insemination. Only one mare showed a positive test. However, since these tests were made, it has been learned that one mare which showed a negative test is to foal this spring. Mares and jennets were also inseminated in the Columbia area. However, no pregnancy tests were made on these animals and none have foaled.

There is a possibility that, despite the fact that the potassium permanganate, when added to the diluter, stimulated motility it may have had a depressing effect upon the fertilizing ability of the sperm. The mechanism whereby the potassium permanganate stimulates motility is not known.

Blood studies of the jacks, jennets, mares, and mules in the herd were initiated in an effort to determine whether any factor which could be correlated with growth or stamina could be found. Glutathione levels were the first to be studied. The average blood concentration of glutathione is shown in Table 6. An attempt was also made to study the blood levels of acid and alkaline phosphatase. However, the blood had to be collected at Columbia and brought back to Knoxville for analysis. Satisfactory techniques for handling the blood to prevent continued enzyme activity were not developed.

TABLE 6—Average blood glutathione levels in workstock

	Total Glutathione	Reduced Glutathione	Oxidized Glutathione
Jacks	50.7 (38.6-74.5)*	45.6 (31.9-68.4)	4.68 (3.7- 6.7)
Jennets	45.0 (39.8-53.2)	40.2 (30.4-47.4)	4.78 (2.1- 9.4)
Mares	34.7 (26.2-44.4)	28.5 (22.2-35.0)	6.2 (2.7-11.0)
Mules	45.7 (38.0-53.2)	40.9 (33.4-49.5)	4.8 (2.1- 7.6)

*These figures represent the ranges within each group

"X" DISEASE OF CATTLE

Knoxville

"X" disease of cattle has spread to all sections of Tennessee and the United States. The malady has reached epidemic proportions in many herds and has caused great mortality in calves and yearlings. In some herds the raising of calves has become impossible making liquidation of the herds necessary.

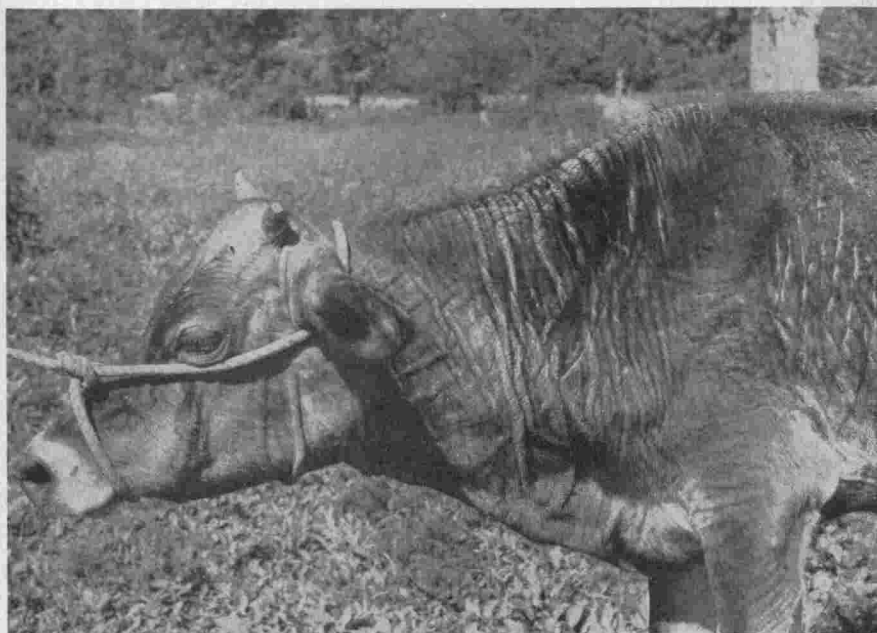


Figure 11—Note in the picture above, which shows an animal with a natural case of "X disease," the poor horn development, thickened condition of skin, and loss of hair along the side of the neck.



Figure 12—In the picture at left, note watering of the eyes in this animal affected by a natural case of "X disease."

The disease has been recognized in 70 Tennessee herds containing 1,726 animals, of which 535 died or had to be slaughtered because of their morbid condition. Approximately one-half of this number

were purebred cattle. It is estimated that the disease has cost cattle producers in the South \$5,000,000. Figures 11 and 12 show two natural cases of this disease.

Observations made on the diseased condition in the affected animals suggest that:

1. Infectious agents seem to be vital factors in the development of the disease.
2. Maintaining affected animals in herds seems to perpetuate the disease and the rearing of healthy calves becomes impossible.
3. Cattle affected with the disease fail to pass through the normal reproductive cycles so that irregular and difficult breeding becomes pronounced.
4. In a number of Tennessee herds where the affected animals have been removed and strict sanitary herd practices instituted the disease has not reappeared in two years and normal calf crops have been produced.

Research on the disease along the lines of transmission includes:

1. A highly infectious and transmissible agent has been taken from field cases.
2. This pathogenic agent produces macroscopic and microscopic pathology in the mouth cavity, indistinguishable from that seen in field cases.
3. All attempts to adapt this infectious agent to laboratory animals have failed.

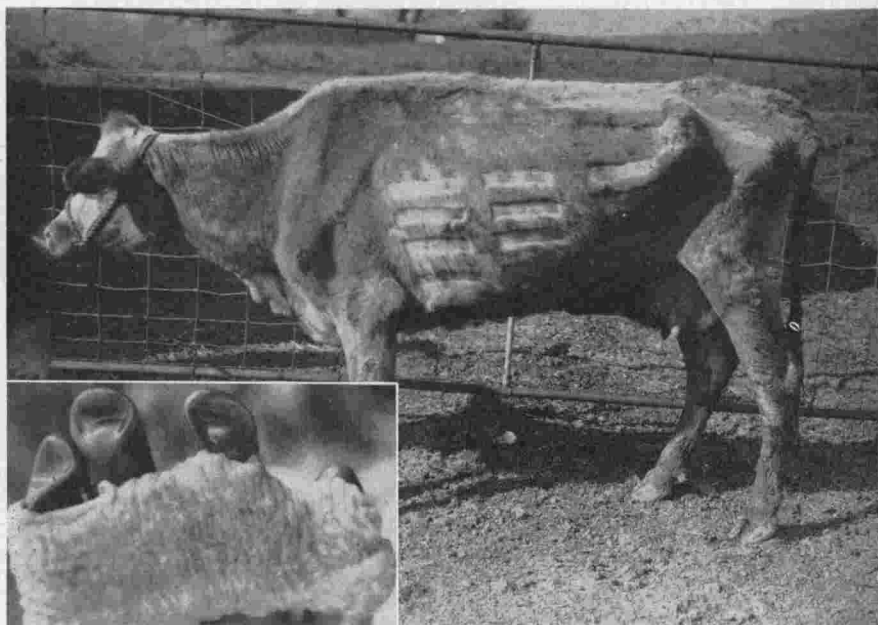
JOHNE'S DISEASE OF CATTLE

This chronic disease of the digestive tract continues to spread among cattle in Tennessee and the United States. Especially is this noticeable in the number of purebred dairy herds infected, which presents a much greater problem in the control and eradication of this disease. The lack of a highly specific and satisfactory biological test which will identify the infected animal has handicapped all efforts to combat this disease. (Figures 13-14).

The aim of work at this Station has been:

1. The evaluation of an intradermic johnin to be used as a biological testing agent on naturally infected cattle.
2. To determine how much time should elapse between tests when repeated tests are made in the same testing site.

The intradermic johnin used in these tests was highly specific for this disease. On the basis of tests it would seem that a period of at least 20 weeks should elapse between tests when the same testing site is used. Only seven percent of all tests were negative at 20-week intervals; whereas 36 percent were negative at 14-week intervals. Perhaps a new testing site is desirable for each repeated test, especially if the previous test was a suspicious one.



Figures 13-14—Note the thickened condition and huge rolls (picture inset, lower left) of the lining of the small intestine of a cow naturally infected with Johne's disease. Above, note the poor condition of the cow, which is a manifestation of this disease. The clipped areas along the side were used as testing sites.

FINISHING YEARLINGS ON GRASS AND GRASS SUPPLEMENTED WITH GRAIN

Jackson

A new project was set up for the purpose of studying the possibilities of finishing yearling steers on grass. Steer calves wintered on a variety of rations, some on pasture the previous winter, were divided into three lots and were treated as follows:

- Lot 11: Permanent pasture until September 1, then divided into two lots—one to be fed 10 pounds grain on grass for 56 days (Lot 15), the other to go through on grass only (Lot 14).
- Lot 12: Permanent pasture plus 5 pounds grain until September 1.
- Lot 13: Permanent pasture only for 60 days then 10 pounds grain on grass until September 1.

A summary of results is reported in Table 7.

Under the above average pasture conditions, there was little difference in the summer gain, slaughter grade, or net returns of the three lots of cattle 11, 12 and 13 on August 30 when the project was terminated.

TABLE 7—Results of finishing yearlings on grass and grass supplemented with grain

	Lot 11	Lot 12	Lot 13	Lot 14	Lot 15
Number steers per lot	14	14	14	6 ^(a)	9 ^(a)
Ave. wt. 4/5/50 when turned on grass, lbs.	620	621	621		
Ave. wt. 8/30/50, lbs.	839	843	862		
Ave. gain 4/5 to 8/30, 147 days, lbs.	219	222	241		
Ave. daily gain ration 4/5 to 8/30, lbs.	None	4.12	4.90		
Ave. feed cost per 100 lbs. gain 4/5 to 8/30	\$10.05	15.46	16.21	13.06	21.31
Ave. wt. 10/26/50				867	919
Ave. gain 8/30 to 10/26, 56 days, lbs.				64	99
Ave. grain consumption 8/30 to 10/26, lbs.					9.25
Ave. appraised or selling price per cwt when sold or project ended	\$25.68	26.81	27.06	27.37	27.56
Ave. slaughter grade when sold	M	HM—	HM—	HM—	LG—
Ave. carcass grade	Not sold	HM—	HM—	HM—	HM
Ave. dressing percentage (selling wt. and chilled carcass)	Not sold	58.2	58.1	54.9	54.0
Ave. returns per head over an initial cost of \$23.50 cwt. and feed on appraised value 8/30/50	\$41.69	38.99	41.56		
Ave. returns over initial cost @ \$23.50 and feed cost on sale returns at Nashville 8/30/50	Not sold	45.47	42.84		
Ave. returns per head over initial cost of \$25.68 on 8/30/50 and feed cost on sale returns				\$21.10	26.67

^(a)Includes some of the lower grade steers from lots 12 and 13 not marketed on 8/30/50.

Carrying lot 11 (new 14 and 15) for 56 days after August 30 increased their sale value \$1.79 per cwt. Not all of this advance was due to improvement in the cattle as the market advanced during this period. These cattle had about the same slaughter values as Lots 12 and 13 fed grain during the summer and sold August 30. Their dressing percentages were not as high, due partially to a very light shrink in marketing these cattle. Lot 15, fed grain, was somewhat more profitable than lot 14, fed no grain on grass.

In this trial, it was profitable to carry lots 14 and 15, some 56 days longer than Lots 11, 12 and 13. The profits shown are based on the appraised values established on Lot 11 on August 30, and are therefore in addition to that shown for Lot 11 on August 30.

A COMPARISON OF ORCHARD GRASS AND TALL FESCUE PASTURES FOR STEERS

Columbia

Twenty acres of land was renovated in the summer of 1948. Two 5-acre replications were seeded to orchard grass and Ladino clover and two 5-acre replications to tall fescue and Ladino clover. Hop clover volunteered luxuriantly in 1949 and 1950, and was an important source of feed. There has been very little Ladino clover in these pastures. In the fall of 1949 it accounted for only 3 percent of the clover. Three yearling steers were grazed on each replication during the summer of 1949. These steers were wintered similarly and again grazed on their respective areas until July 11, 1950, when they were sold for slaughter. (Figure 15). Table 8 gives a brief summary of results.



Figure 15—Top group of steers finished on orchard grass, Ladino and hop clover. They gained 19 pounds more, graded slightly higher on foot and in the carcass, and sold for \$1.16 more per hundred than similar steers grazed on a tall fescue mixture. These steers dressed 59.54 percent.

TABLE 8

	Orchard grass Ladino and hop clover	Tall Fescue Ladino and hop clover
Number steers	6	6
Ave. gain first summer, 225 days, lbs.	204	212
Ave. gain winter '49-50, 143 days, lbs.	98	99.0
Ave. gain second summer, 94 days, lbs.	202	174
Ave. slaughter grade	Good	High medium
Ave. carcass grade	Good+	Good—
Ave. dressing percentage, selling wt. and warm carcass wt. basis	59.54	58.82
Ave. selling price cwt. Nashville	\$ 28.33	27.17
Ave. returns for all feed and pasture	\$182.05	162.84

There was a noticeable difference in the hair and finish of these steers as shown by slaughter grade, buying price and carcass grade and to a lesser degree by dressing percentages.

A COMPARISON OF A GRADED-UP FLOCK WITH A CROSS-BRED FLOCK FOR SPRING LAMB PRODUCTION IN TENNESSEE

Greeneville Station

Two flocks of ewes—a graded-up flock secured by two successive matings of Hampshire rams on the foundation flock of grade Hampshire-Plateau ewes and a crossbred flock secured by two suc-

cessive matings of Dorset rams on similar ewes—are being produced at this station for production studies. Two-year-old and yearling ewes of the first crosses were available for an interim comparison for 1950. The yearlings were exposed as lambs, during August and September only, to rams. The ewes are carried on pasture supplemented with alfalfa hay and a small amount of grain during the winter. The results of 1950 are briefly summarized in Table 9.

TABLE 9—*Spring Lambs Produced from Hampshire X Native Compared with Dorset X Native Crossbred Ewes*

	Hampshire-sired ewes		Dorset-sired ewes	
	2 yr.-olds	Yearlings	2 yr.-olds	Yearlings
Ave. weight 8/6/49, lbs.	141.5	87.1	119.7	84.4
Gain 8/6/49 to 8/10/50, lbs.	10	53	17	49
Number starting year 8/6/49	12	14	12	19
Number ewes lambing	11	5	11	7
Number lambs weaned	16	5	13	4
Percent of lambs weaned to ewes starting year	133	35.7	108	21.0
Ave. birth wt. of lambs, lbs.	8.25	7.39	7.1	7.5
Ave. wt. of lambs 5/25/50 (most of lambs weaned), lbs.	81.4	67.0	68.0	71.0
Ave. daily gain of lambs birth to 5/25/50, lbs.	.57	.57	.54	.51
Ave. grade of lambs 5/25/50	LC+	C	LC+	LC+
Ave. sale or appraised value per cwt 5/25/50	\$29.22	28.00	28.56	28.70
Ave. sale or appraised value per head	\$23.81	18.97	19.38	20.38
Ave. wt. of fleece 1950	6.7	6.1	6.8	5.9
Ave. wt. of lamb fleeces 1949		3.1		3.0
Ave. returns per ewe starting year in fleeces and lambs	\$36.00	12.39	25.25	9.52

The ewe lambs retained in 1949 had an average value of \$24.00 per head. Even though only a small number of them bred on being exposed to the rams for two months, they returned \$11.46 in fleeces and lambs per head, thereby reducing their cost, other than feed, to \$12.54 per head. These ewes graded high good in type and were a thrifty, outstanding flock of ewes easily worth \$30.00 or \$35.00 per head July 1, 1950. In this case, it appeared desirable and economical to breed and save Native ewe lambs for flock replacements as Western yearlings would have cost \$30.00 or more per head.

COW-CALF PRODUCTION STUDIES

Greeneville

The third crop of calves from the herd of grade Hereford cows was produced this year involving the following studies:

1. A comparison of calves dropped in January and February with calves dropped in March and April (Figure 16).

2. A comparison of calves by an Angus bull (Figure 17) with calves by a Hereford bull. The Angus bull which sired the 1948 and 1949 calf crops was used for the 1950 crop, but the Hereford bull was new, having been used previously at the Crossville Station. Each year the cow groups are rotated with the bulls. The early calving cows are fed 4 lbs. of grain mixture after they calve until they go on grass.



Figure 16—Group of late calves produced at Greeneville. Their weaned weight averaged 466 pounds at 227 days of age.

Table 10 gives some of the more important findings for the year 1949-50.

TABLE 10—*Performance of early and late calving cows.*

	Jan. & Feb. Calves	Mar. & Apr. Calves
Number cows per lot	21	20
Ave. weight Nov. 2, 1941, lbs.	1143	1134
Ave. gain for year, lbs.	53	32
Ave. winter feed requirements:		
corn fodder or shucks, lbs.	89	70
hay, medium grade, lbs.	1410	1377
corn silage, lbs.	3533	3500
grain mixture, lbs.	327	
Ave. feed cost of cow per year	\$78.41	\$66.65
Number calves weaned	17	19
Percent of calves weaned to cows bred	80.9	95
Ave. date of birth of calves	Jan. 18	Mar. 20
Ave. birth weight of calves, lbs.	69.5	65.8
Ave. weaned weight, lbs.	538.0	466.0
Ave. daily gain birth to weaning, lbs.	1.617	1.760
Ave. appraised value per head at weaning	\$145.17	126.57
Ave. net returns per cow bred over feed cost	\$38.99 (a)	53.75
Ave. net returns per cow calving over feed cost	66.76	59.92

(a) Low returns due to failure of 3 cows to calve in this group.

A COMPARISON OF TWO-YEAR-OLDS AND YEARLING STEERS FINISHED ON GRASS AND GRASS SUPPLEMENTED WITH GRAIN

Greeneville

The fourth trial of this project was completed with Station-raised steers. Results are reported in Table 11.

Setup of project for finishing period:

Two-Year-Olds

Lot 1: Grass only to September 14.



Figure 17—Cow 16 and her 1950 steer calf weighing 582 pounds at 235 days of age. This cow is the top producer to date in the Greeneville herd. Her three calves averaged 545 pounds at weaning, compared with the average of 381 pounds for offspring of the low producer.

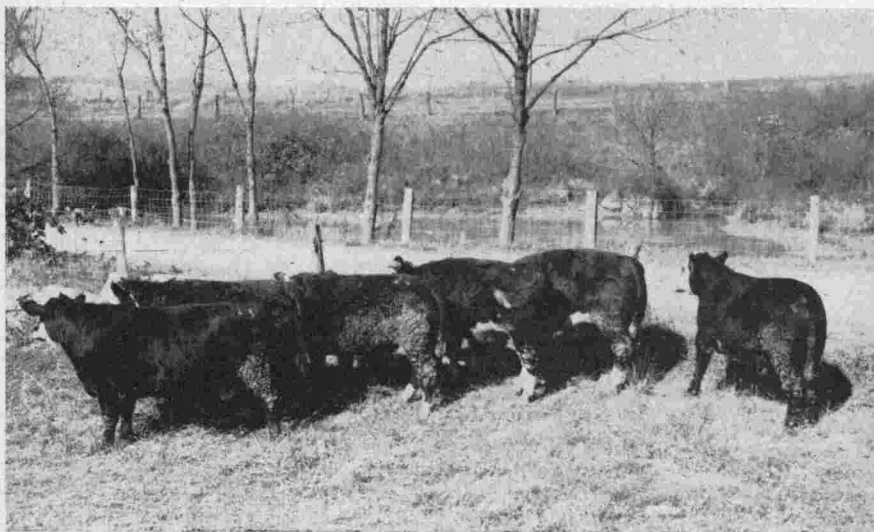


Figure 18—Yearlings finished largely on grass. They had grain on grass from July 19 to September 14, and then for 56 days in dry los. These yearlings finished at 1,018 pounds, dressed 58.1 percent, and produced very desirable carcasses for the Knoxville area. They were less profitable, however, by \$3.62 per head, than similar steers which received no grain during the last 56 days on grass.

Lot 2: Grass only to July 19, then full feed of grain on grass to September 14.

Yearlings

Lot 3: Grass only to September 14, then full feed of grain and mixed hay in barn 56 days.

Lot 4: Grass only to July 19, then full feed of grain on grass to September 19, and then full feed of grain and mixed hay in barn 56 days.

For the second time in four trials, the yearlings made more profit than the two-year-olds. This was due principally to an advance in the cattle market for grass cattle from September to November, a situation contrary to past market changes.

Although the yearlings (Figure 18), had a lower dressing percentage and carcass grade, they had more desirable carcasses for the Knoxville market than the two-year-olds. The yearling carcasses were considered very desirable in finish and weight for the majority of the Knoxville beef trade.

The use of orchard-bluegrass pasture for wintering at one half the charge made for summer pasture, proved more economical than an all-dry-feed ration for wintering both ages of steers.

TABLE 11—A comparison of two-year-olds and yearlings finished on grass with and without grain at Greeneville.

Performance of Cattle	Two-Year-Olds		Yearlings	
	Lot 1	Lot 2	Lot 3	Lot 4
Ave. wt. 12/8/49, lbs.	922.0	916.0	511.8	537.5
Ave. wt. 4/26/50 when turned on grass, lbs.	1042.0	1045.0	608.0	600.0
Ave. winter grain 139 days, lbs.	120.0	129.0	96.0	62.0
Ave. wt. 9/14/50, lbs.	1232.0	1255.0	862.0	884.0
Ave. gain first pasture period to July 19, 84 days, lbs.	141.0	129.0	175.0	183.0
Ave. gain 2nd pasture period to Sept. 14 56 days, lbs.	49.0	81.0	79.0	100.0
Ave. gain 12/8/49 to 9/14/50 280 days, lbs.	310.0	339.0	350.0	346.0
Ave. grain mixture 7/19 to 9/14 corn cob and shuck meal 7 parts and cotton seed meal 1 part, lbs.	none	13.0	none	10.2
Ave. wt. 11/9/50, lbs.			980.0	1018.0
Ave. gain during dry lot period 56 days, lbs.			118.0	134.0
Ave. gain 11/23/49 to 11/9/50, lbs.			468.0	480.0
Ave. daily ration for dry lot period grain mixture, lbs.			18.2	17.1
Mixed alfalfa hay, lbs.			11.2	11.3
Ave. feed cost per 100 lbs. gain all period	\$18.22	22.10	15.83	18.03
Ave. slaughter grade when sold	Good+	H. good	Good—	H. Good—
Ave. dressing percentage (selling wt. & chilled carcass wt. basis)	59.2	60.1	57.9	58.1
Ave. appraised value per cwt. 9/14/50	\$26.81	27.00	25.74	26.11
Ave. appraised value per cwt. 11/9/50			28.10	28.71
Ave. profit over feed and initial cost on appraised values	\$54.57	46.30	83.25	79.63
Ave. margins received (from fall 1949 to selling time)	\$ 3.06	3.25	4.65	5.26

COW-CALF AND PASTURE FERTILIZATION PROJECT

Crossville

This project was continued as in former years except that the plan for renovation was discontinued as it was thought desirable to devise another project.



Figure 19—Group of calves out of grade cows by Hereford bull No. 4, at the Crossville Station. These calves showed an average daily gain of 2.24 pounds from birth to weaning time. A group of calves out of similar cows by Hereford bull No. 5 gained only 2.14 pounds per day per head from birth to weaning. The average weaned weights of these calves, corrected to 210 days' age and with heifer weights adjusted to steer weights, were 559 and 543 pounds respectively. The calves from the better bull, at 30 cents per pound, were worth 4.80 more per head than those from the other bull.

Table 12 gives a brief summary of results secured in 1949-50. The cows were wintered on 2870 lbs. of medium grade hay in addition to what they received from being on the permanent pasture. The 1950 season was above average.

TABLE 12—Performance of Cows.

	Lot 1	Lot 2	Lot 3
Number cows and 2-yr.-old heifers	11	11	11
Ave. wt. of mature cows 11/1/49, lbs.	1037	1078	1149
Ave. winter gain of mature cows, lbs.	—42	—45	—35
Ave. wt. of mature cows 10/31/50, lbs.	1136	1116	1164
Ave. wt. of 2-yr.-old heifers 10/31/50, lbs.	924	1008	1061
Number of calves raised	10	11	11
Percent of calf crop raised to cows bred	90.9	100	100
Ave. birth wt. of calves, lbs.	73.7	72.8	77.5
Ave. wt. of calves when weaned 10/31/50, lbs.	452.4	461.0	478.4
Ave. age of calves when weaned 10/31/50, days	180	187	195
Ave. daily gain birth to weaning, lbs.	2.118	2.071	2.071
Ave. appraised value per cwt. when weaned	\$ 30.07	29.73	29.86
Ave. appraised value per head when weaned	\$136.05	137.06	142.86
Ave. returns from calves per cow bred	\$123.63	137.06	142.86
Ave. beef yield per acre from cows and calves, lbs.	148	150	166
Ave. gross returns in dollars per acre	\$ 40.34	41.78	44.41

Two Hereford bulls—numbers 4 and 5 were compared in the Crossville herd as sires for the 1950 calf crop with results as shown in Table 13.

This herd of grade cows, 18 of which are sired by Shorthorn bulls, is a high producing herd. They are wintered with a minimum amount of winter feed. They calve, mostly, after April 1, on grass. They have been weaned at an average age of 184 days and have not

TABLE 13—*Comparison of two Hereford bulls.*

	Bull No. 4	Bull No. 5
Number of calves from mature cows	15	11
Ave. wt. of steers and heifers adjusted to 180 days, lbs.....		
Ave. daily gain birth to weaning	2.241	2.143
Ave. feeder grade	Low choice	High good—
Ave. slaughter grade	High good—	Good—

only made remarkable gains but produced calves of very acceptable feeder type and fat enough to sell well as slaughter calves on their mother's milk and grass without any grain feeding (Figure 19). The milking ability of this herd seems to be the big factor in its remarkable record.

UT — AEC PROJECTS

Project I: Bomb Radiation Effects Upon Farm Animals

The object of Project One, initiated July 31, 1948, was to investigate the effect of bomb radiation on the growth, breeding efficiency, carcass characteristics, and other changes in the Hereford cattle, at Oak Ridge, that were affected by the explosion of the first atomic bomb in New Mexico. The nucleus of this herd contained thirty-nine exposed cows, seventy-five control cows purchased in New Mexico, and fifteen Polled Herefords purchased in South Carolina. In addition to these cows, there were eighteen exposed steers.

During the past year the entire herd has been weighed at approximately 28-day intervals. Weight gains were compared and observations made as to breeding efficiency and other effects of radiation on the original cattle.

At the beginning of the project the affected cows averaged 721 pounds; and on November 1, 1948, the average was 834 pounds; November 1, 1949, the average was 918 pounds; and November 1, 1950, the average was 1,013 pounds. For the same dates the control cows averaged 685 pounds, 777 pounds, 918 pounds, and 1,019 pounds. The Purebred cows averaged 957 pounds, 1,042 pounds, 1,180 pounds and 1,399 pounds; and the affected steers averaged 923 pounds, 1,083 pounds, 1,273 pounds and 1,558 pounds.

The evaluation of sires and dams by the rate of gain and performance of their progeny was started with the 1949 spring calf crop. Five bulls, viz., one radiated, two F-1 radiated, and two purebred Herefords were used. The cows allotted to these bulls were selected as uniformly as possible as to origin, age, type, condition, weight, etc. Thirty-five calves from these matings were tested. The performance of calves from these bulls is shown in Table 14.

A male calf dropped by a radiated cow and sired by M. H. Domino 13, a registered Hereford bull, began to show a sprinkling of gray hair about one month after birth. This calf is being kept as a bull for observation.

During the year blood samples were taken at intervals and the blood serum submitted to the Pathological Division, B.A.I., in Washington, for the complement-fixation test for anaplasmosis. There have been no cases of clinical anaplasmosis this year.

Blood studies have been continued on the foundation cows, but no significant difference has been noted between the radiated and control cows.

TABLE 14—*Performance of calves in progeny test*

Bull	Birth wt. of Calves, lbs.	Ave. Daily Gain in Wintering Tests	Weight of Calves 172 to 177 Days of Age
R-1	76.5	1.17	382 lbs.
R-40	73	0.82	370
R-137	67.6	1.05	295
Dom. 13	73.3	1.00	381
Pal. P.	68.2	0.98	289

On December 31, there were 303 head of cattle on hand—16 radiated cows, 11 radiated steers, and 85 F-1 and F-2 offspring of the original radiated cows; 45 control cows and 113 F-1 and F-2 offspring of the original control cows; 14 purebred cows, 6 purebred bulls, and 13 F-1 and F-2 offspring of the original purebred cows.

To compare the type of healing between normal animals and animals exposed to atomic radiation, biopsies were obtained which bisected original biopsy or scar areas. The second biopsies were obtained approximately two months following the first. The created wounds in normal animals were reduced to a very thin, slightly elevated reddish line; while in the exposed cattle the scars were wide, depressed, pale reddish gray, and covered by a thin exfoliating tissue.

CHEMISTRY

SOILS, EFFLUENTS, FERTILIZERS

In the long-time experiment on Conservation of Calcium and Magnesium Carbonates under Field Conditions, (Project No. 11), the objective was to determine the capacities of a representative Silt Loam to absorb Ca and Mg from incorporations of various calcic, magnesian, and dolomitic materials under natural conditions, and to determine the resultant releases of Ca, Mg, K, SO₄, and NO₃ to the rainwater leachings. Data on increments through rainwaters and on contents of the leachings, have been tabulated for the annual and quinquennial periods and are ready to be presented as a Station Bulletin.

At the end of the 35th and final annual period of the lysimeter phase of the experiment, the 44 surface soils and the upper and lower strata of the 22 subsoils were sampled for laboratory study as to their final content of carbonates, sorbed calcium and magnesium,

exchange capacities, and other conditions necessary to establish the chemical changes that were induced by the several liming materials. The samples of the air-dried surface soils that had received 8-ton CaO-equivalent incorporations of the various liming materials registered pH values of from 7.5 to 8.0; those that received 32-ton CaO-equivalent incorporations showed pH values of from 8.0 to 8.4, whereas the soils that received the 100-ton incorporations registered pH values between 8.2 and 9.0. The higher pH values were induced by the MgO and the MgCO_3 inputs.

The Conservation of Economic Additions of Liming Materials

After the presentation of findings as to the 20-year outgo of Ca, Mg, K, SO_4 , and NO_3 (Tennessee Station Bulletin 202) from the Tennessee and Virginia soils, the succeeding four-year results as to the effect of residues of Ca and Mg upon the retention of K from applied K_2SO_4 were compiled and will be presented for publication.

Incorporations of Mineral Silicates of Magnesium

The objective of this experiment was to ascertain whether the forsterite minerals could be utilized economically for direct incorporation to supply magnesium in Mg-deficient soils. Olivine and serpentine of 100-mesh and 325-mesh, MgSO_4 , magnesite, and dolomite were incorporated into soils in lysimeters to supply 1,000 pounds of MgO per 2,000,000 pounds of soil. During the 3rd year, the outgo of MgO from the Hartsells Fine Sandy Loam was similar to that from the Claiborne Silt Loam, in harmony with the comparative findings of the preceding 2 years. The outgo of magnesium from 100-mesh serpentine was virtually the same as that from the control soils, and an increase of only 10 pounds MgO passed from the 325-mesh serpentine. The 100-mesh and 325-mesh separates of olivine yielded respective increases of 14 and 50 pounds of MgO. The increases in outgo of MgO from the other materials were 50 pounds from MgSO_4 , 60 pounds from magnesite, and 100 pounds from dolomite. Because of the larger releases of magnesium from the MgSO_4 during the 1st and 2nd years, there was a substantial decrease in the outgo of Mg from the smaller residue during the third year. This lysimeter study will be terminated at the end of the 4th year.

Liming Effectiveness of TVA Quenched Calcium Silicate Slag

The objectives of this experiment were to compare the liming effectiveness of TVA slag in relation to that of calcic limestone, and to utilize the outgo of calcium and fluorine in lysimeter leachings as a measure for the extent of ground water contamination. The slag and limestone of specific fineness were incorporated into a Hartsells Fine Sandy Loam and a Baxter Silt Loam at various rates.

Determinations of the leachings of Ca, Mg, K, SO_4 , NO_3 , and F are being tabulated for the 10th and final year, and the findings will be presented soon for publication. The soils from the 36 lysimeters were preserved for future chemical studies.

After 10-year exposure to the leaching action of rainwaters, the soils that received 2-ton CaCO_3 -equivalent incorporations of slag or of limestone were slightly acidic, or pH 6.2; the 5-ton incorporations of 4-mesh slag or limestone imparted to the soils a reaction of pH 7.0 to 7.1. Incorporations of higher rates of liming induced pH values of 7.8 to 8.4 in both soils.

Potassium Metaphosphate (KPO_3)

The behavior and fate of the potassium of incorporated KPO_3 were investigated through the analysis of annual leachings of K, Ca, Mg, and SO_4 from a Hartsells Fine Sandy Loam and a Fullerton Silt Loam, into which equivalent quantities of the metaphosphate and K_2SO_4 had been incorporated, with and without limestone or dolomite.

The eighth annual outgo of potassium indicated a continuation of the trend previously reported. The availabilities of the K in the two forms can be judged by the overall release and also by current rate of outgo. The eight-year net outgo of K_2O from the five 200-pound annual inputs of K_2O as K_2SO_4 on the acidic Hartsells soil was 760 pounds, against 773 pounds from the corresponding KPO_3 addition, the current annual net outgo of K_2O being 56 pounds and 76 pounds, respectively.

The eight-year net outgo of K_2O from the 1,000-pound K_2O single inputs on the Hartsells soil was 484 pounds from K_2SO_4 and 878 pounds from KPO_3 , but the 8th annual recoveries of K_2O from the integral additions of K_2SO_4 and KPO_3 were down to 18 and 28 pounds of K_2O , respectively. Hence, on the acidic Hartsells soil K_2SO_4 and KPO_3 registered alike in K availability when they were incorporated five times annually at the per acre rate of 200 pounds of K_2O . When incorporated at the heavier rate, the K in the KPO_3 remained as available as that incorporated fractionally; but the K of the single 1,000-pound incorporation of K_2O as K_2SO_4 showed a high percentage of fixation and current unavailability. In respect to source and influence of the rate of K additions, the findings for the acidic Fullerton soil show the same trend as that indicated for Hartsells.

Liming accentuated retention of K by the Hartsells soil to the extent of 200 pounds K_2O , regardless of source or rate of K addition. Liming also induced a fixation of K in the Fullerton soil, but the effect was less pronounced and less uniform in that soil.

Comparative Neutralization Effectiveness of Limestone, Dolomite, and Wilson Dam Slag of Like Particle Size

The objectives of this lysimeter and laboratory experiment were to compare calcic limestone, dolomite, and Wilson Dam slag in

the neutralization of soil acidity under outdoor conditions, upon basis of the following criteria:

- (a) Increase in outgo of $\text{Ca} + \text{Mg}$ in the lysimeter leachings;
- (b) Rise in pH values;
- (c) Extent of carbonate decomposition;
- (d) Decrease in content of exchangeable hydrogen.

A corollary objective was to compare the several procedures as to sensitivity and reproducibility in the determination of the neutralization effectiveness of the several liming materials.

The acidic Hartsells Fine Sandy Loam that was used had an exchange capacity of 12.0 m.e. and an exchangeable hydrogen content of 11.0 m.e. per 100 gms. of soil. The limestone and the dolomite were used as separates of 18- to 20-mesh, 35- to 40-mesh, and 60- to 70-mesh and the slag separates were 18- to 20-mesh and 35- to 40-mesh. The majority of the liming incorporations were in triplicate at the rate of 5,000 pounds of CaCO_3 per 2,000,000 pounds of soil, but some incorporations were made also at the 10,000-pound rate.

The results of the initial year after incorporations are in the nature of a progress report. The leachings of $\text{Ca} + \text{Mg}$ from the 3 separates of marble were greater than those from the corresponding separates of either the dolomite or the slag. Upon basis of such outgo alone, it would appear that the dolomite and the slag were less reactive than the marble of equal particle size. But one year after incorporation, the pH values for the slagged soils registered degrees of neutralization equal to or even greater than that indicated by the corresponding incorporations of high-calcic limestone.

At best, the outgo of $\text{Ca} + \text{Mg}$ did not register the extent to which the soils had absorbed Ca from the incorporated liming materials. The untreated soil, the soil that acquired 5 m.e. from the 18- to 20-mesh marble, and the soil that acquired 10 m.e. from the 18- to 20-mesh marble, contained respective supplies of 1,500, 5,800, and 8,900 pounds of sorbed bases against corresponding leachings of 400, 680, and 1,090 pounds of CaCO_3 per 2,000,000 pounds of soil.

The determination of the pH value of a soil is a simple procedure that may afford a correct indication of the Ca-sorbition status of a soil, but the pH determination is not adequately sensitive and may lead to erroneous conclusions in evaluating small differences in Ca-sorbition. In direct proportion, the pH rise corresponded to .25 units per each 1,000-pound CaCO_3 -equivalent increase in adsorbed calcium. It is well known that the pH of a soil may fluctuate as much as .6 in a unit range from pH 7 without any significant change in calcium status, as a consequence of slight variations in amounts of electrolyte in the soil. Hence, except under limited circumstances, the pH value of a soil does not afford a dependable quantitative measure of the extent of adsorbed calcium in a soil.

The verity of the determinations of exchangeable hydrogen can be judged by their agreement with findings as to the induced decompositions of incorporated carbonates of Ca and Mg. In such comparisons, however, it should be noted that although the determination of exchangeable hydrogen registers the present status as to the adsorbed calcium status in the soil, the carbonate decomposition data register the full change in adsorbed calcium plus the Ca of the nitrates, sulfates and bicarbonate that were engendered in the soil system, and then either leached or accumulated. Hence, agreement between the two sets of data can be brought closer through the combination of the values for the net outgo of Ca+Mg and the values for exchangeable hydrogen. Even after such combinations, the exchangeable hydrogen results were still below the corresponding values for carbonate decompositions, the mean difference being .7 m.e. per 100 gms. of soil. This deviation could be diminished through application of findings from further leaching of soil with Ca-acetate. This procedure would replace the tightly held hydrogen from the more acidic control soil in greater proportion than from the less acidic limed soils, but the procedure would not be feasible for routine laboratory operations.

After one year, the decompositions of the 5,000-pound inputs of marble of 18-, 60-, and 35-mesh were virtually complete, as was true also for the corresponding inputs of 60- and 35-mesh separates of dolomite. Only the 5,000-pound incorporation of 18- to 20-mesh dolomite and the 10,000-pound incorporations of 18- to 20-mesh separates of marble and of dolomite were still undergoing decomposition at speeds that could be determined precisely. These findings show that to maintain a parallel in the decompositions of the equivalent inputs of dolomite and marble, the mean particle size of the dolomite should be half that of the marble. The 1-year results indicate that the reaction between the slag and soil was more advanced than the reaction between the marble and soil, although every outgo of calcium from the moderate-rate incorporations of marble was greater than that from the slag of comparable fineness. For heavy-rate inputs, however, the reverse held true.

The repression exerted by the inputs of calcium upon potassium outgo affords an excellent medium to register qualitative distinctions as to the reactivities of the various liming materials and the influence of the factor of their particle size. The 57-pound outgo of K_2O from the control was repressed to 40 pounds by the 18- to 20-mesh marble, to 30 pounds by the 35- to 40-mesh marble, and to 23 pounds by the 60- to 70-mesh marble, and the repressions that the dolomite and slag exerted upon potassium outgo correspond to their specific reactivities within the soil.

Effects of Incorporations of Various Fluoric Materials Upon Fluorine Appearance in Ground Waters

To determine possible contamination of ground waters from 200-pound per acre incorporations of fluorine as CaF_2 , KF, and as

fluorine-carrying slag, the lysimeter experiment was continued for its second year without additional incorporations. The rainwater leachings from the acidic Hartsells control soil carried 0.8 pound of fluorine; 1.6 pounds went from the incorporated potassium fluoride, nearly 3 pounds from the calcium fluoride, and 5 pounds from the slag, against respective passages of 0.6, 2.8, 2.7, and 9.0 pounds of fluorine from the corresponding leachings from the acidic Clarksville soil.

The limestone incorporation exerted no effect upon the outgo of fluorine from KF or from CaF_2 on the limestoned Hartsells soil, but it did effect a slight increase in the outgo of fluorine from those two fluorides on the Clarksville soil. The parallel incorporations of fused wollastonite induced a decided coloration of organic matter to the leachings, and a 7 to 8-pound outgo of fluorine from the untreated units of both soils, the effect of which was to mask the outgo of fluorine from the inputs of the fluoric materials. Because the leachings of fluorine were so small in the initial two years, a second incorporation of each of the fluoric carriers was made at the beginning of the 3rd year.

Migrations in Fallowed and Cropped Soils

In a related experiment, an initial 300-pound per acre input of fluorine was supplied to a Hartsells Fine Sandy Loam and to a Clarksville Silt Loam in 1/10,000-acre lysimeters through incorporations of cryolite, sodium fluoride, sodium silico-fluoride, magnesium fluoride, and rock phosphate. Subsequent incorporations of the several fluoride materials brought the total input to 975 pounds of fluorine per 3,000,000 pounds of soil. The incorporations were in quadruplicate; three of the lysimeters were cropped while the fourth unit was kept fallow. Cropping did not alter the outgo of fluorine in the leachings from April 7, 1949, to May 15, 1950. The capacity of the Hartsells soil to retain fluorine exceeded that of the Clarksville soil.

Fluorine leachings from the cryolite, MgF_2 , and Na_2SiF_6 in the Hartsells soil were quite similar, about 5 pounds of fluorine per annum per acre and 7 pounds from NaF ; whereas outgo from the control soil and from rock phosphate inputs were only 0.5 pounds each. The cryolite, MgF_2 , and Na_2SiF_6 in the Clarksville soil yielded fluorine leachings similarly at approximate rates of 20 pounds per acre, and 34 pounds from the NaF . Fluorine outgo from the Clarksville control was 0.4 pound and 0.9 pound from the incorporated rock phosphate. The Maury Silt Loam from Tennessee and the one from Kentucky yielded leachings of close to one pound of fluorine per acre per annum.

Effect of Certain Phosphatic Materials Upon the Exchange Cation Status of Two Soils

This base exchange study upon the soil residues was a phase of the lysimeter experiment No. 45 on the migration of phosphorus

from incorporations of various phosphatic materials into an acidic Hartsells Fine Sandy Loam and a neutral Dewey Silt Loam. After 10 years' exposure the acidic Hartsells soil showed an enhancement in its content of exchangeable calcium from the incorporations of the mono- and the di-calcium phosphates. The ortho phosphoric acid (H_3PO_4) had caused little change in the pH value of the Hartsells soil but did produce an appreciable increase in its content of exchangeable hydrogen and in its exchange capacity.

The incorporations of phosphoric acid, mono- and di-ammonium phosphates had caused progressive increases in exchangeable hydrogen content of the Dewey soil, and increases in its exchange capacity. The incorporations of ammonium sulfate had decreased its Ca-content from 9.6 m.e. to 0.65 m.e. and lowered its initial pH value of 6.5 to a final one of 4.7. Other interesting correlations between incorporations and consequential status of exchangeable cation content of the 2 soils will be presented later.

Use of Radioactive Calcium in Lysimeter Experiments

In lysimeter studies upon the conservation of the Ca and Mg of incorporations of liming materials, the assumption has been that the increases in the rainwater leachings of those elements were derived from these materials. Recently, however, that postulation was tested through the use of radiocalcium as a component of precipitated calcium carbonate which was incorporated at rates of 1-, 2-, 3-, 4-, and 5-thousand pounds per acre in a Hartsells Fine Sandy Loam and in a Claiborne Silt Loam. Through determinations of the proportion of labelled calcium in the lysimeter leachings from those soils, it was feasible to establish the outgo attributable to native and additive supplies. The leachings were collected at Knoxville and analyzed for total calcium and radiocalcium at the Oak Ridge laboratories. After a year's leaching by rainwaters, the soils were removed from the lysimeters and analyzed for pH values and carbonate contents. The lysimeter findings as to proportionate distribution of native and additive calcium in the rainwater leachings, and in plant ash from pot cultures, have been brought into manuscripts in two papers that will integrate the indications afforded by the two approaches in this UT-AEC research project.

A near-repetition of the foregoing experiment is in progress through the use of quenched calcium silicate slag, in lieu of precipitated CaCO_3 , as the carrier of radioactive calcium.

Atmospheric Effluents — Their Effects Upon Plant and Animal Life in Two Locales

This study has been pursued through analyses of air, rainwaters, streams, ponds, leachings, soils, and exposed reactants, and samples of vegetation from the field and from integrated greenhouse and lysimeter experiments, and through detailed examination

of bones, urines, and other specimens in the Chemistry-Animal Husbandry Project.

Field Samples—The sampling of vegetation at designated points in Blount and Maury Counties has been continued, to ascertain the occurrences of fluorine at various points in relation to wind directions and other factors. Analyses were made of 370 samples of soil and 211 samples of waters. In the past year, 1,675 analyses of vegetation from Maury County and 799 from Blount County establish relatively high concentrations of fluorine in forage crops at certain locales.

A series of vegetative samples collected near a Blount County industrial plant during normal operation showed fluorine content as high as 2,422 parts per million, and a mean occurrence of 1,157 ppm. During a shutdown, however, comparable collections showed fluorine content as low as 7 ppm, although the mean content of the sample vegetation was 62 ppm.

The samples of vegetation collected at various points in Maury County contained fluorine in range from 2 ppm to 719 ppm, and the forage samples from the new University Farm at Haynes Haven were found to have a fluorine content in range from 7 ppm to 21 ppm.

The fluorine content of rainwater collections at the Cumberland Plateau and Highland Rim Experiment Stations continued to be much lower than the content of the collections that were obtained at the Middle Tennessee Station, at the Blount County Farm, and at Knoxville lysimeters. The mean values were 0.05 ppm at the Plateau Station; 0.31 ppm at MTES Office collector; 0.17 ppm at MTES Plot collector; 0.13 ppm at Blount County farm; and 0.10 ppm at the Knoxville lysimeters.

Some 200 samples of soil obtained at locations where samples of vegetation also were collected were found to contain fluorine in range from 0.01 percent to 0.54 percent, and concomitant P_2O_5 values indicated that an appreciable occurrence of fluorine was present chiefly as fluorapatite.

Fluorine Uptake—Alfalfa grown at Columbia on the Maury Silt Loam of high fluorine content, showed a mean fluorine content of 31 ppm. Grown on that soil at Knoxville and at Crossville, however, alfalfa contained only 6 ppm and 3 ppm, respectively. The mean content of fluorine in crops grown on four East Tennessee soils after they had been transported to Columbia (MTES) was 28 ppm, whereas the crops contained only 6 ppm of fluorine when they were grown on the same soils at Knoxville. The transported Kentucky Maury Silt Loam, of high fluorine content, imparted a fluorine content of 6 ppm to alfalfa grown at Knoxville against a 7 ppm content for that crop when it was grown on the Kentucky soil at its native location. Fluorine determinations were made on 140 samples of vegetation in related pot culture and lysimeter studies.

In further pot culture and plot studies as to whether the fluorine content of soil affects the fluorine content of crops, ten acidic soils

(pH 5.1 to 5.8) representative of five types were selected from regions where fluorosis in locally-grown livestock had been observed. These soils, with and without liming and with and without fluoride supplements, were planted to ryegrass at Knoxville in the fall of 1950, and findings for resultant crops will be reported upon completion of the trials.

Determination of Fluorine Content of Soils

Special attention was directed to the development of dependable techniques for the determination of the fluorine content of soils. Through determinations on certain fluoride-fortified soils, it was established that precalcination of a lime-fortified analytical charge was unnecessary and, in some cases, caused lessened recoveries of the added fluorine. Following non-recoveries of fluorine in the perchloric distillates from the analytical charges of calcium fluoride, after their calcination at 500° C. and at 900° C, volatilization of fluorine was established as the cause, rather than a fixation of the additive fluorine in forms resistant to distillation. It was concluded that, for the soils of the type used, the direct double distillation procedure (the initial step being distillation with sulfuric acid at 165° C.) is preferable to the procedure in which the charge of soil is calcined with or without the inclusion of lime, prior to the distillation from perchloric acid.

In collaboration with the Soils Laboratory of the BPI, the double distillation method was utilized for the determination of the fluorine content of 26 soils that represented diversity of type and composition and came from several areas. Fluorine content was found in the range from 37 ppm to 2,172 ppm. In 23 cases the direct double distillation procedure gave fluorine recoveries higher than those obtained through perchloric acid distillation of the soil charges that were calcined with equal parts of CaO at 500° C. Some of the differences were not appreciable, others were as much as 100 percent. The higher values by the direct double distillation procedure came from the soils of high organic content and from those whose fluorine content was attributable to apatite.

These observations were presented as a report to the Association of Official Agricultural Chemists, with the recommendation that the direct double distillation procedure be adopted as "official" for soils. Considerable work was done in the development and standardization of pre-analytical techniques specifically appropriate for analyses of special materials and biological specimens and through collaborative analyses of check samples and exchanges of information with other laboratories.

Fluorine in Animal Metabolism

Fluorine determinations were made on some 2,000 samples of waters, bones, animal tissues, milk, excreta, and experimental feeds in connection with Chemistry-Animal Husbandry experiments in

the feeding of fluoride-enriched materials to small animals and livestock. Some 285 determinations of calcium and of phosphorus have been made in this connection. Detailed results on the projects for which these data have been obtained will be included in the report submitted by the Animal Husbandry Department.

U.T. - T.V.A. Cooperative Projects

As in previous years, the cooperative studies were upon TVA experimental fertilizers and phosphates and provided control evaluations upon monthly-submitted samples of Wilson Dam slag.

The experimental concentrated materials and standard fertilizers were compared upon basis of N-K-P₂O₅ ratios, approximately 1-1-1. The aggregates of the 2-crop responses indicate that the 11-11-11 material was more effective than the concentrated mixtures, 11-11-12; 14-14-14; and also than the standard 7-7-8 mixture. Tested also was an experimental slag in comparison with basic slag, both of which had some liming value. Upon basis of P₂O₅ content, the two slags appeared to be equal in effectiveness, but they proved less effective than the concentrated superphosphate.

Laboratory and greenhouse studies were conducted as to the efficacy of the P₂O₅ content of different sizings of a TVA calcium metaphosphate that was used also in tests conducted at the U. S. D. A. The separates used were those of —10+20, —20+35, —35+60, and —60+80-mesh screenings through 20-, 10-, 35-, and 80-mesh sieves in comparisons with concentrated superphosphate by means of incorporations into the upper half of Clarksville Silt Loam at rates of 25, 50, and 100 pounds of P₂O₅ per acre surface.

As a mean for the three rates, the aggregates of browntop millet and ryegrass show significant increase in plant response to the —35+60-mesh, —60+80-mesh separates and to the all-through screenings, —20, —35, and —80-mesh; and over the response to the concentrated superphosphate. The 10-, 20-, 35-, and 80-mesh screenings proved superior to the —10+20-mesh separate and the 35- and 80-mesh screenings were more effective than the —20+35-mesh separate. The response to the —60+80-mesh separate was significantly better than that to the 10-mesh separate, but was not superior to the 20-, 35-, or 80-mesh screenings. In the comparison of the 10-, 20-, 35-, and 80-mesh materials only the 35- and 80-mesh fractions proved significantly better than the 10-mesh materials. The findings supply further evidence that calcium metaphosphate is an effective fertilizer.

The unground Wilson Dam slag was evaluated in relation to the —80+100-mesh separates of the monthly composites upon the basis of the effectiveness of P₂O₅ content and through induced changes in the pH of the soil. The effectiveness of the contained P₂O₅ was registered by the growth of ryegrass (crop 1) and of red clover (crop 2), and the pH of the soil was determined after both crops. Fourteen monthly composites of slag of 1947, and 1948, several control slags, limestone, and wollastonite were incorporated

into the Hartsells Loam Soil at rate of 3 tons CaCO_3 -equivalence. The slag composites show rather uniform content of SiO_2 (38 to 41%) CaO (49 to 51%) and CaCO_3 -equivalence of 81 to 84%.

The P_2O_5 content varied between 0.6 percent and 1.5 percent; Al_2O_3 content from 3.1 percent to 6.6 percent and fluorine content from 2.02 percent to 2.62 percent. The unground slags showed considerable variation in fineness. The portion through 20-mesh was in range between 58.8 and 94.9 percent and the portion through —48-mesh varied between 10.1 percent and 68.4 percent.

The crops responded to the unground slag and to —80+100-mesh composites, the P_2O_5 content of and uptake by the ryegrass being in line with the P_2O_5 content of the slag. The effect of the P_2O_5 content of the slag was registered also by the succeeding crop of red clover, even though an incorporation of concentrated superphosphate had provided an 80-pound per acre input of P_2O_5 to all pots prior to the seedings. In general, plant growth and P_2O_5 content and uptake were greater from the slags of higher P_2O_5 content. Although composites of the unground slag induced soil pH values of 5.9 to 6.5, this range cannot be correlated with slag content of either Al_2O_3 or P_2O_5 , or with fineness. The —80+100-mesh separates of the several slag composites induced pH values of 6.7 to 6.9.

Effects of fluoric materials upon crop growth and fluorine content were studied also by means of pot cultures and 56 lysimeters of 1/10,000 acre. Quadruplicated inputs of sodium fluoride, sodium silicofluoride, magnesium fluoride, cryolite, and rock phosphate provided fluorine, 300 pounds per acre surface, into the upper half of a 9-inch depth of limestoned Hartsells Fine Sandy Loam and likewise into a Clarksville Silt Loam. Three of the four lysimeters allocated to each fluorine carrier on both soils were seeded to soybeans and the soil in the fourth lysimeter of each group was kept fallow. Following the soybean harvest, the same materials were used to supply the second input of fluorine into the upper 4.5-inch zone of both soils at per acre rate of 675 pounds before seeding to lespedeza. After the lespedeza was harvested, every 9-inch placement of soil was removed and mixed. Consequently, a near-total input of 975-pounds of fluorine per acre surface was disseminated throughout the 9-inch depth of soil before the sowing of spring oats, the third crop.

Fluorine content was virtually constant in the crops of soybeans, lespedeza, and oats from both soils; and no fluorine carrier caused enhancement in fluorine content of any crop on either soil. The leachings from the 300-pound input of every fluoric material in the Hartsells and Clarksville soil carried small, although significant quantities of fluorine, in contrast to meager outgo from the rock phosphate. Fluorine outgo from the Clarksville soil was, however, considerably more than that from the Hartsells soil. The rainwater leachings showed substantial accentuations in the outgo of fluorine from both soils after the 675-pound supplement

that had resided in the upper zone was mixed into the full 9-inch depth of soil. Every 2-year outgo of fluorine from the 975-pound input into the Hartsells soil was only a fourth or third of the corresponding outgo from the Clarksville soil, the outgo of 32.7 pounds of fluorine per acre from the input as sodium fluoride being the largest outgo from both soils. The differences between the lesser leachings of fluorine from cryolite, magnesium fluoride, and sodium silicofluoride were not significant for either soil, and the growing of crops did not affect the quantities of fluorine carried by the rainwater leachings.

The greenhouse studies included comparisons for incorporations of fluorine and chlorine upon soils and crops through the use of HF, HCl, KF, and KCl, in quantities respectively equivalent to 200, 400, and 800 pounds of fluorine per acre. The HF exerted little effect upon soil pH, in contrast to the decided lowerings induced by HCl. The KF caused significant elevations in soil pH, whereas KCl registered no effect. Millet response was rather erratic, and growth was virtually inhibited by the 400- and 800-pound incorporations of all of the materials other than KCl. The present findings are not in contradiction to previous observations that, on a soil well supplied with calcium, a good growth of forage will not register a significant enhancement in its fluorine content from rational rate incorporations of solid fluorides; but the heavy rate inputs of hydrofluoric acid did impart an abnormal content of fluorine to clover on the limestoned soils, as well as on those unlimed.

Inclusion of radioactive calcium in a precipitated carbonate was used to determine the respective proportions of calcium that plants acquired from supplies native to the soil and from the incorporated carbonate. Crops of red clover followed by oats, and ryegrass followed by crimson clover were grown on two soils that contained the radioactive calcium, and in parallel with the previously-mentioned lysimeter studies. The determined proportions of normal and radioactive calcium in the ash of each crop are now in process of publication.

In collaboration with A.E.C., the problem of the conservation of calcium in the soil is being studied further by means of Wilson Dam slag that was impregnated with radioactive calcium.

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

GENERAL CHEMISTRY

Food Processing

Experiments in the preservation of fruits and vegetables by freezing, canning, and dehydrating were conducted during the year. This work was done to continue improvement of the quality of raw and processed foods, and to aid in the selection of varieties best suited for home use and commercial processing. Bulletin 215, "Home Freezing of Foods," was published in March.

During the year, the following products were studied: asparagus, one variety and two treatments; green beans, 10 varieties; lima beans, 11 varieties; broccoli, two varieties; cauliflower, three varieties; beets, two varieties; okra, two varieties; peas, 12 varieties; and tomatoes, 12 varieties. Apples, one variety and 12 treatments; blackberries, 26 selections; peaches, one variety and 11 treatments; and strawberries, 12 varieties.

In addition to processing the various products and evaluating their qualities, many of the foods were analyzed chemically for vitamin C and other constituents. In the evaluation of processing methods employed in the home and factory, and quality of food produced, chemical information is of considerable importance. Various phases of experimental work during the year are summarized in the following paragraphs:

Sulfur Dioxide Effective in Retarding Discoloration of Frozen Peaches

Experiments were conducted to determine the relative effectiveness of low levels of added sulfur dioxide, and recommended levels of ascorbic acid, and combinations of the two substances, in retarding the browning of frozen peach slices. Sulfur dioxide proved to be very satisfactory at levels of 35 to 40 parts per million.

Freezing Sliced Apples—Experiments show that apple slices of the more tart varieties may be successfully frozen. The slices are held in a 5 percent salt solution for 15 minutes, removed, and allowed to drain. They should be placed in containers, and just covered with 40 percent sugar sirup containing sufficient ascorbic acid and sodium bisulfite to supply 100 milligrams of the former and 40 parts per million of the latter per pound of product, fruit and sirup. The product is then de-aerated, sealed, and frozen. This method is better adapted to commercial than to home processing of apples.

Frozen Fruit Mixtures—Strawberries may be frozen in season and later used to mix with peaches, pears, and other fruits. An excellent frozen fruit salad has been prepared, composed of $1/3$ strawberries and $2/3$ peaches. Other combinations are being studied.

Sweeteners Used in Freezing Fruits—Studies are being made of the various kinds of sweeteners for the freezing preservation of fruits. Sweeteners studied are sugar, invert sugar sirup, brown sugar, high conversion corn sirup, dextrose, and combinations of sugar and corn sirup.

It has been found that sirups are more effective than dry sweeteners in the control of darkening of fruits. Also, when sirups are used less shrinkage of fruit occurs. The ratio of fruit to sweetener in processing frozen strawberries and peaches received attention. Bland flavored fruits require less sugar than the more acid types. Sirup composed of $\frac{1}{3}$ corn sirup solids and $\frac{2}{3}$ sugar solids gives very satisfactory results with frozen peaches.

Wrapping and Packaging Materials For Frozen Foods

Experiments were conducted on the efficiency and cost of various packaging materials offered homemakers and commercial locker plants. Methods of using the various packaging materials were studied. Some attention was given to the quality of frozen green beans as affected by temperature fluctuations in storage. This work is being continued.

Hydrochloric Acid may be Substituted for Citric Acid in Processing Peaches

Because of a shortage of citric acid, the Station was requested to recommend a suitable substitute for neutralizing traces of alkali carried over on the surface of peaches from the lye-peeling tank. Our experiments show that 0.15 to 0.2 percent hydrochloric acid solution serves well for this purpose. Hydrochloric acid is a normal constituent of the gastric juice of man, occurring in the stomach in concentrations ranging from 0.2 to 0.28 percent. This acid will probably be used by commercial processors in freezing peaches next year.

Dehydrated Foods

During recent wars and periods of National emergency much use has been made of dehydrated foods; but the quality of many dried foods leaves much to be desired. There is a tendency to curtail research in dehydration as a method of preserving foods when the "shooting," not necessarily the war, is over. Work in dehydrating fruits and some vegetables of better quality, however, has been continued. Proper storage conditions for dehydrated foods is one of the most pressing problems, and is receiving attention. Dehydration studies are to be continued on a larger scale during the coming year. Bulletin No. 183 "Dehydration of Fruits and Vegetables in the Home," is being revised to include latest information.

Handling Fresh Products

Preliminary studies are being made on the quality of strawberries, green beans, and peaches, as affected by methods of handling from field to processing plant. Of the several factors affecting quality, temperature is one of the most important. Best quality was retained in all products that were cooled soon after harvest and held that way until processed. Plans are under way to continue these studies, including processing operations, on a much larger scale next year.

Experimental Canning of Tomatoes and Green Beans

Twelve varieties of tomatoes and two varieties of green beans were preserved by canning, stored in room temperature for two months, then evaluated for quality. Four of the twelve varieties of tomatoes studied, namely Rutgers 2, Rutgers 1, Lakeland, and Fortune, were of fairly good quality, but all lacked depth of red color commonly desired in commercially canned tomatoes. The Rutgers variety more nearly approached the desired color. Tendergreen and Topcrop varieties of green beans were of almost comparable overall quality, with a slight preference for the flavor of Tendergreen.

Fruit Juices

Experiments show that fruit juices may be preserved by a number of methods such as pasteurization; holding in cool temperature, (26° F. to 28° F.); freezing storage; passing through a germ-proof filter; concentration under reduced pressure until soluble solids are high enough to effect preservation; and by removal of water as ice and centrifuging to separate the concentrated juice. The last mentioned method was employed during the current year. Concentrates of excellent quality were made from strawberries and raspberries.

Food Technology Building

During the year, close supervision was given to the many details involved in completing the building. Considerable time was consumed in purchasing and installing the various pieces of equipment in the laboratories and locker plant. This work will continue into next year. Plans are being made for pilot-plant processing operations during the coming year.

Pasture Fertilization

Quality studies of pasture forage from unfertilized and differently fertilized experimental fields throughout the State, as indicated by chemical analyses, have been continued. Data on forage samples obtained in 1948 and 1949 were completed, tabulated, and

copies submitted to the cooperating Agronomy Department. Analysis of forage samples obtained in 1950 is in progress. Further organization of the data for 1948, 1949, and 1950, and analysis of the data are also in progress. In general, these quality studies indicate that fertilization of pastures, in addition to increasing yields of forage, maintains or improves quality, i.e., the mineral or protein percentage in fertilized forage is as large as or larger than that in unfertilized forage.

Chemical Methods Employed

1. Non-Protein Nitrogen in Field Crops. The protein and non-protein in plants can be approximately separated by digestion in boiling water or boiling 0.5 percent acetic acid. The insoluble protein is considered to be "protein nitrogen;" the soluble protein is considered to be "non-protein nitrogen." Water or acetic acid solution extracted about equal amounts of nitrogen, but subsequent filtration was the more rapid when the acetic acid solution was used as the extractor. From about $1/6$ to $1/3$ of the total nitrogen in the few forage samples analyzed was soluble, or "non-protein," nitrogen. (Figure 20.)

2. Boric Acid for Absorbing Distilled Ammonia. Boric acid long has been used to absorb distilled ammonia in the Kjeldahl determination of nitrogen, and the absorbed ammonia then titrated



Figure 20—Laboratory in which forage crops are analyzed.

with a standard strong acid such as hydrochloric or sulphuric.¹ Advantages of the method are: (1) Neither the concentration nor the volume of the absorption solution, usually 2% to 4% boric acid, need be accurately determined. (2) The use of one standard solution, sodium hydroxide, which is somewhat difficult to prepare and to maintain, is eliminated. Trials made in the Station laboratory, using Laboratory Construction Company No. 1293 distillation equipment at full heat, or without heat control, show that 100 ml. of 2 percent boric acid will absorb all the ammonia derived from plant samples provided the amount does not exceed .06 gm. N, or 6 percent N on the basis of a 1 gm. charge. The boric acid would doubtless absorb greater amounts of ammonia if the heat were controlled and the ammonia distilled slowly.

Comparison of Photoelectric Colorimeters

The Evelyn and Klett-Summerson photoelectric colorimeters were compared for the determination of phosphorus by the Briggs-Sterges method and were found to agree closely.

Use of Bailey-Walker Apparatus. Some work was done on technique for the determination of fat in forage and feeds, using the Bailey-Walker apparatus.

Miscellaneous. During the year, analytical services on many agricultural materials have been rendered to other departments of the College and Station.

DAIRYING

WINTERING DAIRY HEIFERS ON LEGUME HAY

For several years yearling dairy heifers in the University herd at Knoxville have been wintered on legume hay without supplementary concentrate feeding. Heifers have made normal or close to normal gains on both alfalfa and soy bean hay. Yearling heifers when fed all the good leafy alfalfa hay they would consume made an average daily gain of 1.33 pounds. There was no significant difference in field dried or barn dried hay.

Jersey heifers when fed soy bean hay of good quality, made a gain of .58 pounds per heifer per day during the winter. It was found that considerably more alfalfa hay was consumed than soy bean hay. Each heifer on alfalfa hay ate slightly over 25 pounds per day or over a ton and a half during the 120 day period. Even with this all-roughage ration the cost of providing this amount of first quality hay to heifers was considerable. A still more economical method of wintering heifers is needed. Additional tests are being conducted.

¹ References:
Quantitative Analysis, Pierce and Haenisch, 2nd Edition, page 127.
L. Q. Winkler, Z. Angew. Chem., 26, 231 (1913)

Pasturing Alfalfa

Just how much alfalfa may be grazed and still maintain a stand has not been satisfactorily answered. It has been found that continuous grazing of alfalfa is injurious to the stand. To test this, a field of well established alfalfa one year old was divided into nine 1/3-acre plots. Three of these plots were cut when the growth of the plants indicated that cutting should be done. Cows were placed on three of the plots and allowed to graze the crop for one week. On the other three plots cows were allowed to graze for two weeks. The number of cows on each plot was so regulated that the forage would last the above periods. At the end of the first year an excellent stand of alfalfa was still in all plots and no marked difference was noted.

The cows were pastured on the alfalfa during the day and on another pasture at night in order to reduce the danger of bloat. Under this system of grazing each cutting of alfalfa provided pasture for 18 cows for one week and nine cows for the 14-day period, per acre. This test is in cooperation with the Agronomy Department.

ARTIFICIAL INSEMINATION

A problem in handling of bull semen for artificial insemination has been the proper evaluation of semen specimens before they are used. For various reasons the initial motility and vigor of different specimens vary from the same bull. It has been questioned whether the poorer samples could be mixed with the good ones, or whether only the best samples should be used for insemination. Laboratory studies showed that good spermatozoa retained satisfactory livability after being mixed with sperm which had been killed by cold, heat, or watering. A field test showed that breeding efficiency was just as high in mixed samples of unequal vigor as when only the best was used. The 60-70 day non-return rate from the mixed was 66.3 compared to 63.9 from the best alone.

Means of simplifying the preparation of semen diluters have been investigated. Acetone extraction of egg yolk removed harmful material and left a dry, fat-free powder which could be reconstituted with citrate buffer equal to that made with fresh egg yoke. The advantage of using the dried egg yolk material is that a supply of fresh eggs is not required and the dry material may be kept several months without refrigeration. It also may be possible to develop suitable formulas which require only the addition of water and reconstitution to produce a satisfactory semen diluter.

MASTITIS INVESTIGATIONS

Four specialized dairy herds which had been sampled at monthly intervals for two years were continued a third year with sampling at quarterly intervals. Herd A had an initial incidence

of 67% infected cows. The second year after treatment and testing monthly the incidence of infected cows had declined to 30%. This year the third, with continued testing and treating, the incidence of infection averaged 29% for an insignificant change. In Herd B the initial infection had been 40%. It was reduced to an average of 12% the second year by testing and treating. The third year, without treatment, infection in herd B averaged 25%. Herd C was not treated routinely at any time. The initial, second year, and third year averages were 25%, 32%, and 34%. In herd D mastitis infection had been reduced from 67% initially to 22% after two years' testing and treating. The third year, without treatment, it rose to 33%.

These data indicate that although testing and treating for mastitis do not eliminate the infection, they help to keep it in check. The benefit derived from a testing and treatment program is not permanent, but a return to the incidence of infection existing before treatment of the herds was not attained after 12 months without treating. In a herd tested but not treated, little change occurred in three years.

The efficiency of new treatments for mastitis has been investigated. A mixture of penicillin, streptomycin and bacracin in ointment was compared with penicillin in water solution. The former was injected into 19 quarters of 12 cows. After four weeks infections organisms had been eliminated from 13 quarters including all infected quarters of seven cows. Penicillin in water was injected into 19 quarters of 10 other cows at the same time, resulting in elimination of the infection from nine quarters and three cows. It is not known whether the improvement in treatment efficiency was due to the added antibiotic or to the vehicle used for infusion.

Cows which have been freed of the usual mastitis producing organisms have continued to develop acute attacks caused by other types. Flare-ups encountered during the year were caused by *Staphylococci*, *Corynebacteria*, and coliform microorganisms as well as *streptococci*. One case was encountered in which no bacteria were found in the milk. *Corynebacteria* were most frequently found in mastitis developing during the dry period and at time of freshening. These attacks were severe and resulted in loss of function of the affected quarters. None of the antibiotic treatments were successful against *corynebacteria* infection. Growth characteristics of all microorganisms causing mastitis are being studied. Problems in diagnosis of mastitis infection are also being investigated.

THYROID METABOLISM

By using radioactive iodine it was found that the thyroid gland of the fetal calf was more active than that of the mother just before parturition. Evidence was also obtained that the thyroxine elaborated by the fetus was not efficiently excreted or destroyed before birth.

THYROPROTEIN FEEDING

Cows which had been fed 15 gm. per day of thyroprotein during the declining phase of two successive lactations continued to produce satisfactorily the next lactation when thyroprotein was not fed. The stimulating effect of the thyroprotein to milk production lasted only eight to 10 weeks on the average. During this time the cows lost weight even though they were fed more grain. Therefore, there was no increase in efficiency of production due to thyroprotein feeding. There was no apparent effect of thyroprotein upon the reproductive efficiency of the cows or the vigor of the resulting calves.

PASTURE AND GRAZING SYSTEMS

During the past year at Columbia, a second trial of 140 days, starting November 1, showed that Jersey cows on winter grazing three to five hours daily produced 65 percent more milk, ate 39 percent less hay and returned 55 cents more per day while those on pasture continuously with only a shelter shed produced 30 percent more milk, ate 16 percent as much hay and returned 46 cents more per day above feed costs than a third group entirely barn fed. For the two trials, cows on winter pasture three to five hours daily averaged 40 percent more milk, and those on pasture continuously with limited shelter 18 percent more milk than barn-fed cows, and averaged about \$50 more returns above feed cost. They also maintained weight, stayed cleaner, required less labor and housing costs, and apparently did not injure the pastures by trampling in wet weather. The test is being continued with about one acre of grazing per cow. Results to date are in favor of winter grazing even during a severe winter.

DAIRY MANUFACTURING

The dairy manufacturing economy of Tennessee is shifting from butter to cheese and evaporated milk. Since the manufacture of cheese requires a larger part of the milk solids than the butter industry, and the evaporated milk industry uses all the milk solids, the economic structure of the dairy industry in the state will be strengthened. Few states in the past ten years have made greater industrial progress in the manufacture of cheese than Tennessee. In 1938 Tennessee ranked tenth nationally but in 1949 the rank had risen to sixth place.

At the present time the dairy products research program at the University of Tennessee is in its infancy, with work involving the improvement of the quality of the Cheddar cheese made from milk produced in Tennessee. The scope of the Cheddar cheese project is very broad and includes such phases of cheese research as making procedure, ripening agents, time and temperature of

ripening, and the effects of different heat treatment on the raw milk.

For the first time, facilities are available for dairy products research. Two dairy buildings were completed in the spring of 1950, and this project was inaugurated in July of 1950. It is too early to report progress at the present time.

A cottage cheese study is also being initiated so that help may be given the fluid milk plants who normally produce this product.

DAIRY EXPERIMENT STATION, LEWISBURG

Summer Grazing

A project was established to obtain information on a pasture mixture with alfalfa included. The soil in the selected field is not uniform. A soil survey indicated Talbott silty clay loam, severely eroded phase; Hermitage silt loam, eroded phases; and Emory silt loam. This included Class 1, Class 2 and Class 4 land. The field was divided into four equal parts, A, B, C, and D, in such manner that the soils of plots A plus D about equalled the soils of plots B plus C. Each plot was subdivided into three equal parts for rotation grazing.

Lime and manure were applied in preparation for this experiment. An application was made of 474 pounds of 4-8-8 fertilizer and 23 pounds of borax per acre. The seeding was made August 25, 1949, using 13.2 pounds orchard grass, two pounds Oregon certified ladino clover, and 8.2 pounds Kansas common alfalfa seed per acre.

All plots were grazed by producing Jersey cows. Pasture yields were measured in terms of calculated total digestible nutrients supplied per acre of grazing. Grazing was started April 10, 1950, on plots A and D and continued through October. Grazing was started on plots B and C on June 10, 1950, after the removal of one cutting for hay. Rotation grazing was done on each of the plots. The three parts of each plot were grazed 7, 10, and 13 days, respectively, the first time to allow for differences in accumulated growth. After the first time over, each part was grazed for 10 days, which allowed the cows to be 10 days on and 20 days off any given area.

The grazing obtained from plots A and D April 10 through October 31, supplied calculated digestible nutrients at the rate of 3,496 pounds per acre. It would require $3\frac{1}{2}$ tons of alfalfa or 78 bushels of corn to supply an equivalent amount of total digestible nutrients. The cows did the harvesting; whereas if either alfalfa or corn had been produced there would have been expense for harvesting. In addition, if the 3,496 pounds of total digestible nutrients had been produced as corn, there would be additional ex-

pense for soil preparation, planting, and cultivation each year that corn is produced. The herbage established in these plots should last for several years without land preparation and reseeded.

Plots B and C produced 2,883 pounds of hay per acre plus 2,359 pounds of total digestible nutrients per acre. The combined yield from hay and grazing was 3,806 pounds of total digestible nutrients per acre. This was 304 pounds more total digestible nutrients per acre than was obtained from plots A and D from the grazing alone.

The cows consumed grain at the rate of approximately one pound to each 4.7 pounds of milk produced. They were also fed hay ad libitum when brought to the barn to be milked. On all plots the cows obtained approximately 65% of their total nutritive requirements from the grazing. The remaining 35% of the requirements was supplied by the hay and grain.

Plots A and D produced milk at the rate of 7,947 pounds per acre, which has a gross market value as Class 1 milk of \$349.33. If market values for the hay and the grain fed to the cows, and the actual cost of hauling the milk from the farm to the milk plant are deducted, the net return per acre was \$281.40. Plots B and C produced milk at the rate of 5,619 pounds per acre in addition to the 2,883 pounds of hay that was produced per acre. The market value of the milk plus \$30 per ton for the hay amounts to \$306.60 per acre. If the value of the hay and grain consumed by the cows and the cost of hauling the milk are deducted, the net return per acre was \$257.86.

The total rainfall during the 1950 summer grazing season, April through October, was a little more than two inches below normal, but distribution was such that the season was considered better than average. Another favorable factor was temperatures which averaged from two to four degrees below normal during the months of June, July, August, and September.

The first year's results from this experiment indicates that high yields per acre of animal feed can be obtained from pastures on ordinary land when proper fertility additions are made and good seeding mixtures are used.

Cool Weather Grazing

The three-acre plot of alta fescue (8B) which was seeded September 29, 1947, was grazed by producing cows during the 1949-50 winter season. During the previous year (1948-49) it was grazed for a period of 65 days starting February 25, 1949 and continuing through April. During this 65-day period, grazing supplied 1,032 pounds of total digestible nutrients or the equivalent of 2,064 pounds of alfalfa hay. By June 1, there was sufficient growth to warrant additional grazing. Grazing started June 1 and continued for 50 days, through July 20. During this period, calculated total digestible nutrients were supplied at the rate of 535 pounds per acre, or the equivalent of 1,070 pounds of alfalfa hay per acre. During the actual time the cows grazed, they ob-

tained 11.1% of their total digestible nutrient requirements in February, 1949; 53.3% in March; 78.1% in April; 67% in June; and 75.3% in July.

There was no further grazing on this plot until grazing was started again on November 16, 1949, when grazing ran 48 days, through January 2. Grazing was supplemented by hay and grain. By January, the grazing had become short and the cows were consuming enough hay and grain to meet all of their nutritive requirements. During November and December the grazing supplied total digestible nutrients at the rate of 269 pounds per acre or the equivalent of 538 pounds of alfalfa hay.

Due to favorable weather conditions, it was felt that sufficient growth had been obtained to justify starting grazing again on February 21, 1950. This time grazing was continued through May 31. During this 100-day period, the calculated total digestible nutrients amounted to 624 pounds per acre. The 1949-50 winter and early spring grazing furnished a total of 893 pounds of total digestible nutrients per acre or the equivalent of 1786 pounds of alfalfa hay. During the actual time the cows grazed, they obtained 8% of their total digestible nutrient requirements in November; 47.8% in December; 9.8% in February, 1950; 25.2% in March; 68.6% in April; and 75.7% in May.

In order to make additional studies of fescue in combination with clovers, a 12-acre field was divided into 6-acre plots (13A and 13B). Both plots were seeded August 26, 1949. Plot 13A was seeded to Kentucky 31 fescue and ladino clover. Plot 13B was seeded to fescue and hard seeded crimson clover. Satisfactory stands of fescue and clover were obtained in both plots. The soil in this field is Talbott silt loam, eroded phases, and Hagerstown silt loam. The soil survey classified the land in the field as including Class 1, 2, and 3 soils. Fertility additions to both plots previous to seeding included 84 pounds 4-8-8, 167 pounds 20% superphosphate, 84 pounds 50% potash, 25 pounds borax, and 1.67 tons lime per acre. Not much manure was applied for two or three years previously, but available records indicate that approximately 50 tons of manure per acre had been applied over a period of 20 years.

The fescue and ladino clover in plot 13A did not make sufficient growth to warrant the starting of grazing with producing cows until February 21, 1950. The grazing was continued until May 31. During this 100-day grazing period, calculated total digestible nutrients were supplied by grazing at the rate of 630 pounds per acre, or the equivalent of 1,260 pounds of alfalfa hay. Grazing supplied 10.8% of the total digestible nutrient requirements of the cows in February; 28.9% in March; 72.3% in April; and 72.2% in May.

Grazing was started on plot 13B, which was seeded to fescue and hard seeded crimson clover, on November 18, 1949. There was a good stand of crimson clover, which retarded the growth of fescue, and the grazing was virtually all supplied by the crimson clover.

Grazing was continued until anuary 2, 1950, at which time the grazing was short and the cows were consuming enough hay and grain to meet their total digestible nutrient requirements. Grazing was resumed February 21 and continued through May 10 when the clover became too mature for further grazing. There was enough seed produced, it was assumed, to furnish plenty of seed for volunteer reseeding of this hard seeded clover.

The grazing from plot 13B supplied total digestible nutrients at the rate of 1,377 pounds per acre, or the equivalent of 2,754 pounds of alfalfa hay. The cows obtained 29.6% of their total digestible nutrient requirements from the grazing in November; 47.4% in December; none in January; 45.6% in February; 44.7% in March; 70.1% in April; and 79.6% in May.

Weather during the 1949-50 winter grazing seasons is worthy of note. During both winter seasons the temperatures were from 2.5 to 10.3 degrees above normal during the months of December, January, and February.

Tall Fescue

A limited number of experiments with the grazing of tall fescue by producing cows have been conducted. Results and observations are as follows:

A mixture of white clover and Kentucky 31 fescue produced 17.2 percent less summer grazing, April through September, than a mixture of orchard grass and white clover.

The fescue-clover mixture produced less pasture during the warmer summer months than the orchard grass-ladino clover mixture.

Fescue is less palatable than orchard grass. When cattle were allowed the freedom of two adjoining fields, one containing fescue and white clover and the other orchard grass and white clover, April through October, practically all of their grazing was on the orchard grass; in fact the cows grazed the orchard grass-white clover shorter than desirable. Cows declined rapidly in milk production after being moved November 1 from a pasture containing orchard grass, ladino clover, and alfalfa to pastures containing fescue. Other producing cows did not decline in production when moved November 1 to pasture containing winter oats and crimson clover.

Efforts to keep clovers growing with fescue have produced unsatisfactory results. When the fescue was allowed to accumulate growth for fall and winter grazing, it tended to cover the ground and smother white clover. Seedings of reseeding or hard seeded crimson clover with seedings of fescue have not produced satisfactory volunteer stands the second year.

GRASS SILAGE

Eighty-seven tons of grass silage was made from first cutting alfalfa-orchard grass during rainy weather which would have made it almost impossible to secure a satisfactory quality of field cured hay. The silage material usually was raked with a side delivery rake within one hour after being cut and was picked up from wind-rows with a field ensilage harvester within one to three or four hours after being cut. This method of handling allowed some wilting and produced an excellent quality of grass silage with no amendments.

One hundred forty-eight tons of a mixture of sweet sudan and Vol State soybeans was made into excellent silage. The sudan and soybeans were grown following sorghum the preceding year for the purpose of smothering Bermuda grass on creek bottom land. Practically all of the Bermuda was destroyed during the two years.

LESPEDEZA HAY FEEDING EXPERIMENT

The lespedeza hay feeding experiment was repeated during the winter of 1949-50. A comparison was made between U. S. No. 2 lespedeza hay and U. S. Sample Grade lespedeza hay by feeding it to producing milk cows. The double reversal method was used with two groups, each containing eight cows. The feeding period was 150 days.

The quality of the lespedeza in both grades of hay was about the same. The Sample Grade hay graded lower than No. 2 hay because of the higher percentage of foreign material, mostly weeds and small grain stubble.

The cows consumed grain at the approximate rate of one pound for each 3.8 pounds of 4% at corrected milk when both grades of hay were fed. It required 1,321 pounds of the No. 2 hay and 1,668 pounds of the Sample Grade hay to produce 1,000 pounds of milk (4% F.C.). On this basis, if the No. 2 hay is worth \$30 per ton, the Sample Grade would be worth \$23.80.

DAIRY CATTLE BREEDING

At the end of December, 1950, there were 146 registered Jersey females in the herd. This number included 64 cows in milk, 10 dry cows, and 72 heifers.

During the year, 16 cows, which were mostly first calf, 2-year-old heifers, completed Register of Merit records which averaged 8,821 pounds of milk and 484 pounds of fat in 305 days, two-time milking, when calculated to mature equivalents.

The five-year-old bull Sena-Soph Sophi-Tid 45793 was brought to the Station in May, 1950. The daughters and dams were tested at the Coastal Plains Experiment Station, Willard, North Carolina.

On a 305-day, two-time, mature equivalent basis, his first ten daughters and their dams have records as follows:

Daughters, 10,173 pounds milk, 5.16%, 525 pounds fat,

Dams, 8,881 pounds milk, 5.86%, 521 pounds fat.

Two other proved bulls are in service in the herd. The bull Sir G.G.G. Goldie Son Six Tribe 414709 now has 25 daughters in the herd. His first eight tested daughters and their tested dams have records, 305 days, two-time milking, calculated to mature equivalents, as follows:

8 Daughters, 9,300 pounds milk, 5.48%, 510 pounds fat,

8 Dams, 8,748 pounds milk, 5.26%, 462 pounds fat.

The bull Twi-Owl Twi-Senator Sophie J. 426769 has 39 daughters in the herd. His first 19 tested daughters and their tested dams have records as follows:

19 Daughters, 9,034 pounds milk, 5.32%, 479 pounds fat,

19 Dams, 8,185 pounds milk, 5.23%, 429 pounds fat.

The young unproved bull, Highfield Wondrous Sultan 508086, has six daughters in the herd. He is being bred to heifers.

In addition to the above bulls, use is being made by artificial insemination of several of the bulls in the stud of the Tennessee Artificial Breeding Association.

ENTOMOLOGY

Toxaphene Dusts Control Cotton Insects

Well timed applications of 20 percent toxaphene dusts on cotton showed over 300 percent increase in seed cotton by controlling the insect pests, particularly the boll weevil. The experiments were conducted with the cooperation of E. T. Adams near Lawrenceburg.

The experiment included three dust treatments and an undusted area as follows: treatment No. 1, early dusting starting May 25; treatment No. 2, midseason dusting starting July 10; treatment No. 3, late season dusting starting July 25. The last application for all treatments was August 23. The insecticide, toxaphene, was applied as a dust at intervals of about a week, at the average of 13 pounds per acre. The material cost $13\frac{1}{2}$ cents per pound, and labor costs were 50 cents per acre for each application.

The almost total loss of crop from cotton that was not dusted was due to a severe infestation of boll weevil. The value of early dusting is shown by comparing the yields of treatment No. 1 with treatment No. 2 (midseason dusting) which started July 10, which normally will give enough time, with good control of insects, to make a crop. Early dusting controls thrip, tarnished plant bug, flea beetle, and other minor insects and thus gives the cotton a much better start. Cotton which grows off well will set a bottom crop from which the net return is usually greater. Yields of the dusting experiment are summarized:

14 applications, treatment 1, yielded	1158	pounds	seed	cotton	per	acre.
8 " " 2 "	798	"	"	"	"	"
6 " " 3 "	556	"	"	"	"	"
No application, " 4 "	265	"	"	"	"	"

The cotton that was dusted 14 times produced nearly a bale per acre. This is a good return on the cost of \$32 per acre for the dusting.

Woolly Apple Aphid Can Be Controlled With BHC or Chlordane

The woolly apple aphid is a pest of long standing. Tests started two years ago have been completed with promising results. The insect infests all parts of the apple tree but is most injurious on the roots. The infested roots swell abnormally, often like galls, and in many cases the knotted roots decay. Even though tree roots may not be injured, any sign of woolly apple aphids is sufficient in many cases to cause the tree to be discarded. In some years the loss may go as high as 80% of 2-year-old nursery stock.

Exploratory tests in 1949 showed that young apple trees would tolerate rather large doses of chlordane, benzene hexachloride (tech.), parathion, aldrin, and dichloroethyl ether when applied to the soil, in and around the growing roots. No harmful effects from large doses could be detected. Root infestations were gradually killed by chlordane and benzene hexachloride. Parathion and aldrin gave poor results. Dichloroethyl ether, 1%, was used only in one test with good results.

Tests starting with calloused grafts and continued through two growing seasons showed that benzene hexachloride and chlordane gave very good results when applied in the furrow before planting the grafts. Good results were obtained with two pounds of technical gamma benzene hexachloride and six pounds of chlordane per acre. These rates gave 94% clean trees, while trees not treated were only 59% clean. Heavier rates did not give appreciably better control. Trees growing in the treated soil appeared to be normal, showing no ill effects.

Tests starting with one-year-old apple grafts, which were dug after one season's growth, showed that benzene hexachloride, chlordane, and aldrin when applied to the top of the soil around the base of the trees gave good results. Three applications were made, two weeks apart, starting in late April before black-winged aphids appeared in clusters on elm trees. It appears that one pound per acre of technical gamma benzene hexachloride, or one pound aldrin, or 2½ pounds chlordane per treatment, will be profitable. Aerial colonies should be destroyed when observed.

Tomato Fruit Worm Injury Reduced By DDT

The corn earworm, also known as the tomato fruit worm, was kept in check by a dust of 3 percent DDT. Foliage injury with DDT on tomatoes was reported in other states, but under Tennessee con-

ditions no injury or reduction in yield could be detected from either a 3 percent or 10 percent dust. For best results, two or three applications are advised, a week apart, beginning when the first fruits begin to set.

Vegetable Weevil In Tennessee

The vegetable weevil was found in tobacco beds in Knox County in 1949. In 1950 the insect was reported from the following counties: Knox, Roane, Loudon, Monroe, Meigs, Rhea, and Sumner. Injury was found in the plant bed on newly-set plants. Preliminary tests indicate that a dust of 20% toxaphene is effective.

European Corn Borer

The European corn borer has been found in Tennessee since about 1943. It was first discovered in Middle Tennessee, close to the Kentucky state line. In 1948 it was found in several counties in East Tennessee and it had also spread in Middle Tennessee. In 1949 the infested area was enlarged and by 1950 reports indicate that the insect is probably in every county of the State, with the possible exception of the southern counties in West Tennessee.

Although the pest has been known to be present in the State for at least seven years, no commercial damage was reported until 1950. In Robertson County the European corn borer attacked a late-planted field and severely damaged the stand. In the fall, several reports were received indicating injury by the borer. In Monroe County a field was examined on October 10, and was found to be heavily infested. It was not unusual to find four or five borers in each stalk. In the corn belt the pest is controlled, especially in seed and canning corn, by use of 5 percent DDT or ryania. Observance of planting dates usually give effective control for field corn.

TESTS WITH SODIUM FLUOSILICATE AS AN ACIDULATING AGENT FOR CERTAIN WATER- SOLUBLE ORGANIC INSECTICIDES

Certain water-soluble organic insecticides are now used as herbicides and for dormant spraying in the control of insects. These include sodium dinitro-ortho cresylate and the triethanolamine salt of dinitro-o-sec-butyl phenol. Since these materials are water soluble, they are more easily applied than the parent materials which are oil soluble and must be emulsified for use.

Preliminary tests show that the oil-soluble forms are more toxic because they penetrate the waxy cuticle of the insects more readily. However, it is possible to obtain parent materials by acidulating the water-soluble forms, and forming a finely divided suspension in water. Sodium fluosilicate has a very high potential acidity as shown in the following reaction with sodium hydroxide:



According to the above equation, one pound of sodium fluosilicate will neutralize nearly one pound of sodium hydroxide. Sodium fluosilicate is an acid salt, having a solubility of one gram in 154 cc. of water at 17.5° C. A saturated solution shows a pH of 3.6.

Several organic compounds were acidulated with sodium fluosilicate and tested on mosquito larvae as test organism for toxicity.

DN 289 in a concentration of 1-1,000 produced a kill of 80 percent in 24 hours, whereas the addition of sodium fluosilicate 1-4,000 showed 100 percent mortality in 13 minutes. Striking increases in mortality were also produced when sodium fluosilicate was added to sodium pentachlorophenate, sodium trichloroacetate, and sodium dinitro-ortho-cresylate. A change in pH can produce most unusual results. For example, 50 mg. of dinitro-ortho-cresol was added to 200 cc. of distilled water with a pH of 6.8. This 1-4,000 solution produced 100 percent mortality in 30 minutes, whereas the same concentration in tap water with a pH of 7.4 was non-toxic even after 6 days.

Using harlequin bugs as a test organism, a 1-3,000 solution of DN 289 acidified with sodium fluosilicate produced a kill in three minutes when they were immersed for three minutes. DN 289 alone was non-toxic.

Equally striking results were produced when these materials were tested as herbicides on crabgrass and other types of foliage. In all cases the addition of sodium fluosilicate produced much more burning. DN 289 is now being introduced as a pre-emergence spray in the control of weeds. A small-scale test with H-1042 (a formulation of sodium pentachlorophenate obtained from the Dow Chemical Company), and sodium fluosilicate when used as a pre-emergence spray gave good control of weeds even when used at one-third the recommended dilution. The resulting precipitate should have an advantage in case of heavy rains that would tend to leach out the more soluble forms. The same should be true when these materials are used in dormant spraying.

HOME ECONOMICS*

HOME MANAGEMENT

Family Food Consumption in Three Types of Farming Areas in the South

This is a regional project in which the home-produced food supply and the quality of the diet consumed by families living in three types of farming areas were studied cooperatively by the Agricultural Experiment Stations of Arkansas, Mississippi, South Carolina, Virginia, and Tennessee; the Bureau of Human Nutrition

*Staff members of the College of Home Economics cooperated with Experiment Station personnel in many of the project activities reported in this Section.

and Home Economics of the United States Department of Agriculture; and the North Carolina Institute of Statistics.

For each of the specialized farming areas, the Delta Cotton and the Flue-Cured Tobacco areas, the sample was drawn from two states. For a sample of generalized farming in the Mountain area, only one state, Tennessee, was used. The four counties selected for this study were Cocke, Hancock, Johnson, and Unicoi. Regional reports are being completed.

The importance of a well-balanced, home-produced food supply to families in the generalized farming area is evident from the data supplied by 122 East Tennessee farm families. For the year 1947, the average value of the home-produced food supply, calculated in farmers' prices, was \$777 per family. The average amount spent for food used at home, for meals eaten away from home, and for snacks was \$357, less than half the average value of the home-produced food supply. About seventy percent of the value of the home-produced food supply at each income level was derived from milk and milk products, meat and meat products, poultry and eggs.

The farm tenure of the family seemed to have little effect on the value of the home-produced food supply. For owners, the average value was approximately \$800 per family; for tenants and sharecroppers, about \$700 per family.

The nutritive value of the diet was calculated from detailed records of the food used by these farm families for one week in the late winter, or early spring of 1948. Each of the 122 Tennessee families kept a weighted account of all food brought into the kitchen for family use. Ninety-five percent or more of the diets met the calorie, protein, riboflavin, iron, and thiamine requirements for good health according to National Research Council standards. Generous use of home-produced foods played an important part in supplying these nutrients. Diets of one-third of the families were inadequate as sources of vitamin A and ascorbic acid or vitamin C. The use of small amounts of green, leafy, and yellow vegetables, citrus fruits or canned tomatoes during the week of the study largely accounts for these deficiencies.

The first regional report on this study is entitled "Family Food Consumption in Three Types of Farming Areas of the South; I. An Analysis of 1947 Food Data." The second report on the nutritive value of the diets is in preparation and publication in 1951 is anticipated.

HOUSING

Household Activities, Facilities and Family Preferences in Selected Areas of the South

Housing needs and preferences of Southern farm families were studied for the purpose of obtaining information from families themselves as a guide to the development of better farm house plans.

What kinds of activities are carried on in the farm home today? What is the size or scope of each activity? What facilities are used, and what equipment is owned by the family? What is the preferred location for carrying on a particular activity? Answers to these questions were obtained from 1,507 farm-owner families living in six sub-regions of the South delineated by climate, topography, and soil.

The Agricultural Experiment Stations of Alabama, Arkansas, Mississippi, Georgia, South Carolina, Virginia, and Tennessee cooperated with the Bureau of Human Nutrition and Home Economics of the United States Department of Agriculture; and the North Carolina Institute of Statistics in obtaining these data.

Two hundred and fifty-nine Tennessee families contributed information in two of the six sub-regions studied. The Mountain sample included Coffee, Fentress, Hawkins, Knox, Macon, Meigs, Sevier, Sullivan, and Washington counties. The Interior Plain sample consisted of Bedford, Davidson, Lincoln, and Smith counties.

The data have been tabulated and analyzed on a regional and sub-regional basis. A preliminary report has been made available to architects and leaders in the Farm Housing program. Publication of the regional report is expected in 1951.

Information obtained in this study will serve as a basis for future research planned by home economists and agricultural engineers to determine space and structural requirements of good farm houses. Such experimental work is already taking shape at the University of Tennessee.

Functional Requirements for Activities and Facilities for Southern Rural Homes

Tennessee is one of five states in the Southern region cooperating in laboratory studies of functional space requirements for Southern rural homes, which is the second phase of the Southern Regional Housing Project, activated in July, 1950. Tennessee and Georgia are to study the dining and work areas. Tennessee is investigating space requirements for meal preparation and service.

A temporary building is being used as a laboratory. The housing laboratory proper is 19' x 22' with office and storage space adjoining. Meal preparation and dining areas will be set up within the laboratory, using movable panels as walls. These panels will permit experimentation with different-size areas. Storage units with movable shelves and provision for alteration of counter heights are planned. Data from sub-project I are being used as bases to determine the type and quantity of equipment and furnishings used for meal preparation and service by Southern rural families of different socio-economic levels and different household sizes. Meals will be prepared and served in order to test the estimates of the floor, counter, and storage space needed to carry on these activities.

Rural Family Spending Ways

Facts and figures on how a sampling of Tennessee farm families live and use their income were collected in 1950 from 340 families living in 23 different counties. Data were collected from farm families of similar composition living in Blount, Carter, Claiborne, Decatur, DeKalb, Franklin, Gibson, Greene, Hawkins, Haywood, Henderson, Hickman, Lawrence, Knox, McMinn, Morgan, Obion, Overton, Rhea, Rutherford, Shelby, Stewart, and Sumner counties. The figures should give a good over-all picture of the level of living experienced and of the consumption patterns of farm families in Tennessee. Analysis of the data is in progress.

TEXTILES AND CLOTHING

Serviceability of Tennessee Cotton in Consumer Fabrics

The study of Tennessee cotton, started in 1949, has been continued. Objectives of the study are to determine what differences there are between varieties in fiber, yarn, and fabric properties and whether any significant relationships exist among these properties. If a correlation could be found between fiber properties, spinning performances, and fabric properties, the task of developing varieties most suitable for consumer use could be greatly simplified.

Varieties of cotton selected for this study were Delta Pine 15, Stoneville 2B, and Tennessee 241. These were chosen because they represent some of the more popular varieties grown in the state.

After testing the fiber, (Figure 21) the cotton was sent to the government cotton laboratory at Clemson, South Carolina, where the lint was spun into three different yarn sizes. The government laboratory also wove a narrow fabric (12 inches) with a weight of about 5.2 ounces per square yard.

The fabric seemed most suitable for dish towels. Therefore, it was made into towels which were subjected to serviceability studies. The thickness, strength, elongation, weight loss after abrasion, and weight per square yard of the towels were determined after 15-, 25-, and 40-week periods of use. The strength and elongation of yarns removed from these towels were also determined. These results were compared with those of control samples.

Judging from the results of this laboratory fiber study, Stoneville 2B, grown near Rossville, was superior in breaking strength, length of staple, and fineness. Analysis of yarns revealed that the breaking strength in the single strand was also greater for Stoneville 2B. Research shows that variations in yarn strength of different cotton varieties grown under the same conditions are slightly dependent upon differences in fiber length and fiber strength.

In testing the towels, it was indicated that loss in thickness and in weight was caused by wear and abrasion of the fabric during use and bleaching. The control samples had lost more weight after

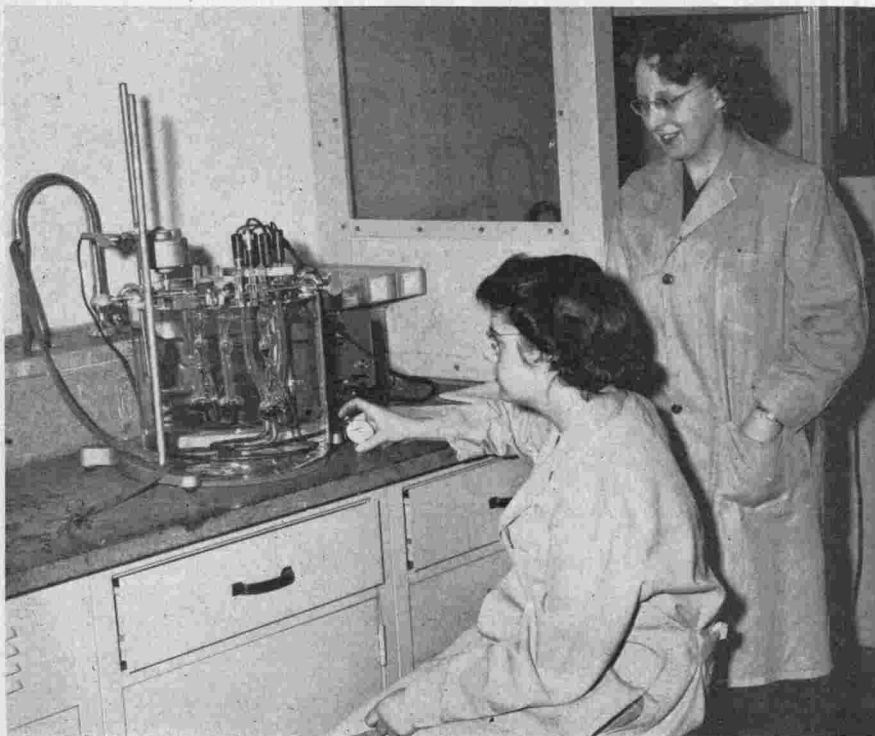


Figure 21—Checking the viscosity of cotton in solution in cupriethylene diamine.

25 washings than had the towels that were in use. These results would tend to show that the main abrasive forces are those which occur during washing, drying, and ironing.

The differences between the thickness of the towels woven from different varieties of cotton were much smaller than the average operator error in using a thickness gauge. Likewise, the losses in weight all seem to be about the same for the different varieties, except for the towels made from Delta Pine 15, grown at Memphis, after 25 washes; and for the towels made from Stoneville 2B after 40 washes. These towels appear to be showing an excessive loss in weight.

All of the towels decreased greatly in breaking strength after 15 washes, but did not lose strength between the 15th and the 25th washes. However, there was a radical decrease in strength between the 25th and 40th washes with some of the strengths falling nearly to the point of failure.

In this study the yarn strengths and elongations have been found to be more reliable indications of fabric deterioration than the fabric strength. This would be expected since the bonding action present in the fabrics is not present in the yarns. However,

enough samples must be tested for yarn strength to lower the high coefficient of variation which at present has an average of about 15 percent.

In general, when the cotton was spun and woven into dish towels, the two varieties, Stoneville 2B and Delta Pine 15, gave slightly better serviceability results in all tests. It may be that Delta Pine's greater maturity, as reported in 1949, accounts for its good showing in serviceability tests although its fiber and yarn properties were not as good as those of the Stoneville 2B.

In most cases the variation in test results within a variety was as great as or greater than that between varieties. This wide variation makes determination of the best variety difficult unless enough tests are run to give a statistically valid average and it also increases the difficulty of finding valid correlations between fiber, yarn, and fabric properties. Figure 21 shows the apparatus for checking the viscosity of cotton in solution in cupriethylene diamine.

Plans are being carried out for the expansion of this research. The study will be based on larger quantities of the same three varieties of cotton now being investigated. Such fabrics as chambray, pique, or madras will be woven from which articles of clothing will be made if funds permit. The clothing will be used for serviceability testing.

The fiber, yarn, and fabric tests on the 1950 cotton crop will be set up in such a way that valid statistical correlations and analyses of the variance may be made relating fiber properties to those of yarns and fabrics.

Consumer Preferences in Selected Clothing Items

Following completion of the first pilot study or pre-test on the study of consumer preferences in selected clothing items in December, 1949, all schedules were revised and conferences were held in Washington with staff members in the Bureau of Agricultural Economics and the Bureau of Human Nutrition and Home Economics.

The suggestion was made that the number of items to be included in the study should be reduced from the original 14 to not more than five or six. The number of articles reduced to six includes blouses, coats, dresses (silk, wool, rayon), hose, shoes, and slips.

Plans were made for the second pre-test and for a pilot study which will be carried on in Knoxville with a representative group of people. The information collected from this pilot study will be analyzed and necessary revisions will be made before proceeding with a larger study.

The second pre-test was completed and a pilot study is now under way. Approximately 60 women are participating. Rural and urban homemakers, some of whom are employed, are included. Records of all purchases of the six items are kept up-to-date and

reactions to satisfaction or dissatisfaction are noted. This information is collected at the end of each six-week period. Trends in buying seem to be showing up and specific reasons for dissatisfaction will be valuable.

Upon completion of the present pilot study and the analysis of information gained, revisions will be made preparatory to a more extensive study.

FOODS

Precooked and Ready-to-Cook Frozen Food Products

Research has been continued toward determining the best procedures for handling pre-cooked and ready-to-cook food products for home freezing. Emphasis has been placed on the use of hard-wheat and soft-wheat flours in frozen yeast doughs, and in comparing the suitability of different types of baking powder for frozen quick breads. Some of the tests on fruit pies, butter-type cakes, and sponge-type cakes have been repeated.

Yeast doughs—The work on yeast doughs sought to determine whether fermentative activity decreases during freezer storage and the possible relationship of this factor to the quality of rolls baked from frozen doughs. The fermentative activity of each batch of freshly prepared dough was measured by means of pressuremeters at the time the dough was placed in freezer storage. Each dough was again tested for fermentative activity after periods of one, two, four, six, and eight weeks of freezer storage. At each test period, rolls were made from these frozen doughs and the quality was rated by a panel of five experienced judges. Comparisons were made of the effects of freezing fermented and nonfermented dough; of thawing at room and refrigerator temperatures; and, of shaping the dough before and after freezing.

Of the factors studied, the one which had the greatest effect on quality was the stage at which the dough was shaped. Rolls shaped after the frozen dough had thawed produced good products, indistinguishable from freshly made rolls. Dough which was shaped before being frozen produced poor quality rolls of lesser volume. Other findings were: (1) no measureable decrease in fermentative activity in hard-wheat doughs; (2) erratic behavior in soft-wheat doughs, with marked increases in fermentative activity after some intervals of freezer storage and slight decreases at other times; (3) no improvement in quality due to fermentation before freezing; (4) little difference in quality of rolls thawed at room temperature and those thawed at refrigerator temperature before shaping; and (5) consistently better quality products from hard-wheat doughs under all conditions.

Quick breads—Muffins were used as the test product to study the effect of freezing on the leavening action of batters made with three types of baking powder: phosphate, tartrate, and combination

sulphate-phosphate. The carbon-dioxide content of each muffin batter was measured in a Chittick apparatus, both before and after periods of freezer storage. At the same time, palatability tests were made on muffins containing each type of baking powder. Volumes of the muffins were measured by means of seed displacement and changes in volume were compared to changes in the carbon dioxide content of the batters at each test period.

The results indicated that there was little difference in the quality of the muffins made with the different types of baking powder when they were baked before freezing. However, there was considerable difference in the quality of the muffins containing different types of baking powder when they were baked from frozen batters.

Muffins made with sulphate-phosphate powder showed only slight decreases in volume as compared to those baked before freezing, while there were marked decreases in the volume of muffins containing either tartrate or phosphate powder. Muffins containing tartrate or phosphate powder were also more tunneled and soggy and less tender than those containing sulphate-phosphate

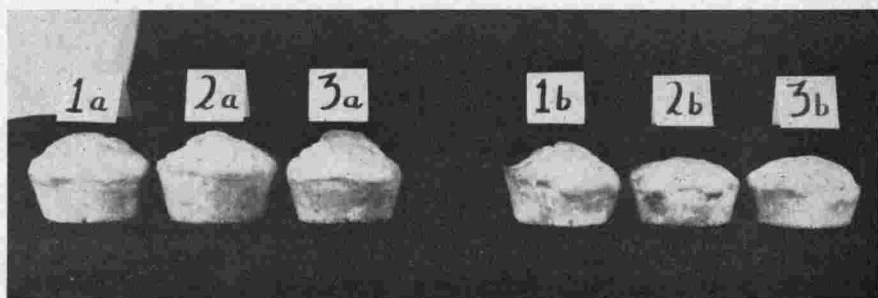


Figure 22—External characteristics of muffins after two weeks of freezer storage. The "a" series muffins (left) were baked before freezing, containing: 1, sulfate-phosphate baking powder; 2, phosphate baking powder; 3, tartrate baking powder. The three muffins in the "b" series were baked from frozen batters containing: 1, sulfate-phosphate baking powder; 2, phosphate baking powder; 3, tartrate baking powder.

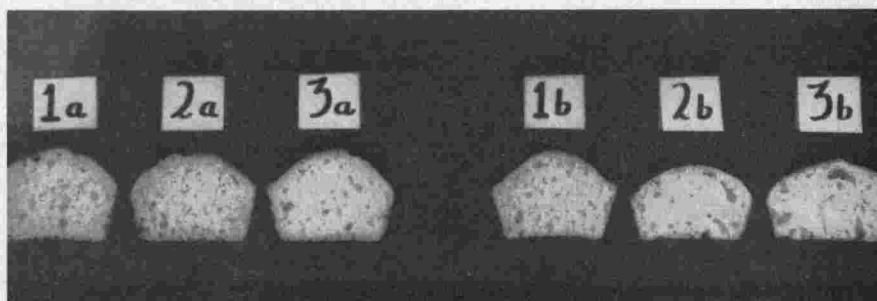


Figure 23—Internal characteristics of muffins after two weeks of freezer storage. The three in the "a" series (left) were baked before freezing, containing: 1, sulfate-phosphate baking powder; 2, phosphate baking powder; 3, tartrate baking powder. Those in the "b" series (right) were baked from frozen batters containing: 1, sulfate-phosphate baking powder; 2, phosphate baking powder; 3, tartrate baking powder.

powder and frozen in the batter state. Some of these differences may be noted in Figures 22 and 23. The carbon dioxide content of all batters was lower after freezing, the decreases being slightly greater with the phosphate and tartrate types of baking powder. There was a direct relationship between the percent loss of carbon dioxide and the percent decrease in volume of muffins baked from frozen batters containing sulfate-phosphate baking powder. With phosphate or tartrate baking powders, however, the muffin volume decreases were greater than the percent losses of carbon dioxide from the frozen batters.

NUTRITION

Calcium Metabolism

Recently a special Food and Nutrition Advisory Committee to the U. S. Department of Agriculture and the Food and Nutrition Board of the National Research Council recommended that research on human nutritional requirements and the interrelationships of nutrients in metabolism be intensified. The research being done here should help in filling some of the gaps in our knowledge of requirements and interrelationships.

Except for time-consuming balance studies, in which analyses for the intake and the outgo of the mineral are made, no suitable method has been found for determining the status of individuals in respect to calcium. A reliable method is needed for use in mass nutrition studies to discover how wide-spread calcium deficiency is in different population groups and to follow the course of therapeutic changes in dietaries. Since bones are the storage place for calcium in the body, development of a method for evaluation of calcium levels in bones should be valuable in the assessment of calcium nutrition in humans.

With the cooperation of the University Hospital and the Physics Department, the Nutrition Department has continued its calcium studies. During 1950, seven college women served as subjects for the study. Three had a history of low milk consumption, one of moderate, and three of good use of milk. The self-chosen diets of the subjects were supplemented with one to four cups of milk daily over a period of three months. Balance studies were carried out just prior to, and at the end of, the period of supplementation to determine the utilization of calcium, phosphorus, nitrogen, and riboflavin supplied by a weighed diet typical of the self-chosen diets of the subjects. X-rays of the heel bone of each subject were made at the beginning, middle point, and end of the period of milk supplementation. The X-rays are being analyzed.

Beginning in the fall of 1950, the emphasis in the experiments has been changed somewhat in order to obtain results which will be useful in the consideration of an adequate dietary for a person suffering from a milk allergy. Five women of college age were first

kept on a diet from which all milk was excluded. Such a diet has a low calcium content, and the subjects receiving it were in negative calcium balance. Calcium phosphate and riboflavin equivalent to the calcium and riboflavin in three cups of milk have now been added to the low-calcium diet. Later, the mineral supplement and riboflavin will be replaced by milk. The utilization of calcium in calcium phosphate can then be compared with the utilization of that in milk. Balance experiments and bone density measurements are being made at appropriate intervals. Phosphorus, nitrogen, riboflavin, vitamin A, and carotene, as well as calcium, are determined in the food and excreta in order to study interrelations of these elements in calcium metabolism.

While carrying on the experiments with humans, studies were also undertaken on rats receiving different amounts of calcium. X-rays were made of the vertebrae of the rats, then the animals were killed and analyzed for calcium. Chemical analyses showed increased storage of calcium with increased intake. Bone density measurements have been made from one set of X-rays at Pennsylvania State College. The results show increased bone density with increased calcium intake in conformity with the chemical analyses. These results appear to indicate that progress may be faster in the study of bone density measurement as a criterion for calcium status when experimental animals are used along with human subjects than if human experimentation alone is used.

HORTICULTURE

The Department of Horticulture has three primary objectives. It attempts to provide those dealing with horticultural crops with new information concerning the choice of varieties of vegetables and fruits for Tennessee. It attempts to provide information on improved practices in crop production, and it attempts to develop new varieties of fruits and vegetables useful in various sections of the State.

With these objects in mind, the Horticulture Department is carrying on projects at three places in the State dealing with vegetable and fruit varieties; at three places in the State with production practices on vegetable and small fruits; and at two places in the State with production practices for tree fruits. It is carrying on breeding programs with pears at Knoxville, small fruits at Knoxville and Jackson, beans at Dandridge, and tomatoes at Jackson. Present personnel is working with crops of most importance to the State.

TREE FRUITS

Projects on peach varieties are in progress at Knoxville, Jackson and the Highland Rim Station; and projects on apple varieties at the Plateau Station and at Knoxville. The pear variety studies

are carried as a part of the breeding project on fireblight resistance, and there are pear varieties at Knoxville, the Highland Rim Station, at the old Mericourt Station, and at Jackson. There are plums at Knoxville.

All of the plantings are young with the exception of the old apple and plum plantings at Knoxville, and the old pear planting at Mericourt. The year 1950 was marked by exceedingly late frosts and no fruit was harvested.

Records on the young apple orchard at Crossville showed considerable differences in the growth rate of the varieties on trial. Stayman made the greatest growth, showing a circumference of 3.22 inches, twelve inches above the ground, as compared with Melba, showing 2.11 inches.

Breeding of pears for fireblight resistance has progressed somewhat. Individuals showing great fireblight resistance have been produced. Some quality has been introduced into many parental lines. Testing of these new pears is being done at Knoxville, the Highland Rim Station, and at the West Tennessee Experiment Station. All new lines are compared with Kieffer, Garber, Waite and other pears being used in the South.

Orchard management studies were established at the Highland Rim Station, using both peaches and pears. These make use of various sod and clean cultural methods. They are set up chiefly as erosion control studies. Growth records are kept of all trees and yield records will be kept after the trees come into bearing.

SMALL FRUITS

Only one small fruit variety test as such is carried on in the Department. This is a strawberry variety test at the Plateau Experiment Station. Results indicate that Tennessee Supreme made the highest yields with 6,000 pounds per acre. Blakemore and Tennessean produced about the same with 5,000 pounds per acre. During the past two years Tennessee Beauty and Tennessee Supreme have both outyielded the standard variety, Blakemore.

Variety yield trials at the Plateau Station have been complicated by the presence of root rots, to which all varieties are apparently equally susceptible. However, the plot areas affected by the disease are of such outline that it is difficult to get an exact measure of yield.

Other strawberry variety tests are carried on as part of the strawberry breeding program. The breeding program is established at the West Tennessee Experiment Station with additional work being done at Knoxville. The outstanding event of the year was the introduction of the variety Tennessean. The excellent color, form, yielding capacity and good plant making ability of this variety should make it a valuable addition to the strawberry business. Other numbers which seem to have promise are Tennessee 393, Tennessee 846, which rank first and second in yields; and

Tennessee 862, a variety having possibilities as a frozen pack berry.

At the West Tennessee Station 18 new strawberry crosses were made which produced a total of 2,600 seedlings. These were set out in 1950 for primary selection in 1951. Results from the selection series of 1950 indicate that Tennessee Shipper x Sparkle is a good combination since it produced the largest number of good individuals. Tennessean x Blakemore made a fair combination, also. Four percent of the plants in this combination showed June yellows. At West Tennessee, yields in 1950 were closely associated with late blooming. Tennessee 1064 produced 307 crates per acre, 34 percent being harvested between May 2 and 17, compared with Blakemore, 44 percent being harvested during the same period from a 137 crate yield.

Breeding work with blackberries and black raspberries was carried on at the Knoxville Station. Fifty foreign strains of *Rubus* were tested as parents and studied for resistance to disease and fruit quality as well as plant performance. Two sorts from Africa showed resistance to anthracnose and have been used to produce some 3,000 seeds of crosses between them and American varieties of black raspberries. From the 1948 crosses, 847 seedlings were studied and 31 crosses were made from them. Selections from the breeding work of previous years will probably be sufficient in quantity for field trial. There are 1,200 seedlings of 1949 crosses ready to fruit in 1951.

The breeding of blackberries has progressed at a fairly satisfactory rate. There have been difficulties in getting good seed germination and in obtaining good parents. From the original selections five have been chosen for further trial. Of the 375 planted in 1949, 15 percent were selected for further study on the basis of yield, vine vigor and quality. Four-hundred new seedlings from controlled crosses were set in the field during the spring and should be ready for selection in 1952.

Five major groups of characters influenced the choice of parents for 1950. These are, in order of importance: resistance to orange rust; yield; and upright habit of growth; earliness; and marketable berry size. Excellent pollination was obtained with Early King on Boysenberry and Dallas, Ozark Beauty on Early King and Dallas, and Dallas on Boysenberry.

Grape variety tests are carried on at Knoxville and Crossville. At the Plateau Experiment Station records on ripening dates show that Kendaia, Van Buren, Buffalo, Fredonia, Athens and Seneca ripen between August 8 and 16. Concord, Niagara, Golden Muscat, Sheridan, Ruby, Yates, and Seibel 1,000 ripened following September 15. Additional data will be required to fix exact ripening dates because early fruiting canes were destroyed by frost in the spring.

Five cultural tests on fruits were carried on during the year with small fruits. Fertilization experiments to determine the method of treatment for new land on the Plateau were set up. Over

the past two years lime at the rate of one ton per acre increased yields when used alone or in combination with nitrogen and phosphorus. Phosphorus increases yields when used alone, but there does not seem to be any great increase from nitrogen when used alone. Growth of plants in a new setting made in 1950 following the same experimental plan indicates about the same response from fertilizer treatment.

Experiments to determine the best pre-planting rotations for strawberries are carried on at Knoxville and the Plateau Station. At Knoxville the five preceding crops were corn, soybeans, sweet potatoes, tobacco, and alfalfa. Because of an exceedingly wet spring, the alfalfa plats were fallowed for the year. At the end of the season a weed count was made showing the relative effectiveness of these treatments. It was found that corn permitted 24 weeds per 16 square feet, tobacco 12, sweet potatoes 7, and soybeans 18. No weeds were allowed to develop on the fallowed land. The weeds in corn and tobacco were greatly stunted and formed few seed heads. Weeds in sweet potatoes and soybeans were tall and produced seed. For the most part, however, the weeds in these two crops were smartweed, a crop not particularly serious in strawberries. At the Plateau Station the crops chosen were the same with the exception that red clover was used instead of alfalfa. The soybeans had to be replanted, being smothered out by weeds early in the season. Red clover was not sufficiently dense to control crabgrass, which developed almost as well as if no cover crop was present. Smartweed was a problem in this crop, too.

Chemical weed control in strawberries was done at the Knoxville Station. All plots showed decreased yields as compared with untreated plots. Syringing the plants in an effort to wash off excess weed control material residues increased rather than decreased the damage due to these materials.

Mulching experiments on strawberries were carried on at Knoxville. Up to this time sufficient cold weather has not occurred to permit a study of the value of mulching with reference to winter injury. Under the conditions of the winter of 1949-50, the later the mulch material was applied to the crop the more effective it was toward improving both quantity and quality of the crop. Plots mulched during December and January showed reduced yields as compared with later mulching and no mulching. Strawberries from mulched plots were 11 percent larger than berries from unmulched plots, and the mulched plots produced 47 percent of U. S. No. 1 berries as compared with 25 percent from the unmulched areas.

A pruning experiment designed to improve production of Boysenberries has been carried on at the West Tennessee Experiment Station for the past three years. For the year 1949-50, when all of the tops were removed following the fruiting season Boysenberries produced at the rate of 8,400 pounds of fruit per acre as compared with 1,100 pounds when only the old canes had been removed.

Over the three year period the completely pruned plots produced an average of 5,472 pounds per acre as compared to 2,513 pounds when only the old fruiting canes were removed following harvest.

VEGETABLES

Variety Tests

Tomato variety tests were carried on at Jackson, Dandridge and Knoxville. Part of these were in cooperation with the Southern Cooperative Vegetable Trials set-up. Results from the tests this year at Knoxville show Rutgers No. 2 to be the most highly productive variety in the test. Of the STEP numbers, 89, from the Vegetable Breeding Laboratory at Charleston, was nearly equally productive. Stokesdale, from the Francis Stokes Company, was also an excellent variety. The tomato producing the most early fruit was STEP 80, from the Illinois Experiment Station, which produced 21,000 pounds between June 26 and July 14. Other high yielding early varieties were STEP 135, from the Cornelli Seed Company of St. Louis, Missouri, with 19,000 pounds and STEP 89, with 16,000 pounds. The variety Stokesdale was rated best in the trial from all standpoints, although the fruit is a little small.

A cooperative variety trial was carried on with the Department of Plant Pathology in an effort to evaluate lines for horticultural value. The best yields were made by S-6-17, 7-S-34 and Reynard's F2 Selection. Results from Dandridge confirm the results on S-6-17, which was the best yielding variety in that area. Jackson reports show that Improved Bison and Early Chatham may have value for early local market.

Variety trials with beans were carried at two stations. Two individual trials were carried at Knoxville and at Crossville. The Southern Cooperative Vegetable Trial at Knoxville indicated that Contender, from the Vegetable Breeding Laboratory at Charleston, might be a satisfactory fresh market bean. It produced a yield of 431 bushels per acre. Contender also appears to be a fair bean on the Plateau. It is hardly satisfactory as a processing bean, however. B 1643-1, which produced 386 bushels per acre, seems also promising for fresh market. As a processing bean, B 1801-7 at Knoxville, and a selection of Topcrop, 9169, at Crossville, appear to be the top ranking beans. Logan performed fairly well at Crossville, producing 445 bushels per acre. In trials at both places both Topcrop and Logan were superior in yield to Tendergreen, although the year was particularly favorable for Tendergreen production. Over a three year period, Topcrop at Crossville has outproduced Tendergreen by 30 percent.

The only test of pole beans was carried at Knoxville this year. The best two varieties were Canfreezer and Blue Lake Stringless, both with yields of 230 bushels per acre in the fall. Kentucky Wonder 191, with less than 150 bushels, was the best of this type.

Variety tests of broccoli were carried on at Knoxville and Crossville. Results from both places indicated that DeCicco was the outstanding variety. From these tests it was apparent that the early forms of broccoli are much more desirable for use under the climatic conditions at both stations than the later varieties. The difference was not quite as prominent at Knoxville as on the Plateau. The fall test at Knoxville showed DeCicco as outstandingly good. California Early was fair.

Cauliflower was grown in the fall, both at Knoxville and at Crossville. Snowball X was outstanding at Crossville, producing 18,000 pounds per acre, but was the lowest yielding variety at Knoxville, producing only 13,000 pounds per acre. The outstanding variety at Knoxville was Snowball 34.

Eleven varieties and strains of Irish Potatoes were grown at the Crossville Station. Of these Sequoia, from Prince Edward Island, made the best yield. It was excellent in quality. Two blight resistant potatoes, Essex and Kenebec, were in the trials this year. Neither produced as large a crop as did Sequoia.

Trials of head lettuce at Knoxville showed the Great Lakes strain to be superior to others. Great Lakes 9457 was the best upland variety, both in the fall and in the spring. The fall trials could not be considered successful, however.

Variety trials of sweet potatoes were carried on at Knoxville. The best yields on Sequatchie fine, sandy loam were made by Unit I Porto Rico. On Cumberland silt loam Heartogold yielded considerably better.

Cultural Studies

Work on the use of growth regulating substances to control early tomato set was carried on at Jackson. P-chlorophenoxyacetic acid produced 1,300 pounds more early fruit than did the untreated plats, but produced 721 pounds less total fruit.

A-o-chlorophenoxypropionic acid was used in an effort to control premature bolting in cabbage. Spray treatments tended to produce fewer elongated heads than did cold treatment. The rate of growth, size of plant and date of maturity were greatly retarded by the chemical.

A study of the effect of lime on the production of various vegetable crops was carried on at Jackson. Sweet potatoes on unlimed soil with a pH of 4.8 outyielded by 25 percent plots limed to pH 6.9. The unlimed plots also produced a higher percentage of U.S. No. 1 potatoes. It is suggested that sweet potatoes should not be planted on freshly limed land, and that they seem to do better on acid rather than neutral or basic soils.

A fertilizer test on sweet potatoes was carried on at Knoxville where it was found that 200 pounds of 5-10-5 had little effect on yield, regardless of spacing, between six and 12 inches. When 500 pounds of this material was applied per acre, maximum marketable

yields occurred at the six inch spacing. When 800 pounds per acre was applied a maximum market yield occurred at the 12 inch spacing. This test was on Cumberland silt loam.

A test of the effect of lime on sweet corn and peanuts at Jackson showed that neither made much response to liming even though the unlimed plots had a pH of 4.8. Anomalous results were obtained from lima beans.

Muskmelons responded markedly to liming, yielding nearly four times as much on the limed plots as on the unlimed plots.

A fertilizer test on broccoli carried on at Crossville showed that with 2,000 pounds of 4-12-4 including a boron supplement and 300 pounds of sodium nitrate as an additional side dressing, 5,136 pounds were harvested as compared with 4,087 pounds from a 1,000 pound application of a 4-12-4 with boron. Ten tons of manure with 1,000 pounds of 4-12-4 and boron did not increase yields over the 1,000 pound inorganic fertilizer treatment alone.

A careful study of the effect of minor elements on tomato production at Dandridge yielded no positive results. Indications are, however, that boron may somewhat increase yields. Zinc on the other hand seems to depress yields.

Breeding

Three primary breeding programs are under way in the Station, one with tomatoes at Jackson; one with sweet potatoes at Knoxville and Jackson; and one with beans at Dandridge.

The tomato project at Jackson produced 52 new tomato crosses this year, seeking to establish yielding ability, earliness, desirable shape, smoothness, good color, wall thickness, freedom from cracking and puffing, and foliage cover. More than 100 selections were made from fourth generation seedlings of two crosses showing promise. Thirty-five were kept from other crosses. A search for new parent material involved 103 new acquisitions. Selections were made from 28 of them. Sixty-one early tomatoes were tested, and the most promising lines selected for use in breeding.

The sweet potato work involves the selection of new lines from Porto Rico I and Nancy Hall. This work has progressed to the point where testing of apparently different lines is desirable. Every year hybrid seed is brought in from several sources, and grown to determine its adaptability to Tennessee conditions. This year 21 selections were made from such seedlings. Six were from Pelican Processor, open pollinated, and 15 from La. Code 21 O.P. Both of these lines are wilt resistant.

Eight lines of beans involving the species cross *P. lathroides* and *P. vulgaris* have been under selection for some time at Dandridge. These show resistance to rust and leaf spots.

Nursery Practice In Ornamentals

The work at Knoxville in nursery practices for ornamentals was considerably reduced this year by unfavorable spring growing

conditions. Two of the ornamentals on trial, *Hemerocallis* and *Tripterigium* continue to show promise as herbaceous perennials. There are now some 40 varieties of *Hemerocallis* on hand.

PLANT PATHOLOGY

Control of major crop diseases by Tennessee farmers is reasonably satisfactory. Nevertheless, losses are still serious from well known diseases while new troubles continually develop in the State. Research in plant disease control has followed the same trend as in the past, with the ultimate goal of finding resistant varieties. In the meantime, measures are being developed to prevent diseases taking too great a toll from existing varieties. Control of plant diseases depends largely on prevention because usually it is not possible to stop a plant disease after it has developed sufficiently to be recognized.

Many specimens were submitted to the Station during the year for identification—a very essential measure in the solution of plant disease problems. Most of these, sent in from various parts of Tennessee, either pertained to projects now under way or represented diseases for which controls are already established.

Effort has been made to round up longstanding research and to intensify efforts on critical problems, resulting in some new varieties. Considerable progress was made on basic research, and new approaches were made to old problems. New laboratory equipment will facilitate investigations. New greenhouse facilities available at Jackson will permit the production of several generations of cotton yearly, thereby hastening the development of disease-resistant varieties badly needed for Tennessee.

Cotton Verticillium Wilt—This disease, which has been known in Tennessee for 20 years, is apparently increasing; and the wet, cool season of 1950, which was favorable for the trouble, afforded a good opportunity to observe its damage. In some areas losses were serious. This wilt readily attacks the Fusarium wilt-resistant varieties. No commercial varieties are resistant to Verticillium. The main effort in control is directed towards obtaining resistant varieties, although work has been started to find the manner in which the disease spreads. Lines showing a measure of resistance have been found by testing in the seedling stage, which will save valuable time by screening in the greenhouse various lines obtained from this Station and from the U. S. D. A.

For field conditions, a plot was again seeded in Lake County where Verticillium wilt is known to be severe. One hundred twenty-five breeding lines were used and 20 commercial varieties were planted. The plot was randomized with five replications. While none showed promise of any immediate value, several showed considerable resistance to the disease. Unfortunately, high yielding, good quality varieties did not possess noticeable resistance,

but it is at least encouraging to find some resistance in some common upland cotton varieties. Selfed seed were saved from numerous individual plant selections.

From the 1950 test, about 40 lots are worthy of further testing, some of which are exceptionally promising from the standpoint of staple length, boll size, plant type, and yield.

Alfalfa and Clover Crown Rot—Emphasis now placed on forage and cover crops has resulted in wide increase in acreage of these important legumes, not only for hay and grazing, but for soil improvement. The winter of 1949-50 was unusually mild; hence these crops made rank growth, providing ideal conditions for development of crown rot. Complete eradication of newly seeded alfalfa and ladino clover was not uncommon. Most crimson clover fields showed crown rot, the characteristic appearance of which is that of dead spots in the field, usually about a foot in diameter, that enlarge rapidly and frequently coalesce. Considerable study of the disease was made and notes were taken throughout the State to observe the effect of various cultural practices. A circular was prepared giving information on this disease as related to Tennessee conditions. Grazing tests at the Greeneville Station substantiated these measures. Pasture management, however, is not regarded as the final solution. Therefore, work was expanded in the fall of 1950 to provide more definite measures for control to include pre-seeding practices, manure and fertilizer application, detailed procedures in management, and the use of fungicides applied in advance of seeding. Resistance has not been overlooked. A technique was developed to insure production of the disease, thereby assisting materially with the experiment.

From these studies it appears that sclerotia can develop during the fall, unknown to the casual observer, and lie in readiness to cause devastating results early in the spring or in warm periods of the winter. Thus control probably will be necessarily effected in the fall. Certain selective fungicides applied to the soil prior to seeding have delayed if not prevented early fall development of crown rot. This may be a means of protecting the young plants until warm spring weather, which arrests further development of the disease.

Root Diseases of Small Cereals—For many years it has been recognized that small grains in Tennessee are affected by diseases not apparent on the above-ground parts of the plant. An investigation has been in progress to determine causal factors that bring about this condition, with the ultimate goal of breeding plants resistant to this complex. It has been found that several different fungi and bacteria as well as unbalanced nutrients, bring about a rotting of the root system and crown. Various factors of environment also contribute to the complex. Laboratory methods during the past two years have demonstrated the presence of many microorganisms affecting the roots of cereals. Some have been found

consistently while others have been isolated occasionally. These studies have included material from both virgin soil and soil in which cereals have been grown continuously for several years. The same organisms occurred in each, but their prevalence is greater in the continuous wheat soil. Approximately 10 different organisms have been found associated with the diseased condition, the more common being *Fusarium* spp., *Phoma* spp., *Helminthosporium sativum*, and *Pythium*, as well as a number of unidentified organisms. Two have been found definitely pathogenic and two others possibly so. Several different strains of *Helminthosporium sativum* collected from various parts of the State are being tested for relative pathogenicity. Inoculation studies are under way to determine optimum conditions for infection by organisms found to be pathogenic. (Figure 24).



Figure 24—Effects of pathogenic fungi on barley roots grown in sterilized soil. Left, check plants. Center, inoculated with *Helminthosporium sativum*. Right, inoculated with *Pythium*.

Studies on effects of different crop rotations on the presence or absence of the disease have not been of sufficient duration to warrant definite conclusions.

Incidental to this project the prevalence of *Rhynchosporium secalis*, causing barley scald in Tennessee, has been established as a serious disease occurring during cold weather, and frequently mistaken for winter killing. Studies show that cool, humid weather favors the development of this disease. A number of strains of

the fungus have been obtained and are being employed to test resistance of different barley varieties under local conditions.

Strawberry Root Rots and Their Control—Fifty strawberry lines, several of which appear promising, are being tested for root rot resistance at least one of those highly resistant to root rot under normal conditions, e.g. 99-11, showed a greater proportion of diseased roots during the wet season of 1950 than usual, but thus far has been able to maintain excellent top growth, including multiplication. A local wild strawberry growing in its native habitat was affected with root rot. Twenty-nine new lines were developed and planted in 1950; additional material is to be obtained, especially from the U. S. D. A.

A root rot and vascular disease of Premier strawberry, confused with red stele, appeared to be caused, respectively, by *Pythium* and *Fusarium*. Similar diseases were found in another part of the State on Aberdeen, a variety immune or highly resistant to red stele. *Rhizoctonia*, possibly the same strain causing root rot, was found to be the cause of a serious leaf blight of strawberries, resulting in the death of plants.

Disease-Resistant Tomatoes—More than 100 tomato lines, including many from this Station and from the U. S. D. A., were tested in the field in 1950 for late blight resistance; and over 60 or more were tested for buckeye-rot resistance.

Late blight was prevalent in 1950, due to the abundance of cool, wet weather. *Cladosporium* mold occurred on a number of tomato lines, while ordinary leaf spots (*Alternaria* and *Stemphyllium*) were conspicuously absent on all lines.

None of the tomatoes was immune to late blight; however, three non-commercial ones possessed high resistance. Currant tomato (P. I. 12643) rated highest in resistance, remaining almost free of the disease. Several lines approaching commercial quality possessed slight foliage resistance, but no fruit rot resistance under the severe conditions of the past summer.

Jerusalem cherry (*Solanum capsicastrum*), a tomato-like relative of possible value in tomato breeding, proved immune to late blight. However, a blight, caused by the buckeye-rot fungus or related strain, was found in a commercial greenhouse. Fruit appeared to be unaffected, except for an occasional fallen fruit.

Wheat Breeding—Studies on resistance of wheat to diseases showed the various selections retained from previous work as being possibly suitable for release. These were relatively free of mildew and leaf rust. However, milling tests showed the most promising were somewhat harder than is desired. This will necessitate further breeding, plans for which have already been made.

New Fungicides—This project was revised to restrict activity to determining effectiveness of new materials in control of crop diseases in Tennessee rather than to devise new chemical combinations. The work has been definitely fruitful. Phenyl mercury acetate

and lactate gave exceedingly good control of apple scab both in East and West Tennessee. These commercial products were found particularly effective for Golden Delicious apples which are so sensitive to lime-sulfur that serious russetting and burning occurs. Hence a non-injurious substance is needed. Such compounds, however, lack residual effect and other combinations are now being tested. No information was obtained on peaches due to a total loss of the crop by freezing. Nevertheless, the Tennessee commercial spray schedule was modified and brought up to date on the basis of the fruit spraying work and studies.

A spray program for home orchards to include peaches and apples was developed and tested at the Jackson Station. The peach crop was a total loss in this case also, but control of apple diseases was excellent. With modifications this schedule is being re-tested as it has wide popular appeal to owners of small plantings and county agents.

Preliminary tests with treated mulch using a dinitro compound for strawberries at Knoxville reduced the incidence of gray mold, while five other fungicides gave no improvement over the checks. It was observed that incidental to this treatment the dinitro treated straw caused a distinct reduction in grass. At Jackson 2,4-D was included, giving marked control of both grass and weeds. The possibility of control of gray mold and weeds at the same time was indicated sufficiently to justify more extensive tests. The cost is small.

Control of late blight of tomatoes by spraying was definitely inferior the past year. While this is explained by the frequency of rains, coupled with cool weather in distinct contrast to the usual summer season, it nevertheless indicates the need for improvement. Tests showed that the disease could at least be reduced in intensity by using copper sprays even under such severe conditions, but an unreasonably high number of applications are required. It appears that the use of suitable stickers will overcome the most serious deficiency, which was washing off of the materials. The inclusion of suitable stickers is being made a part of general recommendations and refinements in development of both sprays and dusts for better adherence will be the trend of work in the immediate future.

Several canners reported losses from a leafspot that destroys turnip greens. Examination showed the cause to be a fungus disease. Preliminary tests with sprays and dusts showed a distinct reduction in spotting and indicated that control by this means is feasible. Correct timing for effectiveness, rates of application, and materials, as well as various practical aspects, remain to be worked out, but the prospects of solving this problem are good.

Growth of strawberry plants was improved greatly, due to disease and insect control, by spraying three times at two-week intervals during the summer. Spray consisted of tribasic copper sulphate, four pounds, and toxaphene (40% wettable) five pounds, plus 1 pint of resin adhesive to 100 gallons of water.

Sclerotinia crown rot of alfalfa and clover was not controlled by single early applications of tribasic copper sulphate dust without sticker, even at the equivalent rate of 100 pounds metallic copper per acre. The disease attacked also "dead nettle" and chickweed, which aided in the spread of the disease from plant to plant. However, "resting" bodies did not form on these plants.

In cooperative spray tests on Irish Cobbler potatoes at Crossville, C-O-C-S and tribasic copper sulphate, in concentration of four pounds to 100 gallons, plus insecticide and one pint resin adhesive, resulted in significant increases in U. S. No. 1 and total yield over untreated potatoes, and considerably above insecticide alone. No late blight was present.

POULTRY

POULTRY NUTRITION

Chicks—Supplements for soybean oil meal type rations for chicks were studied during the year. Vitamin B₁₂ (cyano-cobalamin) was approximately 5 percent as effective as a growth promoting substance as were supplements of fish meal or fish solubles. The antibiotics, procaine pencillin, streptomycin, and terramycin stimulated the rate of chick growth, but not to the extent that the degree of response to and desirability of each antibiotic could be ascertained.

Vitamin B₁₂ exerts a protein sparing action, and improves feathering and livability. It is interrelated to the amino acid methionine and exerts its influence within the chick's body.

The antibiotics exerted their influence in the digestive system. They gave better response when combined with vitamin B₁₂ than when used alone.

Distribution of vitamin B₁₂ and Co⁶⁰ in various portions of the chick's body was determined through intraperitoneal injection of this vitamin labelled with cobalt⁶⁰ and injections of inorganic Co⁶⁰. Analytical work on this study was conducted in the UT-AEC Laboratory. Excreta, blood, liver, spleen, kidney, pancreas, brain, bone, (femur) matrix, bone marrow, and skin (including down and feathers) were analyzed for Co⁶⁰ and B₁₂ labelled with Co⁶⁰.

Vitamin B₁₂ was retained to a greater extent than Co⁶⁰ as evidenced by lower excretion and, in general, higher concentration values in the tissues. The turnover rate of B₁₂ appeared to be slower than that of inorganic cobalt, especially in the spleen.

Hens—Alfalfa silage, alfalfa hay, and green pasture were compared as supplements for Single Comb White Leghorn hens receiving a mash-grain ration calculated to be adequate in all known nutrients. The eggs from the hens receiving the alfalfa silage or green pasture in addition to mash and grain, contained more xanthophyll in the yolk than did eggs laid by hens receiving a ration of alfalfa hay and mash and grain or the eggs from hens fed mash and

grain without supplements. The quality of the eggs, yolk color, and presence of meat spots, were approximately the same from all lots. Fewer eggs contained meat spots in 1950 than during 1949, when Barred Plymouth Rocks were used. This supports a previous report that Single Comb White Leghorns produced eggs containing fewer meat spots than did Barred Plymouth Rocks.

Turkeys—The response of chicks to vitamin B₁₂ and antibiotics initiated work on their value in turkey rations. Procaine penicillin, streptomycin, aureomycin, and vitamin B₁₂ were fed to poultts receiving an all vegetable protein type ration. The poultts failed to respond consistently to the antibiotic supplements; however, when they did, the response was equal to or greater than that obtained from fish meal. One antibiotic appeared as good as another. The poult did not respond to vitamin B₁₂ supplements.

POULTRY PARASITOLOGY

Vermicides—Tests on the effect of the popular nicotine-phenothiazine pellet for single dose treatment of chickens for *Ascaridia galli* and *Heterakis gallinae* on the tissue phase of *A. galli* were made. Aids in this study were the flushing technic for worm recovery from the intestinal lumen (Ackert and Nolf, 1929) and the mass digesting apparatus (Tugwell and Ackert, unpublished) for the recovery of the larvae from the intestinal wall. It was found that these drugs have no effect on the tissue phase of *A. galli* (time which developing larvae spend partially buried in the chicken intestinal wall). This was shown by the fact that chicks infected with embryonated *A. galli* eggs, and later treated during this phase, showed heavy concentrations of larvae which were alive and growing upon examination of the chicken. The drug had its maximum efficiency as a vermicide for this large round worm after developing in the chick for 21 days or longer.

Antibiotics—Antibiotics have received attention in poultry nutrition. To test the coccidiostatic properties of selected antibiotics, streptomycin, terramycin, pencillin, and aureomycin, were incorporated in all mash chick rations.

Chicks were divided into groups according to weights. They were then given feeds containing high and low levels of antibiotics for a period of one week before being inoculated with 75,000 sporulated oocysts of *Eimeria tenella*. High level antibiotic supplement was five grams of antibiotic per 100 pounds of feed; low level was 500 mgs. per 100 pounds of mash. All antibiotics used were crystalline products with the exception of aureomycin, designated 5-25 (25 grams aureomycin per ton of feed); and aureomycin 5-100 (100 grams of aureomycin per ton of feed). Weights were observed daily for a period of two weeks. The antibiotics tested at the levels given resulted in a recovery rate of 56.9 percent for infected controls and a weight gain of 78.4 percent for the two-week period for the non-infected controls; aureomycin (5-100), a weight gain of 65.7

percent; aureomycin (5-25), 61.3 percent; and pencillin (500 mgm. per 100 pounds of feed), 61.1 percent. Antibiotic supplements showing weight gains below that of the infected controls were streptomycin (500 mgm.), 40.5 percent; and penicillin (5 grams per 100 pounds of feed), 48.3 percent. Mortality rates were high with terramycin (low level), aureomycin (5-100), and aureomycin (high level). Low mortality rates occurred with streptomycin (low level) and aureomycin (low level). From this test antibiotics failed to exhibit pronounced value as anticoccidial agents.

Coccidiosis Studies—Strains of New Hampshires, Barred Plymouth Rocks, Single Comb White Leghorns, and two crosses, Barred Rocks x New Hampshires, and New Hampshires x Barred Plymouth Rocks, were tested during 1950 for resistance to *Eimeria tenella*.

Birds in groups of 20 were inoculated with 75,000 sporulated oocysts of *E. tenella*. Daily weight records were maintained from the date of infection until the fourteenth day after infection. Results indicate no significant increased natural resistance of one breed over another. Percent weight gains were slightly higher for the two crosses, interpreted to indicate a slight increase in resistance to *E. tenella*, although probably not statistically significant. Mortality rates for the standard bred chicks averaged 32 percent, while that for the crosses was 15 percent.

Limited testing of anticoccidial agents—sulfamethiazine, sulfaquinoxaline, sulphur plus sulfaquinoxaline mixture, nitrophenide and nitrofurazone—was conducted to compare the preventive effectiveness of these drugs. The trials extended over a fourteen-day period in which each chick was weighed daily. The inoculated control group had a gain in weight of 29.8 percent. Those receiving sulfaquinoxaline suffered no mortality but showed a gain in weight of 30.9 percent; those receiving a mixture of sulphur and sulfaquinoxaline, a mortality of 8.3 percent with a weight gain of 41.8 percent; nitrophenide 16.7 percent mortality and 34.3 percent weight increase; sulfamethiazine 33.3 percent mortality, 36.7 percent gain; while those fed nitrofurazone suffered no mortality and gave a weight gain of 37.1 percent.

The sulphur-sulfaquinoxaline mixture had a decided advantage over pure sulfaquinoxaline as a coccidial agent. This mixture produced a greater weight gain than the other drugs tested. It compares favorably with the non-infected control weight gain of 44.2 percent. The sulphur-sulfaquinoxaline mixture had no manufacturer's recommendations for low level feeding. So that a comparison with sulfaquinoxaline could be obtained, the sulphur mixture was made to contain the same quantity of sulfaquinoxaline per 100 pounds of feed.

POULTRY BREEDING AND PHYSIOLOGY STUDIES

Since 1947 selection has been made of inbred lines of Barred Plymouth Rocks for resistance of coccidiosis. Inbreeding of some lines now exceeds 50 percent. Considerable resistance to *E. tenella*

exists in some families. Resistant and susceptible families are being perpetuated to be used in hybridization.

Fertility of inbred and outbred hens appears to be an individual hen trait or characteristic. Hens low in fertility during their first year of production continued low during their second year of production. Pullets that produced a high percentage of infertile eggs continued as poor producers of fertile eggs when mated to a second male. A mal-physiological functioning of the female reproductive system appears involved rather than preferential mating.

The occurrence of abnormal embryos in eggs produced by inbred Barred Rocks and the occurrence of embryos in malpositions were significantly reduced when inbred hens were mated to Single Comb White Leghorn males. Increased hatchability and growth rate of chicks was noted when outcrossing or crossbreeding was practiced.

Egg Shell Porosity and Hatchability

Several hundred eggs were used to determine the relationship between shell porosity and hatchability. Day old eggs and incubated fertile and infertile eggs were stained and scored, using the histological technique of Almquist-Holst. The average shell porosity score was found to be greater in the small end than in the large end of the fresh day old, incubated fertile and infertile eggs. The incubated fertile eggs showed greater shell porosity than did the incubated infertile eggs. Porosity of incubated eggs increased directly with the length of incubation time. The small end of the egg increased in porosity greater than did the large end during incubation. (Figure 25.)

Most eggs in which the embryo died showed a low porosity score, indicating that there is a relationship between shell porosity and hatchability.

The Influence of Hormones on Chickens

A preliminary study showed certain hormones, namely, estrogen, thiouracil, and protamone had an influence on the length of shanks of three-week-old chicks. The birds which received 15 mg. diethylstilbesterol implants, and those which were fed protamone at a level of 10 mgs. per 100 pounds of feed, had shorter shanks than did the control birds or those fed 10 mgs. of thiouracil per 100 pounds of feed. The relationship between sex and growth rate is of considerable fundamental interest and of great practical importance. The influence of hormones on growth may assist in answering the question of why males grow faster than females.

The influence of estrogen, protamone, and thiouracil on egg shell strength, shell thickness, specific gravity, porosity, and hatchability is being studied. Six pens of eight Single Comb White Leghorn hens, confined in laying batteries, are being used in this study.

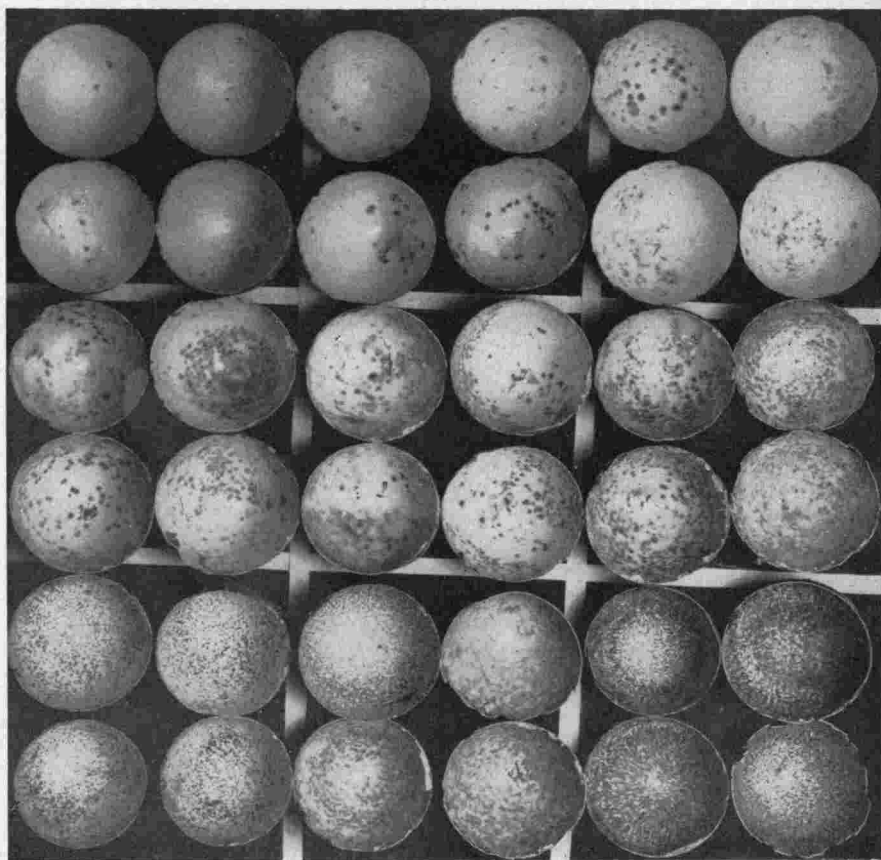


Figure 25—Egg shell porosity standard. The shells are scored 1-9, reading by groups of four from left to right, top to bottom. Each higher score represents shells which show a larger number of stained spots. Each spot represents a pore through the egg shell.

Egg shells are of best quality during the fall and winter months. Shells become thinner, more porous, and possess less strength during the summer months. Longevity of production and interrelationship between hormonal balance and ambient temperature appear to be factors involved in egg shell quality. It is too early to elucidate upon the limited data collected.

Calcium Metabolism

To determine the extent to which calcium metabolism is a factor in egg shell thickness, calcium 45 was administered orally to hens which characteristically produced thin or thick-shelled eggs. Twenty-five to 30 percent of the administered dose appeared in the shell of eggs laid the first day after administration. It appeared that if dietary calcium is not utilized within twenty-four hours after

consumption the hen possesses no physiological means of storing that days' supply of calcium for later shell formation, with the exception of that portion which finds its way to the skeleton.

It was further found that the skeleton of laying and non-laying hens did not differ significantly in Ca^{45} content. Data suggest that less absorption of Ca^{45} from the digestive tract occurs in non-laying hens than in laying hens.

Conformation and Performance

The relationship between body conformation and performance in certain crossbred and standardbred chicks was studied. Standardbred New Hampshire (both broiler and egg strain), Barred Plymouth Rock, Barred Plymouth Rock x New Hampshire, and New Hampshire x Barred Plymouth Rock were used.

It was found that Barred Plymouth Rock x New Hampshire was superior in feed utilization, growth, and feathering. The chicks from this cross gave a higher percentage of breast meat than did the reciprocal cross of either of the two breeds used in the cross.

Further study is being conducted to determine the mature body weight, egg production, egg size, and efficiency of egg production of the pullets from these breeds and crosses.

POULTRY PROCESSING

A preliminary study has shown that mature poultry and birds injured during processing or those which have market imperfections or defects can be used profitably in chicken luncheon loaves, chicken link sausage, and other poultry specialties.

Chicken luncheon loaves and chicken link sausage have received favorable recognition from persons who have tested them. Additional investigation is needed regarding the proper cooking time and temperatures, moisture content, and the shelf-life of these products. Mature cocks and hens yield approximately 30 percent of their carcass as meat satisfactory for these products. Smoked chicken, chicken steaks, and chicken burger are additional products that have been prepared and partially tested.

FORESTRY EXPERIMENT STATION

MORGAN AND SCOTT COUNTY FOREST LANDS

Several projects were completed this year, including the boundary survey and mapping of the two Little Brushy Mountain tracts, and the signing of two coal leases. A survey was started on the west boundary line of the Morgan-Scott tract. Some pulpwood, sawlogs, and fence posts were sold.

Boundary Survey

The survey of the Little Brushy Mountain tracts were completed by the end of 1949. A few corners were set and part of the lines painted. During the first four months of 1950 the remaining corners were set, and the boundary line painted except where it joins lands of the Coal Creek Mining and Manufacturing Company's painted line. This line will be painted later in cooperation with the company.

Maps with a scale of 1"=500' were made of these two tracts showing corrected distances and bearings. A map for field use was made using a TVA contour map for a base. During the summer contacts were made with owners of lands adjoining the Morgan-Scott tract to determine whether "calls" agreed. Several cases were found where the distance and bearing for the same line was different. However, in most cases there was a fair degree of similarity in the "calls." No difficulty is anticipated in reaching a satisfactory agreement with the large landowners. Contacts revealed that the west property line was the least clearly defined; thus there is more controversy over it than any of the other lines. It was decided to start running this line and try to reach agreement on it. The survey was started in November, but because of bad weather, only a portion of the survey was made. It will be finished as quickly as possible.

Timber Sale

No large timber sales were made this year, but there were small sales of pulpwood. These sales were to remove low quality and undesirable hardwoods from the more valuable pine, poplar and oak. Two areas were selected for this cutting. The first area was that logged last year where considerable stands of black gum and soft maple were left. The second area was the land around Dug Hollow, along U. S. Highway No. 27, which had been burned several years ago.

From the first area, 27.4 units of pulpwood, containing 160 cu. ft. per unit, were removed. Much more could have been cut had labor been available. Because of their large size, the trees could be sold only during the peeling season which ended about the middle of July.

From the second area, 28.39 units of pulpwood were removed. There is more wood to come out, but here, too, labor is the limiting factor. Cutting will be continued in these two areas when labor can be obtained.

Contracts are made stating specifically which trees are to be cut and which shall not be cut. Periodic inspections are made to determine whether the contract is being observed and to offer advice and suggestions so that operators may have a better understanding of what the University is trying to do in developing timber lands.

Some 300 locust fence posts were sold at an average price of about 5c per post. Most of these were cut from poor quality and mature trees. There does not seem to be a steady market for posts, but nearby farmers need a few periodically. Locusts have been damaged considerably by fires, but in places they have sprouted vigorously.

Approximately 12,000 board feet International 1/4" log scale of pine logs was sold to one farmer. This pine was cut from an area which had been bedly burned several years ago. Nearly all of the trees cut showed severe fire damage.

About 13,000 board feet, lumber measure, of logs was sold from the area which is being strip mined. More logs will be removed as the strip mine operation progresses.

Coal Leases

During late 1949 and early 1950 interest had been expressed by several coal operators in leasing coal lands from the University. Some of the operators did not have equipment or financial backing to undertake such a project. Two operators, however, were given contracts. The two leases were signed on December 20, 1950.

One mine is near the top of the mountain on the east end of Little Brushy Mountain, where some underground mining had been done during and shortly after World War I. Since this old operation had removed all coal where there was a good top, the remaining coal is being strip mined. It is planned to reforest this area when mining is completed.

The second mine will be an underground operation on the Morgan-Scott tract at the head of Cowan Creek. Little coal has been mined from this property, due largely to inaccessibility and low grade of the coal.

Fire Control

No serious fires occurred in the past year. Last spring was unusually dry, and numerous fires occurred in the vicinity. Two fires were started on adjoining lands in April. Approximately 25 acres was burned on the tract near Coalfield. The second fire, which burned about 30 acres, was on the east side of the Morgan-Scott tract, started on privately-owned land. The damage was not extensive.

Last fall there were no fires on University land, although fires burned lands in other parts of the county.

The fire protection system used last year was used again this year. The same three men were employed to look over the property and to notify the State mobile crew or fire tower lookout if any fire occurred, and to assist the crew in fighting fire on University land.

Both Morgan and Scott County Courts appropriated money for county-wide fire protection. Last spring fire rakes were lent to all

families living on University land, with the understanding that these tools were to be used if a fire started nearby.

Tree Planting

No tree planting was done in the past year. Plans had been made to do some planting on the area where the gas line came through the property, but the area was not leveled until June, which was too late for planting.

An examination was made of the 1949 planting. The majority of these trees have made good growth, about 10" to 14" this year. A few trees grew as much as 24" this year. The sprout and brush growth is not so thick that the trees will be retarded. Plans have been made to plant a mixture of 7,000 trees in late winter or early spring. The majority of this planting will be inter- or under-planting.

Research

On July 11 and 12, 1950, a committee composed of representatives from two Forest Experiment Stations, TVA, State Division of Forestry, U-T Agricultural Experiment Station and Extension Service met in Knoxville to develop objectives, policy and a program for future forest research which may be carried out by the Experiment Station. It was decided that the group would develop a management plan for the forest, and establish research projects as they are needed when the plan is put into operation.

A cooperative research program was carried out at the Plateau Experiment Station in cooperation with TVA and certain Southern colleges. This was a study to determine whether it is practical to cut shortleaf pine for fence posts and let certain insects peel them. Some 480 posts were used; 60 posts being inspected for insect action each 30 days beginning at the first of May. It was determined that the bugs did assist in loosening the bark so that the posts peeled easily by hand. All posts were treated with copper naphthenate and will be put in use at the Station.

A complete report on this project is being submitted to TVA. Results will be combined with results from the other schools and a cooperative research project report will be published.

HIGHLAND RIM EXPERIMENT STATION

SPRINGFIELD

Buildings and Improvements

One new farm labor housing unit was constructed on the Russell farm this year. This house was built by the University of Tennessee farm house plan LC46B. It is a frame house with white asbestos shingle siding and composition roof.

Weather

Rainfall for the year was 61.34 inches, which is more than 25% above the seven-year average for this Station. The heavy rainfall was good for pastures. However, wet weather hampered production of all row-crops and the harvesting of small grains and other seed. This was particularly true on the Russell farm, where the major portion of the tobacco and corn plot work was done.

Tobacco

Dark Fire-Cured, Type 22—In general, the work with dark tobacco was along the same line as that of 1949. It included the testing of five commercial varieties for yield and value per acre; 16 lines for resistance to common mosaic as well as for their relative acre values; 30 lines for black root rot resistance; 36 lines for resistance to wildfire; and 10 lines for resistance to black shank. Other work on dark tobacco included studies of fertilization, cultivation, height of topping, spacing, and curing.

The above-normal rainfall on the Sango silt loam soil in the 1950 plot area caused difficult farming conditions. Adverse weather throughout most of the growing season made it practically impossible to get the tobacco crop in the field when the plants were ready, and to work them after the crop was set. By June 12, when the soil had dried sufficiently to be prepared, most of the tobacco plants were too large for successful transplanting. Even though the tobacco was reset twice, a poor stand resulted on most of the plots.

The rainfall during July, August, and September was more than double the seven-year average for the same period at this Station. Excessive rainfall water-logged the soil, causing a great many plants to die. The greatest number of plants died on the highest areas in the field. Back-crossing of selected mosaic-resistant plants and the black shank-resistant tobaccos on Madole No. 1 was done in late August. By September 5, following a windstorm and about 3 inches of rain between August 31 and September 2, practically every plant on which crosses had been made was dead. The loss was so great in the black shank-resistant breeding plots that it was difficult to find pollen for more crosses and to save seed of the parent lines.

Field losses were so heavy that none of the plot tobacco was harvested for yield and quality data. Because of excessively wet soil it was not possible to cultivate the black root rot-resistant or the wildfire-resistant tobaccos at all. The entire area was heavily overgrown with grass and weeds. No data of value were obtained.

The black shank-resistant lines were grown on the Station for seed increase and crossing only. A planting was made on a farm in Davidson County, in an area where black shank did extensive damage in 1947. This planting was made July 7, 1950, and only about 50% of the plants survived transplanting. Black shank failed to

develop more than a trace in this field prior to September 7 when field inoculations were made. On October 21, stand counts were made to determine the amount of black shank that developed following the inoculations. It was found that 82% of the Madole No. 1 plants had died. Inoculations were made on only three of the resistant lines where black shank varied from 7.5% to 15.4%. Plant selections, based on type and apparent resistance, were made for further study.

Tobacco in the fertilization and rotation study, located on a different soil type, was not so severely damaged by wet weather as that in the other plots. Data from these plots are not yet available. In this rotation study, the wheat was cut with a binder and shocked in the field, but weather damaged it so severely while in the shock that no attempt was made to thresh it for yield data.

A new cooperative project on the curing of dark fire-cured tobacco was initiated in 1950. Data from this project will not be completed until after the tobacco has been processed for market, probably March, 1951.

Burley, Type 31—The burley varieties were grown on a different soil type, better drained than the soil used for most of the dark tobacco work. The burley varieties were transplanted May 30 and 31. Growth in the field was good for all varieties except in two replications of Gr. 17A, where the plants were very small at time of transplanting. Because of wet weather, it was not possible to cultivate and care for the burley adequately. Insect control was particularly handicapped.

Corn

The corn testing was carried on in cooperation with O. H. Long and S. F. McMurray. The spacing and nitrate test will be found in another section of the general report. No report will be possible on the uniform variety test because weather conditions were such that the corn could not be harvested before extreme damage occurred.

Small Grain Varieties

The uniform variety tests of the small grains included seven barleys, six winter oats, and 16 wheats. Barley yields ranged from 27 to 50 bushels per acre. Oat yields ranged from 56 to 81 bushels per acre. The average acre yield of wheat varied from 20 bushels for Carala to 31 bushels for Seneca, a new soft, red winter wheat from Ohio. A more detailed report on all the small grains will be given in another section of the general report.

Tomato

The tomato variety test, conducted for the Department of Plant Pathology, included eight lines or varieties, each with five replications. The plots were located on a Montview silt loam soil in an

area adjacent to that used for the tomato tests in 1949. The yield of Number 1 fruit varied from approximately eight tons per acre for Mildglobe to 13 tons per acre for one of the new selections. A detailed report will be made by the Department of Plant Pathology.

Blight-Resistant Pears

The cooperative work on blight-resistant pears, started in 1947, has been further expanded. The establishment of orchard Number 2 was completed, except for a few guard trees, in December. This second orchard contains over 400 trees, made up of more than 40 lines and varieties.

Peach Varieties

It was anticipated that the peach orchard, established in 1948, would produce a crop of fruit in 1950. Early in the season the prospects for a good fruit yield were excellent. However, a freeze during the full bloom period completely destroyed the crop.

Permanent Pastures

Pastures in general made good growth during 1950. Some additional seedings of orchard grass and Ladino clover were made in mid-October. The sub-zero weather in November may have caused serious damage to the late seeded pastures.

Five cuttings were made on the pasture fertilization plots. Total yields of air dry hay ranged from 2.7 to 3.8 tons per acre. A more detailed report on this project may be found in the Agronomy section.

MIDDLE TENNESSEE EXPERIMENT STATION

Columbia

WEATHER

Total rainfall at Columbia during 1950 was 60.92 inches. Approximately one-fourth of this total fell during January and February, with the remaining amount distributed through the year. This provided a favorable growing season for most crops. However, tobacco harvesting and cutting was disrupted by heavy precipitation in August, and many crops were severely damaged. Five inches of snow was recorded in November.

Meetings

The forty-ninth annual meeting of the Middle Tennessee Farmers' and Homemakers' Institute was held at the Station on May 9. This meeting was attended by 3,000 farmers and home-

makers. The Negro Institute was attended by 500 persons on May 10. Approximately 2,000 4-H Club boys and girls attended the camp located on the Station in July and August. Other annual meetings at the Station included the Farm Bureau presidents, Farm Bureau women, Home Demonstration Clubs, Co-op Managers, and Young Farmers and Homemakers. All of these groups were conducted on tours of the Experiment Station.

PURCHASE OF PROPERTY

In August, 1950, the Board of Trustees of the University of Tennessee approved the purchase of a new farm to replace the old Middle Tennessee Experiment Station. This new farm consists of 593 acres, located approximately seven miles north of Columbia on U. S. Highway 31. The farm was purchased from Mr. W. A. Haynes, of Louisiana, for \$295 per acre. At present this farm is in a high state of cultivation. It contains more land suitable for research than the old station, and the soil types are typical of those in Middle Tennessee.

The new farm is well fenced. It contains three lakes which can be used for watering and irrigation. The largest of these lakes covers eight and eight-tenths acres. The other two contain one and six-tenths, and eight-tenths acres respectively. (Figure 26.)



Figure 26—this scene on the new Middle Tennessee Experiment Station shows the barn and silos which will be used in dairy research. In the foreground is a 1.6-acre lake; and a smaller lake is in the background.

The buildings are considered well above average, consisting of two large barns with numerous small sheds which can be used for machinery and other storage. There are four well-constructed permanent type silos on this farm. Two of the four tenant houses are in excellent condition, while the other two need some repair. There is also one large residence on the property. All of these houses have modern lighting and bathroom facilities. There are a number of springs on the property. All parts of the farm are easily accessible as the result of an excellent farm road system.

In addition to this property, the University purchased all of the cattle, hay and silage on the farm. This included 10,000 bales of hay and approximately 300 tons of silage, as well as 90 brood cows, 20 two-year-old heifers, 41 yearling steers and heifers, and 23 two-year-old steers. Forty of the brood cows and nine two-year-old heifers were immediately culled and sold. Thus the Station has an outstanding herd of Hereford cows to be used for experimental purposes.

When the new station is completely established it is expected that a well-rounded research program in dairying, animal husbandry, and agronomy will be initiated.

SALES OF PROPERTY

It is anticipated that the old station will be sold as soon as research work under way can be completed. Some progress toward this was made when the University of Tennessee Board of Trustees approved the sale of approximately 45 acres to Maury County for \$75,000 for a hospital site.

ANIMAL HUSBANDRY RESEARCH

The Station, during 1950, conducted research with beef cattle, (Figure 27) sheep, hogs, and jackstock with major emphasis placed on investigating the utilization of pasture by various kinds of livestock.



Figure 27—Calves grazing rye and crimson clover on the new Middle Tennessee Experiment Station farm.

The investigation of damage from fluorine in the effluence from the local phosphate plants was continued and expanded to include the use of sheep in evaluating certain alleviators. Details concerning this project are reported in the Animal Husbandry section of this report.

AGRONOMY

A complete variety testing program was conducted again in 1950. Included were corn, wheat, barley, oats, soybeans, alfalfa, red clover, grain sorghum, and tobacco.

Special emphasis was placed on studying relative merits of different legumes and grasses for pasture and hay production. In addition, studies were conducted on fertilization problems facing Middle Tennessee farmers. Results of this work are reported under the Agronomy section.

DAIRYING

During 1950 the station had 70 head of Jersey cows and heifers available for research. Studies were made to determine the value of nitrogen fertilization under irrigation for pasture production. Other research with dairy animals included a winter pasture study comparing the production of cows fed in the barn with those allowed access to good winter pasture.

PLATEAU EXPERIMENT STATION

CROSSVILLE

Weather

The total recorded rainfall at this Station for 1950 was 66.94 inches. The 1949 record showed 63.06 inches, while the normal precipitation is 54.19 inches. January accounted for 14.79 inches; and October, the low month, registered 0.93 inches in the 1950 record. High temperature for the year was 85° reached on June 18 and 26, and on July 3. The low temperature for 1950 was—7° recorded on November 25.

These conditions favored the growth of hay and pasture crops, but made proper planting, cultivating and harvesting impossible with many crops.

Meetings

The first annual field day for the Plateau Station was held on June 1, with approximately 600 farmers present. Many small groups of 15 to 50 with special farming interests visited during the season.

Improvements

One and one-half miles of board fence was constructed on the frontage and entrance way of the main Station on U.S. Highway 70N. Posts 5" x 5" in size and selected crosstie siding of oak were ob-

tained from Station property for the construction. The posts were given a 48 hour cold soak treatment with 5 per cent pentachlorophenol solution after being dried to a moisture content of around 15 per cent. Under these conditions the absorption of treating solution was approximately $3\frac{1}{2}$ pounds per cubic foot.

Since untreated oak will give eight to 12 years' service under Plateau conditions, it is expected that oak posts treated in this manner will give a very satisfactory period of service. After a few months of weathering no difficulty was encountered in painting the posts with oil based fence paint.

The extension of an electric distribution line to Grassland Farm was effected during the summer, allowing for the wiring of buildings and later installation of water pump, hay drier, etc.

Two one-fourth acre ponds were constructed at the Prisoner of War Camp Farm for livestock water. Fifteen acres of the stockade area was cleared by use of a bulldozer, then leveled, limed, fertilized and seeded to pasture.

A selected portion of the old Prisoner of War Camp was set aside for a District 4-H Club Camp when the property was obtained by the University in 1948. Having custody of the property and use of the area suitable for agricultural purposes, the Station lent labor and supervision for renovation of the Club Camp area for use in 1950. Nine buildings were dismantled and stored or used in other buildings. A girls' 20' x 40' bathhouse was constructed. A dining room annex, 20' x 90', was assembled, and a number of other buildings were roofed and re-designed for 4-H Club Camp use. A rifle range with shelter building and earth backstop was made, and playgrounds graded, drained and seeded to grass.

Forestry

Five acres of white pine was underplanted in 1950 on cutover areas which will remain in woodland. Excellent stands have been obtained in four years of these plantings. White pine is making growth superior to shortleaf and loblolly under these conditions. A few white pines transplanted in 1947 are now five feet high under a canopy of oak.

Studies were continued in fence post preservation, using copper naphthenate as a five per cent cold soak solution. Much difficulty was encountered during the rainy season in getting the posts dried to an even, low moisture content. Posts stored in a dry shed consistently retained 18 to 20 percent moisture and required a long period to absorb the standard six pounds per cubic foot of solution. When dried in sunshine, to around 12 percent moisture content, shortleaf pine absorbed the required amount in 12 to 15 minutes.

"Bug peeling" of shortleaf pine posts was studied. Posts 2.5 to 6.0 inches in diameter were cut in February and divided into two size groups. Each size group was divided and stacked in dead pile and crib stacks. Peeling was undertaken at intervals of 30 days. Ease

of peeling steadily improved, even before insect activity began. It appears that cost of peeling pine posts may be cut materially without damage to posts by dead piling posts cut in dormant season and by leaving them to insect activity until the bark begins to flake off. Since peeling consumes much of the labor in preparing posts for treating, study should continue.

Field Crops

In addition to standard field crop studies in small grains, corn, grasses and clovers given in the Agronomy section of this report, the Plateau Station grew nine varieties of burley tobacco in cooperation with the Tobacco Station at Greeneville. One new strain, resistant to wild fire, showed promise of comparably high yield and quality. Analysis of the tobacco grown in this test showed only one-third as much magnesium in the leaf as tobacco grown at the Greeneville Station and at another location in red lands. This supports the observation of magnesium deficiency symptoms in the growing plants. Dolomitic lime had not been applied on these plots.

Maryland tobacco was grown in a fertilization test. Poor harvesting and curing weather, plus mistakes caused by lack of experience, nullified results; however, a satisfactory leaf of Maryland type was produced. Approximately 75 acres of Maryland tobacco was grown by farmers in the Plateau area in 1950.

Pasture renovation studies were started in cooperation with TVA, using an experimental furrowing seeder as compared to complete renovation with bush and bog disc, and with grain drill alone on old sod. The study attempts methods of re-fertilizing and adding Ladino clover and orchard grass to a depleted pasture sod.

An 18-acre field was seeded to button clover along with crimson clover and oats for winter grazing. Button clover plots seeded in 1946 responded poorly at first, but have become very promising as inoculation nears completion.

Livestock and horticulture work at the Plateau Station are discussed in their respective sections of this report.

TOBACCO EXPERIMENT STATION

GREENEVILLE

Weather

The weather in 1950 at the Greeneville Station was unusual in several respects, many of which were favorable for the growing of burley tobacco. Six of the first seven months of the year had above-normal rainfall.

The month of April was 2.19 inches below normal in rainfall, and the temperature was 3 degrees below normal. This dry, cold weather created a problem in the production of tobacco plants.

Many plants were killed and others severely damaged. Rainfall in May was 4.91 inches above normal; June and July were also above normal. This was good transplanting weather, and a good stand of tobacco was secured. The heavy rainfall of early months caused very rapid growth in the burley tobacco.

The weather of 1950 was similar to that of 1949, until July 20. After this time in 1949 there were two periods of eight days each when the weather was extremely hot and dry: one from July 22 to July 30 with an average high of 94 degrees and no rain; the other from August 8 to 15 with an average high of 93 degrees and no rain. These two hot, dry periods dehydrated the 1949 crop in the field, and growers were forced to cut the crop before it matured. This contrasts with the 1950 season, when the temperature was 2.16 degrees below normal. The temperature was never above 90 degrees, with the high average of 84.9 for July, and 84.5 for August. With this temperature in 1950, the crop matured slowly and there was ample time for the crop to ripen in the field before harvest. September and October were above normal in temperature and low in rainfall, making good curing weather. A dry, cold winter caused very little damage to the tobacco hanging on the tier rails before it was stripped and prepared for market.

The quality of tobacco marketed in 1950-51 at Morristown, Rogersville, Johnson City, and Greeneville reflects the effect of the weather on producing high quality tobacco in this section.

The early rains were ideal for early pasture; however, much of the early hay crop was damaged in harvesting. The dry weather in August and September reduced the fall hay crop and combined with early cold weather to do great damage to all fall seeding, especially temporary winter pasture.

Visitation

The Greeneville Station served as host to the 1950 Burley Tobacco Workers' Conference, which was held July 31, and August 1 and 2. The meeting was held at the Clyde Austin 4-H Club Camp with 80 workers from nine states attending. The program consisted of discussions on fertilization, diseases, varieties, and handling practices. On July 31 the group toured the station and saw first hand the experimental work on tobacco.

Each week the 4-H Club members attending the 4-H Club Camp toured the station and observed the different research projects. On August 4, there was 1,600 farmers at the annual Farmers' Field Day.

Project Work

In addition to the tobacco work, various other research projects were carried on. Uniform variety trials were conducted on corn, barley, oats, and wheat. A test was conducted on varied rates of nitrogen with two corn varieties at three different spacings.

Tests of pasture mixtures, consisting of different legumes and grasses, were compared for best yields. Pasture fertilization comparisons were made for yield and quality on Decatur and Shackleton soils. Variety trials were run on red clover and alfalfa. Methods of seeding small grain on red clover sod, and the seeding of oats and crimson clover for temporary winter pasture were tested.

Livestock

Beef Cattle—The study of management problems was continued on the commercial cow-calf herd, comparing the time of calving in January and February vs. March and April; grade Hereford cow bred to Hereford bull vs. Hereford cow bred to Angus bull. Steers and yearlings wintered in the barn on silage and hay were compared to those outside on permanent pasture and hay during the winter. The finishing of steer calves on pasture was compared with pasture and grain at two ages, 18 and 30 months. A new test was started with beef cattle, weaning the heifer calves in early November and finishing for June market on four different treatments.

Sheep—Studies of sheep were continued along the same line as in the previous year.

Livestock and grain tests are given in other Sections of this report.

BURLEY TOBACCO VARIETY IMPROVEMENT AND DISEASE INVESTIGATIONS*

Variety Trials

Eight uniform variety trials were conducted at widely separated locations in the state. The average Crop Indices (value) for seven black root-rot resistant varieties or lines were as follows:

Variety	Crop Index
Greeneville 24	1351
Burley 1	1300
Kentucky 16	1270
Greeneville 17B	1254
Greeneville 17A	1238
Greeneville 18	1237
Kentucky 56	1094

Greeneville 24 (an experimental breeding line) produced the highest average yield as well as the highest crop index. Burley 1 rated second in crop index and produced the highest average grade index and percentage of smoking grades. Kentucky 56 is resistant to tobacco mosaic as well as to black root-rot; however, it was relatively poor in grade quality, being lowest in grade index at seven of the eight locations.

*Cooperative with the United States Department of Agriculture.

According to variety tests conducted at the station in 1949 and 1950, none of the present commercial mosaic and/or fusarium wilt resistant varieties produced as high value per acre in absence of these diseases as Burley 1 and Kentucky 16. In the 1950 trials, Burley 1 and Kentucky 16 showed 13 and 7 per cent, respectively, greater returns per acre than the best fusarium wilt or mosaic resistant varieties.

EFFECT OF MATURITY AT HARVEST

An experiment was conducted with Burley 1 to determine the effect of maturity at harvest on yield and grade quality. Seven different harvests were made at six-day intervals, beginning one week after topping. Highest dollar-value per acre was secured for plots harvested during the fourth week after topping. Following that period, even with favorable weather conditions as existed, there was gradual loss in yield and, to a lesser degree, quality. Similar results were obtained in an experiment conducted in 1948 with Kentucky 16.

RESISTANCE TO WILDFIRE

Work continues toward the development of burley varieties having resistance to wildfire as well as to black root-rot and tobacco mosaic. In 1950, fifty different wildfire-resistant selections were grown for yield and quality evaluation. The most promising material proved to be some of the newly developed lines with resistance to the three major diseases. Two resistant lines were outstanding, showing much higher crop indices than susceptible varieties Burley 1 and Kentucky 16, which had only relatively mild wildfire leaf spot injury.

A few of the wildfire resistant lines produced approximately one third less nicotine than standard varieties.

Field studies with certain wildfire resistant lines grown in absence of disease have also shown them to compare favorably with the better commercial varieties. For example, at one location a line having combined resistance to wildfire, tobacco mosaic and black root-rot returned \$1,401 per acre; whereas, Burley 1 and Kentucky 16 returned \$1,346 and \$1,263 dollars per acre, respectively.

RESISTANCE TO BLACK SHANK

In 1950, a cooperative State and Federal breeding program was initiated to develop burley varieties resistant to black shank. Breeding work was started following the first appearance of the disease in Eastern Tennessee, in 1949. It is estimated that by late in 1950 more than 100 farms in three counties in the area had some

loss from black shank. Spread of the disease has continued in Williamson County, Middle Tennessee, since 1948, when it was first observed on burley tobacco in that area. A portion of a diseased field is shown (Figure 28) to illustrate plants in various stages of the disease.



Figure 28—A tobacco field infested with black shank. The plants show various stages of the disease.

Approximately 3,000 F_2 plants were grown from crosses of burley varieties with black shank resistant cigar wrapper and flue cured varieties. Most of the non-burley (15 green; 1 white burley) resulting from such crosses with green tobaccos were eliminated by careful sorting when the plants were pulled for transplanting. Others evaluated on disease infested soil included 10 burley breeding lines received from the Virginia Agricultural Experiment Station; five resistant varieties of other types; 18 species or interspecific hybrids; and 60 burley varieties or breeding lines having resistance to other diseases.

One hundred and twelve burley plant selections were made after careful examination of root systems of plants with desirable leaf characteristics. Certain *Nicotiana* species appeared to be highly resistant or immune to black shank. Efforts will be made to transfer resistance from these species to burley varieties through interspecific crossing.

PLANT BED TREATMENTS

Methyl bromide, a gas, has been very effective in controlling weeds and the treated beds have produced good stands of healthy, well rooted plants (Figure 29). Successful treatments have been



Figure 29—Methyl bromide gas treatment plot in foreground. Background shows plot with no treatment, from which 216 weeds were pulled per square foot (at left). The picture was made at the Tobacco Experiment Station on May 17, 1950.

made during October and in March; however, weather conditions usually have been most favorable in the fall. Good results were obtained following certain variations in rate, in duration of treatment, and in moisture content of the soil. The best treatment appears to be nine pounds per 100 square yards (one pound per 100 square feet) treated for 24 hours if the soil temperature averages above 60° F; and 48 hours when soil temperatures are between 50° and 60° F. The soil should be loose, free of clods, and with sufficient moisture for good weed seed germination at the time of treatment.

The entire area is covered with a gas proof paper or plastic cover sealed tightly at the edges with soil and supported slightly from the ground with material such as a few straw filled bags or a layer of corn stalks. Methyl bromide is transferred under the cover by means of a special applicator from one pound cans through a tube to a metal pan or trough which is placed in each 300 square foot area treated.

Fall treatment with cyanamid at the rate of 1½ pounds per square yard and the combination treatment with cyanamid one pound per square yard plus uramon ½ pound per square yard resulted in good weed control and plant production. These treatments

have been quite successful for the past four years on the light colored, well drained silt loam soils such as normally occur on the limestone ridges in East Tennessee. Effort should be made to have the soil is optimum moisture content for good tillage at the time of treatment. These chemicals are very high nitrogen fertilizers; consequently, only fertilizer mixtures, such as 0-14-7, without nitrogen, should be used when fertilizing the plant bed. In 1950, the above treatments showed only 14 weeds per square foot compared to 239 weeds for the untreated plots. The same treatments, however, resulted in plant bed failure when made on a heavy, compact, red soil such occurs extensively in the Tennessee Valley.

FERTILITY AND CULTURAL EXPERIMENTS WITH BURLEY TOBACCO*

Most of the agronomic work with burley tobacco in 1950 was a continuation of tests previously established. Some new experiments were begun, however, testing response to various priming and topping practices.

Plant Bed Fertilization

Results from tobacco plant bed fertilizer studies were similar to those obtained in 1949. No particular differences were found between sodium nitrate, ammonium nitrate, urea, and ammonium sulfate as sources of nitrogen for plant production. Even on our better soils, phosphate has proved to be indispensable. Without phosphate in the fertilizer, we have never been able to grow plants of sufficient size for transplanting until it was too late to set profitably in the field. Under our conditions, it appears that one-half to one pound per square yard of a complete fertilizer such as 3-9-6 is sufficient to give adequate tobacco plant production.

Rates and Sources of Fertilizer Materials

Various rates and sources of potash, with and without manure, were tested for the third year in continuous culture. Without manure, 60 pounds K_2O was sufficient to give maximum yield, but tobacco grade quality improved with each increase in potash. All plots receiving manure produced high yields of good quality tobacco, regardless of the rates or sources of commercial fertilizers applied.

In the three-year rotation series, consisting of tobacco, small grain and red clover, the 1950 crop represented the second tobacco crop grown on a particular field. Rates and sources of potash, with and without manure, are again emphasized in this test. Table 15 lists the 1950 data. Generally speaking, there was improvement in tobacco yield, quality, percent smoking grades, equivalent acre value, and burning properties as fertilizer potash was increased.

*Cooperative with the United States Department of Agriculture.

All manured plots produced tobacco of acceptable yield and visual quality. Muriate of potash was very damaging to the burning properties of the tobacco.

TABLE 15—Results of rates and sources of potash in three-year rotation 1950 (averages of four replications).

Fertilizer treatment	Yield per acre (lbs.)	Quality index	Smoking grades (%)	Crop index	Leaf Burn (sec.)
22.5-67.5-0	1791	.451	53.0	871	3.5
22.5-67.5-45	1678	.440	56.5	747	4.5
22.5-67.5-285	1971	.641	72.5	1264	12.7
22.5-67.5-525	2101	.721	78.0	1521	13.7
0-67.5-0 ¹	2186	.708	74.9	1555	7.4
0-67.5-45 ¹	2166	.776	77.2	1683	14.4
0-67.5-285 ¹	2286	.779	78.0	1799	11.3
0-67.5-525 ¹	2297	.746	78.2	1724	11.3
0-67.5-45M ¹	2246	.746	77.7	1683	5.3
22.5-67.5-45 ²	1720	.488	68.8	848	2.4
22.5-67.5-45 ³	1838	.521	69.0	961	10.6
22.5-67.5-285 ⁴	1951	.566	71.8	1108	9.9
L.S.D. (.05)	284	.096	12.8	330	

M Muriate used as K₂O source.

¹ Manure applied at rate of 10 tons per acre.

² Sulfur applied at rate of 555 pounds per acre.

³ This plot received 525 pounds K₂O per acre in 1947.

⁴ All K₂O above 45 pounds sidedressed.

Soil type: Cumberland silt loam.

The high-fertilizer series was continued for the third year in continuous culture. All treatments in this test gave high tobacco yields. The greater rate of potash used was very beneficial in improving tobacco quality. Results of this experiment are given in Table 16.

TABLE 16—Results of high fertilizer series in 1950 (averages of four replications).

Fertilizer treatment	Yield per acre (lbs.)	Quality index	Smoking grades (%)	Crop index
100-90-60	2149	.609	75.4	1309
100-90-300	2273	.788	82.8	1790
100-180-300	2151	.817	84.0	1757
100-90-60 ¹	2084	.630	75.1	1316
100-180-300 ²	2310	.809	87.1	1869
60-90-60	2136	.674	74.9	1438
L.S.D. (.05)	160	.077	5.1	200

¹ Enough muriate of potash included to supply 20 pounds Cl per acre.

² 10 tons manure per acre added to this treatment.

Soil type: Ooltewah silt loam.

Preceding Cover Crops

Results of the test in which several winter annual cover crops are turned under are shown in Table 17. This was the third tobacco crop grown on the same plots. Both crimson clover and vetch again proved superior to small grain (barley) or to leaving the soil bare over winter.

TABLE 17—*Effects of cover crops on burley tobacco production in 1950 (averages of three replications).*

Cover crop ¹	Yield per acre (lbs.)	Quality index	Smoking grades (%)	Crop index
Crimson clover.....	1744	.488	63.1	852
Vetch.....	1822	.517	69.9	939
Barley.....	1035	.396	49.2	412
Fallow.....	1062	.395	44.0	423
L.S.D. (.05).....	285	.089	19.1	214

¹All plots fertilized at rate of 1000 lbs./A 3-9-6

Soil type: Nolichucky silt loam.

Cultural Test

The general cultural test comparing the new variety, Burley 1, with one of the more popular strains was repeated in 1950. Table 18 gives results of this test. Yields for the two varieties were similar, but Burley 1 was strikingly superior in quality and in the percentage of smoking grades produced.

TABLE 18—*Comparison of Burley 1 and Kentucky 16 under several cultural conditions in 1950 (Averages of four replications).*

Cultural treatment	Yield per acre (lbs.)		Quality index		Crop index		Smoking grades (%)	
	Ky. 16	Burley 1	Ky. 16	Burley 1	Ky. 16	Burley 1	Ky. 16	Burley 1
Fertilizer ¹								
22.5-67.5-45.....	2050	2019	.657	.772	1342	1549	74.4	85.6
45-135-90.....	2141	2050	.639	.800	1368	1637	72.3	87.8
Spacing ²								
15 inches.....	2144	2059	.643	.773	1377	1588	77.5	88.6
18¾ inches.....	2046	2010	.652	.798	1333	1599	69.2	84.8
Topping								
20 leaves.....	2095	1969	.648	.812	1355	1592	73.4	89.7
25 leaves.....		2101		.759		1594		83.8
Average.....	2095	2035	.648	.786	1355	1593	73.4	86.7

¹All plots received 10 tons manure per acre.²In row; 3½ feet between rows.

Topping

A topping test, using the Burley 1 variety, was initiated in the 1950 season. Results are shown in Table 19. These data indicate that this variety should be topped at a medium height and suckered as needed. The practice of neither topping nor suckering, as is popular in some areas of the state, was the poorest of the treatments represented.

TABLE 19—*Results of topping test with Burley 1 in 1950 (averages of four replications).*

Topping treatment	Yield per acre (lbs.)	Quality index	Crop index	Smoking grades (%)
20 leaves, suckered.....	2329	.766	1785	81.8
24 leaves, suckered.....	2501	.758	1898	74.0
28 leaves, suckered.....	2526	.708	1790	76.0
Not topped or suckered.....	2342	.681	1593	78.0

Priming

Work with priming was expanded to include several priming practices, using both Burley 1 and the most popular commercial variety. Table 20 lists the results of this test. It appears that one priming is sufficient to get the most profitable labor return for either variety. Under a particular treatment, the two varieties gave comparable tobacco yields, but Burley 1 was of better quality.

TABLE 20—Results of priming test comparing Burley 1 and Kentucky 16 in 1950 (average of four replications).

Treatment	Yield per acre (lbs.)		Quality index		Crop index		Smoking grades (%)	
	Ky. 16	Burley 1	Ky. 16	Burley 1	Ky. 16	Burley 1	Ky. 16	Burley 1
Stalk cut.....	2109	2154	.595	.685	1269	1481	59.8	70.4
Primed once.....	2514	2537	.587	.639	1478	1621	64.4	69.3
Primed 3 times.....	2665	2726	.629	.696	1678	1899	73.4	73.4

U. T. - A. E. C. AGRICULTURAL RESEARCH PROGRAM

OAK RIDGE

Introduction

The origin and scope of the UT-AEC Agricultural Research Program was described in detail in the 1949 Annual Report. The program is operated by contract with the Atomic Energy Commission under the administration of Vice-Director F. S. Chance of the Agricultural Experiment Station, University of Tennessee.

In addition to the normal development of the program, world conditions during 1950 created the necessity for an expansion and acceleration along the following lines: (1) broadening of the scope of the research to include evaluation of important internal radiation hazards particularly in connection with food products, and the initiation of external radiation studies with large animals; (2) increase in scientific staff to prosecute the required work; and (3) increase in the laboratory and farm facilities to provide sufficient working space and maintenance of experimental animals.

It is now generally recognized that this University of Tennessee facility is the outstanding program in the United States for the undertaking of research on the effects and use of radiation in agriculture, particularly in regard to experimentation with the various species of domestic animals.

Farm

During the year 1950, as has been true since the beginning of the program, efforts were devoted to the development of necessary physical facilities for the farm phase. Emphasis was placed on

the reclaiming of crop and pasture lands, the construction and repair of buildings, equipment and fencing for handling the livestock, and the repair of houses necessary for farm personnel.

This year an additional 389 acres was seeded to perennial grasses and clovers for pasture which brought the total pasture area to slightly over 1,000 acres. Approximately 400 acres of other land was used for other feed crops.

A cattle feeding and hay storage barn 50' x 200', with an adjoining concrete lot 36 feet wide, was constructed and arranged to accommodate 10 lots of experimental cattle (Figure 30). An

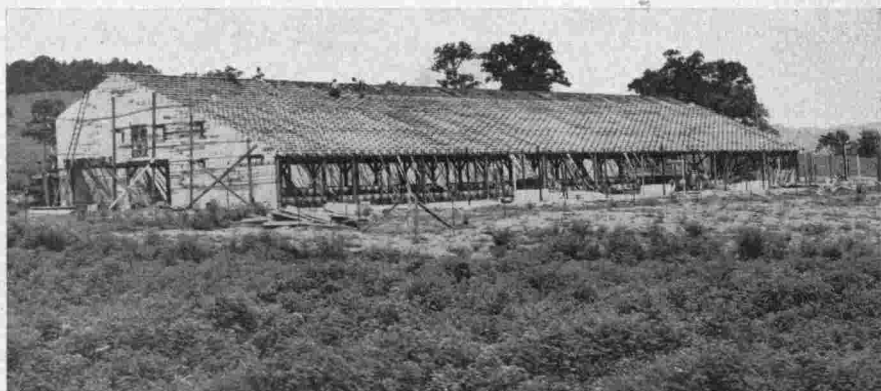


Figure 30—A beef cattle barn, 50 by 200 feet, is under construction. This barn will accommodate 10 lots of experimental animals, with 10 to 15 animals per lot.

existing barn was remodeled for a part of the animals being used in Project 10, and the construction of a new barn and field laboratory for this project was begun.

Other capital improvements in 1950 include the drilling of a well and installation of an automatic water system in house E-418. Eleven dwellings and one barn were painted, two houses were remodeled with provision of bathroom facilities, and two houses were re-roofed. Approximately 60 acres were enclosed with a woven wire fence, and 75 acres with a 4-strand barbed wire fence.

Livestock

Burros—Forty-nine burros were received and maintained for certain biological studies in Project 10.

Cattle—See Project I report.

Horses—Two "cow horses" and two draft mares were purchased this year. Four saddle animals, two draft animals, and one colt are now owned.

Sheep—A small flock of sheep was established this year by purchase of twenty-five southwestern yearling ewes and a purebred Southdown ram.

Swine—Four sows and eight gilts farrowed sixteen litters, averaging 9.8 live pigs per litter.

WEATHER

In cooperation with the U. S. Weather Bureau, a weather station was established early in the year. Official observations were begun May 1st. Following is the record of precipitation and temperature since that time.

Month	Precipitation		Temperature			
	Inches	No. Days Recorded	Maximum		Minimum	
			Extreme	Average	Extreme	Average
May	9.71	22	87.4	78.8	48.3	57.5
June	3.46	12	92.0	78.0	52.0	62.5
July	7.52	19	90.0	83.8	52.0	63.0
August	7.59	15	87.0	83.0	51.0	60.2
September	2.77	11	89.0	77.8	50.0	57.6
October	1.74	6	82	75.2	32	47.8
November	3.33	15	81	52.0	2	29.4
December	3.98	13	66	44.0	7	22.5

LABORATORY

The following laboratory rooms and facilities providing approximately 30,000 square feet of floor space, have been completed and placed in operation:

Room with walk-in refrigeration for autopsy of animals; laboratory dissection room with walk-in refrigerator; tissue dissection room with walk-in refrigerator; laboratory for preparation of samples for radioassay; radiochemical laboratory; air-conditioned Geiger counting room; radiobiological laboratory; chemistry laboratory; biochemistry laboratory; air-conditioned balance room; air-conditioned dark room; small animal colony with supporting facilities.

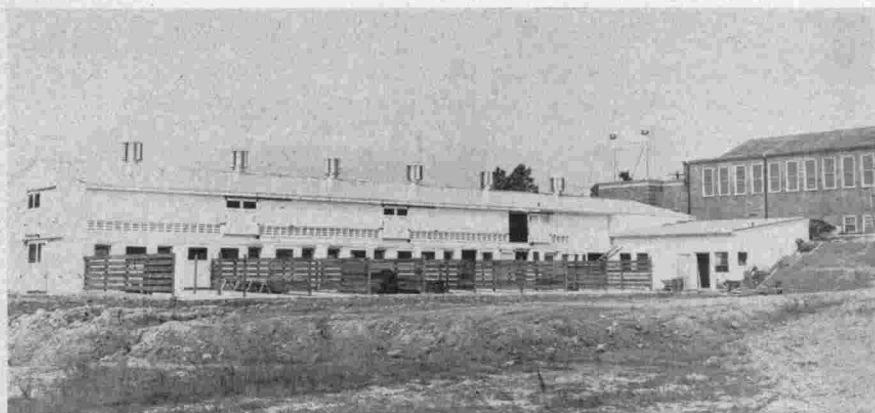


Figure 31—This nutrition barn is especially designed for radioisotope studies with large animals.

ties; stock rooms; nutrition barn (Figure 31) containing stalls, bullpens, hot laboratory, radioisotope metabolism room and animal surgery (40' x 140', with a wing 31' x 26').

The following are still under construction for use in the project on external radiation:

Exposure field for whole body irradiation of large animals; barn containing treadmill and autopsy equipment located near exposure field; blood chemistry laboratory; histology laboratory.

The actual findings of the laboratory work will be reported under the specific projects. The operational accomplishments include obtaining and training of staff, procurement of supplies, establishment of Health Physics procedures, the development of animal handling methods, and the setting-up of the various techniques to be employed. All projects have been initiated and the experimental plan in each case has been well detailed.

UT-AEC PROJECTS

PROJECT 1: BOMB RADIATION EFFECTS UPON FARM ANIMALS

In Collaboration with Department of Animal Husbandry and Veterinary Science

Records and data on the original cattle exposed to the Alamo-gordo test bombing and control animals have been kept. The spring cal crop was weaned and the calves dehorned, branded, and the males (except those kept for bulls) castrated. Also, on basis of consultation with the Bureau of Animal Industry, a number of cattle recommended for disposal were sold.

A male calf, Tattoo U 382, dropped by an exposed cow and sired by M. H. Domino 13, a registered Hereford bull, began to show a sprinkling of grey hair about one month after birth. This calf is being kept as a bull for observation.

Comparison of Calves from Radiated Cows and Bulls with Calves from Control Cows and Bulls

The evaluation of sires and dams by the rate of gain and performance of their progeny is a continuation from last year, using this year's calf crop. The comparison of the sires and dams through the 1950 calf crop is being continued in the feed lot (feeding began in December,) and will be continued through the 1951 grazing period.

The data to date for the 1950 calf crop are as follows:

Radiated Bull RA 617 sired eleven calves which had an average birth weight of 75 pounds and weaning weight of 523 pounds at 193 days of age.

Bull 137 sired nine calves which had an average birth weight of 74 pounds and weaning weight of 517 pounds at 210 days of age.

Bull 40 sired 10 calves which had an average birth weight of 80 pounds and weaning weight of 468 pounds at 196 days of age.

Bull 91 sired 10 calves which had an average birth weight of 65 pounds and weaning weight of 416 pounds at 208 days of age.

Registered purebred bull Palmetto Perfection sired eight calves which had an average birth weight of 79 pounds and weaning weight of 472 pounds at 237 days of age. Registered purebred bull M. H. Domino 13 sired nine calves which had an average birth weight of 66 pounds and weaning weight of 494 pounds at 220 days of age.

Calves sired by all bulls were out of both control and radiated cows.

PROJECT 2B: FISSION PRODUCT METABOLISM IN ANIMALS

At the request of the Atomic Energy Commission, the original UT-AEC Project 2 has been considerably expanded. The purpose of this project is to investigate the retention and distribution in animal tissues, and the effects on health of certain radioisotopes which may be designated as of interest to the Atomic Energy Commission. Particular attention will be paid to the placental transfer of the various radioisotopes and also to the accumulation of activity in products commonly used as food such as eggs, milk, and meat. Studies are also planned on such intermediary metabolic processes as influence the laydown or withdrawal of these radioelements from the critical organs and tissues.

Little or no information is available on the effect on health, of the accumulation in larger animals of the various fission products. It is essential that such data be obtained from the point of view of the effect of widespread dissemination of these materials, the possible use of these materials in wartime and peacetime research and industry, and particularly in regard to filling the gaps in knowledge on the effect of these materials on humans. To this end intensive studies using the larger animals including swine, sheep, goats, beef cattle, dairy cattle, and poultry will be undertaken. The data forthcoming should be of great value in determining the maximum quantitative tolerances of these materials.

It is to be noted that the effects of the fission products and certain other elements in animals are related primarily to their accumulation in bone. They follow the stream of calcium and phosphorus metabolism, and, therefore, a series of coordinated investigations on skeletal metabolism have been initiated and are described in detail under other projects. These include (a) absorption, distribution, and interrelationships with calcium in animals and general skeletal metabolism; (b) role of minerals in the reproductive functions; (c) role of minerals in birds with emphasis on egg formation; and (d) secretion of minerals in milk and effect of lactation process on mineral metabolism.

Evidence is available that many of the factors known to have a profound effect upon the absorption and metabolism of calcium and phosphorus will also have an important effect upon the absorption and metabolism of the fission products of interest. Such variables include calcium deficient diet, phosphorus deficient diet, pregnancy, prolonged lactation, rickets, fracture, parathormone, estrogens, and certain drugs. Studies on these conditioning factors are also planned.

Major accomplishments in the short time that this project has been active include: (1) Development of facilities for use of radioisotopes with large animals; (2) the development of quantitative procedures for measurement of the various radioisotopes, and the preparation of radioisotopes in forms suitable for administration to the animal; (3) the development of autoradiographic procedures, particularly for showing the deposition of the various fission products in bone; (4) the obtaining of preliminary data in swine and cattle on the degree of absorption of strontium from the gut; (5) the obtaining of information on the relative deposition of calcium and strontium in the various tissues of swine and cattle and the relative accumulation of calcium in the dam and the fetus of varying ages; (6) the treatment of certain animals to be maintained over periods of up to two or three years in order to study the long term pathological effects; (7) the initiation of studies on the extent of the secretion of strontium in the milk of the dairy cow; (8) the initiation of experiments using bone fractions to gain information on the role of such processes as exchange, recrystallization, and accretion in the laydown of various elements in bone.

PROJECT 3: CALCIUM METABOLISM IN ANIMALS:

(1) ABSORPTION AND INTERNAL DISTRIBUTION

The primary purpose of this project is the study of skeletal metabolism in large animals, especially the role of calcium. Objectives include the determination of the normal distribution of soluble calcium administered orally and intravenously to cattle, swine, and sheep, and to study thereby the normal absorption and utilization of dietary calcium by these animals. The effects of such factors as age, pregnancy, lactation, previous nutritional history on calcium utilization and its internal metabolism will also be undertaken. In addition to the importance of this study in gaining information on normal nutrition growth and health of animals, it is considered that this project is of prime importance to the Commission, in view of the fact that many of the hazardous fission products are involved in bone metabolism. This project is, therefore, planned to be coordinated with, and supplement the general studies on fission products. Major accomplishments to date include the development of facilities and techniques for using radioisotopes with large animals, the conditioning of animals for the experimental

work, the completion of preliminary absorption and tissue distribution studies.

Some of the high points of findings to date are mentioned to give an indication of the effectiveness of the project. There seemed to be a tendency for cattle on high calcium diets to excrete a higher percentage of orally administered radiocalcium; this may be an important point inasmuch as one would expect that animals on adequate calcium diets would, therefore, absorb and lay down in their bones less of such hazardous radioisotopes as strontium. Accumulation in the calcified tissues was always 50 to 500 times that in the soft tissues. In comparison of bones it was evident that the uptake was always greater in the more rapidly growing sections. The vertebra usually showed a high value, comparable to the rapidly growing portions of other bones, and another finding

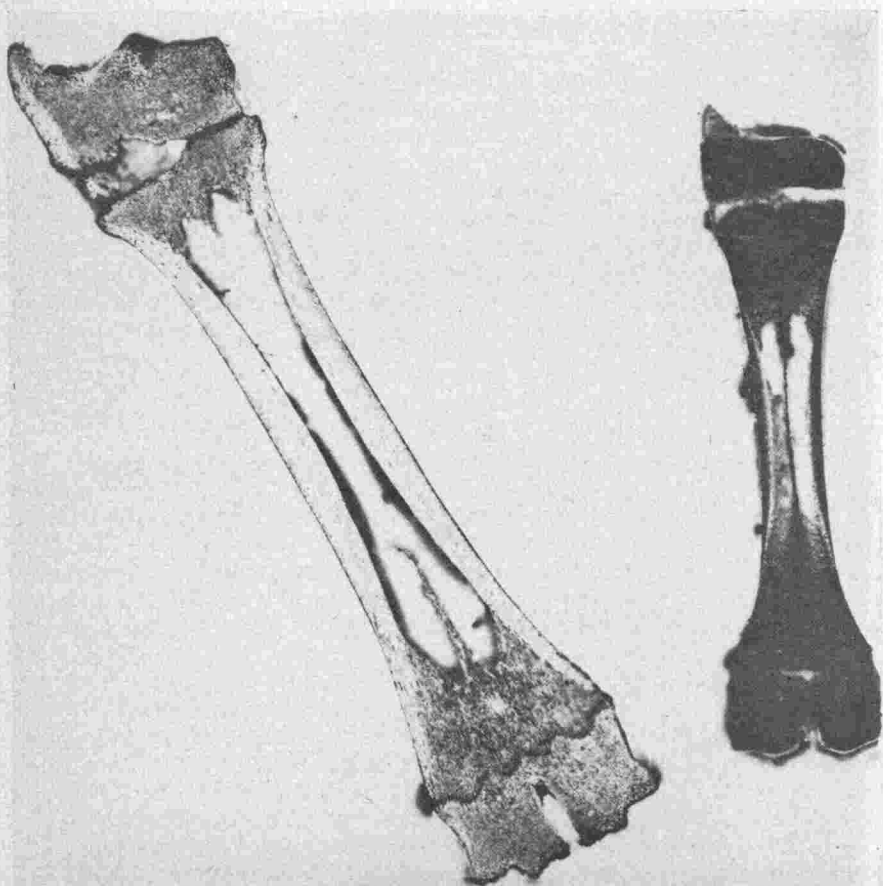


Figure 32—In these autoradiograms the dark areas show where the radioactive calcium administered to the animals is deposited. The bones are from a Hereford cow (left) and her eight-month fetus (right), both sacrificed at 30 hours after injection into the cow. The heavy darkening shows the greater accumulation in the fetus bone.

of significance was the relatively high uptake of the mandible. A fairly complete picture has also been obtained of the movement and behavior of calcium in the blood and the various tissues.

Preliminary studies with cattle have indicated the very important point that the accumulation of radiocalcium in the fetus bones is much higher than in the dam bones (Figure 32). This depends, of course, upon the age of the fetus. In one case of a 3½ month fetus, the accumulation in the metatarsus shaft was thirty-three times that in the metatarsus shaft of the dam.

PROJECT 4: CALCIUM METABOLISM IN ANIMALS:

(II) INTERRELATIONSHIP WITH MINERALS, VITAMINS, HORMONES, AND OTHER FACTORS

The primary objective of this project is to investigate the interrelationships between minerals, vitamins, hormones, and other factors known to affect bone metabolism. Some of these conditioning factors which are important from the standpoint of adequate nutrition and normal bone metabolism, include phosphorus, magnesium, vitamin D, estrogens, parathormones, and organic complexing compounds such as versene, citrates, oxalates, and pectates. There must also be considered elements such as fluorine and beryllium which are known to induce abnormal bone metabolism and which are, therefore, important in that a study of their actions may lead to a clarification of the normal mechanism, as well as an explanation of their toxicological properties.

A considerable amount of detailed data, primarily with rats, has already been obtained. Some of the more important overall findings were that the absorption of calcium from the gut was greatly increased when the animals had been maintained on a low level of calcium in the diet. Likewise, the absorption of calcium in the gut was greatly increased when the specific activity of this element in the intestinal contents was low. The absorption of calcium from the gut was much greater with the younger animals than with the mature animals. The phosphorus level of the ration had little effect upon the absorption and laydown of calcium. The picture of calcium distribution in the tissues of the rat was essentially the same as with the larger animals in that the bones as a whole showed a much greater pickup than the soft tissues, and the younger growing parts of bone showed a greater pickup than the more inactive parts of the bone. Of interest was the fact that the jawbone always showed a relatively high accumulation of this element.

PROJECT 5: RADIATION EFFECTS ON REPRODUCTIVE FUNCTIONS IN FARM ANIMALS—SPERM PHYSIOLOGY STUDIES

(I) USE OF RADIOISOTOPES

(II) EFFECTS OF RADIATION

The primary objective is the study of the physiology of reproduction, using radioisotopes, and the study of the effects of these materials on reproductive tissue. Major accomplishments to date include development of facilities for collection of semen from bulls, boars, and jacks; the training of animals for collection by use of an artificial vagina; and the development of laboratory techniques for use with sperm and semen. Preliminary results have shown that the uptake of phosphorus by sperm in vitro is very small and difficult to measure. Apparatus has been set up for the measurement of the respiration of sperm suspensions; the effect on sperm respiration of radioactive materials incorporated into these suspensions has been measured. Studies will be continued, based on the data obtained.

PROJECT 6: RADIOISOTOPES IN POULTRY NUTRITION STUDIES

In Collaboration with the Poultry Department

The primary objective of this project is the study of calcium distribution and metabolism in laying hens, the study of the physiology of calcium transfer in the developing embryo, and the study of fission product metabolism in the laying hen with emphasis upon the extent of incorporation of these radioactive materials in the edible portions of the egg, (Figure 33).

There is some evidence that skeletal metabolism in the bird is somewhat different from that in the mammal, and it may be of considerable importance to have information on both types of animals in order to be able to clarify the mechanisms involved. It should also be noted that the hen's egg represents an ideal system for the study of the physiology and nutrition of a developing embryo.

Through the use of calcium 45 in tracer experiments it was shown that the metabolism of this element is essentially the same in birds which lay normal eggs as in birds which lay thin shelled eggs. The data indicated that if dietary calcium is not utilized for egg shell formation within twenty-four hours after consumption, the hen is not able to store any great part of that day's supply for later shell formation. There was some indication that non-laying birds are less able to absorb calcium from the gut than are laying birds.

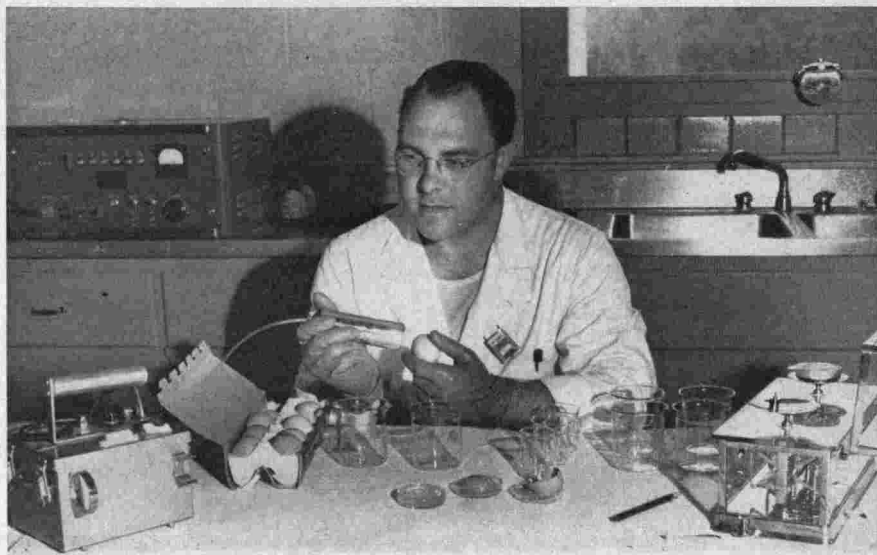


Figure 33—Eggs laid by hens which were fed radioactive calcium are monitored by a Geiger counter and prepared for analysis.

Vitamin B₁₂ labeled with radioactive cobalt was obtained to study the metabolism of this compound in the chick. The distribution of Vitamin B₁₂ was compared with that of inorganic radioactive cobalt. Differences were found which showed that the cobalt is not removed from the B₁₂ as the latter is used by the animal. The outstanding findings were the slow turnover of this compound in the body, the high kidney secretion, the accumulation in the liver and hematopoietic centers, and the high uptake in the skin. Further interpretation will have to await additional experimental information.

PROJECT 7: RADIOISOTOPES IN THE INVESTIGATION OF THE PHYSIOLOGY OF MILK SECRETION:

(I) CALCIUM AND PHOSPHORUS

(II) ROLE OF THYROXINE IN MILK SECRETION

In collaboration with the Dairy Department

The objective of this project is a study of the secretion of fission products in milk, the determination of the effect of lactation on mineral and fission product metabolism, and the obtaining of a quantitative picture of calcium, phosphorus, and iodine economy in the lactating dairy cow.

Facilities have been provided for radioisotope usage with the dairy cow, and several dairy animals have been obtained and conditioned for this work. The transfer of radioactive iodine to

the fetus of the dairy cow and the secretion of this element in the milk have been studied. It was of interest to note that the concentration in the blood and thyroid of the newborn calves greatly exceeded that in corresponding tissues of the dam. The secretion of radioactive strontium in the milk of a dairy cow has been determined.

PROJECT 8: BEHAVIOR AND FATE OF RADIOACTIVE CALCIUM AFTER ITS INCORPORATION IN THE SOIL

In collaboration with the Chemistry Department

Radioactive calcium carbonate at different rates has been incorporated into Hartsells very fine sandy loam and Claiborne silt loam, and lysimeter and greenhouse experiments have been conducted on the soils thus treated. The removal of native and applied calcium in the drainage water and by the crops which were grown on the soils was evaluated.

In general, results from the lysimeter and greenhouse experiments were similar. The two soils behaved very differently as would be expected from their properties. It was noteworthy that labeled calcium increased the removal of native calcium in the drainage of the Claiborne soil, but had little effect in this respect in the drainage of the Hartsells. Detailed results have been prepared for publication.

Labeled calcium will be studied further through its inclusion in quenched calcium silicate slag in a duplicated approach by means of lysimeters and pot cultures. Because the slag contains significant proportions of fluorine and phosphorus, the lysimeter percolates will require analytical determinations beyond those that were employed in the analyses of the drainage waters from labeled calcium in the calcium carbonate-treated soils. Any carbonate content residual to that engendered from the slag will be determined in the second lysimeter experiment, which has been inaugurated.

PROJECT 10: EXTERNAL RADIATION STUDIES WITH LARGE ANIMALS

During the year 1950 this program assumed the responsibility for development of a project on "External Radiation Studies with Large Animals," which had been conceived in the Toxicity Laboratory of the University of Chicago. By virtue of this project the UT-AEC Program is rendered considerably more versatile and is enabled to perform important research on problems involving both external and internal radiation.

The objectives of this project are: (1) to determine the LD 50 for large animals exposed to external radiation; (2) to study the time-intensity relationships as affecting the physiological response

of large animals to external radiation; (3) to determine the degree of physical fitness following the exposure of large animals to sub-lethal doses of external radiation; (4) to study the effects of sub-lethal amounts of external radiation in large animals as determined by (a) hematology, (b) blood chemistry, (c) fertility, and (d) pathology or other criteria (these are to include the study of the delayed, as well as the immediate effects, and also recovery observations); (5) to study the gamma energy dependency of radiation effects upon large animals.

Essentially, no work has been done heretofore on the response of large animals to carefully controlled external whole body irradiation, and it is felt that accurate data are necessary to permit extrapolation to humans. It is imperative that information be available as to how long men can live and work under conditions of exposure to irradiation, and to have an evaluation of the extent of injury which may result from sub-lethal exposures.

During the short time that this project has been active, major accomplishments include the partial completion of laboratory facilities, the partial completion of the exposure field for large animals, the obtaining of animals for this study, and the detailing of the experimental procedures to be used.

WEST TENNESSEE EXPERIMENT STATION

JACKSON

Activities of the West Tennessee Experiment Station during the year have been continued along more-or-less established lines. Extensive programs of research are under way with field crops, horticulture, and plant diseases, and with one project each with dairy cattle and beef cattle. Field production of certain varieties of new crops, developed by Station workers, was given considerable attention.

WEATHER

The 1950 weather at this station brought two extremes, excessive rainfall and the great storm of November. Total rainfall for the year was 74.99 inches, which is slightly more than 50% above the normal 48 inches. The months of April, June, October, and December had less than normal rainfall. The storm of November 25-26, which affected the whole eastern United States, set a new record low temperature at this Station for the late autumn period. Zero reading was recorded November 25, only 20 days passing between the first killing frost and the zero temperature.

MEETINGS

The Spring Field Days were held March 31 and April 1. Discussions included winter crops, pastures, and beef cattle feeding ex-

periments. The Farmers and Homemakers' Institute was held July 25 and 26. The morning program was a tour of the field crop, horticulture, pathology, and pasture experiments, with discussions.

Many groups used the facilities of the Station for meetings during the year.

PROPERTY IMPROVEMENTS

During the year a new head house and a greenhouse were built for the plant pathology work. The fencing program was continued as planned for the Station property acquired in 1941, 1942, and 1943. This work is about 75% complete.

Natural gas was made available to most of the buildings on the Station. This was provided by the West Tennessee Gas Company in payment for the lease of 1.55 acres of land on which gas storage tanks, pumps, etc. will be located. These facilities are designed to make available an emergency supply of gas for the City of Jackson, and otherwise improve the service.

LIVESTOCK

Beef Cattle—Eighty-four steer and heifer beef calves were purchased in the early fall months for use in the project of growing and fattening cattle with the maximum use of winter and summer pasture. This project is in its second year. Much interest has been expressed in the first year's results. This work is discussed more fully in the Livestock Section.

Dairy Cattle—The purebred Jersey herd has been maintained for sufficient time that daughter-dam production comparisons are available from the progeny of eight bulls. Two other bulls have been used, the progeny of which are not yet old enough to make possible daughter-dam comparisons. All the bulls used have shown excellent production in their pedigrees. The daughters of four have produced more than their dams, and daughters of the other four have produced less. All the females in the herd at present are descendants from only one of the eight foundation cows.

Swine—No research with swine is now underway. A herd of 15 brood sows is maintained as a revenue producing project. More research will be initiated as soon as conditions permit.

DEPARTMENT 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

Volumes in Agricultural Library, 1949	24,485
Experiment Station and College	
Additions, 1950	603
Experiment Station	210
College	393
Total Volumes	25,088
Uncataloged Pamphlets, 1949	49,066
Additions, 1950	1,128
Total	50,194

Periodicals Received, 1950

	Purchase	Gift	Exchange	Total
Experiment Station	54	56	28	138
College	129	160	11	300

Volumes bound, 1950	171
Books and pamphlets circulated	24,273
Reference questions answered	1,225

Inter-Library Loans

Volumes lent to other libraries	204
Volumes borrowed from other libraries	26

PUBLICATIONS

AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

Monographs

(Rural Research Series)

- No. 251 Usual Requirements, Practices and Costs in Hay Harvesting, Central Basin of Tennessee, 1945, in cooperation with B.A.E., R. J. Saville, January 1950.
- No. 252 Seasonal Costs of Producing and Marketing Fluid Milk in the Memphis, Tennessee Milkshed, 1948-49, M. L. Downen, February 1950.
- No. 253 Operation of the Fall Season Production Incentive Plan in the Nashville, Tennessee Milk Marketing Area, 1949, M. L. Downen, April 1950.
- No. 254 Distributive Functions of Primary Egg Buyers in Tennessee, B. D. Raskopf, Clyde R. Keaton, May 1950.
- No. 255 Seasonal Costs of Producing and Marketing Milk for Manufacturing Purposes in the Memphis, Tennessee Milkshed, 1948-49, M. L. Downen, June 1950.
- No. 256 Costs and Returns From Dairying on 40 Farms Producing Milk for Processing, Weakley County, Tennessee, 1947-48, in cooperation with B.A.E., T. J. Whately, S. W. Atkins, June 1950.
- No. 257 Cotton Production Practices in Type-of-Farming Area 3, Southwestern Tennessee, 1947, in cooperation with B.A.E., S. W. Atkins, W. E. Goble, R. B. Hughes, Jr., June 1950.
- No. 258 Cotton Production Practices in Type-of-Farming Area 6, Western Tennessee, 1947, in cooperation with B.A.E., S. W. Atkins, W. E. Goble, R. B. Hughes, Jr., June 1950.
- No. 259 Improvements Needed in Tennessee Cotton Quality and Marketing Practices to Meet Mill Requirements, B. D. Raskopf, June 1950.
- No. 260 Seasonal Costs of Producing and Marketing Fluid Milk in the Knoxville, Tennessee Milkshed, August 1948-July 1949, M. B. Badenhop, June 1950.
- No. 261 Farm Adjustments Related to Changes in Farm Returns East Tennessee, 1937 to 1948, W. P. Ranney, June 1950.
- No. 262 Cotton Marketing Practices of Growers, Ginners, and Buyers in Tennessee, B. D. Raskopf, Carl R. Hall, November 1950.

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- No. 217 Some Factors In Farm Organization and Returns To Tenants and Landlords by Type of Leasing Arrangements . . . West Tennessee, 1947, H. J. Bonser. The University of Tennessee Agricultural Experiment Station, Publication No. 7 — Southeast Land Tenure Committee, Bulletin No. 217, June 1950.

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Costs and Margins of Milk Distributors in Memphis, Tennessee in 1948, U.S.D.A., B.A.E., in cooperation with the Tennessee Agricultural Experiment Station, T. J. Whatley (Tennessee) Washington, D. C., 1950.

No. 8 Cotton Marketing Practices in Selected Communities, 1947-48, Southern Cooperative Series, Bulletin No. 8, September 1950, Agricultural Experiment Stations of Alabama, Arizona, Georgia, Louisiana, Mississippi, Missouri, South Carolina, Tennessee, Texas, and bureau of Agricultural Economics, Bureau of Plant Industry, Soils, and Agricultural Engineering and Production Marketing Administration cooperatink. William A. Fought and the following members of the Regional Cotton Marketing Research Committee: R. J. Saville, Chairman; R. F. Anderson, M. J. Danner; W. T. Ferrier; Scott Hathorn, Jr.; J. R. Paulling; W. E. Paulson, B. D. Raskopf (Tennessee); and Felix Stanley.

AGRONOMY

1950 Variety Performance Trials of Field Crops, S. F. McMurray. Experiment Station Bulletin 218

Some Common Weeds and Their Control, J. K. Leasure. Experiment Station Bulletin 213.

Corn Breeding, Frederick D. Richey. Advances in Genetics, Vol. 3, pp 159-92. Academic Press, Inc., New York, N.Y., 1950.

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