THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

SIXTY-SECOND ANNUAL REPORT
1949



McCord Hall and Dairy Industry Buildings

KNOXVILLE, TENNESSEE

Technical Description

Plants: Numerous and height medium, vigorous, productive. Leaf, size, medium; color, medium green; leaf petiole, medium in length and slender.

Susceptibility: Insects, some weevil damage; diseases, slight amount of leaf scorch, free from yellow foliage trouble which is common is Blakemore.

Flowers: Perfect, medium early; petals 5 to 7; stamens numerous; receptacle, medium. Flower stalk, 2½ to 3½ inches long, and lax.

Fruit: Season early (depending on whether the first blossoms are injured by cold), late April and early May at Jackson, Tennessee. Picking quality, good; shipping quality, good; size, medium, somewhat larger than Blakemore. Berries uniform. Shape, long conic, necked and smooth. Color, medium red, glossy and colors evenly. Calyx, large and reflex. Seeds, medium in size, numerous and sunken. Flesh, light red, whitish toward the center. Core, usually hollow, and medium in size. Texture, firm and juicy; flavor, subacid, sprightly and aromatic. Quality, good. Use, market, canning, kitchen and dessert.

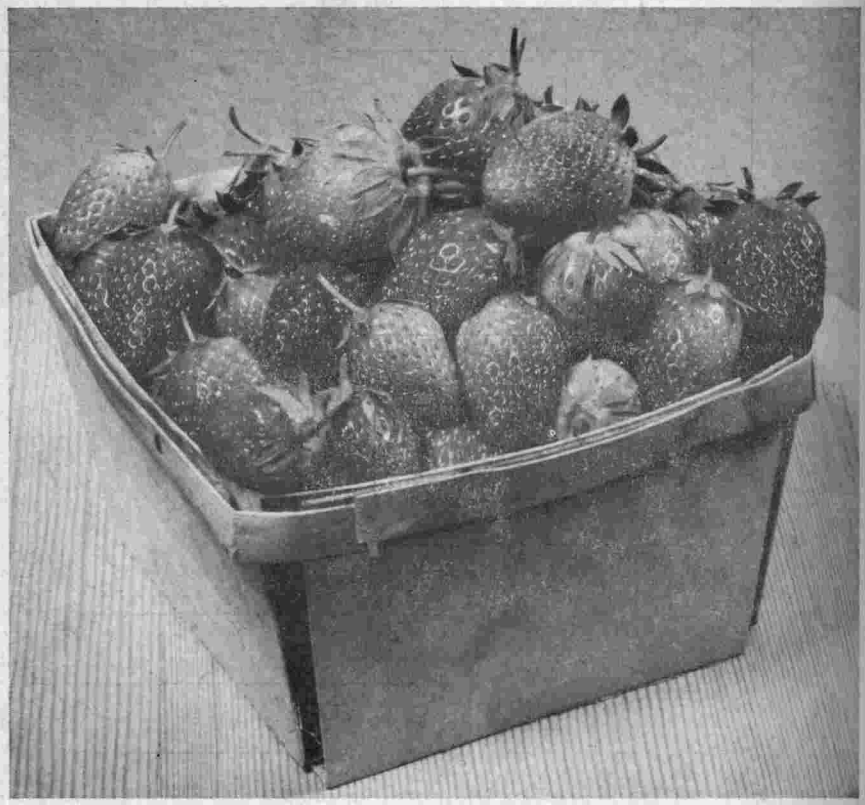


Fig. 3—A box of Tennessean strawberries. The long-shaped, glossy fruits with a large calyx (cap) are very attractive.

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LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 1, 1950

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 1949. 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, 1948-49

	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	$82,169.37	
From Other Sources	.....	.....	.....	.....	.....	$532,479.59
Expenditures						
Personal Services	15,000.00	14,045.21	57,496.36	77,422.68	60,327.87	244,755.40
Travel	.....	.....	224.21	406.21	3,679.35	7,713.56
Transportation of Things	.....	.....	31.46	56.70	187.65	4,318.33
Communication Service	.....	.....	3.50	18.24	25.78	2,911.11
Rents and Utility Services	.....	7.88	103.99	94.44	58.49	4,830.21
Printing and Binding	.....	.....	.....	294.72	33.89	5,167.85
Other Contractual Services	.....	45.40	70.24	687.87	924.95	34,350.23
Supplies and Materials	.....	615.32	1,515.52	6,799.27	6,872.81	140,031.14
Equipment	.....	286.19	554.72	4,193.96	9,529.70	62,146.03
Land and Structures (Contractual)	.....	.....	.....	18.00	.....	26,255.73
Total Expenditures	$15,000.00	$15,000.00	$60,000.00	$89,992.09	$81,640.49	$532,479.59

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INTRODUCTION

J. H. McLeod, Dean and Director

F. S. Chance, Vice Director

The object of the Agricultural Experiment Station is to assist the farmers and homemakers in solving their farm and home problems. The solution of the problems of the rural population is reflected in the living standards of both town and country.

The results of research are evident on every hand when one drives through Tennessee's countryside; better fields of corn, tobacco, cotton, wheat, oats, barley, rye and a number of other crops may be observed. All of these have been worked on by trained scientists and all have been improved to the extent that the present varieties are capable of yielding from 10 percent to 30 percent more than the old varieties. Improved varieties along with better cultural practices and the scientific use of fertilizers have increased the average acre yields more than the percentages indicated above.

Burley tobacco is a striking example of the progress made. Less than twenty years ago, burley tobacco was yielding an average of less than 900 pounds per acre. The average yield now is above 1400 pounds; an increase of about 75 percent.

There has always been too much lag between the discovery of a new and improved practice and the time that it is adopted by farmers. This situation is improving. A new plant variety or an improved fertilizing practice soon reaches the farm. It is notable that many fine pasture fields may be seen now where a few years ago the same fields were covered with a non-productive growth and ribbed with gullies. The increased interest in dairying and livestock, aided by new information as to the proper use of lime, fertilization and the use of most adapted grasses and clovers, has turned the poor non-productive fields into profitable acres.

Studies in the fields of insect and weed control are making great progress. The advent of new materials from the chemical industries has made this possible. These new materials are given careful tests as to their best uses before they are recommended by the Experiment Station.

A new disease affecting and causing considerable losses of cattle was recently found in the state. This malady is known as "X-Disease" for the want of a better name. Investigations have been started in the cause and control of this disease.

Funds for research are not abundant but they come from many sources. In addition to those provided by the State, some are furnished through five different acts of the Federal Congress, cooperative projects with different United States Department of Agriculture departments, the Tennessee Valley Authority, A.E.C. and several commercial and industrial companies.

SIXTY-SECOND ANNUAL REPORT 1949

AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

C. E. Allred, S. W. Atkins, H. J. Bonser, B. H. Luebke, B. D. Raskopf, M. L. Downen, M. B. Badenhop, T. J. Whatley, R. B. Hughes, W. P. Ranney, and graduate research assistants, F. P. Bowers, W. E. Goble, Clyde R. Keaton, Carl R. Hall, and W. P. Stephens.

AGRICULTURAL ADJUSTMENT

The study of income possibilities of cotton and alternative systems of farming in the Brown Loam area of West Tennessee was continued in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture. Major emphasis was given to an analysis of information obtained on farming practices, costs, and returns that will prove helpful in analyzing the possibilities of increasing farm incomes by making adjustments in farm organization. Two reports on separate phases of the study were published during the year—Monograph 243, Production Practices, Costs, and Returns from Lespedeza Hay in West Tennessee, 1947, and Monograph 248, Farm Equipment in Six West Tennessee Counties, 1948. Two other reports in preparation are—Cost of Workstock and Tractor Power, Haywood County, Tennessee, 1947, and Costs and Returns from Dairying on Forty Farms Producing Milk for Processing, Weakley County, Tennessee, 1947-48.

The study of workstock and tractors as sources of farm power on 362 farms in 6 West Tennessee counties shows that the number of workstock decreased 20 percent from 1920 to 1945, while the number of tractors increased from less than 100 to almost 3,200 during the same period. Only about 5 percent of the operators of small farms, having under 30 acres of cultivated land, own tractors, compared with 86 percent of operators of farms having 135 or more acres in cultivation.

One of the most important factors affecting the cost of tractor work is the number of days that tractors are used during the year. Tractor costs in Haywood County show that the cost per hour for medium-size tractors varied from 84 cents for those employed fewer than 50 ten-hour days, to less than 57 cents for those used from 50 to 132 days. Tractor costs, per hour of use, also varied with the size of the tractor as follows: (1) one-plow tractor, 48 cents, (2) two-plow tractor, 63 cents, and (3) three-plow tractor, 76 cents.

The cost of feeding workstock, mainly mules, averaged 23 cents per hour in 1947. The average hourly cost of horse labor can be greatly reduced by increasing the number of days workstock are used.

Milk production per cow was the most important factor affecting net returns from the production of whole milk for manufacturing purposes in Weakley County, located in the Northern Brown-Loam area. Herds producing an average of 4,000 pounds of 4-percent milk per cow returned only $20 per cow for the use of labor. This compares with $71 per cow in herds producing 6,000 pounds per cow. The average net income per hour of labor was 16 cents and 55 cents for the low and high producing herds, respectively.

In cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture, a study was made of costs and methods of hay harvesting in the Central Basin of Tennessee. This was part of a nation-wide study to appraise and evaluate methods, both old and new, of putting up hay. Data secured from 76 farms were analyzed, and the first of two proposed reports—Methods and Facilities Used in Hay Harvesting in Central Basin of Tennessee, Monograph 244—was published. Of the sample farm studies, 20 percent reported tractor mowers, 15 percent side-delivery rakes, and 13 percent pick-up hay balers. The operating and fixed costs of the automatic-tie and hand-tie balers (excluding labor) were about the same per ton baled, $1.09 and $1.01, respectively. Tonnage baled by the automatic-tie baler, however, was 3 times the tonnage baled by the hand-tie baler.

A farm management analysis was made of 27 farms in Knox County. It was found for the year 1948, that increasing the intensity of operations relative to investment in real estate is usually a means of increasing the operator's management returns. Farms with high values per acre call for more intensive enterprises, such as tobacco, truck crops, fruit, poultry, and dairying, and more complete use of the land throughout the year by using double-cropping, alfalfa, pasturing aftermaths, and winter cover crops.

TYPE OF FARMING

The problem of working out new leasing arrangements for dairy and livestock farming has been an acute one for cash-crop renters who desire to change from a one-crop system of farming. Farmers in this State have not had much experience in renting where crop-and livestock-sharing was practiced. To throw some light on these problems a study was made of 55 farm leases that were considered to be successful by farmers in Type-of-Farming Area 3, West Tennessee, where dairying is on the increase.

Leases studied showed some improvisation of, and divergence from, prevailing customary crop-share leases. They permitted landlords to finance more of the farming operations, hence farm businesses were larger and farms better equipped. These leases were also conducive to a different type of farming.

Information obtained thus far indicates that on farms where livestock production is feasible both renters and landlords would profit by jointly owning the stock and sharing in its maintenance, costs, and sales (table 1).

Further study of these problems is needed in other types of farming areas.

TABLE 1—*Some Items of Returns and Costs for Landlords and Renters, by Type of Lease, 47 Selected Farms, West Tennessee, 1947.*

Type of lease (share to landlord)	Gross farm returns (dollars)	Labor earnings of tenants (dollars)	Return on landlord's investment (percent)	Share by tenant for: Costs paid (percent)	Share by tenant for: Returns received (percent)
One-third crop	3180	1172	8.2	77.8	71.3
One-third crop, one-half dairy	4952	1546	7.6	59.8	54.7
One-half crop and dairy*	6761	2254	11.4	54.3	52.6
One-half crop and beef*	9013	2270	9.9	56.4	53.5

* Landlords bear one-half of operating costs other than labor on these farms, but not on the previous two leases.

A study is underway of changes in farming in Type-of-Farming Area 14 over a 31-year period. Identical data were secured on 66 farms in Knox County which have been analyzed for organization and income factors in 1917 and again in 1941.

FINANCIAL PROBELMS OF FARMERS

The study of insurance among farmers in Greene County, which began in 1948, was completed and results were published in Monograph 245, Insurance Among Farmers in Greene County, Tennessee, 1948. The purpose of the study was to help public and private agencies understand the rural problem and situation with respect to farm insurance, and to help these agencies formulate an educational program on insurance for farmers.

Heads of families having life insurance owned and operated larger farms, had smaller families, reached higher grades in school, and were younger than those who had never carried insurance.

Families not having burial insurance were about equally divided between the upper and lower extreme of economic well being.

Forty-three percent of the farmers growing tobacco had carried crop insurance during some years but for the year 1947, only 20 percent had such insurance and only about 2 percent insured their crops consistently.

FARM ELECTRIFICATION

A study of the costs and use of electricity on farms in the East Tennessee Valley was undertaken in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture, and Tennessee Valley Authority. Information was obtained from about 600 homes as to the amount of electricity consumed and electrical appliances in use. Use of electricity on farms will be related to size and type of farm, farm and non-farm income, size of family, and other factors such as number of years farms were electrified.

MILK MARKETING

The study of seasonal costs of producing and marketing milk was continued as part of a regional dairy study. The records obtained from 216 dairymen in Rutherford County during 1948 were analyzed and the following reports were published during the year: Monograph 242, Seasonal Costs of Producing and Marketing Fluid Milk in Rutherford County, Tennessee, 1947-48; Monograph 246, Seasonal Costs of Producing and Marketing Milk for Manufacturing Purposes in Rutherford County, Tennessee, 1947-48; and Monograph 250, Seasonal Costs of Producing and Marketing Cream in Rutherford County, Tennessee, 1947-48.

It was found that cost per cwt. of milk decreased as production per cow increased, and that an increase in the rate of feeding would have been profitable on about 75 percent of the surveyed farms. Also, it appeared that extremely low or very high production at any season was less desirable than fairly even production the year around or with some minor decline in the winter months. Many dairymen depended on permanent pasture as the primary source of nutrients after the pastures had become short and dry, resulting in a sharp drop in milk production.

Dairy studies similar to the Rutherford County study are now in progress in the Knoxville and Memphis market areas. It is anticipated that tabulation and analysis of these data will be completed in 1950.

A study of milk distribution costs in Memphis was conducted in cooperation with the Bureau of Agricultural Economics. This study is nearing completion and it is expected that a report will be published in 1950.

POULTRY AND EGG MARKETING

The Regional Project SM-6, Marketing Poultry and Eggs, in cooperation with 8 other southern states and the Bureau of Agricultural Economics was continued, and the results of the first statewide survey were published as Monograph 249, Practices of Market Egg Producers in Tennessee, 1947-48.

Many farmers were apparently unaware of the need for following practices conducive to high quality egg production. Of 25 improved practices only 5 were followed by as many as 42 percent of the producers: and only 10 practices by as many as 15 percent of the rural families producing eggs for market.

Marketing practices of 197 egg dealers were analyzed, and a report of the results is being prepared. Further study is being made of market outlets for eggs, and of the seasonality of egg marketing.

MARKETING PRACTICES OF FEED MILLS

The Commodity Research Division, Grain Branch, Production and Marketing Administration, U. S. Department of Agriculture, contracted with this Station to determine how feed manufacturers

in the southeastern states protect their stocks of ingredients against price declines. Special attention was given to the use of hedging, a standard type of price insurance. Fifty mills in Tennessee, Alabama, Georgia, South Carolina, North Carolina, and Kentucky were visited and schedules obtained.

The study, which is sponsored by the American Feed Manufacturers Association is national in scope. Four other Experiment Stations are covering the situation in their respective regions. Tabulations of data is under way, and it is expected that a report will be completed early in 1950.

COTTON MARKETING

To adjust cotton 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 factory in the most efficient manner, a regional study is being made, including 19 cotton mills in Tennessee. This study is being made in cooperation with South Carolina, Alabama, Georgia, and the U. S. Department of Agriculture, and is part of the Regional Project SM-1, Regional Marketing of Cotton, Including Cottonseed and Other Products.

As part of this regional project, a belt-wide study was made of 346 cotton oil mills and 307 feed mills and feed dealers in Tennessee. Included in the survey was the newest type of cottonseed extraction unit, shown in figure 1.

Results of cottonseed investigations were published in Monograph 240, Marketing Cottonseed Feed Products in Tennessee, and Monograph 247, Marketing Practices, Facilities and Processes of

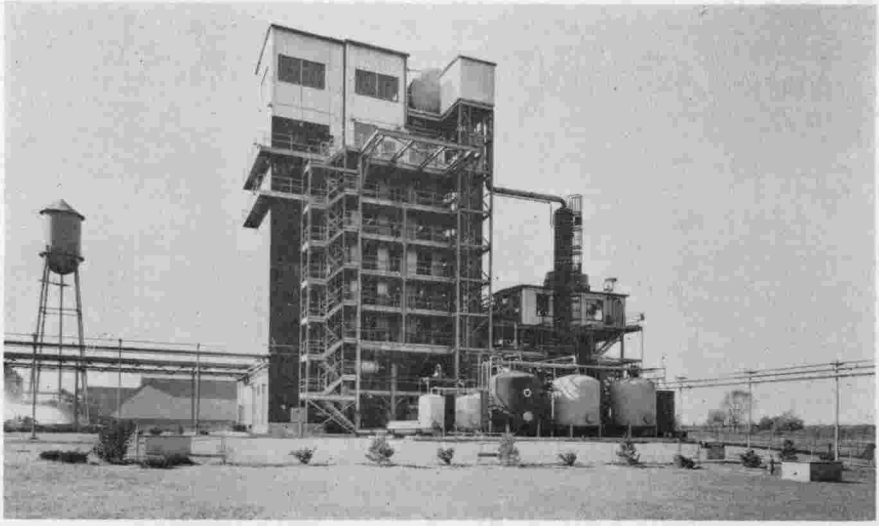


Fig. 1—With development of the cotton seed solvent extraction unit shown here, the oil yield per ton may be increased from ten to fifteen percent above the present average.

Cotton Oil Mills in Tennessee and United States. These reports suggest the following means for improving the marketing of cottonseed products:

1. Expand cottonseed feed products advertising and sales promotion program.
2. Package cottonseed meal and hulls in closely woven sacks, or in paper bags, to prevent sifting.
3. Produce cake and meal of a uniform protein content.
4. Price cottonseed feed products at competitive levels.
5. Adjust the storage of cottonseed feed products to the needs of livestock feeders.
6. Reduce the manufacturing loss per ton of cottonseed crushed.
7. Diversify oil mills by operating other businesses which enable a better labor distribution and aid in overcoming the problem of unused crushing capacity.

To determine the possibilities of extending the market for cottonseed feed products, a survey was conducted of the practices of 290 farmers who fed cottonseed meal and hulls to livestock in five areas of the State.

TOMATO MARKETING

This was the third season of investigation of the marketing practices affecting the quality of tomatoes. Work on this project was conducted in cooperation with the Horticulture Department and is part of the Regional Project SM-3, Marketing Tomatoes.

A survey of 130 commercial tomato producers in the western part of the State shows they were able to sell only 49 percent of their crop to packers and shippers.

Farmers estimated that 25 percent of the 1949 tomato crop was unsalable because of insect damage and disease, 10 percent was culled by dealers, 9 percent was left in the field because low prices made it unprofitable to harvest them, and 7 percent was lost from flooding.

These findings are significant because experiments of the Departments of Entomology and Plant Pathology indicate that over two-thirds of the damage resulting from disease and insects might be prevented with proper control. Better methods of production and marketing should also result in a smaller proportion of cull tomatoes and less field waste.

COOPERATIVE MARKETING

The study made of 107 Cooperative Purchasing Associations in 1947 was completed and the findings published in Monograph 241, Tennessee Farmers' Purchasing Cooperatives—Their Business, Problems, and Practices.

During the past decade there has been a greater development of farmers' purchasing cooperatives in Tennessee than during any previous 10-year period. From 1874 to 1938 there were 107 such organizations of which 59 active ones had 16,171 members doing a business of $889,000. In 1947 there were 107 active cooperatives with 33,555 members whose cooperative purchases amounted to $3,159,878.

Factors favorable to further development of cooperative buying of farm supplies in Tennessee are: 1. Less than 3 percent of farm supplies are purchased through cooperatives. 2. Existing associations are not completely serving their local areas since one-third of them do under $10,000 business and one-fourth have less than 100 patrons per association. 3. County farm bureaus are taking more active part in organizing and sponsoring cooperative purchasing activities. 4. Active cooperatives are improving their financial position by setting aside some savings as general reserves, retiring debts, and increasing investments on the part of the farmers. At the end of 1947 it was reported that 33,555 farmers had an investment of $835,000 in purchasing cooperatives. 5. State and regional wholesale agencies are rapidly expanding their operations. 6. There is an increasing interest on the part of farmers in cooperative buying. 7. Cooperatives are expanding their facilities and broadening their range of services, (fig. 2).

In cooperation with Kentucky Experiment Station a survey was made of 224 members of the Dark Tobacco Growers' Associations in Tennessee, and about the same number in Kentucky, to determine the status of membership relations, attitudes of farmers toward the association and government tobacco programs, and effects of certain characteristics of farmers on attitudes toward and knowledge of the associations and cooperatives in general.

During the field work for this study, it was found that although most farmers who were members of the cooperative were satisfied



Fig. 2—Delivery service to the farm by local Co-ops tend to expand patronage and increase volume of business.

with the operation and management, they had little understanding of cooperative principles, and two-thirds of the growers desired more information about their association. Tabulation of the data and preparation of a report on the study are under way.

AGRICULTURAL ENGINEERING

M. A. Sharp

A new project, a study of methods and equipment for curing dark-fired tobacco, was started in September at the Highland Rim Station at Springfield. This project is cooperative with the U. S. Department of Agriculture, Bureau of Plant Industry, Soils, and Agricultural Engineering, and the U. S. Forest Products Laboratory. R. B. Stone, of the B.P.I.S.A.E., is in charge. Observations were made at several barns during the curing season, and plans were made for remodeling a curing barn on the Station. Special wood burning furnaces will be constructed to produce a maximum amount of smoke with a minimum of heat. Humidity controls will be provided and automatic recorders installed. Observations made during the curing season indicate that very little is known regarding the procedures that produce the best tobacco. Closely controlled conditions should make it possible to obtain valuable information.

A preliminary study of dwellinghouse construction is under way with the expectation that funds will be available to set up a research project in 1950. This project will be cooperative with a government agency interested in farmhouse construction.

FERTILIZER APPLICATOR

An adaptation of a liquid fertilizer pump previously developed here has been used to place ammonium nitrate in the bottom of the furrows at the time of plowing. It also has been used to place solution behind the inside shovel when cultivating corn the second or third time. In one Agronomy experiment it was pushed by hand to place a liquid on top of the ground near the rows of corn. It is easily adjusted to control volume and has been used to place several tons of solution where desired, (fig. 3).

Projects previously under way have been continued.

HAY HANDLING INVESTIGATIONS INCLUDING STORING AND CURING

H. A. Arnold

Self-feeding Hay Curing Bin

The 21-foot diameter self-feeding hay curing bin, completed last year, was filled with a mixture of alfalfa, oats and volunteer crimson clover, partially cured in the field. The moisture content varied from 28 to 48 percent wet basis.

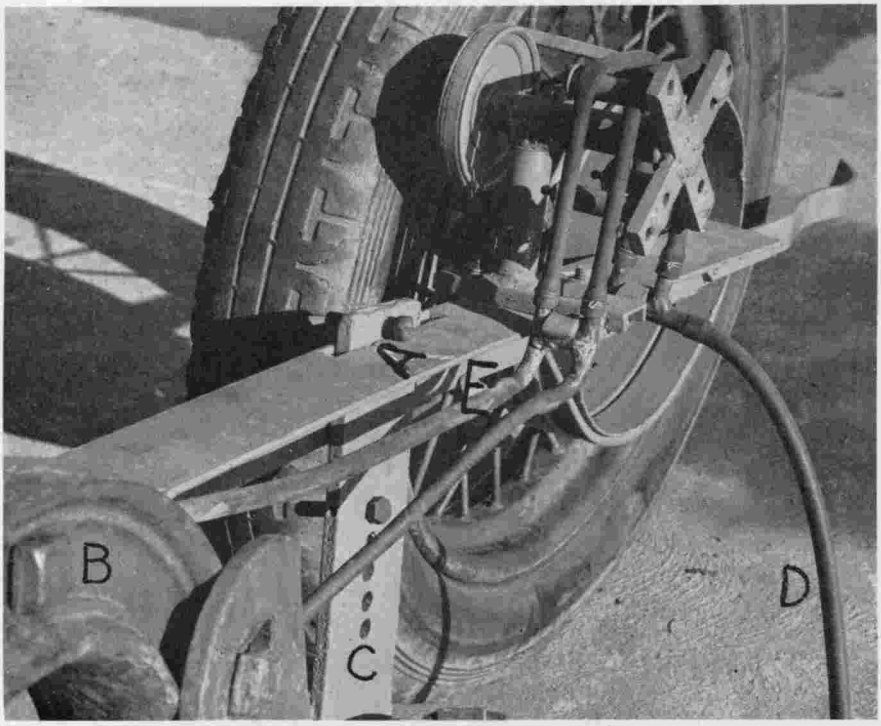


Fig. 3—Liquid fertilizer applicator. The various parts shown are: (A) Angle iron frame, slotted so it can move along support brace (C), which is attached to the furrow wheel bracket. (B) Pivot point of the plow beam. (D) Intake hose from the suppply tank on the tractor and (E) Tubes that discharge solution where desired. When the plow is raised out of the ground the drive wheel is raised so it will not operate the pump. The rotating reel leaves a partial vacuum in the tubes back of the point where they are collapsed and forces liquid out ahead of this point.

Curing of the hay in the bin was completed by forcing air into the center duct with a double-centrifugal fan driven by a 7½ h.p. electric motor. The fan and motor unit was located outside the bin under the surrounding canopy roof. The temporary duct connecting the fan to the conical hay deflector around the bottom of the central vertical duct, was removed before self-feeding. The horsepower delivery of the motor was about 4.9 and the air delivery was estimated at 11,000 feet per minute. About 5 days of steady fan operation plus two days of intermediate operation, was required to cure a batch of hay in the bin. The total time required varies with the time required to fill the bin. Static pressure of .76 inches (water gauge) was required to deliver the 11,000 cu. feet of air through the hay. Increasing the speed of the fan would have reduced the time required to cure the hay.

Late in the fall, as pastures became short, 90 head of cattle (fig. 4) were given free access to self-feed from the bin. The hay at the bottom, and as far up into the bin as the cattle could reach, was consumed first, resulting in a clean bin floor. Therefore all the hay

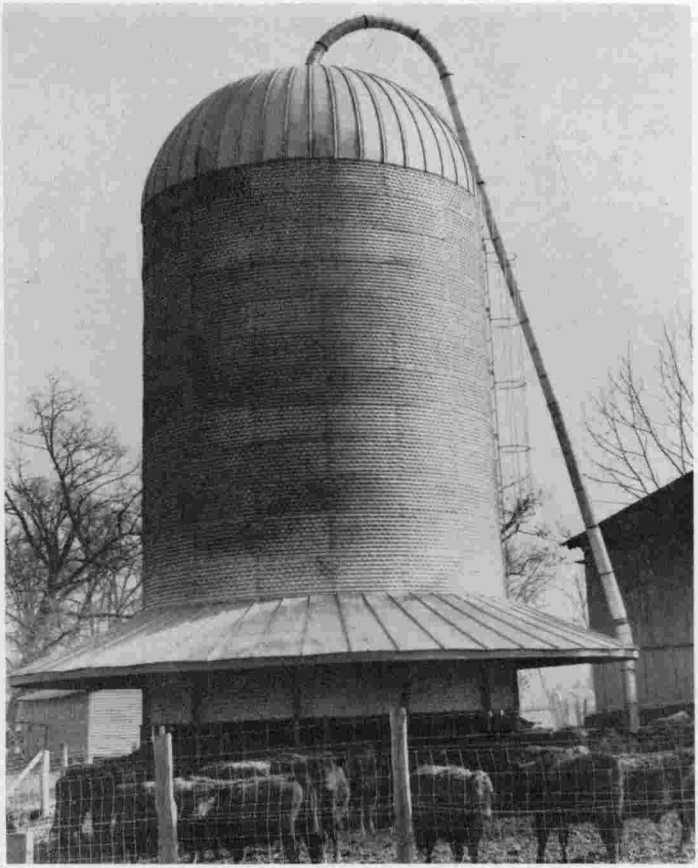


Fig. 4—Self-feeding, hay curing bin as revised, showing cattle feeding cafeteria-style. Bin was refilled with hay from nearby barn by suction.

rested on the conical hay deflector in the center, indicating that the tensile strength of the hay was too great to tear apart due to its weight. With a hay knife, slits were cut in the column of hay resting on the deflector. The four slits extended vertically from corners of the center duct, radially towards the outside. Before the last cut was completed, the hay slid down the deflector.

After the critical starting stage the hay moved down of its own accord except near the end of the feeding trial. The hay hung on the partitions around the outside. The top corners of the partitions were removed and the top pipe railing was notched into the wood. No further difficulties were experienced.

After this trial 4 more divider bars were added, one on each corner and on each side, making 8 in all. The bin was refilled with cured hay from a nearby barn, with a suction blower unit. The dry hay, having a low tensile strength, moved down freely, and partially enclosing the outside to reduce wastage became necessary.

The vertical center duct system for curing chopped hay in round bins, the self-feeding system and the reactance distributor for distributing hay in round bins were first used and developed by this station. These innovations are winning acceptance by commercial manufacturers and all are now commercially produced or incorporated in commercial designs. This not only includes hay bins but the distributor is being manufactured for use with silos. The self-feeding of hay in round bins is now being readapted for use with silos in northern states.

While the curing system was originally developed for use in a plywood sheeted bin, the self-feeding system was first used in combination with a prefabricated steel bin. A design using corrugated siding nailed to vertical studding and adapted for self-feeding has been prepared, where a home-constructed unit is preferred. The air flow in this bin is similar to the plywood sheeted bin. Air flowing horizontally from the center duct through the hay to the outside wall follows the studding to the openings at the top and bottom of the bin.

This bin is designed for trial with long hay as to self-feeding and filling with a long-hay blower and sweep rake. It is an attempt to provide efficient labor saving equipment for small farms where the hay hauling distance is less than ½-mile and where warranted equipment costs are limited.

The general status of the self-feeding hay curing bin may be summarized as follows: (1) The curing system as developed is efficient and satisfactory. (2) The reactance distributor when properly adjusted distributes the hay uniformly around the center duct facilitating uniform hay movement and eliminating irregularities in self-feeding. (3) The self-feeding has proven practical but further possible improvements are apparent and desirable. (4) Wastage is still a problem requiring some attention. (5) Improvements in elevator fan are desirable and factors affecting efficiency as related to streamline flow for design purpose are being investigated.

This project is cooperative with the U. S. Department of Agriculture and T. V. A.

The Mechanized Hay Bin

This bin is similar to the self-feeding hay-curing bin, but the hay is mechanically removed instead of self-feeding. The hay from the mechanized bin can be baled for marketing and can be refilled several times a year for curing and baling out successive crops such as alfalfa.

Preliminary trials showed the mechanical weakness of the hay ejector located at the bottom. The unit has been revised and reinforced for further trial.

WATER MANAGEMENT AND UTILIZATION

A. L. Kennedy

The fact that often there are periods of days and weeks in this humid area with insufficient rainfall has been recognized by farmers for generations. Modern farming with its year-round cropping systems, frequent establishment of crops, expensive mechanization, and inflated prices makes the matter of soil moisture of sufficient importance to induce farmers to do something more postive than wait for rain.

Infiltration, depth of soil, humus, fertilization and irrigation are the major controllable factors involved in soil moisture for any definite cropping system. Infiltration and irrigation have been studied on an experimental basis by this Station for more than 10 years.

Infiltration, Soil Moisture, and Runoff

The first runoff experiments were set up in April of 1936 on a privately owned farm near Knoxville.

Since then studies have been made on a total of 112 plots. Proof that soil management is a major factor in runoff and erosion is given by the data. A finding, the truth of which is not so obvious, is that the water loss from surface runoff on Tennessee land under good management is a surprisingly small factor in soil moisture deficiency. Most of the runoff occurs when the ground is already well-supplied with moisture. After the last soaking rain before a drouth, usable moisture in the top 6 to 12 inches is quickly taken out by evaporation and concentrated shallow feeding by the shallow rooted crops. The showers or small rains that fall during a prolonged drouth are easily absorbed by the dry, thirsty soil.

For the spring and early summer drouths, the abundant supply of moisture in the subsoil is used very little. There has been considerable interest in conditioning the subsoil for deep feeding. Theoretically, deep feeding would be a favorable factor in all aspects of water management. However, it appears that the expense and inefficiency involved would make it impractical on a large scale.

Organic matter or humus in the top soil is definitely a big factor in infiltration, and observations as well as research findings at some other stations indicate that it adds greatly to the efficiency with which the soil moisture is used. However, the additions of sufficient organic matter to appreciably increase the water storage capacity of the soil would be very expensive. About the best that can be done economically for thin soils is to maintain a reasonable amount in the top few inches. The direct effect of fertilization relates to efficiency with which available moisture is used.

Field Work in 1949

In previous years, our engineering work on irrigation was limited to the development of technics and equipment for the present irrigation needs. Work along this line was continued in 1949. Fur-

ther field tests were made on equipment developed by this Station during the last few years. This includes a number of things to help make sprinkler irrigation more simple and less expensive.

A new project was started that involves flood irrigation. Assistance was given Ben Clark of Vonore, Tennessee, in designing and constructing an irrigation ditch about 4000 feet long on a pasture slope. Some conventional methods of spilling water over the lower bank of the ditch were tried. Water can be conducted to the end of the ditch and can be directed down the slope, but none of the methods of getting it out of the ditch were considered entirely satisfactory. The operator complained of too much exposure to water and mud and too much labor.

The ditch is shown in figure 5. There was 1400 feet of 6-inch aluminum pipe used to convey water from the pump at the river. The elevation of the ditch above the river was 85 feet at the highest point. By making more ditches and extending them on around the hill it will be possible for Mr. Clark to irrigate about 75 acres in fields 1, 2, and 3 without moving the pump or pipe. Fields 4 to 14 are irrigated with the portable pipe and pump and experimental giant sprinklers.

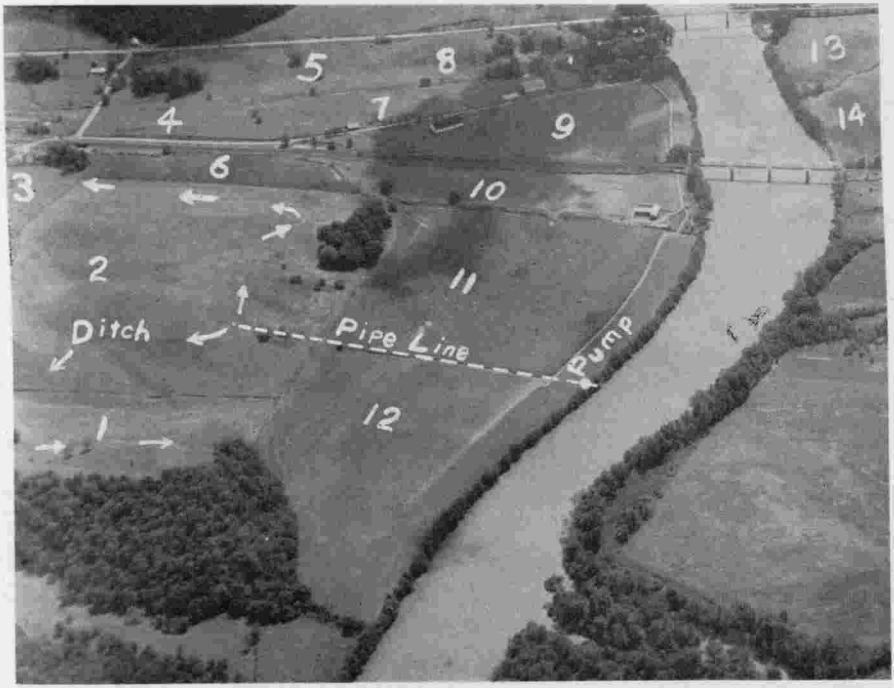


Fig. 5—Aerial view of the Ben Clark Farm on the Little Tennessee River. Wild flood irrigation is being tried in the steep pasture slopes in fields 1, 2 and 3. Fields 4 to 14 are irrigated with portable equipment including 2 giant experimental sprinklers.

STRAWBERRY CAPPER

A. H. Morgan

The strawberry capper work for 1949 was similar to that of 1948. After some repairs and changes, arrangements were made with a processor in Tennessee for testing the capper in his plant. This arrangement was ideal since it afforded an opportunity for comparing machine-capped berries with field hand-capped berries which were being packed in substantial volume.

Uncapped strawberries were supplied for machine capping from time to time and the results tabulated. Also, comparisons were made with fieldcapped berries selected at random.

In all tests except one, the machine capped berries as efficiently as hand cappers for berries ranging in sizes from 5/8 to 1-1/4 inch, and for sizes under 5/8 inch, the machine capped more efficiently.

The one exception of lower efficiency was on insufficiently ripened fruit and the lowered efficiency may be due to the firmer adherence of the stem to the berry in such fruit. The capping operation usually begins in the normal way, but the sepals break off before the entire cap and stem can be grasped and pulled free. A possible remedy for this situation would be the further sharpening of the capping rolls so as to effect more cutting action and less pulling. Changes are now being made to study the effect of sharper capper rolls so that better efficiencies might be attained on insufficiently ripened fruit.

For firm, well-ripened fruit the machine averaged 95.6 percent capping efficiency. In arriving at this figure, all partially capped fruit was grouped with the berries entirely missed. If however, the partially capped berries had been entirely capped, the average efficiency would have been 99.1. The berries which were missed entirely were peculiar in one respect and that is that the caps hugged the berries very tightly, offering no extending sepal for the capping rolls to grasp. Water jets were used, however, with the idea of fluffing or opening such caps, but their effect is negligible because there is no way to orient the berries in such a way as to receive the jets of water immediately below the caps.

Nearly all capped berries, both machine and hand-capped, leave too many short stems 1/8 inch long and under. Efforts are being directed toward improving the capping rolls so as to remove most or all of the short stems.

The machine capping experiments were concluded with one crate of mixed varieties from the test plots of the experiment station at Jackson with excellent results.

Machine capping on an efficient basis can cut the cost of processing measurably. Furthermore, berries remain fresh longer and pickers could pick 50 percent more berries if the capping was done by machine and not by hand, as is the practice at the present time.

AGRONOMY

GENERAL

L. N. Skold

Alfalfa

Methods of Seeding.—The work on methods of seeding alfalfa was continued this year. As for the actual methods employed, it is well enough established that the seed must be distributed uniformly over the land and then the surface dragged or preferably, rolled to cover the seed lightly and firm the soil. Therefore, the work is concentrated on the questions of seeding in the spring or fall and of seeding (if in the spring) with or without a companion crop.

Thus far, more uniform stands have been obtained from fall seeding. However, many stands have had to be abandoned because of severe damage from crown rot disease. This damage is avoided by spring seeding, since the alfalfa crowns are woody enough by the second spring to resist the disease. Spring seeding, alone or in fall-sown small grain, has been less successful than fall seeding for stand establishment. There has been little difference in results between seeding alone or in small grain when the grain is cut in the heading stage for hay. However, when the grain is allowed to stand until ripe some of the alfalfa seedlings are killed by shading.

Advantages of spring seeding include less erosion hazard, especially on steeper slopes, and the escape from alfalfa crown rot disease. Whether these advantages will compensate for the somewhat less certain stand establishment as compared to fall seeding, will require additional work and observation.

Seed Production.—In the fall of 1947, a study of factors affecting alfalfa seed production in this state was initiated. This project is being carried on at Knoxville and at each substation except Crossville. Successful seed production is, of course, necessary for the maintenance and increase of a variety and this work is considered preliminary to any breeding work that might be started. In the summer of 1948, yields of seed varying from 0 to 75 pounds per acre, were obtained at various locations in the state. However, in 1949, no seed was produced except for a small amount at Jackson from the second cutting. The 1949 season was excessively rainy, but the unsatisfactory results during two seasons would indicate that if seed is to be grown in Tennessee special techniques will be necessary. This may involve planting in rows which would be quite unsuitable for forage production. Work will continue during 1950 from a somewhat different approach.

Varieties.—The evaluation of varieties of alfalfa for forage production in Tennessee has become a part of the uniform variety testing program. However, a nursery is maintained in cooperation with

the U. S. Department of Agriculture, for the preliminary evaluation of recent selections developed at various locations throughout the country.

Soybeans

A soybean breeding and testing project is being conducted at Knoxville and Jackson in cooperation with the U. S. Department of Agriculture, for the development of superior varieties of soybeans for this state. Promising new selections developed at various Southeastern states are tested at various locations through the Southeast on a cooperative basis.

Temporary Pastures

The importance of temporary or supplementary pastures in this state was discussed in last year's report. A test to compare the relative production of winter forage by various winter annual grass and legume mixtures and from properly fertilized perennial grass and legume mixtures, was seeded in the fall of 1949 at Knoxville, Columbia and Jackson. The stands obtained were too poor to permit evaluation of production, therefore, the work will be repeated this coming year.

VARIETY PERFORMANCE OF FIELD CROPS

S. F. McMurray

Variety performance experiments were conducted this year on 8 of our major crops—corn,cotton, oats, wheat, barley, soybeans, alfalfa and red clover. These crops were tested, for the most part, at all of the 6 experiment stations across the state, and in cooperation with the station superintendents. Results of these experiments form the basis for the recommendations by the experiment station of varieties of the above crops. Detailed results of the variety performance experiments are given in Experiment Station Bulletin 214.

CORN BREEDING

F. D. Richey and H. C. Kincer

The year 1949 marked a transition year in the corn breeding program cooperative between this Station and the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture. Tests were made of new combinations among inbred lines that previously had been tested in other combinations, and single crosses involving lines previously tested very little, if at all, were begun. Some of the latter showed promise for the future.

During the year, yellow hybrid Dixie 22, formerly experimental T6013, was accepted for certification in Tennessee. Some 30 bushels of seed of this new hybrid were available for demonstration plantings in 1949, and 165 acres of seed were produced under certification by members of the Tennessee Crop Improvement Association.

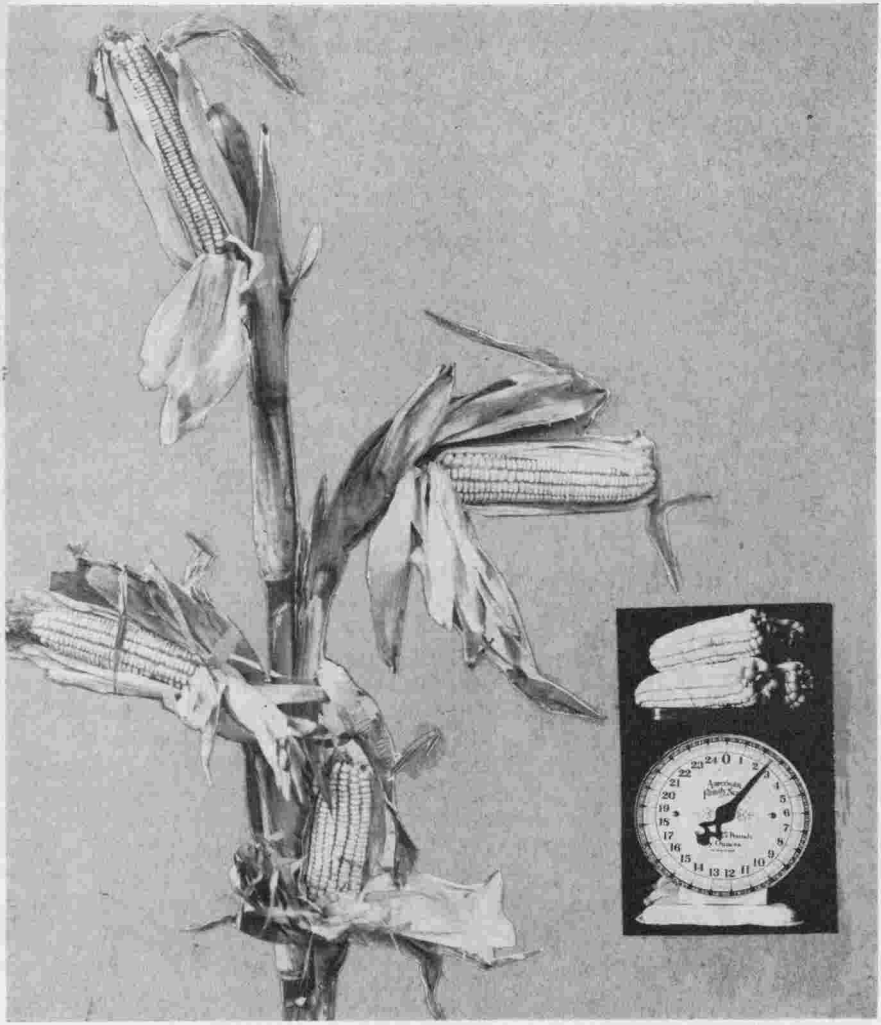


Fig. 6—A prolific corn plant from a single cross. The four ears from this plant weighed 2.5 pounds.

The experimental white hybrid T7112, mentioned in the 1948 report as ready for release, was accepted for certification in 1949 under the designation Dixie 33. About 50 bushels of seed of this new hybrid were produced for demonstration plantings in 1950, and seed stocks were increased sufficiently to permit 800 or more acres of seed production in 1950, if desired.

The yields of the 6 certified hybrids developed in this program and the average yield of the Jellicorse and Neal Paymaster varieties in the official tests in 1947, 1948, and 1949 are shown in table 2, together with the percentage of erect plants. It will be noted that

continued progress has been made in achieving higher yields. There also has been some progress in obtaining hybrids which are more resistant to lodging, although much is left to be desired in this respect.

TABLE 2—*Average acre yields and percentage of erect plants of certain varieties and hybrids in the Tennessee state yield test conducted at 6 locations in* 1947, 1948 *and* 1949.

Entries	Acre Yield	Erect Plants
Varieties	Bushels	%
Neal Paymaster and Jellicorse	76.9	90
White Hybrids:		
Tennessee 10	85.8	90
Dixie 17	86.3	89
Dixie 33	90.7	95
Yellow Hybrids:		
Dixie 44	70.6	95
Tennessee 602	77.6	93
Dixie 22	81.8	93

Newer inbreds tested in single crosses provided some promising results in experiments in cooperation with the Tobacco Station at Greeneville. It will be several years before the final answers can be had as to what these new inbreds may offer. Some of them are quite prolific and resist lodging better than previously available high-yielding inbreds. One single cross illustrates very well why prolific corns regularly out-yield the single-eared hybrids. Part of a plant of this single cross, bearing 4 ears, is illustrated in figure 6. The inset in the lower corner of the illustration shows the 4 ears after husking, with the weight of 2.5 pounds. At the planting rate used of 6,200 plants per acre, this was equivalent to 220 bushels of corn per acre.

Table 3 shows what may be expected from some of these new lines in hybrids. The actual performance of Dixie 33 in the experiments and its predicted performance, based upon the performance

TABLE 3—*Predicted and actual performance of Dixie* 33 *at Greeneville, Tennessee, in* 1949, *and predicted performance of* 3 *new hybrids based on single-cross data from the same experiment.*

(T13 x T61) (T101 x T105) = Dixie 33

	Acre Yield	Erect Plants	Lodging		Grade	Height	
			Root	Stalk		Plant	Ear
	Bu.	%	%	%		Ft.	Ft.
Dixie 33:							
Actual	74.9	82.2	3.8	14.8	2.3	11.7	5.0
Predicted	72.9	81.9	10.5	14.6	2.1	11.0	4.8
Three Prospects:							
(15 x 101) (18 x 30)	75.7	93.1	1.8	5.1	2.4	10.4	4.6
(15 x 18) (10 x 30)	75.8	94.1	3.9	2.0	2.0	10.7	4.7
(14 x 18) (15 x 30)	73.8	95.2	3.8	1.7	2.1	10.2	4.7

of the component single crosses, are first shown. Following this is the predicted performance of three "prospective" hybrids estimated in the same way as the predicted performance of Dixie 33. In view of the outstanding performance of Dixie 33, already shown in table 2, the indicated superiority of the prospective hybrids is definitely promising.

CROP IMPROVEMENT

N. I. Hancock

Cotton

The season was very favorable for high production of cotton at the Jackson station. There was no boll weevil infestation at that location; however in sections south of the station and in counties bordering Mississippi, the weevil caused large decreases in yield. All 10 varieties in the variety test produced around 2 bales per acre, with no significant difference in yield.

Bulletin 211 of this Station covers results of variety tests and related studies on cotton for the period 1936 through 1948. Eight varieties were selected as worth while for farmers to grow in Tennessee. These were selected from the results of the 12-year tests of over 80 varieties from different sections. Tennessee 241, which was developed by the Station, is among these 8.

The breeding and performance of Tenn. 241 is described in more detail in Bulletin 211. Other promising Tennessee strains are obtained from selections of crosses between inbred lines. These lines are the result of selfing and selection for particular characters, but after a period of 5 or 6 years of selfing their vigor is diminished. The vigor is restored by crossing with other inbred lines of unlike parentage. Around 800 of them are selfed each year, but only a few are retained for recombinations. Selections of the same type from a combination are bulked as the strain.

Oats

The LeConte Oat (fig. 7) was released in the summer of 1949. This variety came from a selection out of the cross Tennex (Tenn. 1884) by Bond. It has been carried in the tests as 138-14-427-1. Bond is a spring oat which has stiff straw and is resistant to crown rust and *H. Victoriae* blight. Tennex is very winter hardy, a high yielder and has weak straw. LeConte is very winter hardy, has stiff straw and some resistance to rust. It does not yield as high as Forkedeer and reaches maturity about one week later than Forkedeer. It is easily distinguished from Forkedeer by its dark green leaves both in seedling and later growths. It will stand pasturing as well as Forkedeer on account of its winter hardiness. LeConte will stand up for combine on soils of high fertility where Forkedeer will lodge.



Fig. 7—The LeConte Oat, a new variety recently released by this Station.

Around 3,000 head selections in short head rows are carried in nursery each year. These selections are out of crosses whose parents contain genes for stiffness of straw and disease resistance. In fact, disease resistance is being emphasized. However, in Tennessee crown rust on oats, for example, appears too late for measuring resistance. During the past year 200 lines were tested at the Florida Experiment Station, where natural infection is abundant every year. Only 15 of these 200 lines showed resistance to crown rust. Nevertheless, 1 out of these 15 appears to be promising in yield and other factors for growing under Tennessee conditions.

Barley

Of the small grains, barley is probably the most influenced by infections of various diseases. Scald, scab, and nuda smut were observed in fields over the state this past year. Every year mildew is found in the late growing stage and the Helminthosporiums, spot blotch and stripe, in the early seedling stages of growth. Resistance to these diseases is being emphasized in the breeding program.

In fact, promising strains resistant to mildew are at hand, out of the cross Marett Awnless by Jackson No. 1. Also first and second generation material is at hand for resistance to nuda smut from crosses of Tennessee strains with the resistant varieties of Dorsett, Gatami, MEB 472, 404, 502 and Kinroku. But stiffness of straw must be added also to our present varieties. Wong, a stiff strawed winter variety from China, has been used as a parent in most all crosses, (fig. 8). Strains are designated by their head type such as Awnless 8B1, Wong 707, Upright 9C3, Hooded 9D7 and Short-awn 12B11.

Legumes

Colchicine treatments were used on crimson clover and the lespedezas. Thus far this chemical has been applied in solution of variable strengths to the young growing leaf buds in the seedling state. The 2 per cent solution damaged the growing buds seriously, so that 1 per cent solutions were used this past year. Some effects were observed on Korean and Kobe lespedezas. But seed from affect-

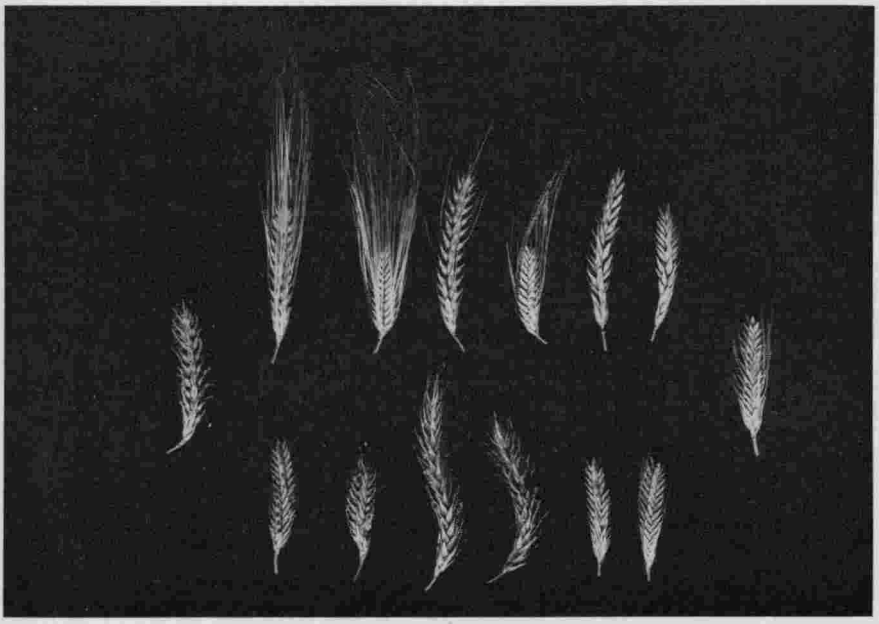


Fig. 8—Types of barley heads from Missouri E. beardless (left, middle) X Wong (right, middle).

ed branches must be planted and the plants observed before any variation can be determined definitely. No observed changes were obtained in the crimson clover plants. Length of time for treatment is another important phase of technique. It should be recognized that only those cells in active division are affected by colchicine which causes new combinations of the chromosomes and in turn variations in the plants. The time fator of treatment is being worked upon, and has not been determined definitely.

GRASS BREEDING

J. K. Underwood

Several grass species and varieties have been selected as having potential qualities useful to a Tennessee pasture and forage crop program. There were approximately 60 selections, which were based on green weight per acre which expresses the degree of adaptation, coarseness of the forage, seed production, and disease resistance. Included in these selections were several strains of *Agropyron, Bouteloua, Bromus, Chloris, Panicum, Paspalum* and others.

Species which appear to be especially adapted to specialized usages are: *Eragrostis curvula* (soil erosion control), *Zoysia Japonica* (lawn), *Zoysia matrella* (lawn), *Buchloe dactyloides* (lawn), *Cynodon dactylon* (dwarf strains for lawns and golf greens).

Work continues on selection and breeding for improvement in the following standard grass species:

Kentucky bluegrass.—Strain 6-06 was isolated in 1939-1940 and collected from an old pasture in a sandy field of the lower coastal plain of Georgia. This strain was planted on the Plateau Station in replicated plots and has become extremely vigorous.

Strains 10-37 and 10-49 have also been isolated at the Knoxville station. They will be grown and multiplied here for several years before they are planted at other stations.

Orchard grass.—The various strains of Orchard grass isolated still remain less productive than common orchard grass, falling short by almost 0.5 ton per acre dry weight. It is doubtful if these lines can be made more productive than common orchard grass.

Tall Meadow Fescue.—Strains of this species such as 8-53 and its variations continued to be equal to Alta Fescue and Kentucky 31 Fescue.

Smooth Brome.—Although the strains developed since the inception of the project are far superior to the unadapted original material, it is doubtful that these superior strains of smooth brome have a place in Tennesse agriculture, because orchard grass not only outyields them, but does not get sodbound. From the standpoint of hay and palatability, smooth brome is superior to orchard grass. It is hoped that a bunch-type smooth brome can be isolated having enough vigor to equal the rhizomatous strains.

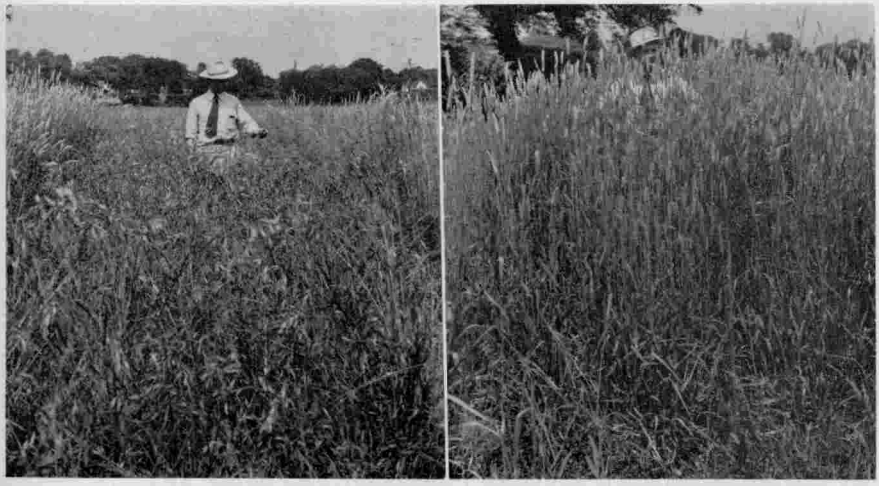


Fig. 9—Left. Rescuegrass 4-40-6, June 1949. A very heavy-seeding strain.
Fig. 9—Right. Harding grass plot, June 1949.

Rescuegrass.—Rescue 4-40-6 (fig. 9—left) a recent isolation out of 4-40, outyielded the best strains of rescuegrass by 0.56 tons. Other strains of rescuegrass checked were 4-40, 4-40-10, Texas rescue 56 and common rescue.

Harding grass.—This species continues to outyield all grasses, including all strains of tall meadow Fescue. Stands in plots (fig. 9—right) were 6 feet tall, or over. The many strains that can be isolated are very coarse as in the case of tall meadow fescue. An endeavor has been made through the years to increase the palatability of this species. On the west coast, this grass is becoming increasingly important. The stock like it and it is a tremendous yielder. It will grow in Tennessee provided it is seeded in late summer in well prepared seedbed and heavily fertilized.

It is a very vigorous coarse bunch grass very closely related to reed canary grass. Like it, it is a heavy seeder when in rows, does not volunteer readily, and the seed are grey and smooth like velvet.

Seeded with white clover as a companion species is the best way to get it and use it.

PASTURE-MIXTURES TEST

J. K. Leasure

Yields from the pasture-mixtures experiments in 1949 were approximately double those in 1948, but the 1949 performances of all 15 different pasture mixtures correspond closely with the 1948 results. The increased 1949 yields were partly the result of a favorable season in 1949, but were due in part to the fact that permanent pastures do not reach their maximum production during the first year.

For the 2-year period, 4 mixtures significantly outyielded all others, and there were no significant differences in yield among these top four mixtures.

The mixtures and their yields of air-dry forage are given below:

	Pounds per acre
Orchardgrass and ladino clover	4330
Orchardgrass and alfalfa	4420
Tall fescue and ladino clover	4430
Tall fescue and alfalfa	4220
Orchardgrass and Louisiana white clover	3400
Various other mixtures ranged from	2400 to 3100

The addition of annual species to a mixture with the idea of securing quick ground cover, and of helping the permanent species become established, is not justified. The orchardgrass and Louisiana white clover mixture when seeded alone yielded from 500 to 600 pounds of dry forage per acre more than the same mixture seeded with ryegrass, crimson clover, or button clover. The mixtures containing annual species made good growth and yields in the spring of 1948, but made very little fall growth. Since the annual species did not reseed on the unworked sod, and since the perennial species had suffered severe competition the first year, yields from these mixtures with annuals were much less in 1949 than yields of mixtures seeded originally without annual nurse crops added.

Hard seeded Dixie crimson clover did not reseed on the pasture sods.

The performance of orchardgrass and tall fescue from the standpoints of yield, aggressiveness, and ground cover maintained was equally good. The tall fescue remained green during the winter, but made no appreciable growth, while the orchardgrass tops were injured considerably. Both grasses made equally quick and equally good spring growth.

FIBER RESEARCH

K. L. Hertel

Testing Division

During the past year 4,461 samples were tested in the laboratory. The samples tested were allocated as follows: Commercial samples, 7.5 percent; Tennessee Experiment Station, 57.1 percent; and United States Department of Agriculture, 35.4 percent.

Fiber Properties

New Arealometer.—Recalibration of the arealometer scale based on round or nearly round continuous filaments has been completed. Capillary resistances and calibration charts for the new area-

lometer have been prepared, and ten of the new instruments are being constructed. Eight of these have been completed and are now in use in various laboratories.

Torsion Scale.—A new torsion scale has been developed which permits rapid and accurate weighing of fiber samples for the arealometer. Ten of these scales will be constructed to go with the new arealometers. Four have been completed and are in use.

Sample Preparation.—Techniques used in preparing samples for the arealometer have been modified slightly to speed up the process without materially affecting the accuracy of the results.

New Instrument.—Work is in progress on the development of an instrument for measuring the fineness of cotton without using weighed samples. This instrument would not be as accurate as the arealometer, but would require less time per measurement.

Compression Studies.—An investigation is being made of the behavior of cotton and other fibers under varying compression. It is believed that a study of the dependence of such quantities as gross volume, resistance to air flow, orientation, etc., on degree of compression may lead to new ways of measuring significant fiber properties.

FERTILIZER INVESTIGATIONS

O. H. Long

Nitrogen In Solution

Preliminary work with nitrogen in solution form was conducted with corn as the test crop. "Solution 32", was furnished by the Barrett Division, Allied Chemical and Dye Corporation. It contains 32 percent nitrogen, one-half of which is derived from ammonium nitrate and one-half from urea. Solution 32 was compared with solid ammonium nitrate. Both were applied as a side-dressing at a rate of 52 pounds N per acre when the corn was head high. There was a third treatment which received no side-dressing. All treatments were fertilized at planting with 6-12-12 in the row at rate of 500 pounds per acre. Only one experiment was conducted. The soil was a Huntington fine sandy loam. Results are shown in table 4.

TABLE 4.—*Comparison of solution 32 and ammonium nitrate as reflected in acre yields of corn.*

Type of nitrogen side dressing	Average (6 replications)
	Bushels
None	87.1
Solution 32	104.0
Ammonium nitrate (A-N-L)	110.5
L. s. d. (5%)	7.5

The results show that corn yields were increased by the nitrogen side-dressings. The yield obtained with the solid ammonium nitrate was slightly higher than that obtained with the solution but the difference is not significant. On the basis of the test, it appears that solution nitrogen compares favorably with the solid form as fertilizer nitrogen. The efficiency of the nitrogen approximated 1 bushel increase per 2-pound application of nitrogen, a return in harmony with results from numerous other experiments.

Fertilizer Studies On Permanent Pasture Seedings

Fertilizer studies on new seedings of a permanent pasture mixture were continued in 1948 and 1949. Forage production was considerably greater in 1949 than in 1948, although responses to nitrogen, phosphate, and potash on a percentage basis were less. Nitrogen was effective in increasing forage yields in most of the 16 trials, the average increase being 631 pounds of air-dry forage from an application of 30 pounds N per acre. Phosphate was effective in increasing yields on all trials except one with an average increase of 1118 pounds of forage resulting from an acre application of 200 pounds P_2O_5. The average increase from an acre application of 100 pounds K_2O was 281 pounds of forage, but responses to potash were statistically significant in only 2 trials.

There was a wide variation in the productiveness of the different soils. For example, the maximum yield was 6958 pounds of air-dry forage per acre on a Hartsells loam at the Plateau Experiment Station, where a complete NPK fertilizer was added. The yield obtained with the same treatment on a shallow Lexington silt loam on the farm of Lawrence Kee, Lexington, Tennessee, was only 3168 pounds of forage.

In 1949 the yields from plots that received small initial applications of phosphate and potash at time of seeding, followed by equal amounts applied as annual spring topdressings, exceeded those obtained from plots receiving a like amount of fertilizer applied all at time of seeding.

Chemical analyses of the forage for nitrogen, phosphorus and calcium are being made on certain selected fields. Changes in botanical composition of the pastures also are being studied.

Fertilization Of Alfalfa

Frequently alfalfa stands become low-producing after 3 or 4 years. Depletion of fertility is believed to be the chief cause of declining yields in most instances. With this in mind, a fertilizer experiment was started at the Plateau Experiment Station, in the fall of 1947, on a Hartsells loam. The entire area was limed at the rate of 2 tons dolomite per acre. Borax was applied at rate 20 pounds per acre and will be repeated annually. Initial rates of phosphate and potash ranged from 0 to 200 pounds P_2O_5 and 0 to 150 pounds K_2O per acre respectively. One treatment was fertilized at the rate

of 0-100-75 per acre and will be repeated annually as a spring top-dressing beginning in the spring of 1949. This particular treatment produced a yield of 4.64 tons of hay per acre in 1949 as compared to 3.90 tons where an equal amount of fertilizer was applied all at the time of seeding.

This experiment will be continued to determine the effect of top-dressing on yield and longevity of stand.

Subsurface Applications Of Fertilizers On Permanent Pasture Sod

A comparison of subsurface and surface applications of phosphate and potash on permanent pasture sods, on which data were collected in 1948, was continued in 1949. The experimental machine used for the subsurface application was a development of the Agricultural Engineering Division, Tennessee Valley Authority. With this machine, it is possible to place the fertilizer at various depths with very little disturbance of the sod. Subsurface applications were placed at a depth of 3 inches with one-foot spacing between the furrow slices. Surface applications were applied broadcast by hand. The rate of fertilization was 80 pounds P_2O_5 and 50 pounds K_2O, acre basis. An unfertilized check was used in most cases.

The results obtained during the 2-year period are summarized as follows: (1) responses to fertilizer were not pronounced with either the surface or subsurface applications, and differences in yields over the unfertilized check were not significant in most trials, and (2) surface applications were equally as good if not better than subsurface applications in those few cases where forage yields were increased by fertilization.

These comparisons were made on fields either not recently fertilized, or if recently fertilized, the fertilizer applications were at low rates.

Nitrogen and Spacing Experiments With Corn

In previous plant-population studies with corn in Tennessee, the rate per acre has rarely exceeded 9,000 plants. There is some question that maximum yields were reached at that rate, particularly when nitrogen had been applied at high rates. In addition, the question has been raised as to whether single-eared corns should be planted thicker than prolifics.

With these two questions in mind, seven experiments were conducted in 1949 on a variety of soils in various parts of the State. Six trials are covered in this report. Two corns were used: Dixie 17, a late prolific white hybrid, and Kentucky 103, a yellow single-eared hybrid typical of the Corn Belt varieties.

Spacing was such as to provide 8,000, 12,000, and 16,000 plants per acre. Nitrogen at 60, 90, and 120 pounds per acre was applied at each spacing. Phosphate and potash were supplied in adequate amounts. Yield data are presented in figure 10.

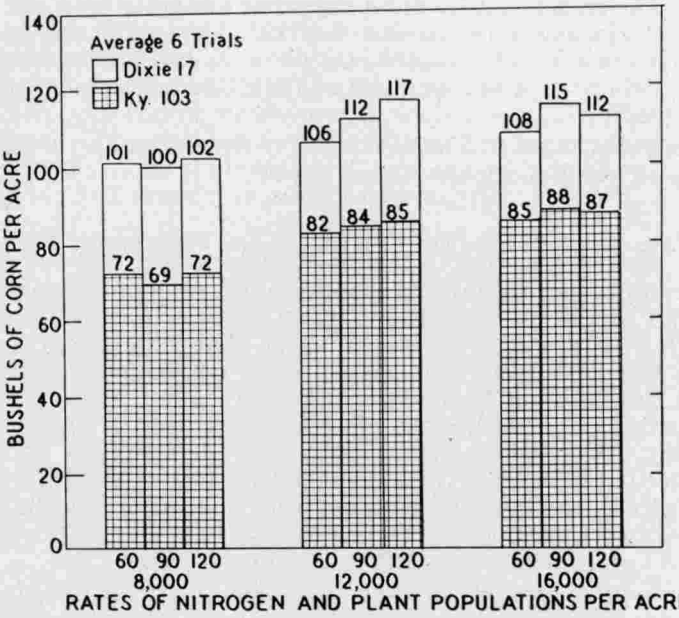


Fig. 10—Nitrogen and spacing experiments on corn. Average of trials located on Huntington fine sandy loam, Knoxville; Emory silt loam, Knox County, Etowah silt loam, Knox County; Crossville loam, Crossville; Elk silt loam, Columbia; and Lintonia silt loam, Jackson.

Weather conditions generally were favorable for corn in 1949. Dixie 17 produced 108 bushels per acre as an average of all spacing and all nitrogen treatments, in all tests and Kentucky 103 produced 81 bushels. This is a difference of 27 bushels in favor of Dixie 17, or 33 percent. Morever, yields of Dixie 17 were higher at all plant rates and all nitrogen rates at all locations. The highest yield of Kentucky 103 was only 84 percent that of Dixie 17 and was as low as 55 percent that of Dixie 17 at the 8,000-plant rate at one location.

Nitrogen applications in excess of 60 pounds N per acre had little effect on corn yields. Differences in yields obtained with the different rates of nitrogen were significant in only one trial. Ninety pounds of nitrogen appeared to be sufficient in all trials.

Wilson Dam Slag As A Liming Material For Red Clover

Calcium silicate slag is a by-product in the production of elemental phosphorus. It contains a small but variable amount of phosphorus. Some work has indicated that the phosphorus content of this material should be taken into consideration in its evaluation as a liming material, although it is considered essentially as a liming material only.

An experiment was set up at the Plateau Experiment Station, in the spring of 1949 for the purpose of (1) comparing Wilson Dam calcium silicate slag with a high calcic limestone and with a dolo-

mitic limestone as a liming material for red clover, and (2) evaluating the effect of the phosphorus content of the slag on crop growth. Rates of liming were 0, 1, 2, and 2½ tons per acre, all liming materials being applied at the same rate with no regard to particle size or $CaCO_3$-equivalence. Nitrogen, potash and borax were applied as a uniform over-all treatment.

The soil was a Hartsells loam, recently cleared from woods and had not been previously limed or fertilized.

Where calcium silicate slag was added at a rate of 2½ tons per acre with no added phosphate, the yield was 2290 pounds of hay. This compares with a yield of 2675 pounds where dolomite was added at the same rate, supplemented with enough triple superphosphate (40 pounds P_2O_5) to match the phosphorus applied in the slag. Dolomite at a 2½-ton rate with no added phosphate resulted in a yield of 875 pounds of hay.

Red clover was practically a failure where either lime or phosphate was omitted, producing about 850 pounds per acre of red clover hay with either treatment. Where both triple superphosphate (100 pounds P_2O_5 per acre) and lime were added, yields were in the neighborhood of 3000 pounds of hay.

The yields obtained with the different liming materials were not significantly different, the 1-ton rate resulting in yields about the same as those obtained with the 2-ton rate.

These results indicate that slag, limestone and dolomite were equally satisfactory as liming materials for red clover and that, in addition, the phosphorus content of the slag was of some value in the production of the crop.

CHEMICAL WEED CONTROL

S. F. McMurray, E. J. Chapman, James Epps, and J. C. Dunn[1]

Experiments were conducted with selective herbicides on cotton, corn, soybeans, and permanent pastures at the Knoxville station and at the West Tennessee Experiment Station. Tests were also started with non-selective contact weed killers on Johnson grass and Bermuda-grass.

Both the pre-emergence and post-emergence methods of spraying were used. If a chemical is sprayed on the soil after a crop such as corn or cotton is planted and before it comes up, this is called pre-emergence spraying; if it is sprayed on a crop after emergence from the soil, it is called post-emergence spraying. The first method is used to prevent weed growth in a crop and the other is used to kill weeds after they have become established.

A brief summary of experiments conducted this year are as follows:

Corn.—2, 4-D has been found to be an economical and effective weed killer on corn. The sodium salt and amine formulations of 2,

[1]The chemical weed control test on cotton at Knoxville was in cooperation with D. M. Simpson, Agronomist, U. S. Cotton Field Station, Knoxville.

yield responses to phosphorus fertilization are obtained on soils testing "low", while in other cases no yield responses to phosphorus fertilization are obtained on soils that are equally low in phosphorus.

Dilute hydrochloric acid did not extract as much phosphorus as did dilute sulfuric and dilute arsenic acids. However, differentiation among soil samples was greatest using hydrochloric acid. The addition of ammonium fluoride to these dilute acids increased the amount of phosphorus extracted over the amount extracted by the dilute acid alone. These results would indicate that the fluoride ion is capable of exchanging with phosphate ions held on the soil particles.

Successive extractions of phosphorus using dilute acids showed that different soils released phosphorus to the solution at different rates. The rate of release was closely correlated with the phosphorus activity of the sample. The higher the phosphorus activity of the sample, the more rapidly the phosphorus was released into the extracting solution during successive extractions.

STATE SOIL SURVEY

E. Winters

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. Department of Agriculture.

A detailed soil survey of 499,968 acres was completed during 1949, bringing the total to 9,007,535 acres. Field work has now been completed for 28 counties, parts of 2 counties and 6 special areas. Field work continues in 4 counties.

One report—Grainger—was made available to the public during the year, bringing the total of available published reports to 10. The manuscripts for 4 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 5 counties during 1949.

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

Profile samples are collected of all important soils in the areas surveyed, and are tested for acidity, organic matter and available phosphate and potash. Analyses of soil samples for available plant nutrients were completed for 3 counties during 1949.

WEST TENNESSEE EXPERIMENT STATION
Jackson

J. C. Dunn

Rotations.—Three crop rotations are being compared at this Station. They are (1) a one-year rotation of barley and lespedeza, (2) a three-year rotation of corn, wheat, and red clover, and (3) a three-year rotation of cotton, wheat, and red clover. The effects of lime and different fertilizer treatments on the yields of barley and lespedeza in the one-year rotation has been studied since 1936. Yields of both barley and lespedza were increased by liming, the average increase being 92 percent and 75 percent for the barley and lespedeza, respectively. Turning under the lespedeza crop resulted in barley yields that were 5.4 bushels per acre greater, on the average, than were obtained where the lespedeza was cut for hay. Total growth of lespedeza, determined before it was turned under, averaged 0.44 ton more than on plots where lespedeza was cut for hay.

Corn.—The projects in 1949 included continuous corn at various fertility levels, corn at various rates of nitrogen and plant populations, and corn interplanted with soybeans. The results of these tests showed that an application of 100 pounds of nitrate of soda alone resulted in an average increase of 14.5 bushels of corn per acre. Phosphate, potash, and manure produced the highest yield, which was approximately 25 bushels per acre greater than the unfertilized check which yielded 15.2 where limed and 11.9 where not limed. At these somewhat low yield levels, phosphate and potash were of no importance. In 1946, the applications of nitrate of soda were increased to 300 pounds per acre. The response to the additional nitrogen was pronounced. Furthermore, at these higher N levels the plots receiving phosphate and potash produced somewhat higher yields than those which received none.

ANIMAL HUSBANDRY

THE IMPROVEMENT OF THE PRODUCING ABILITY OF BEEF CATTLE

C. S. Hobbs, H. J. Smith, H. R. Duncan, R. P. Moorman, J. W. Cole, J. A. Ewing, E. J. Chapman, Hugh Felts, John Odom, Ben Hazlewood and Dennis Latham

The work is being initiated and carried forward as outlined at Knoxville, Greeneville, Oak Ridge, Crossville, Columbia, Springfield and Jackson. The breeding season was completed on 12 bulls (9 Herefords and 3 Angus) part of whose progeny will be tested in 1950. The 1949 heifer progeny of 2 bulls at Greeneville are being progeny tested on three levels of nutrition. The steer progeny is being tested under two different management conditions. Individual

feed records and weight gains are being continued on 1948 progeny of 3 bulls. The 1949 progeny of 5 bulls has been started on test and will be continued into 1950.

Ten registered Aberdeen-Angus cows with 7 registered Angus heifer calves were moved to the Plateau Station to start developing an Angus line.

Ten registered Aberdeen-Angus heifers which had been previously mated to a half brother were purchased to start a line. Five of the heifers are out of dams by the same sire. These were purchased from a reliable breeder who will cooperate in this program. Pedigrees of the entire herd are being obtained. Weights, grades, etc., will be made on this herd at periodic intervals. Agreement was made to retain breeding privilege to the sire used and another half brother. Portable weighing equipment is being developed for work with this and other herds. A dynamometer was found to be unsuitable but a portable scale unit seems to be practicable and suitable.

Individual monthly weights and individual grades for end of grazing period have been completed on 833 cattle at the various stations. Facilities for the level of development of steers, bulls, and heifers have been completed with preliminary work stared on one group.

Carcass grades and studies of the progeny tested steers from Greeneville Station were made. The meats laboratory should be completed by June which will furnish adequate facilities for complete carcass studies where desired.

Considerable time has been spent in developing a portable photographic chute with a side grid to be used in taking photographs of animals for permanent records and obtaining various body measurements. Various details including type of camera, use of artificial lights, and photographic distortion have been worked out satisfactorily. This photographic chute is being used at the Knoxville, Crossville, Greeneville, and Columbia Stations to obtain photographs of all calves at the time they are graded and placed on feeding tests and at regular intervals thereafter. To date, photographs have been taken of 23 calves at Greeneville and 16 calves at Crossville. Two groups of 11 calves each are being photographed monthly at the Knoxville Station for a study of the correlation and repeatability of various body measurements taken from photographs and live animals. It is planned to expand this phase of the study to include all the cattle if it proves satisfactory. The photographic chute will also be used to obtain permanent photographic records of sire progenies.

Summarization and analysis of the data involving cow-calf production studies at the Greeneville Station are being completed and will soon be ready for publication. Summary of the data available at the Crossville and Columbia Stations has begun and correction factors for adjusting weaning weights to a standard weaning age are being calculated for the Greeneville, Crossville, and Columbia Stations.

PASTURE INVESTIGATIONS WITH SWINE: LIMITED VS. FULL FEEDING OF GROWING AND FATTENING HOGS ON PASTURE—KNOXVILLE AND COLUMBIA

C. S. Hobbs, E. R. Barrick, H. J. Smith, J. A. Ewing, R. P. Moorman, J. W. Cole, E. J. Chapman & James B. McLaren

To study the optimum use of high-quality pasture in a swine production program, a series of experiments were started in spring of 1949 at the Knoxville and Columbia Stations with the following objectives:

1. To investigate the extent to which pasture can be substituted for concentrates for growing and fattening swine.
2. To compare different kinds of pastures for swine.
3. To compare the economy and efficiency of production of full-fed swine with swine fed approximately 80 percent and 60 percent of a full feed of concentrates on good pasture.
4. To investigate the value of adding protein to a ration of corn, mineral and pasture for full-fed and limited-fed swine.
5. To investigate methods of self-feeding limited-fed concentrate rations for swine on pasture.

Pigs full-fed on pasture gained 1.62 pounds per head daily as compared to 1.56 pounds for the pigs full-fed in drylot. They required 373 pounds of concentrates per cwt. of gain compared to 432 pounds for the drylot pigs (14 percent less) and required the same length of time (83 days for both groups) to reach market weight. On the basis of feed costs per cwt., of gain, the pasture saved $4.43 per pig on the cost of concentrates for fattening from 80 pounds to market weight.

Pigs fed 80 percent of a full feed on pasture gained 1.40 pounds per head daily as compared to 1.56 pounds for pigs in drylot (9.8 percent less), and required 11.7 percent more time (94 days compared to 83 days, respectively) to reach market weight. Using feed costs per cwt., of gain as the base, pasture in the 80 percent of full feed group saved $6.07 per pig on the cost of concentrates for fattening.

Pigs fed 60 percent of a full feed on pasture (fig. 12) gained 1.18 pounds per head daily as compared to 1.56 pounds for the drylot pigs (24 percent less rapid gains) and took 26 days longer (24 percent more time) to reach the same final weight (109 days compared to 83 days, respectively). The pigs on 60 percent of full feed on pasture required 27 percent less feed per cwt. of gain (314 pounds compared to 432 pounds) than the drylot pigs. Pasture in the 60 percent of full feed group saved $8.44 per pig on the cost of concentrates for fattening.

Results show that the full-fed pigs on pasture made gains of 1.62 pounds per head daily as compared to 1.40 for pigs on 80 percent of full feed on pasture (12 percent less), but the pigs on 80 percent

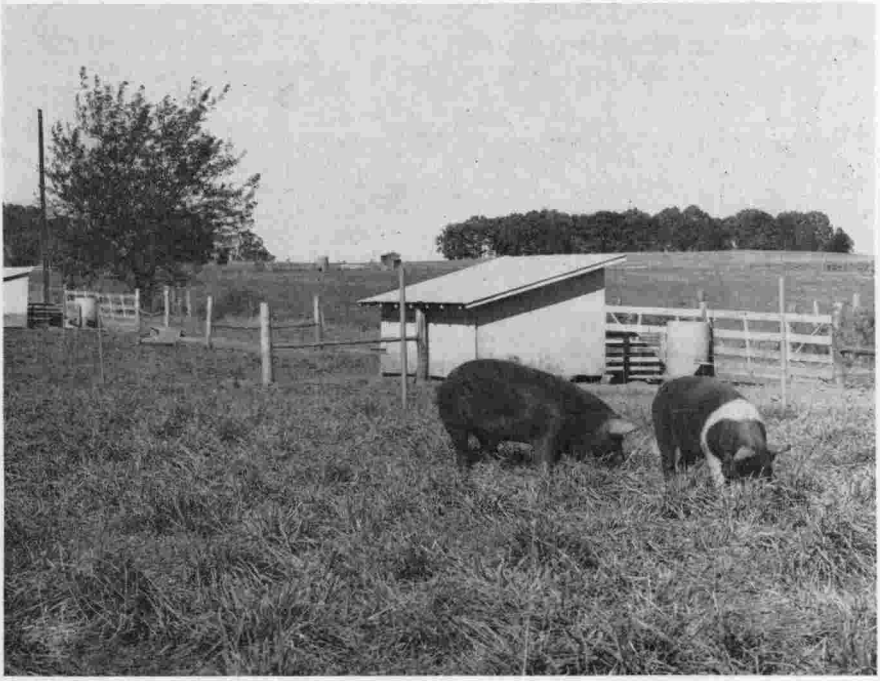


Fig. 12—Pigs fed 60 percent of a full feed on pasture.

of full feed required 8 percent less concentrates per cwt. of gain (342 pounds compared to 373 pounds for the full-fed pigs).

The pigs on 60 percent of full feed on pasture gained 27 percent less rapidly than the full-fed pigs on pasture (1.18 pounds per head daily as compared to 1.62 pounds) but required 15.8 percent less feed per cwt., of gain (314 pounds compared to 373 pounds respectively).

Pigs on 80 percent of full feed on pasture made 18.6 percent faster gains (1.40 pounds compared to 1.18 pounds) but required 9 percent more feed per cwt. of gain (342 pounds compared to 314 pounds) than pigs on 60 percent of full feed on pasture.

Pigs on corn and supplement on pasture made an average daily gain of 1.79 pounds as compared to 1.13 pounds for the pigs on corn alone on pasture (59 percent greater) and required 61 percent less time (70 days as compared to 113 days, respectively) to reach approximately the same final weight. They also required 12 percent less feed per cwt. of gain (358 pounds compared to 408 pounds for the pigs fed corn alone on pasture).

Under conditions of the Columbia Station experiment, Ladino and Louisiana White Clovers were equally good as pasture for swine.

The Hampshire-Duroc crossbred pigs at Knoxville made slightly higher average daily gains than the purebred Hampshires.

The amount of total fat in the carcasses as measured by the thickness of backfat was lower in the lots on limited rations, but the percentage of primal cuts, based on live weight, show only slight differences between lots.

Carcasses produced in lots on full feed graded slightly higher according to USDA proposed standards than the limited-feed lots. Lots on full feed, however, had a higher percentage of excessively fat carcasses.

A growthier kind of hog was apparently produced at the Columbia Station as indicated by differences in mean carcass measurements of length and width of body and thickness of backfat. These differences may be attributed to variations in the amount and quality of pasture at the two stations.

THE EFFECTS OF CERTAIN ATMOSPHERIC EFFLUENTS UPON THE GROWTH AND COMPOSITION OF PLANTS, AND UPON ANIMAL LIFE AT KNOXVILLE, COLUMBIA AND SPRINGFIELD

C. S. Hobbs, E. R. Barrick, D. E. Becker, J. A. Ewing, J. M. Griffith, R. P. Moorman, Dennis Sikes, J. L. West, E. J. Chapman and James McLaren in collaboration with Agricultural Chemistry

Cattle.—The cattle phases of the project at Knoxville, Columbia and Springfield are being continued as outlined in last year's report. Under the conditions of the experiment to date, the permanent teeth of the cattle on medium and high fluorine pastures, (fig. 13) show changes similar to the changes observed on the teeth of individually fed cattle on a comparable level of fluorine.

The permanent teeth of the individually fed cattle are showing changes starting with a mottling and chalky appearance and progressing to erosion, caries and abnormal wear at the high levels. The permanent teeth of the cattle on test at Columbia are beginning to appear and effects appear similar to those at Knoxville.

A survey of the cattle in the Columbia area was made. Using the Middle Tennessee Station as the center point, tangents were laid

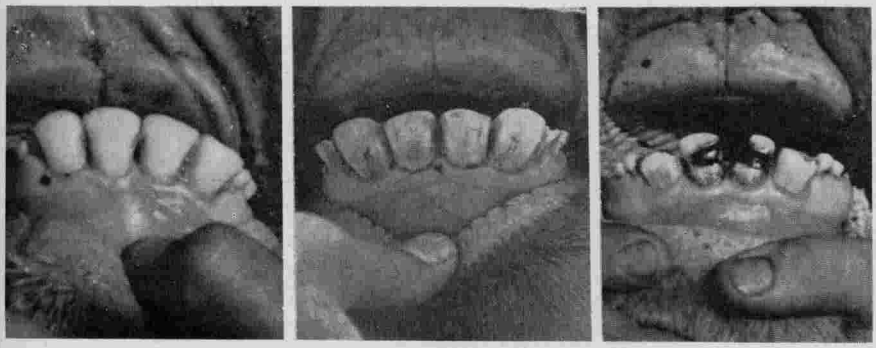


Fig. 13—Teeth of cattle as effected by different levels of fluorine (L-R) low, medium, and high.

off at each 22½° angle. On each tangent, at 2 mile intervals, cattle were checked for evidence of fluorosis. The distance from the center on each tangent depended upon the number of cattle to be found and evidence of fluorosis. In cooperation with the Agricultural Chemistry Department, forage samples at or near these points were secured for fluorine analysis. A summary of this first animal survey was made and will be correlated with future surveys, chemical analysis of forage, type of soil, level of nutrition of the herds, etc., in so far as practical and possible.

Animals slaughtered for the studies at Columbia and Knoxville were checked and samples taken for chemical analysis. Periodic gross examination of the teeth and general conditions of animals in the affected and control areas have been and are being made routinely.

Samples of urine, from the cattle on controlled levels of fluorine, were taken and analyzed for fluorine to see if urine analysis can be used as a diagnostic measure of fluorosis.

A preliminary study was conducted of the calcium, phosphorus, and fluorine balance of the individually fed heifers. The levels of dietary fluorine studied were control, 10, 20, 40, 50, 70, 100 defluorophos and 100 ppm. of fluorine added as sodium fluoride. The animals were fed their regular ration of corn, cottonseed meal and lespedeza hay. They had received the dietary level of fluorine for approximately 12 months before the trial. The balance trial was 10 days in duration.

A project is underway to find some means of counteracting fluorine toxicosis in cattle and sheep. It is designed to identify the metabolic derangement in fluorotic animals. Although fluorine is already recognized to influence calcium and phosphorus metabolism, other effects on the metabolism, such an enzyme inactivation, or antimicrobic influences may be equally important.

Sheep.—Studies are being made with sheep as the experimental subject because of the greater economy and ease of handling in metabolism investigations. Western lambs are being fed a ration of ground yellow corn, wheat bran, and lespedeza hay to which are added various levels of fluorine in the form of sodium fluoride. A study of the alleviating ability of aluminum compounds in the ruminant is also being conducted.

During the course of this test a number of investigations are being undertaken as follows:

1. A study of the effect of fluorosis in the initial stages upon the growth and efficiency of feed utilization.
2. Digestibility trials determine the ability of lambs consuming different levels of fluorine to digest the various fractions, particularly crude fiber, of the ration.
3. Coincident with the digestibility trials, additional samples are being collected in order to ascertain the calcium, phosphorus, and fluorine balance.

4. Periodically, lambs are sacrificed from each lot, and from these animals various tissues are collected for study. Calcium, phosphorus and fluorine analysis will be performed on the large metatarsal, lower mandible, liver, spleen, cardiac muscle, kidney, lung, and wool. Samples of these tissues are also collected for pathological studies.
5. Blood levels of calcium, phosphorus, magnesium, sodium, and potassium are also being conducted on all lambs.
6. A bacteriological study of rumen samples has been conducted. Excellent culturability of the samples was obtained, and further investigation of the microorganisms present is underway.

Small Animal Studies.—During the past year the small animal facilities have been devoted to a study of possibilities for alleviation of fluorine toxicosis. It is hoped that some substance will be recognized which has the ability to ameliorate the effects of a given intake of fluorine, perhaps, by preventing intestinal absorption of the toxic element or by otherwise interfering with its metabolism. The level of fluorine storage in the bone has been selected as the criteria, since this characteristic has been noted to vary directly with dietary fluorine intake, and hence, the extent of dental damage.

Various compounds have been studied. Aluminum sulfate, aluminum chloride, potassium phosphate, thyroprotein (Protamone), sodium borate and colloidal aluminum phosphate were some of the materials investigated. All substances were tested by feeding to weanling albino rats receiving various levels of fluorine for a period of six weeks. Variant levels of fluorine supplied as sodium fluoride were fed in order to be able to evaluate the alleviating materials in cases of chronic and acute fluorosis.

TABLE 5—*Mean Fluorine Content of Femur Bones of Rats Fed Possible Alleviators at Various Levels of Fluorine Intake*

Level of Dietary Fluorine (p.p.m.)	45	95	145	245	345
	%	%	%	%	%
Treatment—Experiment 1					
Control	.042	.155	.210	.371	.570
.02% Thyroprotein	.040	.124	.204	.388	.537
.053% Aluminum Chloride	.036	.102	.169	.268	.436
.133% Aluminum Sulfate	.036	.109	.170	.283	.406
Treatment—Experiment 2					
Control	.....	.132	.215	.388	.....
.1% Colloidal Aluminum Phosphate	.....	.132	.207	.....	.....
.04% Potassium Phosphate	.....	.135	.215	.....	.....
.08% Potassium Phosphate	.....	.....	.222	.385	.....
.1% Sodium Tetraborate	.....	.....	.197	.....	.....

Results presented in table 5 show that aluminum sulfate or aluminum chloride have possibilities as an ameliorant of fluorosis. Feeding .05 percent aluminum chloride with diets containing 45, 95, 145, 245, and 345 p.p.m. of fluorine decreased the bone storage of fluorine at these levels to 85.7, 70.3, 80.9, 76.3, and 71.2 percent of

the control value, respectively. Aluminum sulfate fed at a rate to supply approximately an equal amount of aluminum exhibited a depressing effect on bone fluorine to a similar magnitude. Feeding .02 percent thyroprotein did not significantly reduce the level of bone fluorine at any of the levels of dietary fluorine. Growth data collected did not reveal any differences.

An additional study on the effectiveness of variant levels of aluminum sulfate in the diet have been conducted utilizing rations containing 145 and 245 p.p.m. of fluorine. The results are presented in table 6.

TABLE 6—*Mean Fluorine Content of Femur Bones of Rats Fed Aluminum Sulfate as a Fluorosis Ameliorant*

Item	Ration Fluorine p.p.m.	Bone Fluorine %
Control A	145	0.28
.13% Aluminum Sulfate	145	0.20
.265% Aluminum Sulfate	145	0.16
.530% Aluminum Sulfate	145	0.13
Control B	245	0.48
.530% Aluminum Sulfate	245	0.26

The fluorine content of the femur bone of rats was markedly reduced at the levels of fluorine fed. Actually, at a dietary level of 145 p.p.m. of fluorine feeding .530 percent of aluminum sulfate reduced the bone fluorine level 53.5 percent, although the compound exerted a significant effect when only .13 percent of the aluminum sulfate was offered.

CREEP FEEDING VERSUS NO CREEP FEEDING FOR NURSING CALVES—COLUMBIA

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

The calves from the grade cow herd were used for this comparison again in 1949, which was the fourth trial involving creep feeding. A bermuda-bluegrass-white and hop clover pasture is used for these cows. This pasture has a high carrying capacity but does not produce as heavy or as fat calves as some pastures. The herd is also affected with fluorosis and is not giving creditable performance. Table 7 gives some of the more important results of this experiment.

Short-Feeding Creep-Fed and Non-Creep Fed Calves After Weaning

Representative middle weight steer and heifer calves were selected from the 1949 crop of creep and non-creep fed calves on October 18th and started on a feed of medium grade alfalfa hay and grain. This was the third trial of this kind conducted at this station. The more important results of this trial are shown in table 8.

TABLE 7.—*Creep Feeding Vs. No Creep Feeding For Nursing Calves*

Item	Lot 1 Creep-fed	Lot 2 Not Creep-fed
No. calves in test	13	13
Average date of birth	March 2	March 6
Average weight of calves when weaned 10/18/49	461.9	413.9
Average gain during creep feeding period from 6/1/49 to 10/18/49, (139 days), lbs.	236.5	186.9
Average daily gain during creep feeding period, lbs.	1.701	1.345
Average gain in favor of creep feeding, lbs.	49.6	
Average gain on cows during creep feeding period, lbs.	42.8	41.3
Average daily consumption of grain during creep feeding period, lbs.	4.95	
Average consumption of grain per head	692.0	
Average grain consumption per 100 lbs. extra gain.	1440	
Average value of grain consumed per head	$18.08	
Average appraised value per cwt.	$22.92	$21.88
Average appraised value per head when weaned	$105.86	$90.53
Average slaughter grade when weaned	Good—	H Medium +
Average loss per head attributable to creep feeding	$2.75	

TABLE 8.—*Showing Results of Short-Feeding Creep and Non-Creep Fed Calves After Weaning*

Item	Lot 1 Calves Creep-Fed	Lot 2 Calves Not Creep-Fed
Average initial weight 10/18/49 when weaned and started on feed, lbs.	470.4	415.8
Average final weight (Jan. 10 for Lot 1 and Feb. 7 for Lot 2) lbs.	615.8	633.5
Average gain for the 84 and 112 day periods, lbs.	145.4	217.7
Average daily gain for time on feed, lbs.	1.731	1.943
Average daily ration:		
Medium grade alfalfa hay	7.59	7.31
Grain—6 parts corn cob and shuck meal and 1 part CSM, lbs.	11.22	12.38
Average feed requirements for 100 lbs. gain, lbs.:		
Medium grade alfalfa hay, lbs.	438.7	375.9
Grain, lbs.	648.0	611.5
Average feed cost of 100 lbs. gain	$17.86	$16.86
Average slaughter grade when sold	High good	Good
Average dressing percentage (Final exp.wt. and hot carcass wt.)	56.94	55.96
Average appraised price 10/18/49 when weaned	$23.50	$21.00
Average selling price	$22.33	$23.00
Average profit over feed and initial cost	$1.11	$21.49

Remarks

1. After a feeding period of 112 days the non-creep fed calves were not in as good condition as were the creep-fed calves at the end of an 84-day feeding period. Both lots carried sufficient finish to be well received on the local markets.

2. The non-creep fed calves, selling on a higher market with a $2.00 margin, showed a $21.49 profit per head while the creep-fed calves with a minus $1.17 margin showed a profit on feed and initial cost of only $1.11. In this case it would have been advisable to have sold the creep-fed calves at weaning time.

BARN-WINTERING VERSUS PASTURE-WINTERING OF STOCKER CALVES—COLUMBIA

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

A lot of 8 weanling calves weighing 500 pounds were fed 142 days in the barn, 11.07 pounds medium grade alfalfa hay, and 1.5 pounds grain mixture daily compared with a similar lot wintered outside on fescue-ladino and crimson clover-oat pasture and 1.5 pounds grain mixture. The winter was very favorable for winter grazing and the calves ran outside without any hay or shelter. The winter gains were 149.8 and 190.1 pounds respectively and the winter feed costs per head exclusive of pasture $33.19 and $5.68.

The two lots were thrown together in the spring and run on a bluegrass pasture until October 21. The gains on summer pasture for 197 days were 147.5 and 161.4 pounds respectively. During a feeding period of 81 days on corn, cob and shuck meal, cottonseed meal and sorghum silage these steers gained 147.7 and 164.0 pounds with slaughter grades of low good minus and good minus respectively.

The winter pasture calves gained more during the first winter, and during each of two subsequent periods, sold for 21 cents cwt.. higher, and dressed 2.3 percent higher, than the barn wintered lot. The winter pasture calves returned $42.68 per head for the pasture used the first winter.

A COMPARISON OF ORCHARD GRASS AND KENTUCKY 31 FESCUE FOR YEARLING STEERS—COLUMBIA

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

Twenty acres of land was renovated and seeded during the fall of 1948. It was divided into four 5-acre pastures. Two were seeded to orchard grass and Ladino clover and the other two to Kentucky 31 fescue and Ladino clover. A thick stand of hop clover volunteered in all areas. Each 5-acre pasture was stocked April 1, 1949 with 3 yearlings which had gained approximately 100 pounds during the previous winter. During the spring and early summer the growths on all the areas were rank, with hop clover predominating, but by fall all the pastures became short. Some hay was made from the excess growth on the pastures during May.

During a 225 day period from April 1 to November 12 the average gain per steer of the two lots on the orchard grass mixture was 204 pounds and 212 pounds on the fescue mixture.

YEAR-AROUND GRAZING OF PERMANENT BLUE GRASS, HOP AND WHITE CLOVER PASTURE ("McFall" Project)—Columbia

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

This project was revised in its eleventh year (1948) to include fall and spring applications of ammonium nitrate. The 43 acres used for this project have carried approximately 20 head of calves

and yearlings annually. Each fall, weanling calves are added and they remain on the area until they go off as 2½ year old grass cattle. The cattle are wintered on the grass and hay made from the surplus pastures at different seasons. They, therefore, receive no feed from other lands and no protection from the weather except from a thicket and low hills. This system, over an eight year period, has produced 125 pounds of beef per acre and some excellent grass-fat steers have been produced.

No results are being released this year due to the fact that this pasture is affected with fluorine. There was a large difference in the rate of gains on the steers. Several of the yearlings and calves became unthrifty. The dressing percentage on the 2-year-olds sold in September varied from 48.7 to 59.8 percent.

FATTENING AND WINTERING YEARLING STEERS ON CORN SILAGE, ALFALFA HAY, COTTONSEED MEAL AND CRIMSON CLOVER AND RYE GRASS PASTURE—JACKSON

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

This project was repeated during the winter of 1948-49 under conditions which were very favorable for winter grazing. The steers were out on pasture 106 days of the 113-day period in contrast to 59 days for the previous year. Two-thirds of an acre was supplied for each fattening steer and 1½ acres for each animal being wintered. The ⅔ acre was not enough for the fattening yearlings, even during an open winter, to give them maximum benefits from the pasture.

Rations and Management

Lot 1. A fattening ration of corn silage and cottonseed meal fed in open shed.

Lot 2. Same as Lot 1 with access to a winter pasture of crimson clover and rye grass.

Lot 3. A wintering ration of corn silage and alfalfa hay fed in open shed.

Lot 4. Same as Lot 3 with access to a winter pasture of crimson clover and rye grass.

The cattle in lots 1 and 2 were sold each year in early April and the packers made no criticisms of the carcasses of the cattle which had had pasture. It appears that winter pasture can be used for either class of cattle when weather conditions are favorable and the necessary preparations are made. The pasture used was August sown and was not grazed until December 18. The land was occupied therefore, from July 1 until April in order to get 106 days grazing. It took from 3 to 5 times as many acres of feed, where pasture was used, as when dry feed was used. Enough dry feed should be provided to carry the cattle because even under average weather conditions it is too hazardous not to have feed in the barn. Table 9 summarizes briefly the results of this year's work.

TABLE 9.—*Performance of Fattening and Wintering Yearlings on Winter Pasture*

Item	Fattening		Wintering	
	Lot 1 Without Pasture	Lot 2 With Pasture	Lot 3 Without Pasture	Lot 4 With Pasture
Average initial weight of steers Dec. 18, 1948, lbs.	713.4	713.5	668.8	669.9
Average gain for winter (113 days) lbs.	236.0	288.5	94.5	260.8
Average daily ration for 112 day winter period:				
Corn-sorghum silage, lbs.	54.4	38.8	47.4	19.3
Cottonseed meal, lbs.	4.5	4.5	4.0	4.0
Winter Pasture	None	2/3 acre grazed 106 days	None	1½ acres grazed 106 days
Average feed cost per head exclusive of winter pasture	$50.66	$41.92	$35.50	$19.77
Average value of an acre pasture difference in feed cost per head and extra gain @ 20¢ lb.		$28.56		$32.66
Average acre feed requirements per head for wintering exclusive of C.S.M. [1]	.339	.907	.369	1.694
Average slaughter grade at end of winter period	H. Med.+	Low Good		
Average selling price at Nashville, cwt.	$23.50	$24.00	Not sold	Not sold
Average margins received	$—1.02	$ .52		
Average profit per head over initial and feed cost exclusive of pasture	$—14.08	$10.62		

[1] Based on yields of 9 tons of silage and three tons alfalfa per acre and pasture as used.

A COMPARISON OF TWO-YEAR-OLDS AND YEARLINGS FINISHED ON GRASS AND GRASS SUPPLEMENTED WITH GRAIN—GREENEVILLE

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

The third trial of this project was completed this year. The set-up was the same as in previous years with the exception that the two ages of steers were run together on the same pastures.

TABLE 10.—*A Comparison of Two-Year-Olds and Yearlings Finished On Grass With And Without Grain*

Performance of Cattle	Two-Year-Olds		Yearlings	
	Lot 1	Lot 2	Lot 3	Lot 4
Ave. weight 4/20/49 when turned on grass, lbs.	933.6	926.8	629.5	616.3
Ave. gain first pasture period 4/20-7/31, lbs.	118.5	123.3	156.6	151.6
Ave. weight 9/27, lbs.	1160.4			
Ave. gain second pasture period, lbs.	109.0	1221.6	890.7	902.3
Ave grain mixture per head daily 7/31 to 9/27, lbs.	None	171.1	102.2	134.3
Ave. weight 11/23/49		15.5	None	14.4
Ave. gain during dry lot period 9/27 to 11/23/49			1031.5	1052.8
Ave. daily ration during dry lot period:			140.8	150.5
Grain mixture			21.9	22.3
Alfalfa hay			9.67	9.49
Ave. feed cost 100 lbs. gain all periods (including winter feed cost)	19.38	19.90	15.81	17.89
Ave. slaughter grade when sold	L Good +	Good —	H Good —	H Good —
Ave. carcass grade (Federal)	L Good	L Good	Good	Good
Ave. dressing percentage final exp. wt. and warm carcass wt. basis	55.5	57.8	59.99	60.63
Ave. appraised value cwt. when sold	$21.00	$21.88	$22.50	$23.50
Ave. profit when sold over feed and initial cost on appraised values and final exp. wts.	$—14.94	$—5.11	$31.97	$33.27
Margins secured (sale price-price previous fall)	$—3.00	$—2.12	$—.50	$ .50
Ave. charges made for feed and pasture after 4/20/49	$32.00	$48.25	$60.65	$77.23

Table 10 gives a brief summary of the information obtained on these cattle.

Remarks

1. The 2-year-olds (figs. 14 and 15) made nearly twice as much gain during the winter period as the yearlings on approximately the same treatments and although their gains during first and second summer periods were some lower, they made an average of 80 pounds more gain than the yearlings from December 9, 1948 to September 27, 1949.
2. A full feed of grain on grass for 58 days was responsible for 62.1 pounds additional gain on the 2-year-olds and 30.1 pounds on the yearlings.
3. Feeding grain on grass proved advisable for the first time in this three year series on the 2-year-olds. The grass yearlings were more profitable than the grain-grass yearlings, September 27, 1949. The dry-lot feeding of the yearlings for 57 days proved very profitable this year due principally to an advance in the cattle market during this period. This situation made the yearlings more profitable than the 2-year-olds for the first time in this series.



Fig. 14—Two-year-old steers averaging 1221.6 pounds on September 27, 1949 after a full feed of grain on grass for 58 days. They consumed 15.5 pounds grain mixture daily during this period. They dressed 57.6 percent on final experimental weight and hot carcass weight basis and the carcass grade was low good. They were appraised 88 cents higher per cwt. than steers which went through the summer on grass alone and made $9.83 more profit per head.



Fig. 15—Two-year-old steers, finished entirely on grass, weighed 1160.4 pounds when sold on September 27, 1949. They gained 62.1 pound less than the grain-grass steers during the last 58-day period. These steers dressed 55.5 percent and their carcasses graded low good.

Setup of Project for Finishing Period

Two-Year-Olds:

Lot 1. Grass only to September 27.

Lot 2. Grass only to July 31, then a full feed of grain on grass to September 27 (58 days).

Yearlings:

Lot 3. Grass only to September 27, then a full feed of grain and alfalfa hay in barn (57 days).

Lot 4. Grass only to July 31, then a full feed of grain on grass to September 27, (58 days) and then a full feed of grain and alfalfa hay to November 23, 1949 (57 days).

EWE-BREEDING AND SPRING LAMB PRODUCTION PROJECT GREENEVILLE

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

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 successive matings of Dorset rams on similar ewes, are being produced at this station for production studies.



Fig. 16—A flock of ewes raised at the Greeneville Station are shown grazing on a pasture of oats, ryegrass and crimson clover, December 30, 1949.

While the ewe flocks are being developed the two original flocks are being studied for spring lamb production. The ewes (fig. 16) are carried on pasture, supplemented with alfalfa hay and small amount of grain during the winter. The results of the past year are briefly summarized in tables 11 and 12.

TABLE 11.—*Spring Lambs Produced from Grade Plateau Ewes by Dorset and Hampshire Rams*

Item	By Dorset Rams	By Hampshire Rams
Number ewes starting year	30	25
Number ewes lost during year	1	4
Number ewes barren or not raising lambs	3	9
Average weight of ewes 8/1/48, lbs.	139.4	137.8
Average weaned wt. of lambs 5/23/49, lbs.	82.7	83.1
Average daily gain of lambs to weaning	.687	.649
Average returns per head on lambs sold or retained	$23.87	$24.25
Average weight of fleece, lbs.	6.5	7.18
Average returns per ewe raising lambs, in lambs and fleece	$35.17	$33.82
Average returns per ewe starting year	$31.99	$22.52

TABLE 12.—*Showing Weights and Gains on New Flocks*

Item	By Dorset Rams	By Hampshire Rams
A. Ewes born in 1948:		
Number Dec. 31, 1948	12	14
Average weight Dec. 31. 1948, lbs.	100.8	113.8
Average weight Dec. 30, 1949, lbs.	141.9	162.1
Average gain for year, lbs.	41.1	48.3
Average weight of 1949 fleece, lbs.	10.5	10.36
Average value of fleece @ 51.55 cwt.	$5.42	$5.34
Average grade on type 12/30/49	H Good +	Choice —
B. Ewes born 1949:		
Number 12/30/49	19	14
Average weight 12/30/49, lbs.	105.6	108.6
Average grade on type 12/30/49	H Good —	L Choice —

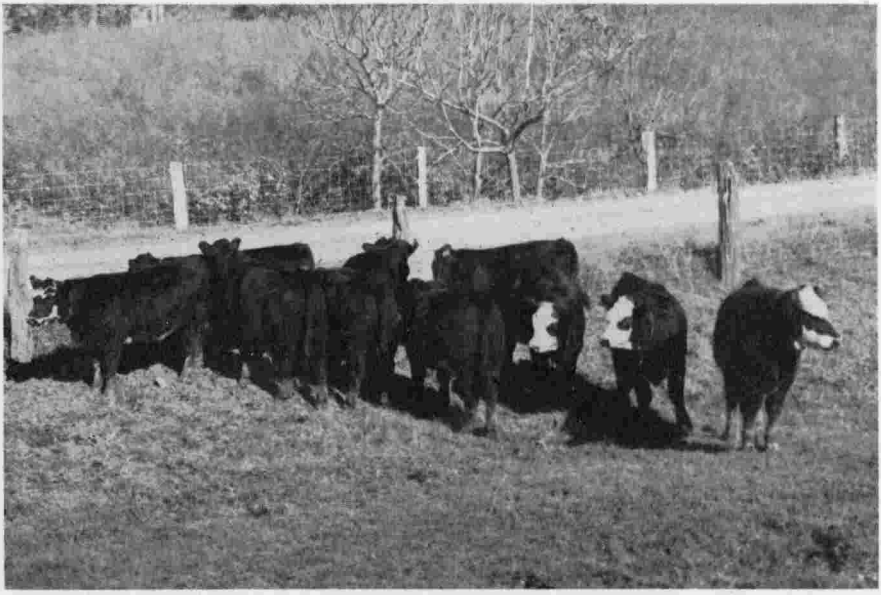


Fig. 17—Calves dropped in Jan. and Feb. 1949 out of grade Hereford cows by an Angus bull. They averaged 503.6 lbs. when weaned 11/3/49, having gained 1.557 lbs. per day from birth to weaning. The average birth weight was 64.5 lbs. Average feeder grade low choice.

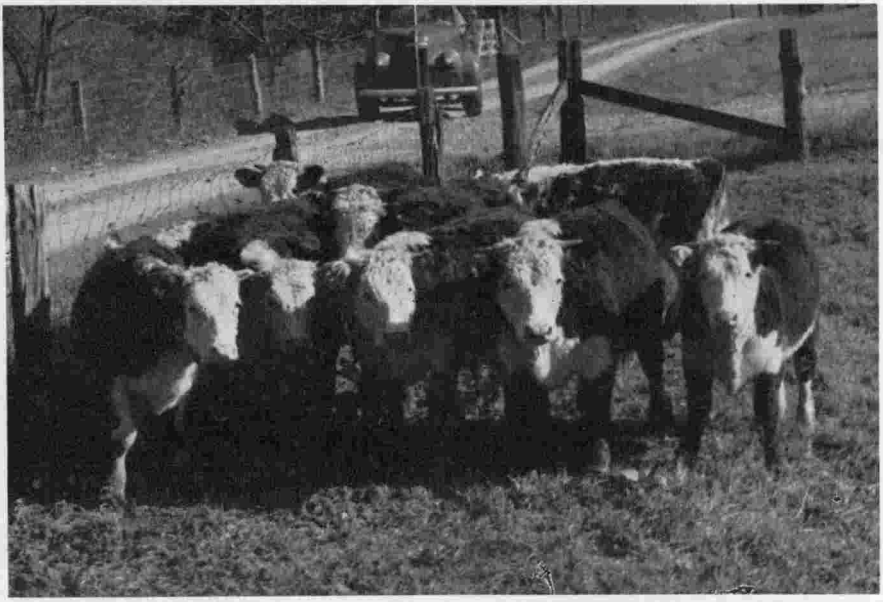


Fig. 18—Calves dropped in March and April 1949 out of grade Hereford cows by a Hereford bull. The average weight at weaning time 11/3/49 was 479.3 lbs. with an average daily gain from birth to weaning of 1.739 lbs. The average birth weight was 79.2 lbs. and the feeder grade high good. The late calves (March and April) gained faster from birth to weaning than the early calves (Jan. and Feb.) in the 1949 and 1948 trials.

COW-CALF PRODUCTION STUDIES—GREENEVILLE

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

The second 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 (fig. 17) with calves dropped in March and April. (fig. 18).
2. A comparison of calves by an Angus bull with calves by a Hereford bull.

The same bulls were used for the 1948 and 1949 calf crops but they were changed to different cow groups for the 1949 calves. The early-calving cows were fed some grain from the time they calved until April 1.

Tables 13 and 14 give some of the more important findings for the year 1948-49.

TABLE 13.—*Performance of Early Vs. Late Calving Cows*

Item	Jan.-Feb. Calves	Mar.-Apr. Calves
Cows, number per lot	21	21
Average weight Nov. 3, 1948, lbs.	1092	1081
Average gain for year 11/3/48 to 11/2/49, lbs.	55	52
Average winter ration 12/29/48 to 4/28/49		
Medium grade hay, lbs.	11.0	13.8
Silage, lbs.	31.5	28.3
Grain mixture (4 parts corn cob and shuck meal, 1 part CSM) lbs.	2.6	
Feed cost per cow for year	$80.88	$75.88
Calves, number weaned	21	19
Average date of birth of calves	Jan. 24	Mar. 19
Average birth weight, lbs.	72.5	72.0
Average weight when weaned 11/2/49, lbs.	524.9	453.5
Average age when weaned, days	282	228
Average gain from birth to weaning, lbs.	1.607	1.672
Average appraised value per head at weaning	$124.12	$106.10

TABLE 14.—*Calves by Angus Bull Compared With Calves by Hereford Bull*

Item	Calves by Angus Bull	Calves by Hereford Bull
Average birth weight, lbs.	64.7	78.9
No. steer calves	7	13
No. heifer calves	13	6
Average daily gain birth to weaning	1.581	1.698
Average appraised value per head at weaning, 11/2/49	$109.74	$118.13

THE INFLUENCE OF WINTER PASTURE ON RETURNS FROM TWO-YEAR-OLDS AND YEARLINGS FINISHED ON GRASS WITH AND WITHOUT GRAIN—GREENEVILLE

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

During the winter of 1948-49, 2-year-old and yearling steers were wintered on pasture in comparison to similar lots wintered in the barn on dry feed. The pasture for the 2-year-olds was mostly permanent bluegrass (2.3 acres per head). Mixed orchardgrass pasture (2.5 acres per head) was used for the yearlings. Alfalfa-

orchardgrass hay of good quality at $35.00 a ton and alfalfa hay also of good quality at $40.00 a ton was used for wintering the respective groups. With hay at these high values and silage at $10.00 per ton the wintering costs appear high. The 2-year-olds were charged 10 cents and the yearlings 7½ cents per day for winter pasture. Since equal numbers of steers on the two winter treatments were represented in the treatments given during the following summer and fall a comparison of the winter pasture influence on subsequent gains and returns is possible and is shown in table 15.

Remarks

1. The winter gains secured particularly on the 2-year-olds were higher than are considered desirable for the best and most economical use of grass the following season.
2. The pasture-wintered 2-year-olds gained slightly more on grass than the barn-wintered 2-year-olds, while the barn-wintered yearlings gained 17.9 pounds more than the pasture-wintered yearlings.
3. The returns as figured are in favor of the pasture-wintered lots. This is due principally to the difference in wintering charges. The dry feeds were charged at their relative market values while the pasture charges were placed at one-half the charge made for pasture during the summer. Summer pasture at $6.00 per month for 2-year-olds and $4.50 for yearlings are higher charges than are usually made, but may or may not be in keeping with the charges made for hay and silage. However the winter pasture charges made give little return for the pasture used. In case of the yearlings, each steer had the use of 2½ acres for 132 days, which at 7½ cents per day gives a return of $9.90 or $3.96 per acre. These steers in reality had the use of this pasture from September 15, 1948 to April 20, 1949, as it was allowed to accumulate growth from September 15, until December 9 when the steers were turned on this pasture for the winter.

TABLE 15.—*Showing the Influence of Winter Pasture on Subsequent Gains and Returns from 2-Year-Olds and Yearlings Finished on Grass and Grass Supplemented With Grain the Following Summer and Fall*

Item	2-Year-Olds		Yearlings	
	Barn Wintered	Pasture Wintered	Barn Wintered	Pasture Wintered
Average daily winter rations:				
Alfalfa-orchard grass hay for 2-yr.-olds; alfalfa for yearlings, lbs.	22.4	15.8	9.05	.57
Corn silage, lbs.	21.4		14.91	
Winter pasture		ad lib		ad lib
Average feed cost per head for wintering (132 days)	$58.52	$44.52	$30.75	$11.23
Average winter gain, lbs.	198.6	209.7	101.0	137.3
Average gain 4/20 to 9/27/49 when sold, lbs.	258.9	262.4		
Average gain 4/20 to 11/23/49 when sold, lbs.			347.7	329.8
Average gain 12/9/48 to 9/27/49, lbs.	458.5	472.1		
Average gain 12/9/48 to 11/23/49 (349 days) lbs.			448.7	467.1
Average returns per head over feed and initial cost to 9/27/49	$—6.96	$9.00		
Average returns per head over feed and initial cost to 11/23/49			$22.39	$51.05

COW-CALF AND PASTURE FERTILIZATION PROJECT CROSSVILLE

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

Herds of grade beef cows are maintained on pastures on which two levels of phosphate have been applied. The annual applications of P_2O_5 since 1939 have been approximately 13 and 42 pounds per acre on the "low" and "high" areas, respectively. Since the "low" area is twice as large as the high, two lots of cows are run on this area. For several years Lot 2 received a dicalcium phosphate supplement. This was discontinued after 1946 as it did not appear to be giving any results. A pasture renovation program was started the summer of 1947 with the hope of increasing the carrying capacity of the pastures. The old seedings made in 1939 had become weak. Each year one fifth of each area is worked up with a heavy disc, relimed and reseeded about September 1. The five-year phosphate applications are put on at the time of seeding.

Table 16 gives a brief summary of the results secured in 1948-49. The cows were wintered on 1108 pounds medium grade hay, 1120 pounds of wet corn stover and 90 pounds of corn and cob meal per head. Approximately two-thirds of this winter feed was produced on other lands, as insufficient roughage for wintering was made from the pasture areas. The 1949 grazing season was favorable until September. A crop of heavy calves was produced, (fig. 19).

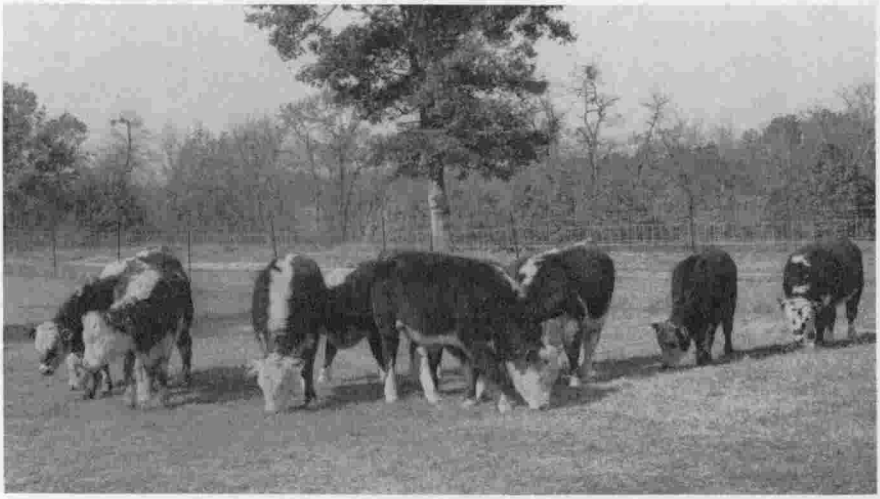


Fig. 19—A sample of the lusty, fast-gaining calves produced at the Grassland Station near Crossville from a herd of grade cows carrying considerable Shorthorn blood and sired by a Hereford bull. The calves are shown at weaning time November 1st. They did not have any grain.

TABLE 16.—*Performance of the Grassland Cows*

Item	Lot 1	Lot 2	Lot 3
Number of cows starting year	10	10	10
Number of calves raised	10	9[1]	8[1]
Average weight of cows in fall 10/31/48, lbs.	969.3	976.7	1087.5
Average gain of cows 10/31/48 to 11/1/49, lbs.	63.8	88.5[2]	72.7[2]
Average birth weight of calves, lbs.	70.2	64.0[3]	76.8
Average weaned weight of calves 11/1/49, lbs.	432.5	431.9	558.3
Average age of calves when weaned 11/1/49, days	174.1	184.7	213.8
Average daily gain birth to weaning, lbs	2.103	2.024	2.262
Average appraised value per head at weaning	$95.15	$95.01	$122.87
Average returns per cow bred	$95.15	$85.51	$ 98.92
Average net returns per acre from gain on cows, calves and yearling heifers (gross income less value of feed from other areas)	$28.46	$26.79	$31.19
Average beef yields per acre from cows, calves and yearlings (includes gain on some feed from other lands), lbs.	148	143	166

[1] One calf born very late in the year in each of Lots 2 and 3 were not included in the results. One calf was lost from Lot 3 at five months of age.
[2] Includes one cow in each lot which had not nursed a calf but for a very short time.
[3] Six of the nine calves were heifers.

JACKSTOCK AND MULE BREEDING—KNOXVILLE AND COLUMBIA

H. R. Duncan, R. L. Murphree, C. S. Hobbs, J. A. Ewing, E. J. Chapman and E. G. Morrison

The jackstock and mule breeding project was revised. The sperm physiology work is being done at Knoxville with the breeding herd still being maintained at Columbia. As this is the only jackstock and mule breeding project in the United States and since it has Regional and National application, the Bureau of Animal Industry of the U. S. Department of Agriculture decided to cooperate and aid in financing the project. The main objectives are to conserve and improve jackstock necessary to sire good mules and improve the keeping qualities of jack semen.

Studies of problems of jack semen for artificial insemination were continued. Most of the emphasis was placed on finding a satisfactory diluter for jack semen. In the undiluted semen jack sperm retain their motility less than 24 hours. An egg yolk-glucose diluter (1 part of egg yolk to 4 or 5 parts of 5 percent glucose in distilled water) mixed in a 1:1 ratio with the semen, was found to be more effective in maintaining sperm motility than the phosphate buffered diluters. The addition of minute amounts of potassium permanganate and vitamin B or C to the diluted semen appeared to have a stimulating effect upon sperm motility. The results are shown in table 17.

The jacks were bred to both mares and jennets and the offspring studied in an attempt to evaluate the transmitting ability of these animals. Observations, weights, measurements and photographs (fig. 20) were made of all animals. In so far as possible each jack was mated to mares of different types, i.e. light and

TABLE 17.—*Effect of Diluters on Maintenance of Motility of Jack Sperm*

Diluter	Init. Mot.	48 hrs.	96 hrs.	144 hrs.	192 hrs.
Undiluted Semen	0	0	0	0	0
Egg Yolk-Glucose	3.9	3.6	3.1	2.2	.9
Egg Yolk-Glucose Vitamin C	3.9	3.6	3.2	2.0	1.1
Egg Yolk-Glucose Vitamin C, potassium permanganate	3.9	3.8	3.6	2.0	1.2
Egg Yolk-Glucose Vitamin B	3.9	3.9	3.4	1.4	.8
Egg Yolk-Glucose Vitamin B, potassium permanganate	3.9	3.8	3.2	.75	.7

draft types. As the mules reached maturity, they were broken to harness and their reactions to various work loads recorded Preliminary analysis of respiration and pulse rate data obtained in the work tests indicated sire difference.

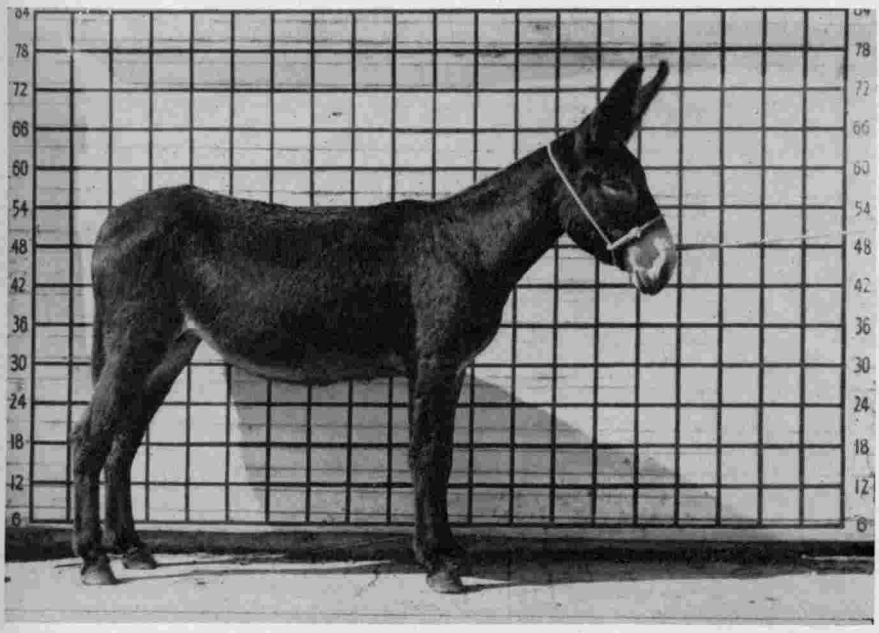


Fig. 20—Marvel's Mona 37024, a 3-yr. old jennet bred at the Middle Tennessee Station. She is the result of a half brother—half sister mating from linebred Logan stock with one line tracing to Limestone U. T. Monarch, a foundation jack purchased from L. M. Monsus & Sons.

VETERINARY SCIENCE

"X" Disease Of Cattle—Knoxville

Dennis Sikes

This relatively new disease of cattle is spreading in Tennessee. In the last two years 41 herds of cattle in Middle and East Tennessee have been affected in varying degrees. A total of 1190

cattle were in these herds and 501 died or had to be slaughtered. It is conservatively estimated that this represents a loss in excess of $100,000.00.

Field observations by the author suggest the following:

1. The rapid rate of spread in many herds, and the continued increase in the number of affected herds indicating an infectious agent or agents, is concerned in the development of the diseased condition.
2. Young calves and yearlings seem to suffer more from the disease than adult cattle.
3. The disease affects the reproductive tract of female cattle and abortions may occur or the animals become difficult breeders.
4. The removal of affected animals from the herd with strict sanitary herd practices instituted has proved successful in controlling the disease in 17 herds during 1948. Normal calves were produced in these herds in 1949.

Continued study and research will be done on the disease dealing with the following phases:

1. To identify the causative agent or agents.
2. To determine whether it is contagious and transmissible.
3. To study the pathogenicity and pathology caused by this disease.

Johne's Disease of Cattle—Knoxville

Dennis Sikes

This insidious disease of cattle, sheep and goats is increasing in the United States in the number of infected herds and animals. Unfortunately, a number of purebred herds are affected which presents an even greater problem in trying to control the disease.

The perfection of an accurate and reliable diagnostic test which will identify the infected animal has been our goal. A continuation of the testing work with intradermic johnin on cattle naturally infected with the Johne's bacillus was carried out in 1949.

All test sites gave positive reactions on the original or first test, and the suspicious and negative tests occurred on subsequent tests. All animals remained positive during the trials when tested in a previously unused area. Four animals were used in this series of tests and 60 repeated tests were made in the same site at 14, 16, 18, and 20 week intervals.

It is interesting to note that 35 percent of the tests were negative at 14 week intervals while only 8 percent were negative at 20 week intervals. Thus, when a herd is to be retested, it would seem that a period of at least 140 days is necessary between tests.

CHEMISTRY

SOILS, FERTILIZER, EFFLUENTS

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

Various Calcic And Magnesic Materials—Their Effects Upon Chemical Changes In A Cumberland Clay Loam

The primary objective of this experiment, initiated in 1914, was to determine the distinctive chemical and biochemical transitions that ensue after the several calcic and magnesic liming materials are incorporated in soils. The inputs were at 3 rates in soil alone and underlain with one foot of clay in 44 lysimeters.

The analyses of the 1948-49 rainwater leachings of Ca, Mg, K, SO_4, and NO_3 were for the 35th, and final, annual interval and they registered the effects of the incorporations of ground alfalfa. Those incorporations were intended to reflect present nitrifying powers of the variously limed soils, which have yielded only meager quantities of nitrates to the rainwater leachings in recent years. The increases in outgo of Ca, Mg, K, NO_3, and SO_4 are deemed attributable to the freshly incorporated organic material, to a heavy annual rainfall, and to the aeration incident to the incorporation of the alfalfa. The mean of the year's outgo of calcium from the alfalfa and calcic materials was 1300 pounds $CaCO_3$-equivalence per acre against 790 pounds from the calcic materials, with corresponding nitrogen leachings of 41 pounds and 17 pounds. The 24-pound difference represents 20 percent of the nitrogen introduced by the alfalfa, whereas the recent aerations of the calcium controls caused only a 10-lb increase over the nitrogen outgo that occurred in recent years.

After 35 year's exposure the soils were removed from the lysimeters, screened, mixed, and sampled for a laboratory study of the changes induced by the incorporated calcic and magnesic materials.

The Conservation of Economic Additions of Liming Materials

This lysimeter project dealt with the conservation of 4 liming materials, under influence of rate, periodicity, mode and zone of incorporation and was conducted in cooperation with the Virginia Experiment Station. The 20-year results were reported in Tennessee Station Bulletin 212, and in Virginia Station Technical Bulletin 112. The effects of residues of Ca and Mg upon repression in the outgo of K from K_2SO_4, applied in solution to the surfaces of the soils 20 years after liming, are yet to be presented.

The leachings of calcium from the inputs of limestone in the Tennessee soil were high during the initial years. They tapered off gradually, in parallel to the generation of nitrates and to the biochemical decomposition of organic matter of the soil, whereas such early leachings from the Virginia soil were at a lower rate and were more sustained.

In proportion to occurences in exchangeable form, the magnesium leachings from the Tennessee and Virginia soils were 1.8 times and 2.2 times the paralled leachings of calcium. In advocacy of the concept that the internally generated hydrogen ion is the principal replacing agent and factor responsible for the leachings of basic materials from soils, limed and unlimed, it is emphasized that there is no conflict between the conventional theory of base exchange and repeatedly observed phenomena of "reciprocal repression" that inputs of calcic liming materials exert upon outgo of magnesium, that inputs of magnesic liming materials exert upon outgo of calcium, and that inputs of both of those materials exert upon the outgo of potassium in lysimeter leachates. Rather, that theory is in accord with those phenomena upon basis of the well established principles of "complementary ion" effects.

Comparison of Calcium Silicate Slag And Limestone

The objectives of this 36-unit lysimeter experiment on Hartsells loam and Baxter silt loam were to compare TVA slag and calcic limestone as to neutralization values, through determinations of Ca outgo and to study the migration of fluorine from the incorporated slag. The materials used were 4-, 20-, and 100-mesh, and rates were 2-, 5-, 10-, and 20-ton $CaCO_3$-equivalence per 2,000,000 pounds of soil.

In the ninth year, the 4-mesh slag and limestone registered alike for $CaCO_3$-equivalence in net outgo of calcium from their 5-ton incorporations, through respective increases of 300 pounds and 400 pounds from the Hartsells and Baxter soils. The net increase in outgo of Ca from single 2-ton incorporations of 20-mesh material, and of 100-mesh material, was 130 pounds from the slag and from the limestone in the Hartsells soil and 160 pounds from each of those incorporations in Baxter soil. The net outgo of calcium from the 20-ton single incorporation of the 100-mesh materials in the limestoned soils was 600 pounds, against 900 pounds from the equivalent input of slag.

Fluorine occurence of 10 ppm was imparted to the leachings from single 20-ton incorporation of 100-mesh slag and to the leachings from four 5-ton incorporations of 4-mesh slag. Fluorine concentrations of 5 to 6 ppm occurred in the leachings from the four 2-ton incorporations of 20-mesh and 100-mesh slag and 3 ppm in the leachings from the 5-ton input of 4-mesh slag.

Comparisons of Calcite, Marble, Dolomite, Wilson Dam and Monsanto Slags and Wollastonite In Liming Effectiveness

The primary objective of these comparisons was to determine the rapidity with which the various materials effect neutralization of soil acidity, upon basis of their particle size.

The separates were incorporated into a Hartsells loam and into a Claiborne silt loam in lysimeters, at rate of 5000 pounds of $CaCO_3$ per 2,000,000 pounds of soil, June 1947. Both soils possessed de-

composition capacity beyond that rate. The coarser separate of dolomite was minus No. 60 sieve and plus No. 70 sieve; the finer separate passed No. 120 sieve and was stopped on No. 140 sieve. In processing the other materials, the coarser fraction comprised particles that passed No. 18 sieve and were stopped on No. 20 sieve; the finer particles were minus on No. 35 sieve and plus on No. 40 sieve. Periodic determinations of the pH values of the soils, increases in outgo of Ca and Mg in the rainwater leachings, and periodic determinations of carbonate residues served as measurements for specific liming effectiveness.

After two years, the highest pH value registered by the Hartsells soil was 6.3, through a pH elevation of 1.1 that was induced by dolomite. In relative effectiveness to counteract soil acidity, the materials ranked in the decreasing order, marble, calcite, dolomite, unquenched slag, quenched slag, wollastonite, and Monsanto slag. However, this order is applicable only upon basis of equal particle size, and not to products comprised of particles of different size and in variable proportions.

The rainwater leachings of Ca + Mg indicated an order of liming effectiveness similar to the order indicated by the pH values. Net outgo from the coarser separate of marble was 1.5 times net outgo from the coarser calcite separate. Because the finer separates of both marble and calcite had undergone nearly complete decomposition within the first year after incorporations, the two materials registered alike in calcium outgo. Since the dolomite particles were ¼ the size of the particles of the other carbonates, the outgo of Ca + Mg from the incorporated dolomite is not directly comparable to that from any other carbonate material.

The 200-pound net outgo of Ca + Mg from the Wilson Dam slag was half such outgo from the marble. Two years after incorporation, the Monsanto slag still registered the least reactivity, through an 80-pound net outgo of Ca + Mg from the Hartsells soil and a considerably smaller one from Claiborne.

Periodic determinations of carbonate residues afford the most accurate basis in the rating of the carbonate materials as correctives for soil acidity. Two years after incorporation the -35 +40-mesh screenings of both marble and calcite had suffered complete decomposition, but 27 percent of the 18- to 20-mesh separates of the calcite, and 14 percent of the marble, remained undecomposed in the soils that registered pH value of 6.2.

Incorporations of Mineral Silicates of Magnesium

The objective of this lysimeter experiment was to ascertain the behavior of inputs of olivine and serpentine in magnesium deficient soils.

Their separates of -100 and + 200-mesh, and of 325-mesh, were incorporated full depth into two soils to provide 1000 pounds of MgO per 2,000,000 pounds of soil, against controls of dolomite, magnesite, and magnesium sulfate, with and without calcic liming.

Only a small quantity of MgO appeared in the second year's leachings from the -100 + 200-mesh separates of either olivine or serpentine, or from the 325-mesh serpentine. However, there was an increase of 90 pounds in the outgo of MgO from the 325-mesh olivine in the unlimed Hartsells soil against only 20 pounds from the limed soil. Respective increases of 17 pounds and 5 pounds of MgO were leached from the 325-mesh olivine in the Claiborne soil, unlimed and limestoned.

The increases in outgo of MgO from the 100- and 325-mesh magnesite in the unlimed Hartsells soil were 53 and 94 pounds, respectively, against respective increases of 17 and 73 pounds from those separates in the limestoned soil. The passage of MgO from the dolomite was nearly as much as that from the 325-mesh magnesite, and much more than the outgo from the 100-mesh magnesite. The repressive effect of limestone upon the outgo of MgO from the dolomite was less than upon the outgo of MgO from the magnesite. Moreover, the 100-mesh dolomite proved as effective as the 325-mesh silicate materials, whereas this was not true of the magnesite. After two years, a fourth of the 1000-pound input of MgO as dolomite had appeared in its rainwater leachings against a 50 to 60 percent passage from the $MgSO_4$ control.

After two years, the leachings from the olivine and serpentine in Hartsells and Claiborne soils still indicate that an adequacy of magnesium in forms available for plant nutrition would not be provided through direct incorporations of olivine and serpentine.

Potassium Metaphosphate vs. Potassium Sulfate

The objective of this experiment was to determine the behavior of K carried by incorporations of potassium sulfate and potassium metaphosphate, the variables imposed being rate of input, liming, and soil type. The current findings are those of the seventh year of the experiment and the second year after the fifth and final 200-pound input of K.

Within 7 years the unlimed Hartsells soil released nearly 70 percent of the K from the 200-pound per annum inputs of both potassic materials against a 47 percent outgo from the single 1000-pound input as K_2SO_4- and an 85 percent outgo from the equivalent input of KPO_3. In its 7-year effect upon the leachings from the Hartsells soil, limestone caused a repression of from 200- to 250-pounds in the outgo K_2O. In the seventh year, there was decided contrast in the leachings of potassium from the inputs that were made at two rates. Residues as low as 250 to 300 pounds of K_2O from the five 200-pound inputs of K_2SO_4, yielded an outgo of 80 pounds of K_2O against a 10- to 20-pound outgo of from the 500- to 600-pound residues from the single 1000-pound inputs.

The findings for the corresponding incorporations into the Fullerton soil were similar, in all respects, to the findings detailed for the Hartsells soil.

These results indicate that the potassium residual from the 1000-pound input of K_2O as K_2SO_4 is "mineralized" into phases that are more resistant than are the residues derived cumulatively from the five 200-pound annual inputs.

The repressive effect of potassium metaphosphate upon outgo of Ca and Mg was referred to in previous reports. The unlimed Hartsells soil that received the 1000-pound input of K_2O as K_2SO_4 yielded a 1558-pound total outgo of Ca + Mg against one of 1205 pounds from the equivalent input of KPO_3. The limestoned Hartsells soil yielded 3634- and 3071-pound Ca + Mg totals from the corresponding inputs of K_2SO_4 and KPO_3, the larger outgo from the sulfate being accounted for entirely within the first year.

Fluorine Mobility In The Soil

This lysimeter experiment was inaugurated in 1948 to ascertain the extent to which ground waters acquire fluorine from inputs of calcium fluoride, potassium fluoride, Wilson Dam slag and concomitant effects from incorporations of limestone and of calcium silicate. The fluorides were incorporated full depth at the rate of 200 pounds of F per 2,000,000 pounds of soil.

The fluorine migrations from the KF, and from CaF_2, were 5 pounds per acre per annum in the unlimed Clarksville soil and 6 pounds from each of those fluorides in the unlimed Hartsells soil. The outgo of fluorine from KF, and from CaF_2, was repressed by the limestone in the Hartsells soil, but, this effect was not a certainty in the Clarksville soil, whereas the slag yielded nearly 10 pounds from the Clarksville soil but only 3 pounds from the Hartsells soil.

The effect that the 2- and 3-ton incorporations of finely ground fused wollastonite exerted upon fluorine outgo was the same as the effect exerted by limestone; but the heavier incorporations of the silicate caused large increases in the outgo of fluorine. The increases may not have been derived entirely from the added fluorides, however, because sole applications of wollastonite induced increases in the outgo of F as much as 7 pounds, against an outgo of only 0.6 pound from the untreated soil. The 12,000- to 16,000-pound incorporations of fused wollastonite caused considerable organic matter coloration in the rainwater leachings.

A related lysimeter experiment comprises fifty-six 1/10,000 acre lysimeters and calls for determination of plant uptake of fluorine from full-depth 300-pound per acre incorporations as cryolite, rock phosphate, magnesium fluoride, sodium fluoride and sodium silicofluoride in the Clarksville and Hartsells soils, which were limestoned full depth with 100-mesh limestone at respective rates of 9,000 and 6,000 pounds per 3,000,000 pounds of soil. Incorporation of every fluoric material was in quadruplicate; one lysimeter was kept fallow and 3 lysimeters were seeded to soybeans. These installations were supplemented by like placements and croppings of a Maury silt loam from Columbia, Tennessee, and one from Lexington, Kentucky.

Between June 29, 1948 and April 7, 1949, increases of fluorine in the leachings from the Clarksville soil were 1.5, 1.4, and 1.2 pounds per acre for the incorporations of MgF_2 NaF, and Na_2SiF_6 respectively, and a minus 1.9-pound outgo for the incorporated cryolite. The somewhat larger respective quantities, 3.3, 3.2, 2.8, and 4.0 pounds of fluorine, were leached from the corresponding incorporations in the Hartsells soil. The totals for outgo of fluorine from the Clarksville and Hartsells controls were 0.3 and 0.4 pounds per acre, whereas the leachings from the phosphatic Maury soil, one from Columbia, Tennessee and one from Lexington, Kentucky, carried a fluorine outgo of 0.7 pound per acre. The outgo of fluorine from the rock phosphate was intermediate between the outgo from the control soils and that from the Maury silt loam of high natural content of fluorine. The growing of soybeans registered no significant effect upon the concentration of fluorine in the rainwater leachings.

Behavior And Fate of Incorporations of Radio Active Calcium

Radio active calcium is being employed to determine the proportions of calcium that the rainwater leachings derive from supplies native to the soil and those introduced as limestone. Enhancement in outgo of calcium from an experimentally limestoned soil has been deemed attributable in the incorporated limestone. It was thought that this simple computation may not be truly indicative of the conservation of the old and new supplies of calcium in soils after they are either limestoned or dolomited. Hence, a U.T.-A.E.C. project was inaugurated in expectation that the quantity of calcium the rainwater leachings derive from the supply of that native to the soil can be differentiated from quantity the leachings derive from the incorporated limestone.

Radio active calcium was made a component of a precipitated calcium carbonate that was prepared in the A.E.C. laboratory at Oak Ridge, to provide incorporations into 100-pound placements of Hartsells and Claiborne soils in lysimeters at the rates of 1000, 2000, 3000, 4000, and 5000 pounds per 2,000,000 pounds of soil. The rainwater leachings are to be collected frequently for analysis at Oak Ridge. Parallel incorporations of the activated carbonate are being made in greenhouse cultures, the crops from which are to be analyzed to establish the proportions of normal and labeled forms of Ca that pass into the above ground growth.

Effects of Atmospheric Effluents Upon Plant And Animal Life At Two Locales

The studies upon this objective have been pursued on an extended scale by means of additional personnel and facilities at both Knoxville and Columbia. A prefabricated-structure of steel and aluminum was erected near the laboratories to facilitate and expedite the preparation, incineration, and analysis of samples of bones,

feces, urine and other noxious specimens submitted by Animal Husbandry.

Particular effort was made to improve the technique and to assure complete recoveries and reproducibility in the determination of fluorine content of various materials, through comparisons against standards and through exchanges of analytical findings with other laboratories. Because of the large collection of soils awaiting analysis, particular effort has been directed to the perfection of a procedure that will be applicable to all soils and soil minerals. To establish the dependibility of the presently prescribed 5-minute heating of $Ca(OH)_2$-saturated charges of soil at 500°C., as a step prefatory to distillation of the fixed fluorine and to determine duration for distillation, a study of the overall procedure is being conducted collaboratively with the Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A., on soils of various types and on parent minerals.

Collections of Field Samples: The effluent program calls for systematic and repetitive collection of samples of air, rainwater, streams, ponds, and vegetation from two areas in accordance with a grid pattern that covered radial distances from the University Farms in Maury and Blount Counties.

Sampling of vegetation was established as being representative through determinations of fluorine content of semi-monthly samples of bluegrass that were collected at points as far apart as 1,000 feet on four quadrangles in a 30-acre field.

Reported were 3,541 analyses, 1970 of which were for fluorine on materials from Maury County and 1054 from Blount County, together with 517 specimens of bones, animal excrements, and rations fed in the metabolism experiments carried on collaboratively by Chemistry and Animal Husbandry. Because of the inclusion of determinations of calcium and phosphorus, the analyses of those specimens are rated as requiring the effort and the time requisite for 2,000 determinations of the fluorine content of charges of plant tissue.

Identity of Effluent-Derived Fluorine: Upon examination by means of the spectrographic microscope and also through exposure to the X-ray spectrograph of the Bureau of Mines at Norris, Blount County specimens of vegetation registered the distinct pattern of calcium fluoride. After exposures 10 feet above ground at several points in Maury County, charges of sodium carbonate were found to have acquired appreciable proportions of fluorine. At the office of Middle Tennessee Experiment Station, such exposures acquired 4 ppm after 20 days, 17 ppm after 80 days, and 22 ppm after 8 months. Similar exposures nearby an industrial operation had acquired 19 ppm of fluorine after 30 days and 250 ppm after 8 months. On one farm in Maury County, the window panes were etched severely, the effect being the one produced when glass is exposed to vapor of HF in the laboratory.

Upon basis of daily output of product from one Maury County phosphate operation, the fluorine discharges were equivalent to 3,969 pounds of hydrofluoric acid in 1947, to 4,032 pounds in 1948, and to 2961 pounds in 1949. Since May 1949 an installed equipment for fluorine recovery has served to diminish greatly the discharge of fluoric effluents. The discharges of hydrofluoric acid for the years 1948 and 1949 were computed to be 1,467,900 pounds and 1,080,450 pounds, respectively.

In or near Mt. Pleasant, two companies are manufacturing "rock wool", by means of a re-fusion of the calcium silicate slag that is drawn from electric rock phosphate reduction furnaces. The fluorine discharges from those operations are equivalent to a mean of 25 pounds of hydrofluoric acid per ton of slag that is processed.

Fluorine Content of Vegetation: Samples of vegetation collected in Blount and Maury counties were found to contain fluorine in range of 2 ppm to 1300 ppm.

The soils of Blount County contain but little fluorine, but the soils of Maury County are characterized by unusual content of fluorine. Hence, it has been postulated that uptake therefrom causes vegetation to acquire an abnormal content of that element. In further consideration of this aspect, collections of Maury silt loam from Tennessee and from Kentucky were transported to locations not subject to fluoric effluents and there cropped in parallel with cropping at the point where the collections were obtained. The crops grown on the soil at Columbia attained a fluorine content of 34 ppm but corresponding crops showed decidedly lower content of 4 ppm on the Cumberland Plateau, 8 ppm at Knoxville, and 8 ppm at Springfield, whereas the Kentucky soil registered 8 ppm, for crops grown at point of origin and at Knoxville.

In an opposite procedure, crops were grown in parallel on four East Tennessee soils in rims at Knoxville and at Columbia. Fluorine contents of 3, 8, 7, and 5 ppm were found for the vegetation grown on the four soils at Knoxville, in contrast to contents of 42, 37, 35, and 33 ppm for the corresponding vegetation that was grown on the same four soils at Columbia. A mean of only 7 ppm of fluorine was found for the eleven collections of bluegrass and the eleven of alfalfa that were supplied by the Kentucky Station. Although these samples of vegetation were grown on the Maury silt loam of unusual content of fluorine, and of phosphorus, they were collected at a point where vegetation is not subjected to contamination from fluoric effluents. In a related experiment a per acre input of 975 pounds of fluorine in each of three forms caused no increase in fluorine uptake by successive crops of soybeans and lespedeza and those crops showed a mean of only 7 ppm for fluorine content.

Metabolism studies: Some 500 analyses of bones, animal tissue, excretions and experimentally prepared feeds were made, as contribution to the experiments in the feeding of fluorine-enriched materials to livestock and to small animals.

U. T.—T. V. A. Cooperative Projects

Greenhouse Studies: Among the experimental materials tested for fertilizer effectiveness were mono- di- and tri-magnesium phosphates; 6 nitrated dicalcium phosphates; 3 complex metaphosphates and pyrophosphates; 8 mixtures of superphosphate and magnesium silicates; several phosphornitrilic and phosphimate compounds; 3 of boronated fused tricalcium phosphate, concentrated superphosphate and superphosphites, mixtures of superphosphate and superphosphite, phosphorous acid and calcium phosphite.

In general, the magnesium phosphate, the nitrated dicalcium phosphates, the complex metaphosphates and pyrophosphates and superphosphate-magnesium silicate mixtures proved effective, as did the phosphornitrilic compounds; but the phosphimate compounds registered different degrees of effectiveness. The polymetaphosphimic acid and NH_4-metaphosphimate were as efficacious as the concentrated superphosphate and ca-metaphosphate controls, on the unlimed and the limestoned soils.

Through infusions of 0.4, 0.7, and 1.1 percent of boron into fused tricalcium phosphate, incorporations of that product provided alfalfa with an adaquacy of that element. However, the 1.1 percent infusions caused considerable decreases in the efficacy of the phosphorus content of the fused tricalcium phosphate, as indicated by chemical procedure and by plant response.

The phosphorous and phosphoric materials were incorporated at the rate of 160 pounds of P_2O_5 and crops of red clover, ryegrass, alfalfa, millet, and soybeans were grown in parallel and in succession. The superphosphites proved superior to phosphorous acid and to calcium phosphite on the initial seeding, and were even more effective upon the second crop. With increases in ratio of phosphate to phosphite in the mixtures of superphosphate and superphosphite, those mixtures registered increased effectiveness through larger plant response. The greater effectiveness that the second seedings registered for the phosphorous and phosphite materials was interpreted as the result of the transition of the phosphite to the phosphate ion. For a given input, plant response to the phosphorous materials was always better on the limestoned soils than on those unlimed.

Because effluent fluorine reaches the soil as hydrofluoric acid, applications of 200 ml of that acid were made to the Hartsells loam and the Clarksville silt loam, unlimed and limestoned at respective rates of 4 tons and 2 tons per acre. The fluorine inputs were at rates of 100, 400, and 800 pounds per acre surface and were made after the limestone and the supplements of phosphate and potash had been incorporated full depth. The hydrofluoric acid was sprinkled on the surface of the potted soil and a week allowed for reaction. The upper ¼ zone of soil of each pot then was removed, mixed and replaced.

Grown on the unlimed Hartsells soil, red clover showed fluorine contents of 16 ppm for the control, 19 ppm for the 100-pound input of fluorine, 82 ppm for the 400-pound input and no crop on the soil

that received the 800-lb. applications. Grown on the Clarksville soil, the corresponding crops of red clover showed fluorine occurrences of 14, 19, 86, and 150 ppm. Grown on the limestoned Hartsells soil, red cloved showed fluorine contents of 20, 18, 24, and 44 ppm for the order of inputs given for the unlimed soil. The corresponding crops from the limestoned Clarksville soil showed fluorine concentrations of 13, 15, 28, and 92 ppm.

On the soils of series B, where the standard rate for limestone incorporation was augmented by an amount equivalent to the added hydrofluoric acid, the red clover on the Hartsells soil showed fluorine contents of 20, 21, 19, and 23 ppm, with corresponding occurrences of 13, 20, 29, and 44 ppm of fluorine in the red clover on the Clarksville soil.

On the soils of series C, the applied hydrofluoric acid was allowed to react with the unlimed upper zone before the appropriate fraction of the limestone incorporations was made into that zone. The crops of red clover showed fluorine contents as follows: 11, 12, 23, and 25 ppm for the control and respective inputs on the Hartsells soil; and corresponding contents of 15, 16, 22, and 43 ppm of fluorine on the Clarksville soil.

On the unlimed soil, the effect of the hydrofluoric acid was to diminish the growth of clover, in line with the increase in rate of applications. The 400- and 800-pound inputs of fluorine in the acidic form were much less severe upon the growth of red clover on the Clarksville soil than on the Hartsells soil.

Because applications of cryolite (Na_2AlF_6) may reach the soil when the material is dusted or sprayed for insect control, the natural and synthetic forms of that fluoric material were incoroporated in pot cultures of the Clarksville silt loam, unlimed and limestoned to supply fluorine inputs at per acre rates of 100, 200, and 500 pounds. Grown on the unlimed soil, the successive crops of ryegrass and soybeans acquired higher concentrations of fluorine from the relatively heavy incorporations of both of the cryolite materials. On the limestoned soil, the vegetation acquired fluorine increases that were not so high, although they were significant. At the 200- and 500-pound rates for fluorine input, the natural and synthetic forms of cryolite showed repressive effects upon the growth of the soybeans on the unlimed soil. On the limestoned soil, however, those two inputs were not repressive upon soybean growth, although they did effect increases in fluorine content, and in P_2O_5 content and uptake. It appears improbable that the use of cryolite as an insecticide would develop cumulative residues that would induce a toxic effect upon plant growth or abnormal uptakes of fluorides from the soil.

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

GENERAL CHEMISTRY

G. A. Shuey

Frozen Foods

With a view to further improvement in the quality of frozen foods, and the study of varietal suitability of the various kinds of fruits and vegetables, experiments in freezing-preservation were continued during the year, (figs. 21 and 22). The following products were prepared, frozen, stored in 0° F., and later examined for quality: Apples, 6 varieties; blueberries, 1 variety; boysenberries, 1 variety; peaches, 2 varieties and 38 different treatments; red and black raspberries, 1 variety each; strawberries, 14 varieties and 30 different treatments; green snap beans, 11 varieties; sweet corn, 12 varieties; and peas, 20 varieties. Also, 21 varieties of pears were canned and later tested for quality.

Varieties with highest quality ratings are as follows: Green snap beans—Tendergreen, B-1627, and Topcrop. Sweet corn—Gulf Coast, Golden Cross Bantam, Erie, Tendermost, Iona, and Flagship. Strawberries—Tennessee Shipper, Tennessee Beauty, Blakemore, and No. 965. Garden peas—P-47, Progress X, Large Pod Little Marvel, P-87, Victory Freezer, Wyola, and Dark Skinned Perfection. Pears—38S63 excellent quality, Orient, 38S94, 38S387, and 34S142.

In addition to the processing and taste testing of the various samples of frozen fruits and vegetables during the year, more than 100 samples of fresh and processed foods were analyzed for vitamins and other constituents. Data are being accumulated on the chemical composition of numerous fruits and vegetables.

The following paragraphs briefly summarize the various phases of our experimental work on frozen foods. For more detailed infor-

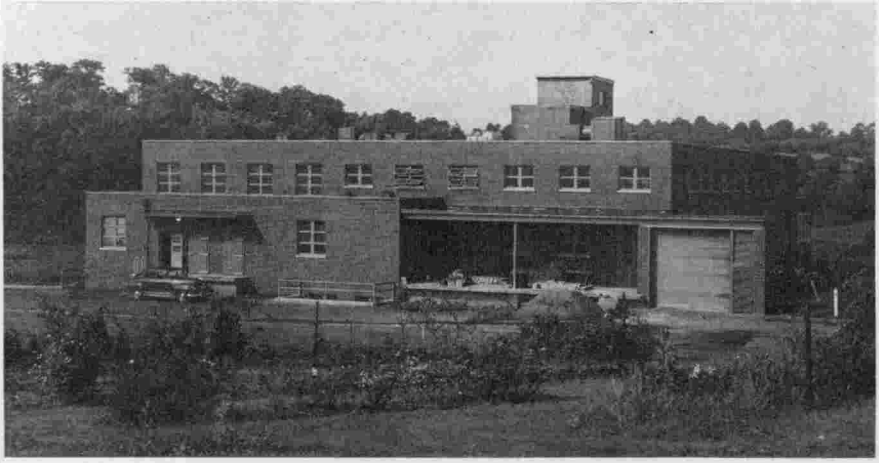


Fig. 21—New Food Technology Building—As the year draws to an end, we find the new Food Technology Building, referred to in the 1948 Annual Report, well enclosed and taking form within. The building should be completed and ready for use during the fall months of 1950.



Fig. 22—Preparing pie and other foods for freezing.

mation the reader is referred to Bulletin No. 215, "Home Freezing of Foods," University of Tennessee Agricultural Experiment Station.

Prompt Handling is Important—Our experiments show that perishable fruits and vegetables should be processed promptly after harvesting. Washing and sorting are necessary to eliminate dirt and defective parts. Also, it has been found by chemical analysis, and by organoleptic procedures, that some of the good qualities possessed by freshly-harvested vegetables are lost if they are allowed to remain too long in ordinary room temperature. Vegetables and the small fruits should, therefore, be kept cool until processed.

Blanching and Chilling.—Heating of vegetables in boiling water or steam prior to freezing arrests enzyme activity and helps the product retain its fresh characteristics. After blanching, vegetables should be thoroughly chilled in cold water prior to packaging and freezing. Chilled, packaged vegetables should be frozen without delay.

Protect Frozen Foods Against Loss of Moisture.—Our experiments show that the use of containers, and of wrapping materials, that will prevent the loss of moisture from products in low temperature storage, and will not impart foreign odors and flavors, is

necessary for the retention of quality and wholesomeness. Considerable data are being accumulated on the protective qualities of wrapping papers.

In filling rigid containers with foods to be frozen, a head space of ½ to 1 inch, depending on size and shape of container, should be allowed. This permits of expansion of the contents on freezing without damage to the container. After filling, air should be eliminated from pliable containers—cellophane and paper bags—by pressing together from the contents upward, and then sealed.

Freezing Meats and Poultry.—Our experiments indicate that the most common causes for the development of off-flavors in frozen meats and poultry are (1) the oxidation of fatty tissues, and (2) loss of moisture from the product in 0° F. storage. Quality in frozen flesh foods is largely retained by using wrapping materials that are impervious to moisture-vapor. Such materials must be tightly applied to the product.

Green Whole Tomatoes Can Be Frozen.—Our recent experiments show that green whole tomatoes can be satisfactorily preserved by freezing, and later utilized in the making of relish and in other culinary preparations. The green tomatoes are washed, and placed unwrapped in the zero compartment of the cabinet until solidly frozen. The tomatoes then are removed from the cabinet, dipped into cool water, peeled, wrapped in cellophane, or placed in other suitable moistureproof containers, and returned to the zero storage. When removed from the zero storage cabinet for use, the tomatoes are allowed to defrost slightly before slicing for frying, or cutting into pieces for making into relish.

Fruit Juices.—Juices of the various fruits may be prepared in season and frozen for later use. After thawing, fruit juices may be blended together for beverage purposes, or utilized in the making of jelly. Simple methods of preparing fruit juices are described in Bulletin No. 215, previously mentioned.

Flavor of Apple Juice Preserved.—Natural flavor of apple cider may be preserved by adding ascorbic acid (vitamin C) at the rate of ½ teaspoon per gallon. The cider is then poured into containers and frozen without delay.

Freezing Prepared and Precooked Foods.—Prepared foods, such as cakes, rolls, casserole dishes, and pie, may be wrapped in cellophane and frozen for later use. Such foods are defrosted and cooked just before serving. Precooked foods include a wide variety of items—fish, meat, poultry, soups, potatoes, baked apples, and many others—that are prepared, cooked, and then frozen. Precooked foods are defrosted and heated just before serving.

Sweetpotato Utilization

Freezing Candied Sweetpotatoes.—Experiments have shown that candied sweetpotatoes can be preserved by freezing according to the following procedure: After boiling and removing jackets, the

sweetpotatoes are cut into pieces of suitable size, and neatly arranged in shallow aluminum pans. The proper amount of sugar-butter mixture then is added, the containers sealed, and frozen. To prepare for table use, the product is allowed to partially defrost, and baked in the oven at 400° F. for about 35 minutes. The potatoes may be baked in the container in which they were frozen. Sweetpotatoes packed with granulated sugar, or with corn sirup, were of better quality than those packed with brown sugar, or a mixture of granulated sugar and brown sugar.

Fifty-Percent Sirup for Canned Sweetpotatoes.—Experiments in the use of sugar media for canning sweetpotatoes was continued. The Porto Rico variety was used in these experiments. Two sirups of 50-percent sugar solids were employed. One sirup was composed of granulated sugar solids and water; the other sirup was composed of ⅔ granulated sugar solids, ⅓ corn-sirup solids, and water. Calcium Chloride was added (0.1 percent of the product weight) as a firming agent. Prepared sweetpotatoes were neatly placed in No. 2 cans, covered with hot sirup, sealed, and processed at 10-pounds steam pressure (240° F.) for 30 minutes. After an incubation period of 4 months in 85° F. the potatoes were examined. Experiments show that sweetpotatoes are equally well preserved in the two sirups. However, those preserved in sugar-corn sirup mixture possessed the better flavor. Experiments in the freezing of sweetpotato pulp were continued and the products are being examined for quality.

Protein and Minerals in Pastures

K. B. Sanders

Chemical analysis of a large number of forage samples from unfertilized pasture plots and from plots differently fertilized in regard to both kind and rate of fertilizer applications was continued in 1949. Analyses of forage samples collected in 1948 from 14 experimental fields, located in major geographical areas of the state, were completed. Averages of these data show that the percentage of protein, calcium and phosphorus in the forage was maintained and usually was increased by the fertilizers, although the yields also were usually materially increased. (See Agronomy section of this report for further details.) In 1949 forage samples were obtained from 10 of the 14 fields which were studied in 1948. Analyses of these forage samples for protein, calcium, phosphorus and potassium were about half completed at the end of the year.

Samples of forage and of soil were collected periodically at the Grassland Station, near Crossville. The forage samples were analyzed for protein, calcium, phosphorus and potassium content. The soil samples were analyzed for field moisture percentage, acidity and available phosphorus and potassium content. This work is part of a soils-plants-animals or beef cattle production study on a farm

scale. (See Animal Husbandry section of this report for further details.)

A Perkins-Elmer flame photometer was obtained to facilitate the chemical analysis of plant and soil samples for calcium, potassium or sodium content. Considerable time was spent in learning to use this instrument and in adapting a digestion technique so that determination of calcium, phosphorus, potassium and sodium could be made on the same digestion solution.

CHEMICAL INVESTIGATIONS OF BURLEY TOBACCO

D. R. Bowman

Chemical phases of the Burley Tobacco project, under way at the Tobacco Experiment Station, were conducted during the year.

Studies are being made of the chemical composition of Burley tobacco as affected by: fertilizers—rates of application and sources, variety of tobacco, and other factors.

During the year, 809 samples of tobacco, 50 samples of cover crops, and 134 samples of soil, were analyzed in connection with the tobacco project. Tobacco samples were analyzed for moisture, nicotine, potassium, calcium, and magnesium; cover crops for moisture, nitrogen, phosphorus, potassium, and calcium; and soils for available potassium and calcium. The use of the recently acquired flame photometer greatly facilitated the estimations of potassium and calcium.

DAIRYING

GRAZING INVESTIGATIONS WITH DAIRY CATTLE

R. H. Lush, John A. Ewing, E. J. Chapman, A. G. Van Horn, J. N. Maddux, B. P. Hazlewood, and C. E. Wylie

Irrigation of Pastures

At Columbia, a breakdown in irrigation equipment plus rather even rainfall distribution resulted in little use of supplemental water during 1949. Differences in grazing capacity were probably due to the previous four years watering which resulted in a more favorable vegetation. The irrigated pasture from April 1 to October 25 produced 20 percent more cow-days of grazing, 23 percent more milk and 25 percent greater returns above feed costs per acre than similar non-irrigated permanent pasture. The cows on irrigated pasture consumed 12 percent more grain and 17 percent more hay but lost less in weight. If this year's results are included with the previous four comparable tests for 1945-48, irrigation gave a 5-year average of 37 percent more cow days of grazing, 38 percent more milk and

39 percent greater returns or $54.77 above all feed and irrigation costs per acre than non-irrigation.

Alfalfa-Orchardgrass

Rotational grazing of an alfalfa-orchardgrass hay field starting August 9 gave 108 cow-days grazing and 1960 pounds milk per acre during the following 63 days. There were no bloat difficulties and cows gained in weight 19 pounds, but by the end of the season, the third for this practice, the field was noticeably grassy and weedy. Two crops of hay were cut earlier.

Sudangrass

Sweet sudan, following Balbo rye and crimson clover was grazed continuously with four or more cows per acre from July 1 to August 9. About 150 cow-days grazing and 2718 pounds milk per acre were obtained during 39 days. Sudan grazing has been profitable and valuable for maintaining milk production during the dry summer period of the past 10 years.

Fescue and Orchardgrass-White Clover for Summer Grazing

At Lewisburg, a 2.3 acre plot of Kentucky 31 fescue and two 2.3 acre plots of orchardgrass and white clover were grazed experimentally. The fescue was seeded with alfalfa September 10, 1947. The alfalfa died probably from continuous grazing during the dry year of 1948, but a good stand of fescue with some volunteer white clover remained in 1949. The two plots of orchardgrass and white clover were seeded August 26, 1948. These plots were grazed by Jersey cows in production from April 1 through September 30. The cows received no other roughage than that furnished by the grazing plots, but they were fed a home-mixed grain ration. Records were kept of the amount of grain consumed, the amount of milk and butterfat produced, and the gain or loss in body weight. From these records, and from figures based on Morrison's feeding standard showing the nutrients required by cows under favorable conditions, the amount of total digestible nutrients furnished per acre of pasture was calculated. The fescue plot furnished total digestible nutrients in an amount equivalent to 3917 pounds of alfalfa hay per acre. One of the orchardgrass-white clover plots furnished the equivalent of 4732 pounds of alfalfa hay and the other the equivalent of 4395 pounds, or an average of 4563 pounds per acre.

About 36 percent of the total digestible nutrients from the fescue and 22 percent from orchardgrass-white clover were obtained during April. But the amounts of digestible nutrients supplied by the orchardgrass-white clover plots were more equally distributed through grazing season and the grazing remained a good deal more palatable than in the plot of fescue. The cows which grazed the fescue obtained 67.5 percent of their calculated total nutritive requirements from the grazing and those which grazed the orchardgrass-white clover obtained 68.3 percent.

Fescue and Crimson Clover for Early Spring Grazing

A three-acre plot of Alta fescue was seeded September 29, 1947. A fair stand of fescue was obtained. It was grazed heavily in the early spring of 1948 and not grazed during the dry summer and fall of that year. Hard seeded crimson clover was broadcast on the sod September 10, 1948, at the rate of 10 pounds of seed per acre. Considerable crimson clover resulted. There was also a considerable amount of volunteer white clover growing with the fescue by the fall of 1948 which apparently came from manure hauled from barns and spread on the plot during the summer of 1947. Experimental grazing was started February 25, 1949.

A four-acre plot was seeded September 10, 1948, on a well prepared seedbed to hard seeded crimson clover using seed at the rate of 11.5 pounds per acre. An excellent stand of crimson clover resulted. Due to the dry fall, there was not sufficient growth to warrant grazing before February 25, 1949. To compensate for earlier fertility additions, 35 pounds of nitrogen per acre was applied to the crimson clover and 25 pounds to the fescue in late February.

Both plots were grazed by producing cows from February 25 through April and results were calculated in the same manner as for the summer grazing. The pastures did not provide enough roughage before April and the grazing was supplemented by both hay and grain until April. The results indicate 2291 pounds alfalfa hay equivalent per acre from crimson clover and 2064 pounds from fescue-clover were obtained in the 65 days.

The crimson clover furnished 23 percent of the calculated total digestible nutritive requirements of the cows during the four days of February, 58 percent during March, and 77 percent during April. Fescue furnished 11 percent during the four days of February, 53 percent during March, and 78 percent during April.

The fescue was grazed again from June 1 through July 20, during which time it supplied digestible nutrients at a rate equivalent to 1069 pounds of alfalfa hay per acre. After July 20, the fescue was allowed to accumulate growth for fall and winter grazing.

Grazing from Winter Barley

A 5.15-acre plot of barley, which was grazed from February 25 through March 15, supplied total digestible nutrients at the calculated rate of 46.4 pounds total digestible nutrients per acre or the equivalent of the amount of total digestible nutrients that would be supplied by about 92.8 pounds of alfalfa hay. Grazing was continued through March 31 on 2.75 acres which produced a calculated total of 163.5 pounds total digestible nutrients per acre or the total equivalent of about 327 pounds of alfalfa hay. The yields of barley per acre were as follows: ungrazed, 22.2 bushels; grazed through March 15, 17.2 bushels; grazed through March 31, 15.7 bushels. Nitrogen in the form of ammonium nitrate was applied to both the grazed and ungrazed barley at the rate of 18 pounds per acre on November

12, 1948, and 24 pounds per acre on February 24, 1949. The area has been in barley continuously for a number of years and had a heavy infestation of cheat.

WINTER GRAZING FOR DAIRY COWS

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

Three groups of Jersey cows were used from November 1, 1948 to April 1, 1949, with group 1 barn fed, group 2 on winter pasture 3 to 5 hours on those days with no precipitation, and group 3 on winter pasture continuously except at milking time. All groups were fed grain in proportion to production, limited silage, and alfalfa hay free choice. Group 2 cows produced 4.2 pounds more milk daily, an increase of 21.4 percent, ate 37 percent less hay and returned 31 cents more profit per day than group 1. Group 3 cows, with only an open shelter for protection, produced 2.2 pounds more milk daily, an increase of 11.6 percent, ate 32 percent less hay and returned 22 cents more profit per day than group 1. The average of the 2 groups on winter pasture was 9 pounds less gain in weight, cleaner condition, and $34 more above feed costs for the five month period. The winter pasture was not badly injured by trampling in wet weather but apparently one acre or more of productive pasture per cow was needed to provide sufficient grazing. The March production of group 3, with an acre of pasture per cow, was 82 percent; that of group 2, 68 percent; and of group 1, 63 percent of November's respective production.

THE PHYSIOLOGY OF LACTATION

Eric W. Swanson and S. A. Hinton

A more complete knowledge of the milk excretion process in dairy cows has been obtained by injecting pituitary hormone intravenously following a normal milking. One group of 10 cows was treated in this manner each month of the lactation, and others were treated near the beginning and near the end of lactation. The amount of the "residual milk" left in the udder decreased from about 5 lbs. per cow at the peak of lactation to less than 3 lbs. per cow in the last month. While the fat test of normal milk generally increased with advancing lactation, the fat test of the residual milk decreased. The non-fat solids percentage in both normal and residual milk did not change appreciably during the lactation. The evidence indicates that the complete excretion of milk fat depends upon thorough letting down of the milk and milking rapidly or in such manner as to secure as much milk as possible during the maximum let-down period. As cows progress in lactation, and give less milk, the emptying of the gland in normal milking is more complete and a higher fat test results. The sum of the residual milking plus the following milking was about 20 percent more pounds of fat than the normal milking. This indicates that fat production and fat test may be increased by more complete milking.

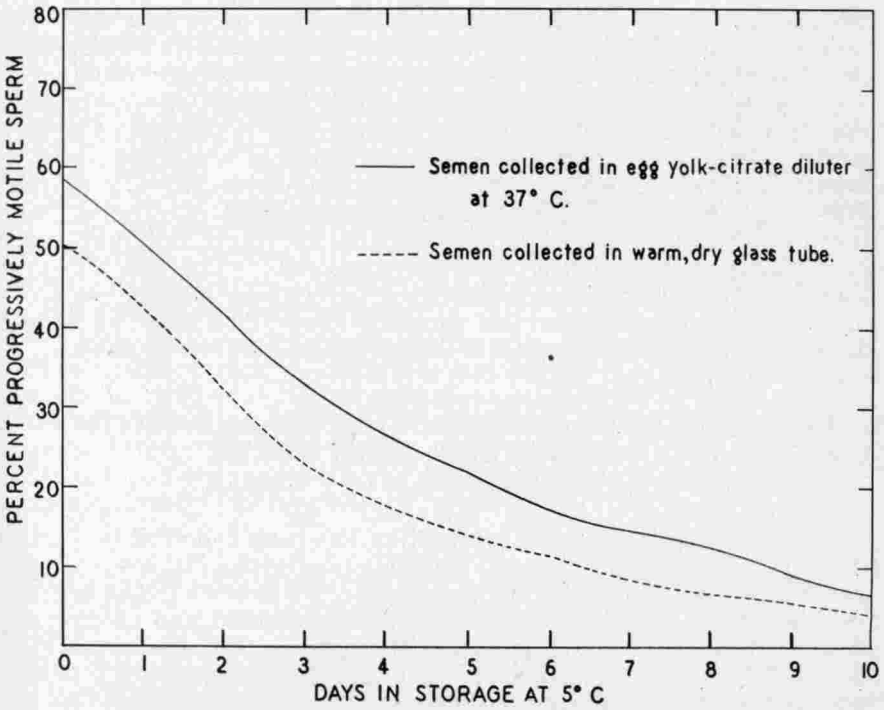


Fig. 23—The average percentage of progressively motile sperm from each collection method, and their livability under good storage conditions.

BULL FERTILITY INVESTIGATIONS

Eric W. Swanson

Sires in the Knoxville herd were continued on a system of alternate pasture and dry-lot yearly management. Significant differences in the quality of semen produced on pasture or dry-lot have not been observed. One bull with a reasonably good breeding record in dry-lot became practically sterile when changed to a pasture lot, but due to the bull's advanced age, 10 years, the pasture is not considered a factor in this change.

The relative fertility of semen used one, two, or three days after collections has been determined from a survey of records of the East Tennessee Artificial Breeding Association. Although there was considerable variation between bulls, the average results were 63.3 percent non-return with one day semen and 62.0 percent with two day semen, while three day semen gave only 55.7 percent non-return. Of ten bulls included in the study, five had just as good record on two day semen as on one day. Three of the bulls, had from 7 to 15 percent lower record the second day and about 20 percent lower the third day than the first day. Three other bulls had just as good record the third day as the first day. It would thus be advisable to

not use semen for artificial insemination after it is two days old, without careful attention to the semen quality and the bull's past breeding efficiency, if high conception rate it to be maintained.

The possibility of improving livability of semen by instantaneous dilution with egg-yolk citrate diluter was investigated during some cool days of 1949. Semen was collected simultaneously in double test tubes, one of which contained warm (37°C.) diluter, while the other did not. The average percentage of progressively motile sperm from each collection method, and their livability under good storage conditions is shown in figure 23. The use of warm diluter in the collection vial increased percentage motility equivalent to about one day's natural motility loss. This practice should therefore increase the time of usefullness of semen to be stored.

INVESTIGATIONS OF THE INCIDENCE AND CONTROL OF MASTITIS IN DAIRY HERDS

Eric W. Swanson and B. T. Throop

The incidence of mastitis infection has been followed in a number of Tennessee dairy herds by monthly bacteriological tests of milk from each milking quarter for two years. First tests in these herds revealed that about half of the cows were infected and an average of more than two quarters were involved on each infected cow. More infected quarters appeared throughout the year until a yearly summary showed that almost three-fourths of the cows had had the infection sometime during the year, and nearly three quarters per infected cow were involved. In 4 herds that did not use intramammary treatment 37.3 percent of the infected cows and 52.1 percent of the infected quarters developed spontaneous cures. In herds that used penicillin infusions for the infected quarters, 77.9 percent of the infected cows and 82.4 percent of the infected quarters were cured, showing that penicillin was a distinct aid to the natural resistance of the cow in combatting the disease. The number of treatments required to produce a cure varied with the cows, but 79.6 percent of those cured required two monthly courses of treatment or less. The proportion of cures in cows requiring more than three courses of treatment was very low.

Data relating mastitis infection to the age of the cow indicated that age was probably not a factor in resistance. Most heifers were free of the infection at first freshening and over half of them remained free during their first lactation. However, during the second lactation 82.5 percent of the cows were infected at some time during the year, while corresponding figures for the fifth, sixth, and seventh lactation were 81.6, 82.4, and 74.1 percent. In general, young cows did not recover from a first infection any more quickly than old cows.

Several methods of treating to control or eliminate mastitis infection were studied. Milking cows in order according to their degree of infection arrested the spread of the disease in the herd

but produced very slight improvement in incidence. Treating infected quarters with four daily infusions of penicillin during lactation was found to be more effective than using one large infusion. Use of an oil emulson base for penicillin infusions was slightly more effective than water when single treatments were made. In this study treatments during the dry period did not clear the mastitis from a herd as quickly as treatments during lactation, but less treatment and expense was involved. Herds with a staphylococcus infection problem were treated with streptomycin-penicillin mixtures during lactation, without striking results; i. e. 25 percent of treated quarters were cured and 14.8 percent of non-tested infected quarters recovered spontaneously.

A few cows retained infection in spite of repeated treatments with penicillin during the lactation and during the dry periods. Organisms isolated from these cows were indentified as *Str. agalactiae.* When they were submitted to very dilute solutions of penicillin in tryptose broth, they were killed. This fact indicated that they had not developed resistance to the penicillin, but evidently were not being reached by the treatments.

EFFECT OF FEEDING THYROIDALLY-ACTIVE MATERIAL TO DAIRY COWS

Eric W. Swanson

An iodinated casein having thyroidally active properties[2] has been fed to 5 cows in two successive lactations in the Knoxville herd, and two other cows have been fed the material for one lactation, in order to evaluate the effects upon milk secretion and other conditions in the cows. After about one week of feeding 15 grams of iodinated casein daily, milk production increased about 2.5 pounds per cow per day, and it remained above a control group of cows for eight to ten weeks. During the period of milk stimulation the treated cows' heart rates increased, but after 10 weeks these had returned to normal. Body weight losses occurred in the treated group in spite of increased feed allowances, but these returned to normal following the stimulation period. Body temperatures of some of the cows were elevated and others were not affected. Two cows of low inherited lactating ability gave the lowest response, hence this feed cannot be used to make good producers out of poor ones. There appeared to be no significant carryover effect from one lactation to the next. Cows were not stimulated in a noticeably different manner in either of the two lactations. The increased feed consumption of the thyroid stimulated cows made their greater milk production no more economical than normal production would have been. The use of such material to stimulate milk production may have limited practical application, such as in base-establishing periods. The experiment is being continued with a few cows to measure the carryover effect, if any, on a third lactation.

[2]For this experiment "Protamone" was supplied by the Cerophyl Laboratories, Kansas City, Mo.

INVESTIGATIONS OF THE PHYSIOLOGY OF MILK SECRETION USING RADIOISOTOPES

E. W. Swanson

Plans and facilities are being developed for use of radioisotopes of calcium, phosphorous, and iodine in critical studies of the physiology of milk secretion. This work is being conducted at the U. T.-A. E. C. Agricultural Research Laboratory at Oak Ridge. Cattle from the dairy herd at the Knoxville Station are being used in the experiment. It is intended to do the major part of the work with dairy cattle, using small laboratory animals only where necessary. The experiment has not progressed to a point as yet where detailed results could be presented.

CALF RAISING

S. A. Hinton

The Experiment Station at Knoxville has successfully raised many calves without these receiving any colostrum. This is of value to the farmer who has a valuable brood cow which does not give colostrum which may be utilized by the calf and to the dairyman who is practicing milking the cows before calving in order to relieve congestion of their udders. The advantages of colostrum are well known, it being much higher in minerals, many times higher in protein, especially in albumin and globulin, is slightly laxative in effect and some 20 times as high as normal milk in Vitamin A. Calves which receive ordinary cows milk but no colostrum are very hard to raise. Those which survive are usually very much retarded in growth. It has been found that by feeding the calf large doses of Vitamin A together with a mixture of all the other vitamins known to be needed in calf nutrition, that calves may be raised successfully without any colostrum. Some success was also experienced in giving large amounts of Vitamin A and then treatment for any disturbances which may occur. These treatments, however, should be given by an experienced practitioner and should not be attempted by the average farmer.

In order to encourage dairy farmers to raise more heifer calves from their best cow, an economical means of feeding these calves is necessary. Realizing that milk at the present market prices is not an economical calf feed, the Experiment Station has tried various calf mixtures and various practices in order to reduce this expense to a minimum. It has been found that calves may be taken off whole milk feeding at 40 to 50 days of age depending upon the individual calf. The age at which milk feeding is discontinued depends upon the consumption of calf meal rather than the actual age of the calf. As soon as a calf is eating as much as one pound per day of calf meal, milk feeding may be successfully discontinued without stunting the calf. The saving in milk on calves taken off at an early age compared with those which received milk until four months of

age is approximately 400 pounds of milk for Jersey calves and 600 to 700 pounds for the larger breeds. Calves allowed to nurse cows grew faster the first four months than did calves that were fed milk from a pail or which were fed calf meal. These calves also were sleeker in appearance at an early age. It was found that upon weaning these calves at four months of age that they did not grow quite as well as the calves which began eating dry feed at a much earlier age. At 10 months of age the calves on calf meal were fully as large and fully as well developed as those which nursed the cow.

DRY COW FEEDING

There are many recommendations regarding the proper feed and management for cows during the dry period. There is, however, very little experimental evidence to back up many of these general recommendations. It is with this in mind that the Tennessee Experiment Station has set up a project to check various methods of handling cows during the dry period and their effect upon the lactation and health of the cattle involved. Grain feeding during dry period will be compared with no grain feeding. Investigations are also planned for comparing production of cows which have no dry period with those with the dry period. We feel that this investigation will answer a number of questions which vitally affect our dairy farmers.

DEVELOPMENT OF STRAINS OF DAIRY CATTLE ESPECIALLY ADAPTED TO SOUTHERN CONDITIONS

R. H. Lush, John A. Ewing, E. J. Chapman, A. G. Van Horn, J. N. Maddux, B. P. Hazlewood, and E. M. Knepp

This long-time project was proposed in 1948 and started in 1949 to develop superior germ plasm in the state. Jersey sires bred in the South for two or more generations are mated to purebred Jersey females maintained under near maximum forage conditions. Grazing and other forage conditions have been improved and two new herd sires located and placed in service. Proved sires in artificial breeding associations are used where possible. About 225 females in three locations are involved. Line-breeding and cross-breeding with other southern Jersey strains will be followed.

DAIRY EXPERIMENT STATION,—LEWISBURG

A. G. Van Horn, Superintendent

Organization

This Station was established in July, 1929, and was operated by the Bureau of Dairy Industry, U. S. Department of Agriculture, to conduct experimental work concerned with the breeding, feeding, and management of dairy cattle. The University of Tennessee Ag-

ricultural Experiment Station became a cooperative agency under a Memorandum of Understanding, effective October 1, 1948.

The work at the Station (fig. 24) is planned and conducted under the direction of a joint committee of five, consisting of two staff members of the University Dairy Department, two members of the Bureau of Dairy Industry, and the Station Superintendent.

Improvements and Equipment

Improvements made during the year include painting the barns and the erection of two 14x40 permanent-type silos. New equipment purchases include a 3-plow tractor, manure loader, tractor-operated spray outfit, tractor mower, 8-can milk cooler, portable elevator, field ensilage harvester and blower, and ensilage unloading equipment.

Elimination of Bermuda-Grass From Permanent Pastures

Bermuda-grass has gradually spread in some of the creek-bottom pastures which were originally bluegrass and white clover, until more than 50 percent of the area in these pastures has been covered by Bermuda-grass. For several years, records of the amounts of hay milk-cows would consume while grazing on these pastures showed the cows consumed about 2 pounds of hay per cow per day when the bluegrass and clover were lush and green. Later in the season when the bluegrass and clover did not supply much grazing and with an abundance of Bermuda-grass in these pastures, the milk cows consumed up to 15 pounds of hay per cow per day.



Fig. 24—Some of the barns and other facilities at the Dairy Experiment Station, Lewisburg.

Ten acres of this pasture land was plowed during April and worked down to a seedbed for forage sorghum. Sumac cane seed was drilled with a grain drill on April 25 and 26, the object being to obtain a dense growth to shade the Bermuda-grass. Nine acres of the resulting growth of sorghum was harvested for ensilage. Ensilage was produced at the rate of 23.9 tons per acre. Probably 90 to 95 percent of the Bermuda-grass was killed. After the sorghum was removed for silage the land was disced and drilled to winter barley and hairy vetch. It is planned to plow the barley and vetch under about May 1 and seed to soybeans and Sudangrass in an effort to completely eradicate the Bermuda-grass.

Proposed Pasture Experiments

A seeding was made August 26, 1949, on an area of 20 acres which included a light seeding of alfalfa with orchardgrass and Ladino clover which will be divided into four plots for summer grazing. Rotation grazing will be followed. One cutting will be obtained from the first growth on one-half of the area and made into either hay or silage. Later growth on the cut area will be grazed later in the season.

An additional 12 acres of Kentucky 31 fescue was seeded August 27, 1949, which will be used experimentally for fall, winter, and spring grazing. Reseeding crimson clover was seeded with six acres and Ladino clover with the other six.

A portable-pipe, sprinkler-type, irrigation system is on hand which was loaned to the Station by the Soil Conservation Service and studies will be made on the cost and effects of irrigation on summer pastures. After the Bermuda-grass is eliminated from the creek-bottom pastures, they will be reseeded to suitable mixtures and utilized for experimental grazing projects.

Soil Survey

The station farm contains about 480 acres, of which over 300 acres is cleared land and available for field crops and pasture. During the year, the Division of Soil Survey prepared a soil map of the farm and also obtained soil samples which were tested for phosphate, potash, and lime requirements. The results show a great variability of soil classes and of available phosphate and potash. Twenty tons of commercial fertilizer and 72 tons of agricultural lime were applied to fields during the year. From 400 to 600 tons of manure is applied to fields annually.

Hay Feeding Experiment

A hay feeding trial was conducted in cooperation with the Bureau of Dairy Industry, United States Department of Agriculture, using U. S. No. 3 leafy green lespedeza hay and U. S. Sample Grade green extra leafy lespedeza hay. The double reversal method was used with two groups of cows with eight producing cows in each

group. The feeding period was 150 days. The hay was fed ad libitum with a grain mixture fed at the rate of one pound for each 4 pounds of 4 percent fat-corrected milk.

Silos

One 14 x 40 foot silo was filled with first cutting of alfalfa and orchardgrass during weather which would have made it impossible to make a satisfactory grade of field-cured hay. A portion of the alfalfa and orchardgrass was wilted to about 70 percent moisture and was ensiled without amendment. The remainder was ensiled without wilting and about 200 pounds of ground barley was added per ton of silage. All the silage was very palatable to cows. A second 14 x 40 foot silo and a temporary silo were filled with sorghum. Experimental work is planned which will compare ensiling with field curing of grass and hay crops.

Weather

The year 1949 was one of the exceptional years when there was no appreciable deficiency in rainfall to affect unfavorably the growth of pastures and hay crops before late July. Below normal rainfall during August, September, and November was very unfavorable for the growth of fall pastures and fall seedings.

Cattle Breeding

There are over 100 females, including cows and heifers, in the present herd of registered Jerseys. The size of the milking herd will be increased until 60 to 70 cows are in milk. Proved sires are used so far as possible through the use of station-owned bulls and membership in the Tennessee Artificial Breeding Association. As a rule, all heifers are placed on official test during the first lactations. Forty-one females in the present herd have completed records, which average 9005 pounds of milk and 477 pounds of butterfat when calculated to their 2x milking, 305-day, mature equivalents.

Predicting Calf's Future Producing Ability

Work was initiated a number of years ago by the Bureau of Dairy Industry Experiment Station, Beltsville, Maryland, whereby the future producing ability of calves is predicted with a considerable degree of accuracy by determining the size and stage of mammary gland development by feel (palpation) when calves are 3 to 5 months of age. This Station is cooperating in the work here and at Columbia.

Grassland Farming

Because of the rolling nature of the farm, a grassland-type of farming is practiced. All feeds required by the dairy herd were produced on the farm except protein concentrates, such as cottonseed

meal and soybean oil meal and special feeds required for experimental purposes. During 1949, 93 tons of grass silage (alfalfa and orchardgrass), 215 tons of sorghum silage, 64 tons of alfalfa hay, 95 tons of lespedeza hay, and 1622 bushels of barley were produced. Other information is included under the dairy department projects.

ENTOMOLOGY

NEW INSECTICIDES

W. W. Stanley

The testing of new insecticides continues to result in control of insects that were previously uncontrolled. Thus, the new discoveries are continually giving the farmers means to produce more with less cost, and such savings are ultimately passed on to the consumer.

From the beginning the value of certain new insecticides was recognized, but before these new compounds can be recommended for use they must be tested over a period of years. Also, the new insecticides bring up new problems which in many cases take considerable time to solve.

Some of the new problems are soil poisoning, effect on flavor and odor of edible parts, residue remaining on the plant which may be eaten (this applied to both man and animals), and the hazard and danger of applying the insecticides, of which some are very poisonous to warm blooded animals as well as to insects. It is not possible for the Station entomologists to solve all these problems, but keeping up with the information and supplying it to our farmers as it becomes available will greatly help in the control of many pests. The main part of the work in testing new insecticides has been to obtain information on control, effect on plants (foliage injury), and in some cases the effect on flavor and odor.

Squash and Cucumber.—Control of insects attacking squash and related crops has been difficult. At least 6 different insects are known to attack squash. Previously no one insecticide would control all the pests; for instance, cryolite was very effective against the cucumber beetles but would not control aphis or squash bugs. Of the new insecticides tested to date it appears that lindane (purified benzene hexachloride) offers the best solution. In 1947 it was first found that benzene hexachloride was particularly effective against the various insects attacking cucurbits. Tests in 1949 showed that a dust containing 4 percent lindane gave excellent control of the pickle worm and high yields on cucumber and squash.

During the three seasons' work squash and cucumbers were given to staff members for taste tests and no ill flavors or odors were reported. However, in 1949 coded samples of yellow crookneck squash were submitted to the General Agricultural Chemistry

Department and no ill flavors or odors were detected from use of 4 percent lindane, but fruit dusted with ½ percent gamma technical benezene hexachloride had a pronounced off-flavor. No samples were submitted for the nitroparaffins.

Foliage injury was observed only in 1947 when 1 percent gamma technical benzene hexachloride was used. After this observation the strength was reduced to ½ percent gamma with no injury. No injury has been observed with 4 percent lindane.

Peach.—The tests in 1949 on peach insects completed 3 years' work on this crop, and as previously stated insect control has not been greatly improved but the main discovery is that lead arsenate injury can now be avoided. This factor alone is sufficient reason for changing to the insecticides. Of the insecticides now commercially available, benzene hexachloride and chlordane are best for plum curculio. Benzene hexachloride has given a little better control of plum curculio but under some conditions, not yet understood, the material has been reported as causing off flavors to processed fruit. No reports have indicated that chlordane has caused bad flavor or odor. Neither of these materials control the oriental fruit moth; however, DDT is recommended for this pest. Another advantage of the new materials is that spraying can be started earlier which will kill the early emerging curculio and control catfacing.

This past season a new schedule was followed which called for five applications: (1) Petal fall, (2) shuck fall, (3) 10 days later, (4) mid-June, and (5) two weeks before harvest. In 1948 catfacing was quite severe, but the data obtained in 1949 show only light damage. Catfacing is controlled by the petal fall spray which is to kill sucking insects such as the tarnished plant bug.

Two new chemicals, Commercial Solvents 645 and Julius Hyman Compound 118, gave excellent control of peach insects in their first tests.

Tomatoes.—The tomato fruit worm (*Heliothis armigera*) is always a good test insect as it is rather difficult to control and is generally present. A small block (200 staked plants) of Rutger tomato was divided into random blocks for testing. Four applications of insecticides were made, starting when the young fruit was about the size of small marbles, and repeated at about weekly intervals. The data obtained show that dusts of 80 percent cryolite, 3 percent DDT, 2 percent Commercial Solvents 645, and a spray of 1-1600 of Commercial Solvents 645 were equally effective.

Green June Beetle.—During the past season further field tests were conducted using benzene hexachloride for the larvae of the green June bettle in pasture or alfalfa fields. Successful control was obtained with as little as ½ pound of gamma benzene hexachloride per acre. The insecticide is easily applied by mixing 5 pounds of technical 10 percent gamma benzene hexachloride with fertilizer and applying the mixture with a fertilizer applicator such as a grain drill. This amount of insecticide was applied with different amounts of fertilizer, ranging from 50 to 200 pounds per acre.

LABORATORY TESTS WITH TOBACCO HORNWORM

(*P. sexta*)

In the laboratory, dusts of the various new insecticides were fed to larvae of the tobacco worm. The dusts were deposited with a dust chamber on a tobacco leaf, thus with known deposits the amount of insecticide consumed was calculated. The data shown in table 18 are not considered M.L.D.'s, but some of the figures indicate closely an M.L.D. Previous work (Tenn. Ann. Report of 1938) on hornworms show that lead arsenate has an M.L.D. of .085 mg. Thus the nitroparaffins and others show a toxicity greater than lead arsenate which is an excellent insecticide.

TABLE 18.—*Summary of laboratory tests showing toxicity of several new insecticides to the tobacco hornworm (P. sexta)*, 1949

Insecticide	No. used	Av. gm. weight larvae	Deposit mg./sq. cm.	Dust mg./gm. body wt.	Percent killed
CS-674A	29	2.27	.030	.036	78
CS-645A	13	1.52	.030	.047	53
Toxaphene	15	1.10	.030	.044	80
DDT (TDE)	15	2.54	.030	.041	47
Chlordane	13	2.07	.030	.048	23
Methoxychlor	8	1.68	.030	.045	25
Methoxychlor	8	1.56	.058	.048	38
Gamma BHC	13	2.23	.015	.019	46
Parathion	8	2.38	.010	.015	100
Comp. No. 497	9	2.58	.005	.009	44
Comp. No. 118	7	2.77	.005	.007	None
DDT	15	1.94	.240	.291	33
DDT	14	1.77	.120	.513	21
DDT*	8	2.59	.058	.061	88

*Tests with *P. quinquemaculata.*

Bean.—Rotenone and cryolite are the standard insecticides for control of the Mexican bean beetle. Of the many new insecticides that have been tested, only a few have been particularly effective against the Mexican bean beetle. In 1949 two materials known as nitroparaffins were tested both as sprays and dusts and were found to be very effective against the Mexican bean beetle, as well as against many other insects.

Sweetpotatoes.—The various new insecticides have certain properties that make them effective against certain insects that inhabit the soil. Thus, five new insecticides were mixed with fertilizer (4-10-4) and applied to the soil in a small furrow. Next the soil was well mixed with a rototiller and finally "hilled up" in the regular manner as is done for growing sweetpotatoes. The various treatments were replicated six times, each replication was 32 feet long and was planted on May 17 with slips placed at 1-foot intervals. The insecticide-fertilizer mixtures were applied four days earlier.

Shortly after planting, disease gradually reduced the stand to about two-thirds. The plants were given the usual cultivation during the growing season and were harvested October 3, 1949. The data obtained are given in table 19.

TABLE 19.—*Summary of data on use of soil insecticides to control "pin holes" in sweetpotatoes*

Insecticide	Rate per acre	Total No. hills	Total wt. roots	Av.wt. roots per hill	Av. No. pin holes per roots[1]
	Pounds				
Check	None	92	156.7	1.71	14.1
Tech. BHC	1½ lbs. gamma	112	129.1	1.15	1.3
Parathion	2	104	148.6	1.43	9.0
Chlordane	10	108	108.7	1.01	.9
DDT	25	107	108.3	1.01	3.5
No. 497	1	95	155.7	1.64	2.1

[1]The number of "pin holes" was obtained by examining 20 roots of potatoes from each replication.

Apple.—The woolly apple aphid is a pest of long standing with the nursery growers of this state. Early in the season of 1949 work was started again in an effort to control this pest. Tests were set up that will require two seasons' growth. The aphids on the roots were killed by injecting chlordane and benzene hexachloride in with a spray pump. The kill from these chemicals was not evident for several weeks and practical methods are still to be determined. Dichloroethyl ether also killed the aphids on the roots.

European Corn Borer.—This insect has continued to spread over the State, but it is interesting to note that no commercial damage has yet been reported for this pest.

The Vegetable Weevil.—This pest was reported from Knoxville vicinity early in the season. This is a "southern" insect and attacks many crops. It was found on tobacco.

SOIL TREATMENTS WITH SODIUM FLUOSILICATE

S. Marcovitch

Previous work in the laboratory indicated that a rate of one-half ton of sodium fluosilicate to the acre would keep nematodes in check. It was also found that sodium fluosilicate reacts with calcium cyanamid as follows:

$$2CaCN + Na_2SiF_6 + 2H_2O = 2H_2CN_2 + CaF_2 + 2NaF + SiO_2$$

In the above reaction, hydrogen cyanamid is produced which is thought to be the active principle for use in cotton defoliation and for combating soil pests.

In field tests on tomatoes a combination was used at the rate of 1000 pounds of sodium fluosilicate and 1000 pounds of calcium cyanamid per acre. These field tests showed some reduction in nematodes but not enough for satisfactory control. Similar results were obtained with 2000 pounds of sodium fluosilicate.

There was a noticeable reduction of crab grass in the sodium fluosilicate plot. This may have some application in growing strawberries where crab grass is a real problem.

HOME ECONOMICS

FOOD CONSUMPTION STUDY

Josephine Staab, Florence L. MacLeod, and Dorothy Stockburger

The Tennessee Station, in cooperation with Agricultural Experiment Stations of Arkansas, Mississippi, South Carolina and Virginia, the Institute of Statistics of North Carolina State College, and the Bureau of Human Nutrition and Home Economics, has been studying the food consumption of open-country farm families in three types of farming areas in the Southern Region since 1948.

Tennessee was selected to represent the mountain-type of farming. A description of the selection of the areas and of the method of collecting the data is given in the 1948 Annual report.

The first regional report, tentative title, "Incomes and Food Expenditures and Production for Home Use During 1947 in Three Types of Farming Areas of the South," is now being written and will probably be ready for publication in 1950. The data in this first report will include carefully constructed estimates of the 1947 annual income, home-produced family food supply and expenditures for food.

The unpublished tabulations show that meat, dairy and poultry products were important in the home-produced food supply. Over 90 percent of the families reported the use of milk, pork, fryers, and eggs produced on the farm.

Other data, such as average quantity of each food home-produced and used by the family, amount and sources of incomes, and expense of food at home and away from home, will be given in the published report.

The second report, which is also in process and which will probably be published in 1950, is a detailed analysis of the nutritive value of the individual family's diet during one week of the winter season, 1948. It includes an analysis of the weighed quantities of food used at home during a 7-day period and of the nutritive value of these foods without adjustments made for cooking losses.

PRECOOKED AND READY-TO-COOK FROZEN FOOD PRODUCTS

Bernadine Meyer, Ruth Buckley, and Ruth Moore

Work has been continued during the year on handling precooked and ready-to-cook products for home freezer storage. Emphasis has been placed on determining best methods of preparing various bakery products, including fruit pies, butter-type cakes, sponge-type cakes, and yeast breads. The general objectives and procedures for this project were outlined in a previous report.

Fruit Pies

Peach Pies.—Tests of peach pies made with Elberta and Hale Haven peaches from the 1948 crop were completed during this period. Elberta was the more satisfactory of the two varieties from the standpoint of color, flavor, and texture of the fruit, whether the pies were baked before or after freezing.

Currently some tests of methods of pre-treating peaches to prevent discoloration are being repeated, using Elberta peaches from the 1949 crop. Forty pies were placed in freezer storage. The addition of 40 p.p.m. of crystalline sodium bisulfite was more satisfactory than the use of 0.15 percent sulfite dip. The addition of 0.1 percent ascorbic acid was almost as effective and would be the preferred treatment for home freezing.

Apple Pies.—Fifty-five pies made with either Stayman Winesap or Golden Delicious apples were placed in freezer storage. The chief purpose was to investigate the suitability of using the Golden Delicious, a variety grown extensively in Tennessee, as compared to the Stayman Winesap, a variety which in previous tests was found to be very satisfactory for frozen pies. To date, 33 pies have been tested by means of palatability ratings, using a panel of six judges. The pies made with Stayman Winesap apples have been judged superior to those made with Golden Delicious from the standpoint of color, flavor, and texture of the fruit. The Golden Delicious apples seemed to have less tendency to "brown" during freezer storage, but the deep yellow color of the cooked fruit was considered to be too artificial in appearance and consequently was scored lower by this panel. The texture of Golden Delicious apples was more tough and leathery than that of Stayman Winesaps in either prebaked or ready-to-bake pies. The difference between the varieties in this respect was more pronounced when a 0.15 percent sulfite dip was used than when ascorbic acid was used for the pretreatment.

Cakes

Sponge Cakes.—One hundred and four sponge cakes were prepared and tested after intervals of freezer storage. The chief purpose was to investigate means of preventing the development of "off" flavors during the storage of frozen sponge-cake batters. The addition of lemon juice, ascorbic acid, or G-4, a commercial product containing propylgallate, was effective in preventing the development of "off" flavor during nine months of freezer storage. Presumably, those substances were acting as anti-oxidants. The peroxide numbers of the ether extract of the cakes indicated that oxidation was probably occuring in the raw, untreated batters. There was no detectable development of peroxide in the frozen baked cakes nor in the frozen batters containing lemon juice, ascorbic acid, or propylgallate. Additional work to determine the nature of this "off" flavor is under way.

Butter Cakes.—A series of 99 plain butter-type cakes were prepared for freezer storage to compare the suitability of using different methods of home preparation for freezing cakes. Cakes were prepared by the conventional home method of hand mixing; by one of the newer short methods of hand mixing; and by a short method in an electric mixer. With each method of mixing, some cakes were baked before freezing; some were frozen as a batter and baked without thawing; and the rest were frozen as a batter and thawed before baking. With all methods of mixing, the baked cakes or cakes baked from thawed batters were superior to cakes baked from unthawed batters. The volume, grain, and texture of baked cakes and cakes baked from thawed batters both of which were in freezer storage for 9 months were approximately equivalent to that of freshly baked cakes. Cakes baked from unthawed batters were smaller in volume, more compact in grain, and less tender in texture. Some of these differences are shown in figure 25. A slightly "off" flavor was noticeable in cakes baked from frozen batters after six months of freezer storage. Freezing caused slight increases in specific gravity and hydrogen-ion concentration of cake batters. There was a tendency for the increases in specific gravity to become progressively larger with increased storage time. The length of freezer storage did not affect the change in hydrogen-ion concentration.

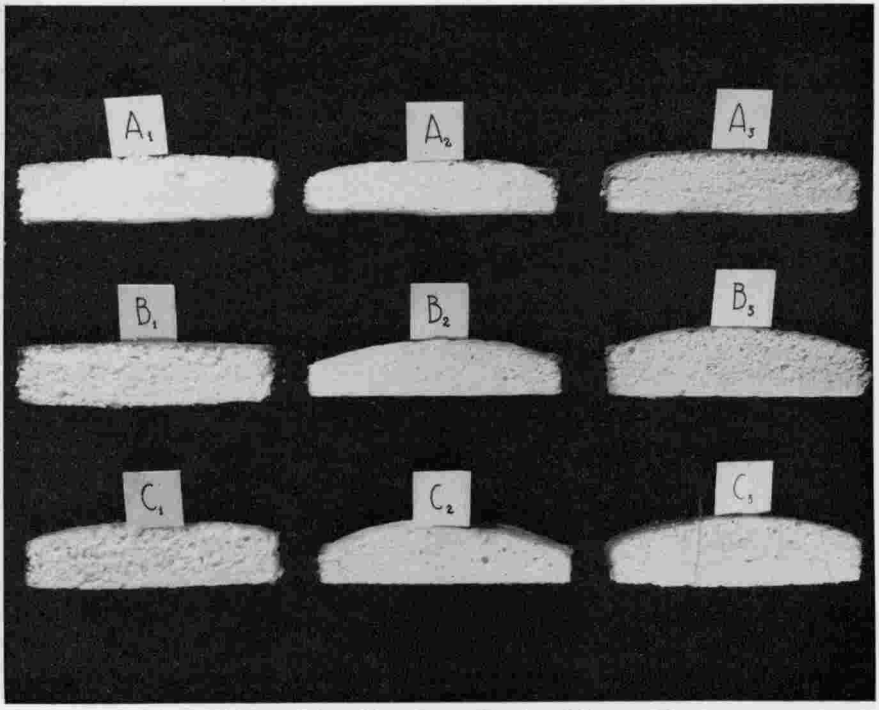


Fig. 25—Butter Cakes After Seven Months of Freezer Storage.

Yeast Breads

Work has been continued on determining causes of, and means of preventing, the deterioration in quality which yeast breads undergo when frozen in the dough state. Measurements were made of the carbon dioxide produced in aliquots of the dough after intervals of freezer storage. Using this procedure, some additional evidence has been obtained that loss of viability of the yeast is not the chief cause of deterioration. If the dough was shaped before freezing, a marked decrease in volume of yeast rolls, as measured by seed displacement, was obtained after one to two weeks of freezer storage; while decreases in carbon dioxide did not occur until after four to eight weeks of freezer storage. If the dough was shaped after freezing, considerable improvement was obtained in volume, grain, and texture of yeast rolls. The addition of 0.17 percent of a commercial dough improver, containing potassium bromate, caused some improvement, but the addition of 0.1 percent of primary ammonium phosphate afforded no improvement. Some of these tests are being repeated.

HOUSING STUDY

Josephine Staab, Elizabeth Speer, and Dorothy Stockburger

The Tennessee Station, in cooperation with Agricultural Experiment Stations of Alabama, Arkansas, Georgia, Mississippi, South Carolina and Virginia, the Institute of Statistics of North Carolina State College, and the Bureau of Human Nutrition and Home Economics, has been making a rural housing study since the spring of 1948 for the purpose of obtaining data for developing functional farm house plans.

In the 1948 report, information was given as to areas sampled and number of families included in the study.

The information collected from the families by personal visit included the kinds and scope of activities carried on in the farm house; the kinds and amounts of storage space needed; and the family's preference regarding space arrangement and other housing features. Analysis of the data is under way for publication.

SERVICEABILITY OF TENNESSEE COTTON IN CONSUMER FABRICS

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

Cotton grown in Tennessee is being studied to determine the best variety which can be produced for ultimate consumer use. Knowledge of the importance of fiber properties will be of value to all those concerned with breeding, production, and manufacturing. The more that is know about the relationship between fiber proper-

ties and spinning performance the easier it will be to develop varieties of cotton for specific uses. It has long been known that the spinning performance of a cotton depends upon certain fiber properties such as length, strength, and fineness.

Materials and Methods

The cotton varieties chosen were 3 lots of Delta Pine 15 from different locations, 1 lot of Stoneville 2B and 1 of Tennessee 241. These fibers were selected for this study because they represent some of the more popular varieties grown in the State. After testing the fiber for length, strength, and fineness, the cotton was sent to the government laboratory at Clemson, South Carolina, where the lint was spun into yarn and woven into fabric.

The yarn was spun into 3 different sizes. These yarns are under tests for strength, elongation and twist. Figure 26 shows a technician reeling skeins of cotton yarn for testing. The woven fabric has been desized and made into dish towels, which have been issued to home management houses, graduate apartments, and faculty apartments. Serviceability tests will be carried on for thirty weeks. Weekly check sheets are filled out by the individuals using the towels. At the end of the service period, the fabric will be submitted for the usual tests.



Fig. 26—Reeling Skeins for Yarn Testing.

Results

The results indicate that the average maturity of all the cotton studied was 85 percent. However, Delta Pine 15 variety appears from the test results to be more mature than the other cotton samples. Maturity tends to vary inversely with moisture content, ash content and alcohol-extracted impurities. Variation of maturity, ash content, moisture content and alcohol-extracted impurities due to varietal differences is significant.

Longer fibers spin stronger and more uniform yarns. The fibers in any specific quality grade or lot vary considerably in length. The lots of fibers with the more even staple length are more desirable for spinning purposes. In length-distribution tests, Stoneville 2B variety, grown near Rossville, appears to be the longest staple. In skein strength tests the results, so far, indicate that Stoneville 2B is the strongest yarn. Yarn skein strengths were high for classers' length of staple.

Proposed Work

This study is a preliminary one, and by itself does not provide data from a large enough sampling to end further investigation. Expansion of this problem is therefore under consideration. Plans are being formulated for a study based on larger quantities of the three varieties now being investigated. Such fabrics as chambray, pique, or madras will be woven and thereby a wider range of information will be provided.

CONSUMER PREFERENCES AMONG FOURTEEN SELECTED CLOTHING ARTICLES

Virginia Wilson Baron and Anna Mary Creekmore

Previous studies in this area have either recorded what, where, when, and for what price consumers purchased, or they have been geared, by means of one single interview, to determine those characteristics which consumers seek in making purchases.

The Bureau of Agricultural Economics in 1947 published a study, "Women's Preference Among Selected Textile Products" which showed consumer preferences in a rather wide field of textiles and clothing. A check sheet type of questionnaire was used by oral interviewers to determine those characteristics which consumers sought. Much of the information then was limited by the scope of the questions included in the questionnaire, with little opportunity for voluntary, spontaneous responses on the part of those being interviewed.

There was no information as to whether consumers were able to find those characteristics which they sought or whether compromises had to be accepted. Neither was there any followup of the

satisfactions and dissatisfactions which people had with their purchases, nor whether, after use, peoples' opinion of their preferences changed.

This study was initiated following conference in the spring of 1947 in New York City of a representative group of college teachers of textiles and clothing, on textiles and clothing research related to the social sciences. The purpose of this study is to go further than those features for which people were shopping. It takes into consideration the extent to which people are able to find that for which they are shopping, what satisfactions and dissatisfactions they derive from their purchases, what labeling information would they consider helpful; and having used the article for a year's time, what features would they be shopping for when repeating the purchase.

Materials and Methods

After consultation with Edward Garrison of the Department of Marketing in the College of Business Administration, University of Tennessee, a pilot study was started with a small group of local women who were willing to cooperate. Some of the women were married and employed, some married and unemployed, and most of them were single women who work. The articles of clothing to be considered in the study were selected on the basis of frequency of purchase and the expenditure involved.

The records in the clothing section of the study by the Department of Marketing at the University of Tennessee were used as a basis for this selection. The original list of items included blouses, cloth coats, dresses (silk, rayon, and wool), gloves, handbags, hosiery, millinery, shirts (men's), shoes, and slips. The women participating in the pilot study were interviewed by appointment each month for six months concerning purchases made that month. Information was recorded as to date of purchase, place of purchase, season for which the article was purchased, description of article, price paid, characteristics sought, basis for final selection and labeling information the interviewed person would have considered helpful.

Six months following the date of purchase, each person was interviewed again to ascertain what satisfactions and dissatisfactions had been derived from their purchases, whether or not articles were still in use, and whether the price now seemed reasonable or unreasonable after the article had been used for that period of time.

A final interview was held after one year of use to determine satisfactions or dissatisfactions experienced after longer use, repairs necessary, and those characteristics which the consumer would want when repeating the purchase.

Results

The interviewing for the pilot study was completed in December, 1949, and the information from the interview recorded in tabular form. During the course of the pilot study many changes were

discovered to be necessary. Suits, bras, and girdles were added to make the list of 14 items of apparel. The question concerning reasonability of price has meaning only if the price of the garment is considered reasonable in terms of use. The interview schedule, it was decided, would have to be formally written, identical questions asked of each person, and space left on the interview schedule itself for recording of responses.

Terminology varied in meaning from person to person, and it became necessary in several cases to find out specifically by means of additional leading questions what people meant to say. Sketches and, in some cases, swatches of fabric with which interviewees can make comparisons, may help to insure greater consistency in responses.

Proposed Work

Upon completion of a tentative new schedule, the two workers involved in this project will go to Washington for a conference with Forest E. Clements of the Division of Special Surveys, Bureau of Agricultural Economics, and with members of the Bureau of Human Nutrition and Home Economics. Plans are for completion of the schedule forms for the new, larger study, selection of the sample to include urban and rural women, training of necessary lay interviewers, and launching of the main study as soon as is possible.

CALCIUM AND PHOSPHORUS METABOLISM

Florence L. MacLeod, Dorothy E. Williams, Elise Morrell, and Bonnie McDonald

Calcium Metabolism Studies on Humans

The studies started in 1948 on the calcium metabolism and bone density of college students have been continued with the assistance of the staffs of the University Hospital and the Department of Physics.

Balance studies in which the intakes and excretions of calcium, phosphorus, nitrogen and riboflavin were determined were conducted in February and May. Each study was of five days' duration with collections of urine and fecal samples on the last four days. Seven of the eight subjects selected for the study were students whose usual dietary records indicated low milk consumptions, and, therefore, low calcium intakes. All were consuming less than the calcium allowance recommended by the National Research Council. The eighth subject drank milk regularly and served as a control. The same subjects, six females and two males, served as diet squad members for both balance studies.

The weighed basal diet which was served to the students during the experimental periods contained very little milk and was comparable to the subjects' self-selected diets. The caloric content of the

diet was increased for the male subjects by adding extra quantities of bread and potatoes.

X-rays of the heel of all the subjects were made by the University Hospital staff at the time of each balance study and midway between the two studies. Bone density measurements, using a Leeds and Northrup microphotometer, were obtained from these X-rays by the Physics Department.

During the 3-month period between balance studies, the subjects' self-selected diets were supplemented daily with varying amounts of milk. Two subjects added 2 cups of milk each day to their regular diets, two added 3 cups, three added 4 cups, and the control subject followed her normal pattern of liberal milk intake. In the second balance study the basal diet was supplemented with these same quantities of milk.

During the first study, an average intake of 0.57-0.59 gm. of calcium resulted in slightly negative balances. The control subject, receiving 1.0 gm. of calcium, was in positive balance. In the second balance experiment all subjects but one received more than 1.0 gm. of calcium. The subject who had 0.87 gm. was in slightly negative calcium balance while all the others stored calcium. The figures for phosphorus, nitrogen and riboflavin intakes and excretions will be used as reference points in further work on calcium utilization.

Records of the usual dietaries of another large group of students were obtained and calculated in the fall of 1949. From this group, eight students have been chosen for balance and X-ray and bone density studies in the winter of 1950. Following the initial studies, the subjects will again be given varying amounts of milk for three months and balance studies and X-ray examinations will be made. Not until the results of all these investigations have been obtained, can conclusions be drawn concerning the effect of increased calcium intake on bone density or of the influence of other nutrients on calcium metabolism. It must be pointed out also that the method for measuring bone density is still in the experimental stage.

Calcium and Phosphorus Metabolism Studies on Rats

Work was continued during the year in an attempt to develop a standard synthetic diet which will be as nearly optimum as possible for growth, reproduction and lactation. To date, no synthetic diet has been found which is equal to one of natural foods. Plans for a series of synthetic diets containing different combinations of the more recently discovered B vitamins were completed at the end of 1949 and rats matched as to litter, age, and sex are receiving these diets at the present time.

The rats on the Anderson and Smith diet of natural foods, mentioned in the 1948 report, have been killed. This diet proved to be superior, in all criteria examined, to the diet of natural foods which has been used for many years in this laboratory. The results obtained with this diet wil be used in judging the synthetic diets.



Fig. 27—X-ray of Hind Legs of a Weanling Rat.

Attempts are being made also to measure bone density in rats which have been raised on diets containing different levels of calcium. The X-ray apparatus of the Department of Biology is being used and the Department of Physics is determining bone densities with the microphotometer. Figure 27 shows the type of X-ray from which the relative bone density of an animal is calculated.

HORTICULTURE

EXPERIMENTS AT KNOXVILLE

VEGETABLES

R. E. Ogle and Brooks D. Drain

Snap Beans.—Varietal trials of snap beans are conducted as part of the bean breeding project. Logan, Rival, and Topcrop varieties had been outstanding in trials conducted both at Knoxville and Dandridge before being recommended for grower trials. These newer varieties are resistant to common bean mosaic, but some greasy pod, which is believed to be caused by the southern bean mosaic virus, was observed in all varieties in our trials this year. Tendergreen, our standard variety, is susceptible to both greasy pod and common bean mosaic.

Numbered varieties which have not been named and released are being secured for trial plantings in commercial fields. This is being done in cooperation with J. J. Bird, Extension Horticulturist.

Quality tests and vitamin C determinations made in cooperation with the General Chemistry Department have been considered in placing these newer varieties into grower trials. Shipping tests and consumer acceptance studies are being planned with A. W. Woodward, Marketing Specialist, to complement these grower trials.

A green strain of *Phaseolus Mungo* received from India was grown as a parent plant for making crosses with the garden bean and Urd hybrids. Mosaic appeared in the first planting and it was discarded. Difficulty was encountered in bringing both parents of succeeding plantings into the blossoming period simultaneously, since it apparently requires a longer period for the green strain to blossom than the darker one, both requiring a much longer period than the common garden bean.

Sweetpotatoes.—An experiment set up to determine the effects of spacing and rate of fertilization on yield and size of sweetpotatoes indicates that fertility levels affect yields more than spacings. The spacings used were 6, 9, and 12 inches. Three fertilization rates of a 4-8-8 fertilizer were used—200, 500, and 800 pounds per acre. The greatest yield of U. S. No. 1 and No. 2 potatoes, 312 bushels per acre, was obtained at the 500 pound rate with no significant spacing difference. The greatest yield of U. S. No. 1 potatoes, 261 bushels, was obtained with 12 inch spacing as compared to 240 bushels at the 6 inch spacing.

Tomatoes.—STEP trials were conducted for the fourth year. The performance of Southland tomato (a U. S. D. A. introduction), which was in grower trials this year and is to be tried further next year, was tested in these trials at Dandridge, Jackson and Knoxville, as well as other southern stations before being introduced. Recommendations for grower trials of the more promising varieties are being made on the basis of these trials.

Sweet Corn.—The Station participated in the Southern Sweet Corn Testing Program, growing 16 varieties in a replicated yield test and thirty-five other strains and varieties in a single row observational trial. Records taken in these trails include yields by weight and number, earliness, stalk type, quality, husk protection, ear length, and disease resistance.

Peas.—Twenty-one entries of English peas were grown in replicated trials in cooperation with 14 other experiment stations. Records taken by all cooperators included yields by picking and grades; pod shape, fill, size, and appearance; number of pods touching the soil; cold and disease resistance; and quality.

In these trials at different stations and for different years the higher yielding varieties range from medium to late in season; have small to medium pods borne doubly and large, and vigorous semidwarf vines. Some of the lesser yielding earlier varieties have larger pods and better eating qualities. The poor yielders have been very early, very large podded types, and susceptible to cold injury.

Dark Skinned Perfection and Wando led in yield, producing at the rate of 4,162 and 3,722 pounds per acre, respectively. These two varieties are adapted to canning and freezing but lack the size and earliness for market garden peas. P 84, a breeding line from the U. S. Vegetable Breeding Laboratory at Charleston, South Carolina, produced at the rate of 3,258 pounds per acre, and was second early in season and of very high quality. It also lacks the size desired in a market garden type, but its high quality indicates its possibilities as a top quality freezer and home garden pea. Another breeding line from the Vegetable Breeding Laboratory, P 17, though not quite equal to P 84 in quality and productivity, is of larger size, thus being more adapted to fresh market production.

Asparagus.—Ten of the best selections were chosen from the 1945 planting of 34 selections and propagated for replicated trial. Records, including earliness, diameter of stalks, and yields by U. S. Standards, were taken on these 34 selections for the third cutting season. The average annual yields of these selections ranged from 960 to 3,060 pounds per acre.

Cucumbers.—Eight varieties of cucumbers were grown in a cooperative trial with 11 other experiment stations. Records taken included length, color, shape, vine vigor, disease resistance, and yield by grades.

Table 20 summarizes the vegetable varietal trials by presenting crops tested, number of entries, sources of seed, and outstanding varieties.

Processing studies.—Vegetables grown in the varietal trials and in other tests were processed by the General Chemistry Department. These cooperative studies enable us to evaluate vegetables as processed products, newer varieties, and new methods of processing.

TABLE 20.—*Vegetable Variety Testing*

Crop	Number of Entries	Sources	Outstanding Varieties
Snap beans	15	Commercial seedsmen, U. S. Veg. Breeding Lab.	Topcrop, Contender, B1801, B1515, B1627
Tomatoes	11	Commercial seedsmen, N. J. Exp. Sta., S. C. Truck Exp. Sta., U. S. Veg. Breeding Lab.	Southland, Rutgers, STEP 68
Sweet corn	51	Commercial seedsmen, Iowa Exp. Sta., Mass. Exp. Sta., U. S. Veg. Breeding Lab.	Golden Hybrid 1734, Aristogold, Bantam, Ioana Hybrid, Oto
Peas	21	Commercial seedsmen, U. S. Veg. Breeding Lab.	Dark Skinned Perfection, Wando, P 17, P 84
Asparagus	34	Tenn. Exp. Sta.	Selections 23, 29, 8, 5, 17
Lima Beans	10	Commercial seedsmen, Okla. Exp. Sta., U. S. D. A.	Stand so irregular that no records were taken.
Cucumbers	8	Commercial seedsmen, S. C. Truck Exp. Sta.	Santee, Palmetto, Cubit

MISCELLANEOUS

R. E. Ogle and Brooks D. Drain

Weed control.—Asparagus rows were treated on March 7, a month before spear emergence, with grandular calcium cyanamid, as part of a complete fertilizer concentrated in an 18-inch band at the rate of 290 pounds per acre. Good weed control was obtained on the treated plots during the cutting season. No injury was observed.

Four varieties of Irish potatoes: Irish Cobbler, Chippewa, Katahdin, and Sequoia, were used in an experiment to study the effects of 2,4-D on yield. An application of 2,4-D sodium salt was made as part of an insecticidal spray and applied when the plants were 8 to 12 inches tall.

The 2,4-D, used at the rate of one-half pound per acre, gave good control of broad-leaved weeds but produced a stunting effect on the potato plants. This effect was observed for about two weeks, but later in the season the treated plots could not be distinguished from the untreated. There was a varietal difference in this stunted appearance of plants, Irish Cobbler being affected most and Sequoia least. There was, however, no significant difference in yield between the treated and untreated plots of the four varieties.

Nematode Control.—Experiments conducted at this and at other stations have shown that the root-knot nematode can be satisfactorily controlled on valuable truck land by soil fumigation. Ethylene dibromide and dichloropropane are soil fumigants adapted to large scale application, both in cost and method of application. Methyl bromide and chloropicrin require a gas proof cover or a water seal and are more expensive. Thus, their use has been limited to plant beds, greenhouses, and small plots of land. They are however, also effective as herbicides and, to a lesser extent, fungicides.

SMALL FRUITS

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

Raspberries (Drain and Ogle).—Tennessee Prolific (fig. 28), a new red raspberry variety, was released for plantings. The sale of plants indicate that more than 100 plantings were made.

A large population of black raspberries were fruited for the first time and 42 were selected as worthy of further trial. These selections were propagated, and will be set in replicated plots.

About 1200 progenies (fig. 29) from the 1948 crosses were set in the field and many should fruit in 1950. Further crosses, using selected parents, were made, the seed gathered, stratified and planted in shredded sphagnum moss. A considerable number of seedlings are now growing in the greenhouse.

Further attempts to grow the Akala raspberry from Hawaii have not been too successful. It germinates easily in sphagnum moss culture at warm temperatures. Seedlings of this species fail to grow satisfactorily under our usual greenhouse care.

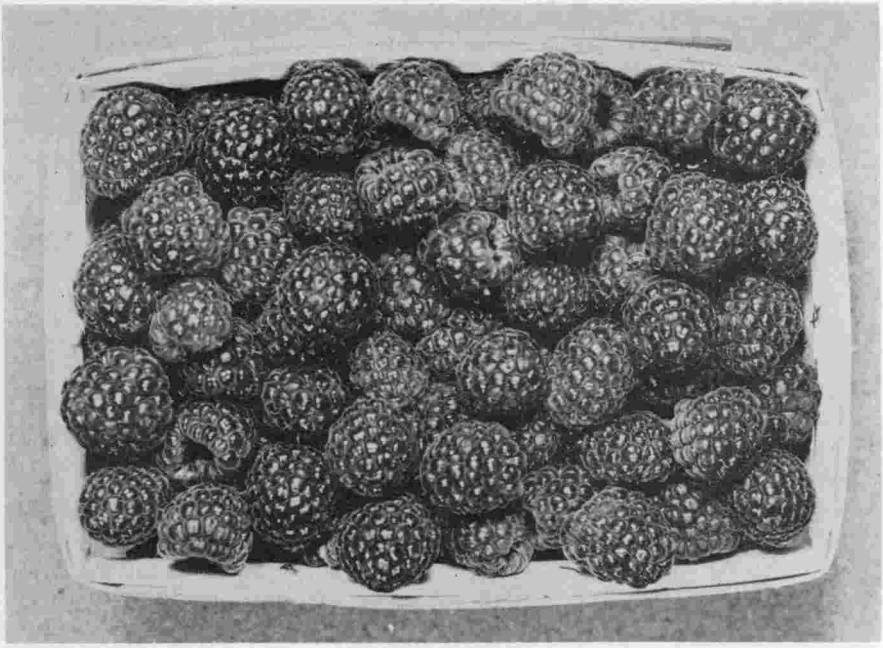


Fig. 28—A box of Tennessee Prolific red raspberries. Red raspberries are ideal for frozen pack.

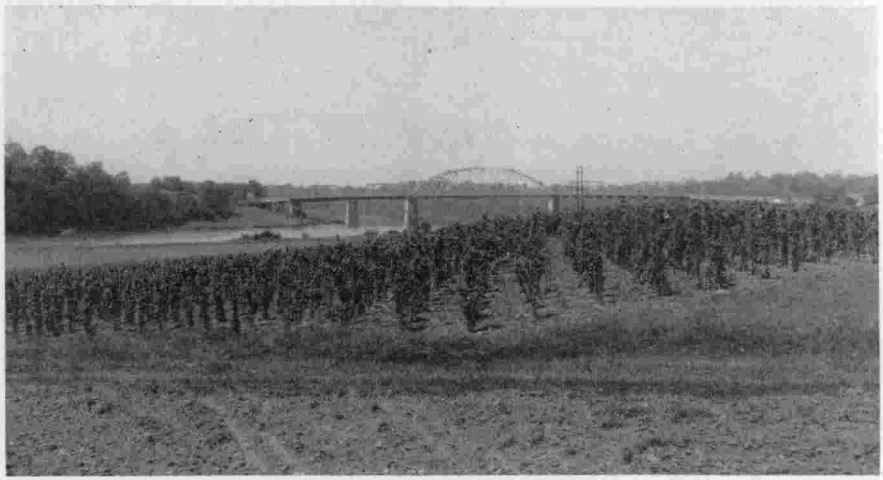


Fig. 29—A 2-year-old planting of black raspberry progenies. There are 1636 seedlings in this planting. Large numbers of progenies are essential in isolating superior varieties and evaluating a given cross.

Blueberries (Drain and Ogle).—A planting of blueberries failed to make satisfactory growth although mulched with sawdust and given good care.

Strawberries (Drain and Ogle).—A nursery planting of about 3 acres was set with wide spacing for nursery purposes, using our new variety, Tennessee No. 965. Grower trials of this strawberry were started in cooperation with J. J. Bird of the Extension Service. Many orders were taken and some shipments of plants were made during the fall.

Plots of selections from the strawberry breeding work at Jackson fruited for the second season. None appeared to be superior to our best varieties. Cold injury destroyed the early bloom, markedly influencing yield, quality of fruit, and time of ripening. The plots were renovated and will be fruited another season.

GRAPE VARIETY TRIALS

Troy H. Jones

The grape variety vineyard was expanded considerably during 1949. Four new Muscadine varieties were added, raising the total of this species to 20. Eight extra American bunch-grape varieties were set out, making 42 named varieties. Six selections still under number were received from the U. S. D. A. and 2 selections from New York State were included in the trials.

Nine representatives of the French-American hybrid group were sent to the Station by a private fancier and breeder in North Carolina. Only the table-stock kinds were requested since the Station is not concerned with the wine types. This type of grape holds great promise for the future as a tremendous improvement over the standard American slipskin grape. Hybrids of this class combine the excellent quality of the French varieties with the ruggedness of the American grape. It has only been in recent years that rooted cutting of the French American hybrids were available. Cutting wood of 11 French-American seedling numbers will be lined out to root as soon as weather permits.

For two years the spray schedule called for fermate as the fungicide in the hopes of avoiding the slight spray injury following applications of Bordeaux. Fermate controls black rot well and leaves are free of spray burn, but unfortunately this organic fungicide does not hold downy mildew in check. With so many varieties to deal with, many of which are very susceptible to mildew, Bordeaux is going to be used again since it will control both diseases. The spray burn from Bordeaux is not as serious as mildew without the Bordeaux.

The grape crop was all but completely eliminated by the pre-Easter freeze. Shoots just out of bud and all the way up to 2 feet long were frozen back without exception. All new growth originated from the secondary and tertiary buds. There were very few bunches and yield records were not taken.

BREEDING AND SELECTING OF BLACKBERRIES AND DEWBERRIES

Twenty-seven different parental combinations were made during the blooming season of 1949. From these crosses involving several thousand hand pollinations, 3141 seeds were harvested and sown in flats containing shredded sphagnum moss. The seeds were never allowed to dry out as they were removed from the pulp and placed immediately in the flats, then kept moist while in cold storage for 3 months.

The greatest number of seeds in proportion to pollination was collected from crosses involving Alfred X Ozark Beauty, Alfred X Eldorado, Early King X Ozark Beauty, Eldorado X Ozark Beauty, Eldorado X Alfred, Eldorado X Early King, and Thornless Boysen X Early King. At the end of the storage period the flats were moved to the greenhouse to await germination.

Pollen of *Rubus macrocarpus* arrived from Bogota, Columbia, South America, on May 18. Flowers of our own varieties were scarce at this date on account of a rather early spring. About 50 blossoms were pollinated on the Station grounds and the rest of the pollen was carried to a private breeder in Kentucky where blossoms were abundant and a better assortment of *Rubus* species was available.

From the hybridizing efforts, both on the Station and on the premises of the private breeder, 11 seeds matured out of a cross of Eldorado **X** *R. macrocarpus*, 35 seeds from Alfred **X** *R. macrocarpus*, 14 seeds from Latham **X** *R. macrocarpus*, 11 seeds from Royal **X** *R. macrocarpus*, 2 seeds from Latham **X** *Parvifolius* **X** *R. macrocarpus*, and 10 seeds from Bedford Giant **X** *R. macrocarpus*.

Seeds from Quito, Ecuador of *Rubus glaucus* and from Hakgala, Ceylon of another giant blackberry were received and sown in flats and handled similar to the other seeds from local crosses.

The primary objective of importing these foreign species is to increase size of individual fruits. Our local varieties and species have hardiness, resistance, etc., but are short of being the giant size desired by the trade. The commercial interests of Tennessee want a blackberry that ripens in June, a definite slack season in the processing schedule, with a recognizable blackberry flavor, of good size and with seeds as inconspicuous as possible.

The poor performance of 7 selections justified their elimination from further trials. Twelve of the old selections were sufficiently good to save for additional observation.

Of the (F_1) seedlings that were carried to the field in 1948, none produced sufficient fruits in 1949 to justify harvest records. The dry growing season of 1948 plus the frosts and red mite outbreak of 1949 reduced the crop to a few berries per vine. Notes on vegetative development were taken, but no roguing was employed.

MULCHING AND WINTER INJURY STUDIES WITH STRAWBERRIES IN TENNESSEE

Pre-sprouted wheat straw at the rate of 1½ tons per acre was applied at two-week intervals beginning December 1 and ending March 15. At each application of straw, 10 plants were pulled at random from each of the 5 plots to be mulched. When the straw was applied to the final 5 plots on March 15, all plots previously mulched (Dec. 1—Mar. 15) were sampled and sectioned for study. There was no internal injury on any of the established plants regardless of whether mulched or unmulched. It should be said that the winter of 1948-49 was very mild and far short of a good test year for low temperature injury studies to strawberry crowns and roots.

From 40 mulched plots, were harvested 363 pounds of 10 ounce berries. From the same area of unmulched rows, 444 pounds of 8 ounce berries were harvested. Yields from the plots mulched in December, January, February, and March were 93 pounds of 11 ounce, 88 pounds of 9 ounce, 88 pounds of 4 ounce, and 93 pounds of 2 ounce berries respectively.

Our data show that mulching favors berry size, reduces rotting, and provides for berries rather free from particles of dirt or grit. The presence of the mulch down among the leaves and flowers tended to increase the problem of misshapen berries. Many of these deformed berries were not so irregular as to decrease their marketability, but they were definitely not as plump or uniform as an uninjured berry.

STRAWBERRY ROTATION STUDIES

The first crop of Blakemore strawberries was harvested in 1949 from the 18 plots that had been handled for two years (1946-47) under 6 different rotations, preceding the setting of strawberries in 1948.

The most striking features throughout the duration of the test was the weediness of the lespedeza (Kobe) plots, not only while the clover was occupying the plots, but also when strawberries were

TABLE 21.—*Yield of Strawberries (4-60' rows) from Six Rotations* (1949)

Replicates	Corn—1946 Winter Cover Corn—1947		Lespedeza 1946 1947		Late Tom. 1946 Winter Cover Soybeans-1947		L. Beans 1946 Winter Cover Late Tom. 1947		Tobacco 1946 Winter Cover Tobacco 1947		Corn-1946 Winter Cover Sweetpotato	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
I	62	3	30	6	38	15	53	7	92	5	76	5
II	62	7	52	7	61	14	60	1	65	9	57	2
III	65	10	56	4	55	15	97	1	57	2	98	2
Total	190	4	139	1	156	12	210	9	215	0	232	3
	Man Hours of Hoeing and Cultivating Strawberries 1st year—1948											
	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.
I	3	53	4	15	3	32	3	55	3	50	3	33
II	3	47	5	57	4	1	3	14	3	35	3	6
III	3	42	7	19	5	11	5	22	4	5	4	0
Total	11	22	17	31	12	44	12	31	11	30	10	39

growing in the areas. It took more man hours to clean up these plots and the weeds were so rank and rampant it was impossible to remove them without injuring the strawberry plants. This damage was reflected in decreased yield of berries from these plots.

All crops in the rotations (see table 21) were handled according to recommendations released by the Agricultural Experiment Station. The winter cover was a mixture of rye and crimson clover.

CHEMICAL WEED CONTROL IN STRAWBERRIES

This is a new project which was initiated in March, 1949. It represents one phase of the overall station project in chemical weed control.

The 10 treatments chosen to work with were replicated 4 times in random fashion. A standard clean cultivation was the check. Aero-cyanamid was applied at the rate of 150 pounds per acre before setting the strawberry plants. Aero-cyanate at 2 percent concentration was applied after the weeds made their appearance on the cyanamid plots. Three applications of this material (cyanate) were applied through the strawberry growing season. Sodium salt of 2,4-D was applied at the rate of 1 pound acid per acre when weeds made their appearance following the setting of strawberries. This material at the same concentration was applied once more during the season. The sodium salt was applied as a pre-setting spray at rate of 3 pounds acid per acre. A post-setting spray of the same material, but at the rate of 2 pounds per acre was applied. By post setting is meant after strawberry plants are set. One half the post treated plants were syringed immediately with plain water with the view of possibly reducing injury to the strawberry plant in case such injury did occur. The Amine salt of 2, 4-D was used at the rate of 3 pounds and 2 pounds acid per acre applied as pre-setting and post-setting applications respectively. One half of the plants that had received the post-setting application were syringed with water. The isopropyl ester of 2,4-D was used at the rate of 3 pounds of acid per acre and only as pre-setting application.

The variety, Blakemore, which was used in all plots, was spaced 2½ feet apart in rows 4 feet apart. Plots receiving a pre-setting application were sprayed March 24 and set March 25. The check plots were set March 25. Plots receiving post-setting application were set March 30 and sprayed April 8. One week was allowed between setting and applying the 2,4-D as a precautionary measure to allow the plants to slightly recover from shock of transplanting before perhaps shocking them again with the chemical spray.

The check plots had to be hoed on May 4 for the first time. It was not necessary to hoe the treated plots until May 26. By this time the check plots had to be hoed again so one hoeing operation was saved through the use of chemical weed eradicants. All plots were plowed out following the hoeing on May 26. Once all plots were

plowed, then there was no way of detecting the treated from the untreated areas. Weeds grew equally well on all plots.

On August 2, the 2,4-D plots were sprayed for the second time during the season, using 2 pounds acid (except one treatment of 1 pound acid) per acre of the sodium salt. A thorough hoeing and plowing preceded this application. The purpose of spraying at this time was to observe the effects upon late summer weed development, especially crabgrass, and upon runner formation of the strawberry plant.

Two pounds acid equivalent of 2,4-D is rather strong dosage for a summer application, but apparently strawberry plants are quite tolerant because it was impossible to detect widespread wilting of the foliage or twisting of the petioles and stolons. Under the conditions existing when the plots were sprayed there was only an occasional plant distress. From a weed eradicating standpoint it is doubtful whether this summer application of 2,4-D accomplished positive results especially where 1 pound was used. Johnson grass, milkweed, the trumpet vine, large spotted sperge and false mallow were not deterred in the slightest. But crabgrass, the main weed in most strawberry fields in Tennessee, appeared slightly impeded in seedling germination. The slowdown in weed growth was too minor, however, to justify omitting a single hour of labor at this time of the growing season.

As winter approached and plant growth ceased, strawberry plant stands were taken. The treated rows were just as well filled with healthy vigorous looking plants as the untreated rows. Microscopically there appeared to be no injury to either the original plants, or the runner plants as the result of spraying with 2,4-D, but macroscopically whether there is any damage remains to be seen.

TREE FRUITS

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

Peaches (Jones).—Five named varieties and 10 selections under number were added to the peach planting in 1949.

The pre-Easter freeze completely eliminated the crop on all young trees of all varieties. There was a normal set of fruit on old trees of the varieties Rochester, Vedette, Halehaven, Goldeneast and Fair Beauty. Redhaven set a very light crop and for the first time developed fruit of large size. Ordinarily this crop sets in such profusion the peaches never size. These few varieties escaped the frost largely from late blooming. Vedette was very striking in this respect because of its long chilling requirement.

Due to the circumstances records were not taken.

The June bug is becoming a real problem in the Station peach orchard. The adult will attack the peach fruit if the skin becomes minutely broken for any reason.

Figs (Drain and Ogle).—Fig production in Tennessee is limited to home plantings made in sheltered locations. The Station plantings around the abutments of Cherokee Bridge and near Loudon Lake produced a large crop of good quality.

Fire Blight Project (Drain and Ogle).—Cold weather during blossoming time reduced fire blight infection and destroyed a large part of the pear crop with more or less cold injury on other fruits. Blight cankers could not be found near the Station orchards and inoculation work was delayed. All control crosses were destroyed by cold this season. Seedlings already in the nursery row were sorted for fire blight resistance, and the more promising ones set in orchard form. Selections and seedlings from the Mericourt Station were propagated as that station has been sold.

Fruit notes were taken of seedlings fruiting, the less desirable were destroyed and promising selections propagated. Storage and processing trials were made where fruit was available.

Plums, Apples and Crab Apples (Drain and Ogle).—The constant threat of taking land for new buildings has prevented new plantings of these crops. Pilfering destroyed any yield records. Cold injury destroyed many blossoms. No data of value were secured.

OTHER CROPS

Brooks D. Drain and R. E. Ogle

Nursery Planting.—The policy of the Station is to maintain a small nursery planting of any new variety that we have developed and released. This includes 4 strawberries, 3 red raspberries, 1 pear and a number of varieties that are being tried by fruit growers. Land for these plantings is becoming scarce.

Cold destroyed the seed crop on the *Pyrus calleryana* trees and indicates that sites for this crop should be selected with care. Stock of this species already growing in the nursery row will be used to further the Station's work.

Insecticidal Crops.—Pyrethrum. An older planting of pyrethrum was discarded and a new planting of the Tennessee strains made. This is just a nursery planting and no experimental data were taken.

All the larger plants of *Tripterigium wilfordii* were dug, the roots cleaned, dried and shipped to the U. S. D. A. for assaying. A new planting was made, as this crop appears to thrive in Tennessee.

Competition with sage gathered wild in Southern Europe has reduced the price of sage oil below the cost of production under Tennessee conditions. This station published our experimental data up to the present time and suspended this project.

Grower trials of black walnut and pecan varieties were started on a number of farms in Tennessee. This was in cooperation with J. J. Bird of our Extension Service and the Tennessee Valley Authority. All plantings made a good start.

FLOWERS, TREES AND SHRUBS

Brooks D. Drain

Day Lily Varietial Trials—Additional varieties were added to our day lily varietal trials through the cooperation of a local garden club. There are now more than 40 varieties in this planting and about half of the more recent acquisitions. Some of the new varieties have darker colored blossoms and flower later.

New Introductions—A considerable number of plants of the Preziosa variety of torch lily, an upright type of Wandering Jew, and lily grass or Liriope grass (*Liriope graminifolia*) were propagated for distribution through organization. These new plants appear to be real additions to plants grown around Tennessee homes.

HORTICULTURE AT CLARKSVILLE

Brooks D. Drain

Blight Resistant Chestnuts—The planting of *Castanea mollissima,* blight resistant chestnuts, was started more than 18 years ago. Trees planted on fertile soil made an excellent growth. Those planted on less fertile soil were less satisfactory. The yield of nuts has been excellent. The nuts are large, attractive and good in quality. These plantings indicate the probable value of this type of chestnut for nut production in Tennessee. Trees propagated from these plantings have been distributed in this State.

Blight Resistant Pears—We have completed propagating all pear trees, promising selections and a few seedlings that have not matured fruit to date. Early blossoming varieties often show cold injury and fail to ripen fruit in this planting. This has been a very valuable orchard and we will miss the fruit that was being used for processing, storage, consumer preference and marketing trials. This part of this project will be delayed until a new source for fruit of these varieties can be grown. Cold injury destroyed a large part of the pear crop this year, but fairly good notes were secured from the stray fruits on many trees. A few trees, such as that shown in figure 30, produced moderate yields.

HORTICULTURE AT HIGHLAND RIM STATION
SPRINGFIELD

Brooks D. Drain and Troy Jones

Nut Crops (Drain)—A planting of nut varieties was made in cooperation with the Tennessee Valley Authority. These trees were held under refrigeration until just before planting and a good stand was secured.



Fig. 30—One of the older pear trees with a moderate crop of fruit. Sixty promising selections were made in this orchard before it was sold. These new varieties have been propagated and are growing at other stations.

Fire Blight Project (Drain)—Pear selections from the Knoxville breeding work that were planted during the winter of 1946-1947 have made good growth, and a few fruits were produced. A second orchard was started in the fall of 1949 with trees from the Knoxville nursery. Twelve selections and a check variety were included in the first orchard. Replicated 3-tree plots were used. Fifteen selections and a check variety was planted in the second orchard.

The young variety peach orchard at the Highland Rim Station was pruned moderately and sprayed during the dormant season. Growth of the trees during 1949, their second season, was highly encouraging. A summer cover of cow peas occupied the orchard between the trees and a winter cover of crimson clover was sown in early fall.

HORTICULTURE AT THE PLATEAU STATION

CROSSVILLE

T. R. Gilmore

VEGETABLES

Snap Bean.—The Topcrop variety of snap beans gave a yield of 272 bushels per acre in a variety test, while Rival produced 158 bushels and the best Tendergreen lot made 222 bushels.

Seed of the Tendergreen variety from eight sources were grown. The yields ranged from a low of 108 bushels to a high of 222 bushels per acre. Virus infection ranged from 26.4 percent in the lowest yielding lot to 6.3 percent in the best yielding lot.

Broccoli.—A spring set variety test of broccoli included Ferry-Morse Early Green Sprouting, Decicco, Christmas Calabrese and Texas 107. The variety Christmas Calabrese did so poorly no yield records were taken. The other varieties ranked in order of yield, Texas 107, Dicicco and F-M Early Green Sprouting.

Plantings of broccoli in the field on April 4th gave a 56 percent increase in yield over an April 19th planting date. The date of the heaviest cutting from both settings was June 2.

The development of data on the proper date of making direct seedings of broccoli for a fall crop was undertaken by making three seedings 10 days apart. The dates were June 25, July 5 and July 15. The variety used was F-M Early Green Sprouting. The date of June 25 gave the best yield and the July 15th date gave very low production.

Six fertilizer treatments were used on broccoli plots, ranging from 1000 lbs. of 4-12-4 per acre to 2500 lbs. of 4-12-4 per acre. Yields increased with increased amounts of fertilizer up to 200 lbs. per acre.

Irrigation of a fall crop of broccoli gave an increase in yield of 24 percent despite heavy rains in August and October.

The Station cooperated with Dr. T. P. Dykstra of the USDA, in his Southeastern Irish potato breeding program. Twelve thousand seedlings were grown on the Station and increase plots were also produced.

SMALL FRUITS

T. R. Gilmore and Troy Jones

Blueberry

Plantings were made of a number of blueberry varieties, including standard Northern varieties and some varieties from Georgia and North Carolina under number.

Strawberries

Variety.—Plots of Blakemore, Tennessee Shipper, Tennessee Supreme, Tennessee Beauty, Tennessee 965, Temple and New Jersey 377 were set in the spring. All varieties made a satisfactory row, but New Jersey 377 was severely attacked by leaf spot late in the season. Yield records will be taken in 1950.

Fertilization.—A new planting of strawberries was made on newly cleared Hartsell fine sandy loam, using 9 fertilizer treatments, both on limed and unlimed areas. Poor rows resulted when either nitrogen or phosphorus was omitted from a treatment. The limed replicates were noticably better, as was the case in the 1947 setting of the same test.

Rotation Studies.—Yield records were taken on strawberries, following six different crops. The yield following lespedeza was much below the yields following sweet potatoes, tobacco, corn, soybeans and snapbeans. There was little difference in the yields of the last five.

GRAPES

The grade variety planting was in its second year. The varieties making excellent growth were Concord, Fredonia, Niagara, Athens, Sheridan, Van Buren and Buffalo.

Those making medium growth were Golden Muscat, Kendaia and Seibel No. 1000.

Those making poor growth were Catawba, Dunkirk, Seneca, Urbana, Ruby, Hector, Yates, Eden and Lucille.

HORTICULTURE AT WEST TENNESSEE STATION

JACKSON

W. E. Roever and Brooks D. Drain

SMALL FRUITS

Strawberry Breeding and Inheritance.—Forty-six preliminary selections were made from 1732 seedlings crossed in 1947. 1800 seedlings from crosses made in 1948 were set. New records on 34 preliminary selections from crosses made in 1944 show Tennessee 1029 and 1019 to be the highest yielding of the new group. Fifty-three selections of the latter crosses were picked early.

Effect of Winter Superphosphate Top-Dressing on Yield of Blakemore Strawberries.—At the end of one year there was no significant difference between plants receiving additional phosphate when all plots received a top-dressing of 1000 lbs. of 4-8-8 fertilizer applied the previous summer.

Boysenberry Pruning Test.—Initial indications are the removal of fruited canes only is better than removal of all canes from the

standpoint of yield. Later indications, however, seem to indicate that complete cane removal following fruiting may be the best methods of pruning.

TREE FRUITS

Peach Variety Trial.—Erly-Red-Fre has proved to be an outstanding second-early. Redhaven, an early mid-season peach, was of excellent quality and gives an outstanding frozen product. Sullivan's Elberta, Dixiered and Triogem show promise.

Pear Selection Trial.—A number of selections from the Knoxville breeding work are being maintained for observation on tree, fruit and disease characteristics.

VEGETABLES

Tomato Breeding.—104 F_3 selections were made in nine combinations having merit. Two of these show distinct promise for the shipping deal.

Hybrid Tomato Trial.—Twenty seven F_1 hybrids were made. Crosses involving Rutgers, Pritcherd, Stokesdale, Pennheart and Indiana Baltimore are excellent selections.

Early Tomatoes.—Thirty two lines and varieties of early tomatoes have been tested. Progress has been made. The early tomatoes are smaller and of poorer quality with less disease resistance than the mid-season varieties.

Step Yield Trial.—The best market yields were made by Grother's Red Globe, 13,363 lbs. Step 57, 13,280, Step 68, 12,803, Stokesdale, 12,774, Marglobe 11,425, and Rutgers 9,267 pounds.

There were 41 lines in the observational trials. The leaders were Jefferson and Lakeland, which were rated the best varieties in the trial together with Step 135. Lakeland and Step 135 are second-early to mid-season. Jefferson is medium-late to late.

Effects of Lime on Tomatoes.—pH of the limed plots was 6.2, and for the unlimed plots 5.1. An average increase of 30.2 percent was obtained from the use of lime under these conditions. When transplanting tomatoes, if banded, the results suggest that removal of bands is preferable.

Southern English Cooperative Pea Tests.—The highest yielding varieties at Jackson were P 87-32, Wando and Progress. Only Wando has really proved adapted to the Jackson area.

Spring Cabbage Trials.—Twenty four lines were tested. Of these, the earliest was Earliest Wonder. This was the lowest yielding variety in the test, but earliness may compensate for small yield. Copenhagen Market Source B, Resistant Golden Acre Source C, Copenhagen Market Source D and Green Acre Source D, are highest in total yield.

Lime Effects on Overwintered Spinach.—Nine spinach varieties were planted on adjacent limed and unlimed plots having pH 7.2 and 4.8. The limed plots out-yielded the unlimed plots by an average of 500 percent. From the results, it would appear also that Old Dominion was the best variety for overwintering.

Peanuts and Lime.—With the unlimed soil showing a pH of 5.1 as compared with 6.1 on the limed plots, there was a 35.3 percent increase in yield due to lime and an additional 2.3 per cent due to filling of the husks.

Sweet Potatoes on Limed and Unlimed Soil.—The unlimed plots with a pH of 4.9 out-yielded the limed plots by 116 bushels per acre. Furthermore, the unlimed plots produced 90 bushels in salable potatoes per acre more than the limed plots.

Sweet Corn on Limed and Unlimed Soil.—The unlimed plots had a pH of 4.8; the limed plots 5.6. The differences in yield were not significant.

Sweet Potato Selections.—The top-yielding clone of the 1949 planting produced 595 bushels per acre. The second best line gave 581 bushels.

Lima Bean Trials.—From the standpoint of freezing, the most suitable of the tested limas were Early Thorogreen, Oklahoma N 13.1, Oklahoma 8-2, Oklahoma N-10 and Clarks Bush. The best yields were made by Oklahoma N 13-1, with 2025 lbs. freezable green shelled beans per acre, Oklahoma 8-2 with 1844, Early Thorogreen with 1772, and Oklahoma N-10 with 1761.

TRUCK-CROP PROJECTS IN THE DOUGLAS RESERVOIR AREA

(Cooperative with Tennessee Valley Authority)

A. B. Strand

Weather conditions during the growing season of 1949 were somewhat unusual, but excellent crops of all truck were made. May and June were cool and somewhat dry with a total of only 5.55 inches of rain. July and August were hot with 10 inches of rain, 6 inches of which fell between July 5 and July 18.

CROP PRODUCTION STUDIES

Tomato rotation and minor element studies.—Tomato rotation studies were carried out on Holston fine sandy loam, slightly eroded phase. The plots were established in 1944 on barley land. The plots were so arranged that triplicate plantings of tomatoes could be made, following annual lespedeza; alfalfa; red clover; sweet clover; lespedeza serecia; mixed grasses; and weeds, in one-, two-, and three-year series. The tomato plots were fertilized with 600

lbs. of 5-10-10. The other plots received no fertilizer. The rotation was carried out twice during the period 1944 to 1949.

Tomatoes, following mixed-grass crops, outyielded those following all other treatments. Total yields of tomatoes for 1949 show 9.4 tons following mixed grasses; 7.6 tons following weeds; 7 tons following annual lespedeza, lespedeza serecia, sweet clover, and alfalfa; and 6.1 tons following red clover. Over the four-year period from 1946 to 1949, differences are not as large. Mixed-grass rotations yielded 10.2 tons of tomatoes as compared with 9.25 to 9.5 tons for alfalfa, weeds, and sweet clover. Red clover, lespedeza serecia, and annual lespedeza rotations produced about 8.60 tons to 8.75 tons per acre.

Minor element trials were set on Holston cobbly fine sandy loam, eroded phase soil. All treatments, except 7, which serves as a check, are of 1000 lbs. 5-10-10 fertilizer applied ½ beneath plants, and ½ broadcast. Treatment 2 includes 5 lbs. borax, 10 lbs. $CuSO_4$, 10 lbs. $MnSO_4$, 10 lbs. $ZnSO_4$ added to the fertilizer. Treatment 3 is the same, except that borax is omitted. Treatment 4 is like treatment 2, except for copper. Treatment 5 is like treatment 2, except for manganese. Treatment 6 is like treatment 2, except for zinc. No fertilizer or minor elements constitute treatment 7. All treatments are replicated 3 times.

Yields varied from 7.3 tons per acre with no fertilizer or minor elements to 12 tons per acre when $MnSO_4$ was not present in the minor element mixture. In only one case were yields apparently reduced below the yields produced by 1000 lbs. of 5-10-10 per acre. This, when all minor elements were included, suggested that both zinc and manganese somewhat depress yields in the soil used. Boron, and perhaps copper, may be of some value in tomato production in Holston cobbly fine sandy loam soil. Under the conditions of this experiment there were only 29 percent rots as compared with 37 percent in the crop rotation experiment which, however, represents a second crop grown on the same land.

A valuable sidelight from this experiment is given by the fact that barley grown without fertilizer proved a complete failure; where following a tomato crop, the residual effect of the fertilizer was such that a yield of 47 bushels of grain was produced per acre.

Irrigation of tomatoes has increased average yields under all general fertilizer treatments by 7 percent in 1944, 11.5 percent in 1945, and 14.6 percent in 1947, or for the 3 years, an average increase of 12.3 percent. Cabbage, in 1949, showed an average increase in 6 varieties and one comparison of 326 percent. Resistant Detroit produced the highest yield without irrigation, yielding 6 tons per acre as compared with 9.8 tons when irrigated. Ferry's Round Dutch produced 4.2 tons on dry land as compared with 14.2 tons when irrigated, increasing 63 percent and 238 percent respectively.

STRAWBERRIES

This experiment was set on Holston fine sand loam, eroded phase considered to be the poorest soil of the Holston series. Two phases of irrigation were studied; the primary and residual results. Non-irrigated strawberries of 4 varieties yielded an average of 108.8 crates per acre as compared with 128 crates per acre on plots irrigated the previous fall. The effect of irrigation during 1949 showed an average increase of 20 crates per acre. The average yield of strawberries without irrigation for 1947, 1948, and 1949 was 143 crates per acre; irrigated in the fall only (residual effect) 195 crates per acre; and irrigated during the entire season 215 crates per acre.

The best non-irrigated berry was Tennessee Beauty with an average of 218 crates per acre. Fall irrigation increased the yield of this variety to 250 crates per acre, but irrigation during the entire season produced fewer berries than no irrigation. The best berry under irrigation was Tennessee Shipper with a yield of 234 crates per acre.

VARIETY TRIALS

Ferry's Round Dutch cabbage proved best under irrigation, with a total yield of 14.2 tons per acre as compared with the standard Wisconsin All Seasons, and Flat Dutch with yields of 6.85 tons and 8.6 tons respectively. Under dry land conditions, Resistant Detroit was best with a yield of 6 tons as compared with 0.3 to 1.0 ton for Wisconsin All Seasons and 0.52 ton for Late Flat Dutch.

FERTILIZER TRIALS

Asparagus was fertilized with 1000 lbs. of 5-10-5 and 8 tons of manure per acre and compared with an application of 2000 lbs. of 5-10-5 per acre. The manured plots outyielded the non-manured plots 750 lbs. of asparagus tips to 662 lbs., an increase of 13 percent.

PLANT PATHOLOGY

C. D. Sherbakoff

BREEDING FUSARIUM WILT-RESISTANT COTTON

The breeding of cotton for Fusarium wilt resistance up to 1947 was previously given a general review in the 1946 Annual Report.

In the review it was stated that of the new cottons developed, the most promising appear to be several which are of especial interest because of their high wilt resistance, relatively high strength of lint and long length of staple. Most of the lines came from a cross of Acala x Okra Leaf x Dixie 14-5, made in 1937 by Homer C. McNamara. Since 1938 selections were made from the cross during

several seasons from open-pollinated plants, grown in proximity to the Seabrook Sea Island cotton and its crosses with various upland cottons. Certain characters of the best lines indicate that they were naturally crossed with the latter cottons.

Over 300 different selections made in 1948 were grown in 1949 on the Blount Farm near Knoxville. Nine of these from open pollinated seed were grown in small increase blocks. The seed will be used for future yield tests.

Of the cottons grown in 1949, 251 which showed a good lint percent and acceptable field appearance were tested for the staple length, fineness, and strength of the lint.

The records were turned over to N. I. Hancock who plans to continue the breeding in cooperation with James M. Epps. On the basis of his field observation of the cottons and the records of their performance, he selected a number of different lines for the 1950 work.

A systematic selection from the new cottons for the high yield, with retention of the long staple, high strength, and disease resistance, appears to be the main phase of future work. There should be added also the breeding for incorporation in the better wilt-resistant lines, the resistance to the bacterial leaf spots which had been found in the Acala 20 cotton by D. M. Simpson, of the U. S. Department of Agriculture.

COTTON VERTICILLIUM WILT

The test of cotton Verticillium wilt resistance was conducted by James M. Epps. Different varieties of cotton were compared for their relative resistance to the disease. The test was planted on the L. Donaldson farm at Tiptonville. The part of the field used for this test has been known to be generally and severely affected with the disease since 1927. Sixty-six different cotton varieties and certain of our new breeding lines were tested there during the 1949 season.

Nine of the cottons selected for the test were from the breeding lines developed for Fusarium-wilt resistance by this Station. The other cottons were received from the Mississippi Agricultural Experiment Station where a large number of different cotton varieties are maintained for the benefit of cotton breeding, under the regional project of "National Cooperative Research in Plant Science for improvement of Cotton." No yield records were made of the different cottons because, due to the wilt, the stand was very irregular in most of them, and because of the small amount of cotton planted.

Of all the cottons tested there only Giza 7 showed neither external nor internal symptoms of the wilt. This is an Egyptian cotton of no direct value for culture in Tennessee. The data for the 10 cottons that showed apparently good resistance and yield are given in table 22.

TABLE 22.—*The staple characters, lint percentage, and boll size of the* 10 *cottons that appeared to resist Verticillium wilt and possibly useful for culture in Tennessee, in* 1949 *test*

Variety	Staple	Strength	Lint %	Bolls per pound	Field Notes
Plant Path. Lot 2-1	1.34"	8.51	37.2	65	Very little wilt. Plant and yield good
" " " 2-2	1.38	8.20	36.2	64	Very little wilt. Plant and yield good
" " " 2-3	1.47	7.40	36.2	57	Very little wilt. Plant and yield good
" " " 4	1.27	7.95	39.6	65	Highly resistant. Good yield.
" " " 7	1.25	7.56	40.4	70	Good resistance. Good bolls and yield
" " " 8	1.33	6.90	38.4	57	Good resistance. Good bolls and yield
Express 432[1]	1.03	7.26	33.9	Small	Extra good looking. High resistance. Good boll yield.
D & PL 4-8[1]	1.03	6.33	37.5	"	Good resistance. Good bolls and yield
Pandora[1]	1.04	8.33	33.5	Medium	Extra good looking, high resistance.
Cook 144-68	1.05	8.12	32.7	Large	Best looking in the test. Some wilt.

[1] According to N. I. Hancock, Express 432 is very poor picking cotton; D & PL 4-8 has weak lint; and Pandora too late for Tennessee.

The characters of the first 6 cottons in the table above were determined on their 1949 performance at Knoxville; while the data for the remaining 4 are taken from the 1948 records of Mississippi Agricultural Experiment Station.

The other 56 cottons tested were either killed by the wilt, or were of definitely poor yield, or too late for culture in Tennessee.

A number of other cotton varieties and hybrids of a definitely promising resistance to this disease, including Giza 7 and one extremely promising African cotton, obtained from or through the U.S.D.A. cotton breeders, were planted in the greenhouse at Knoxville, for testing of their relative resistance under the conditions of artificial inoculation, and for their suitability for hybridization with the more promising upland cottons.

WHEAT BREEDING FOR RUST RESISTANCE

Wheat breeding for rust resistance, reviewed in the 1946 Station Report, continued along the same line of selection of the more rust-resistant, better yielding wheats of better grain characters.

During 1948-49 season 9 of the new wheats, including Indiana's Vigo, were grown on a 10-acre field at the Greeneville Tobacco Experiment Station, to obtain enough seed for field tests on a larger scale than the breeding plots. One of the wheats which during the preceding season was high in yield and rust resistant, was badly lodging and hence was discarded from further tests. The other wheats were placed by the Superintendent of the Tobacco Experiment Station with some of the local growers for increase so that when and if some of them will meet the growers' acceptance, and are approved by the State Crop Improvement Association, there will be enough of the seed for certification.

During this season 15 different, more recent rust-resistant wheat selections were grown at Blount Farm, on a 1½-acre field. None of these appeared to be better than the wheats grown at Greeneville and most of them were discarded.

The 1948-49 yield and disease resistance test of various wheats by the Agronomy Department, in 6 different locations in the State, showed some of the new rust-resistant varieties at the top of the list by their yield. The Agronomy tests of 1949-50 include also a few additional new Plant Pathology wheats, and some of them are planted at Highland Rim Experiment Station at Springfield for an increase, preliminary to possible release to the growers.

In the fall of 1949, at Knoxville, on a rolling land, 12 of the selections from 1947 and 1948 harvests were planted, with Tenn. 612 and Thorne as checks, in 6 randomized replications, in plots of one grain-drill width across 60½ ft. wide range, for yield and grain quality comparisons. And on the second river bottom were planted, with spaced kernels 73 different lines of new selections. Some of them were sufficiently promising to expect a better performance than the older selections gave.

The Agronomy tests and the results of the few trials by the growers and the Pathology records indicate that in Tennessee, the new wheats will shortly replace the old wheats, provided proper increase and certification of the wheats proceeds as expected.

TOMATO BREEDING

The first tomato resistant to Fusarium wilt, Tennessee Pink, was developed at Tennessee Agricultural Experiment Station, by the late Professor S. H. Essary. He continued the work of developing wilt- and early blight-resistant tomatoes until his death, in May 1935. His work consisted primarily in testing his own wilt-resistant selections and a large number of others obtained from various commercial and experimental sources in the United States and from foreign countries. His records show, for instance, that a number of different sorts was received from Australia where the wilt has been also of a considerable economic importance.

From 1935 the tomato work at this Experiment Station was carried with Essary's breeding material, by the Departments of Horticulture and Plant Pathology. One of Essary's selections, No. 4 or No. 5—not determined, from Marglobe tomatoes in a commercial field near Newport, Tennessee, was found by the Department of Horticulture to be desirable for the growers and released under the name of "Essary." J. M. Epps' selection from this tomato has been used in our work under the same name.

The work with Essary's tomatoes by the Plant Pathology Department from 1935 to 1949 was continued with the same aims as those of Essary—improvement of wilt-resistant varieties, increase of wilt resistance, and search for early blight-resistant materials. At that period we had no wilt-immune or highly resistant tomato which would grow throughout the season without showing any symptom of wilt in the soil heavily contaminated with the wilt fungus, where the "resistant" varieties known at the time, such as Essary's and Louisiana's Pink and Red, Marglobe, Pritchard, Rut-

gers, etc., would go down with the disease early in the season though not as rapidly as the truly susceptible varieties. At that time it was considered possible that the resistance may be increased by crossing and sib-crossing different "resistant" varieties then available. This work was carried in the greenhouse and in the field. Several new selections somewhat better than the common resistant varieties were developed in that way. This work was carried by J. O. Andes at Knoxville.

During the same period other plant pathologists engaged in similar studies—W. S. Porte and H. B. Walker, of the U. S. Department of Agriculture, and G. W. Bohn, and C. M. Tucker, of Missouri Agricultural Experiment Station, discovered that a wild currant tomato from Peru, U. S. Accession No. 160, was immune from Fusarium wilt, to the extent that it showed no wilt throughout the season under the condition of artificial inoculation with the fungus and in the fields naturally heavily contaminated with the pathogen. They also found that, by crossing, the factor for resistance to wilt is readily transferred into commercial edible tomatoes.

In 1939 Bohn and Tucker[3] reported their discovery of wilt immunity in the currant tomato and its utilization in their tomato breeding and in 1941 Porte and Walker[4] developed the variety Pan America, entirely resistant to wilt and otherwise indistinguishable from Marglobe. Pan America was obtained from repeated back crossing the currant tomato on Marglobe and systematically saving only the resistant larger fruiting segregates. In our yield tests Pan America appeared to be somewhat less productive than the better lines of Marglobe.

After the discovery of the resistance of the currant tomato 160 it was obvious that in the breeding for wilt resistance it should be fully utilized. The writer believed that Bohn and Tucker's crosses with the currant tomato and Pan America already were a definite advance in the breeding, and, hence, these tomatoes instead of the currant tomato were used in our breeding from 1940 up to the present.

TABLE 23.—*The yield and earliness of the more promising new and the best commercial tomatoes tested in Tennessee in* 1949, *under the condition of a mild form of Fusarium wilt at Jackson and Knoxville fields and no wilt at Springfield.*

Variety	Jackson				Knoxville				Springfield				
	Yield, tons per acre			Earliness rank	Yield, tons per acre			Earliness rank	Yield, tons per acre				
	Total	Yld. rank	Marketable		Total	Yld. rank	Marketable		Total	Yld. rank	No. 1	No. 2	Culls
S-6-17	10.52	I	7.33	II	10.28	I	5.04	I	11.65	I	6.41	4.15	1.09
Tucker's 7-S-34	.....	.....	.....	.....	8.60	II	4.49	II	12.64	I	5.94	5.48	1.22
203	9.23	I	7.66	II	.....	.....	.....	.....	.....	.....	.....	.....	.....
T 2 x 2	9.60	I	7.50	II	.....	.....	.....	.....	.....	.....	.....	.....	.....
E402	9.18	I	7.21	I	.....	.....	.....	.....	.....	.....	.....	.....	.....
Essary	7.35	III	5.57	III	5.19	III	2.71	III	9.39	III	4.78	3.90	0.71
Marglobe	7.61	III	5.50	III	4.74	IV	2.50	III	10.20	II	5.09	4.14	0.97
Rutgers	7.15	III	5.84	III	.....	.....	.....	.....	.....	.....	.....	.....	.....

[3] Bohn, G. W. and C. M. Tucker. Immunity to Fusarium wilt in tomato. Science 89: 603-604. 1939.

[4] Porte, W. S. and H. B. Walker. Pan America tomato. U.S.D.A. Cir. 611: 1-6. 1941.

To bring out more clearly the performance of the best new tomatoes in comparison with the three best tomatoes which have been most generally grown in Tennessee, in table 23 are presented the data for only those tomatoes.

In all of the tests from which the data above was taken, the unit plot was usually of 20 plants, spaced mostly 3′ x 4′ and repeated four or five times, unstaked.

At Jackson, where a larger number of varieties were tested, including certain segregates from some additional crosses made by Epps, the data show that in marketable and total fruit the tomatoes 203, T 2 x 2, E402, and 302, together with S-6-17, were of about equally highest rank.

In the earliness, at Jackson the tomato 57 x Essary, E402, and 306 were ranked best, with S-6-17 next to them in earliness; and at Knoxville, where the four tomatoes which gave highest yields at Jackson were not tested, S-6-17 ranked first, 7-S-34 and STEP 57 next to it, and 57 x Essary third.

STEP 57 and Southland appear to have too soft fruit at Knoxville. Southland was tested also at Jackson, where due to its conspicuous blossom-end scar and low yield it was considered to be of no direct cultural value, though it may be useful in the breeding because of its tolerance to early blight and, therefore, Epps used it in some of his recent crosses. It may be noted here that E. L. Felix, at Knoxville, gave some attention to the juice color of different tomatoes and notes that the juice of Southland was deeply colored and that of S-6-17 poorly colored. In cooperation with G. A. Shuey he also made some preliminary determinations of 14 different tomatoes for total acid, pH value, ascorbic acid, and sugars.

The tomato S-6-17 which gave the highest yield was also highest yielding in our test in different locations in 1947 and 1948. Another important character of this variety is that it is practically free from fruit checks and cracks. However, it is still rather uneven in plant and fruit characters. The other varieties deserving special attention are 7-S-34 and the four best yielding varieties at Jackson test. One of the latter varieties, E402, was also one of the earliest in the test.

Conclusions

It seems that of the tomatoes used in our recent tests several new ones are definitely higher yielding than the best wilt-resistant and susceptible varieties now available to the growers. With the exception of E402 these high-yielding varieties are also highly resistant to Fusarium wilt.

In the tests of next season emphasis may be well placed on these varieties, the work to include: Selection of a number of the more promising single plant progeny lines of each variety, to improve their uniformity; and to determine the growers' acceptance of the best of these tomatoes.

THE EFFECT OF CERTAIN CULTURAL PRACTICES AND SOIL TREATMENTS ON "SOIL ROT" OF TOMATOES

Staking of tomato plants in the field is a very common practice in gardens and, especially, in the areas of green-wrap culture. There are two reasons for staking: (1) A fair insurance against large losses from soil rot of tomatoes—the rot which is caused by certain soil fungi (molds) which invade the fruit when it is in direct contact with or close to the soil; and (2) a somewhat greater yield of early fruit from the staked tomatoes.

The staking is, however, a very expensive operation and therefore it has been considered worth while to study some other less expensive means of reduction of the rot.

The only thing the staking does, in controlling soil rot, is to keep the fruit away from the soil and in that way away from the molds causing rot. It seems feasible that the same results may be attained by placing sufficient amount of the right kind of mulch under tomato vines. It seems also that there should be less of the rot on the drier soil surfaces under tomato vines—on high beds. Besides, if the soil surface under the vines were covered with an effective fungicide, the rot should be greatly reduced.

The three hypothetical means of control of the fruit rot have been tested in a preliminary way during the preceding two seasons at Knoxville, Jackson, and Springfield. The test indicated that there may be some benefit along the expected lines. During the 1949 season Mr. Epps conducted somewhat more extensive tests of this nature at Jackson. The data obtained from the tests are given in table 24.

TABLE 24.—*Tomato yield and fruit rot in high and low beds, staked and unstaked, fungicide treated and untreated.*

Treatment	Regular beds	High beds
	Marketable fruits Pounds per plot	Marketable fruits Pounds per plot
Staked and pruned	107.5	.....
Untreated	107.5	97.6
Soil sprayed 10-10-50 Bordeaux mixture	119.3	97.1
Mulched	153.0	136.2
Mulched and sprayed 10-10-50 Bordeaux mixture	.....	133.2

In the test each treatment was repeated four times, with the rows 4 feet wide and 30 feet long, with three rows for each plot. The data recorded were from the center row. Copper sulphate, in form of bordeaux mixture, was applied to the ground at the rate of 150 pounds per acre.

The data of the table above seem to show definitely that the mulched plots gave better yield; that the yield was higher in the regular beds than in the high beds; and that the treatment with bordeaux apparently did not decrease the fruit rot.

Some previous tests indicated that the unstaked tomatoes gave materially larger total yields of marketable fruit, with somewhat lower yield of early fruit. It seems that a pruning of the unstaked tomatoes, similar to that of staked plants, may correct the lateness of the unstaked tomatoes.

Red Clover

Breeding and testing of purple-seeded clover, resistant to anthracnose and powdery mildew, was continued by James M. Epps, at the West Tennessee Station. The following is his account of the work during 1949:

Crosses.—Some seed were harvested from two of the crosses. All came up to poor stands and produced very few seed. One plot did not come up to a stand and was lost. Seed are available from this cross for planting again in 1950.

Selections.—All of the selections made good plants and a good supply of seed was saved from each. There were very few off-type plants and the seed were uniform. No yellow seeded plants were found. A few plants were discarded because of mildew. These selections appeared vigorous throughout the season.

Variety Test.—The Agronomy Department made a variety planting in the fall of 1948. Yield records show that the purple-seeded was somewhat lower in the early hay yield. However, at the end of the season it was apparently in better shape than any of the other lines. The stand appeared better and the plants were more vigorous. The yield test will be continued in 1950.

Seed Increase.—From the seed-increase plot enough seed was harvested to make a sizeable increase planting. The planting was made in September and a good stand of plants are making good growth. From this planting we hope to harvest seed in 1950. The old planting will be used to further increase the present line. This increase planting did not develop mildew and at the end of the season the stand appears to be as good as it was in the spring.

Variety Test Plans for 1950.—The Agronomy Department made variety plantings at most of the sub-stations in September with the purple-seeded clover included. At the Jackson Station two of the purple-seeded lines were planted, one from seed saved in 1948 and the other from seed saved from the increase block in 1949.

STRAWBERRY ROOT ROT

E. L. Felix continued the work of development of better root rot-resistant strawberries, by making new crosses and testing the one made in 1947. The latter were fruiting in 1949. From the large number only 105 of the seedlings were selected as promising for further test of their reaction to root rot and their horticultural qualities.

"Portland 136," a strawberry selected from a cross made at the Knoxville Station in 1941, produced especially high yields in 1944 tests at Portland but shortly became severely damaged by yellows, with some scattered plants apparently resistant to the trouble. Mr. Felix made several selections of the yellows-free plants in 1948 and a number of them continue to remain free from yellows.

Strawberry 99-11 [(Geneva 92455 x Plant Path. 1937 (B16 x B53) x SW5)] was found by Mr. Felix to possess a high proportion of healthy roots with good top growth. This crop ripens about one week later than most varieties in the test and bears very attractive though somewhat soft fruit. New crosses with this strawberry will be made in 1950.

TOBACCO DISEASES

Dennis H. Latham continued his breeding work aiming to develop varieties of dark-cured tobacco resistant to black root rot, wildfire, and black shank. In the work are employed standard methods of procedure, and since it is still in its early stages there is nothing as yet of special interest to report here.

TOBACCO BLACKSHANK

Tobacco blackshank was not known to be present in Tennessee before 1935. In August of that year Dr. Paul R. Miller, of the U. S. Department of Agriculture, and L. F. Mendelson, Plant Pathologist from Australia, brought to this Station a few specimens of diseased tobacco plants found in a field of about 20 acres near Adams, Tennessee. The specimens were not sufficiently good to identify with certainty the suspected blackshank. Because of the great importance of the disease, a special trip to the field near Adams was made and 50 excellent specimens of the disease were secured. It was found that each of the specimens showed definite symptoms of blackshank. When the specimens were cultured each gave characteristic culture of the fungus which causes the disease. The identification was later confirmed by Drs. E. E. Clayton, of U.S.D.A., and W. B. Tisdale, of Florida Experiment Station.

Since then the disease was gradually spreading farther south through Middle Tennessee; however, only during this season, 1949, it was found also in the Burley area of East Tennessee, in Greene County.

WATERMELON FUSARIUM WILT

The work with watermelon wilt was conducted by Mr. Epps, at Jackson.

During 1949 a comparison of 18 different varieties of wilt-resistant and susceptible melons were made on soil apparently free from the disease. In the test were included several V.B.L. (U. S. Vegetable Breeding Laboratory, Charleston, S. C.) varieties received

from Dr. Watts. Each variety was planted in 8-hill rows. All fruit of 10 pounds and over were counted and the total weight recorded. The data are presented in table 25.

TABLE 25.—*Yield and fruit size of watermelons of different resistant and susceptible varieties at Jackson*

Variety	No. fruits 10 pounds and over	Weight of fruits	Average weight of fruits
Miles, U. T. Sta. seed	33	520	15.7
Mo. Queen	23	438	19.0
Corneli Dixie Queen W. R.	24	428	17.8
Miles, Assoc. Seed Co.	30	404	13.4
V.B.L. W290	22	401	18.2
Black Diamond	20	380	19.0
Dixie Queen 110 Taylor	21	359	17.1
Yellow Meat Melon	21	339	16.1
Ironsides	16	318	19.9
V.B.L. 48-12	19	319	16.8
Brownlee	14	212	15.1
W319	14	212	15.1
W320	12	181	15.1
V.B.L. W298	11	143	13.0
W407	7	102	14.5
White Hope	4	61	15.2
V.B.L. 46-40	Only two plants alive when the last fruit harvested.		
V.B.L. 47-3	—All plants dead—		

The work of purifying the various breeding lines of watermelons was continued in 1949. Seed was obtained from all lines that showed promise. Several of the lines look promising and have continued to grow in the breeding range where wilt normally kills all susceptible varieties.

The work was continued with the Miles variety, to develop a line of larger fruit with a thicker rind.

The Associated Seed Company has continued to increase the Miles variety and seed will be available in quantities for planting in 1950.

ALFALFA CROWN ROT

The studies of alfalfa crown rot were initiated in 1949 because the disease has become a major threat to alfalfa culture.

In these studies it is considered that the main efforts should be placed on search for resistant varieties of alfalfa and finding what changes in the present method of alfalfa culture are necessary and practical to control the disease.

During 1949 the first step was made in search for a disease-resistant line of cultivated alfalfa. Toward this end, during the winter of 1948-49 the seeds of a large number of different varieties were planted in the greenhouse and in the spring the seedlings were set out in the field, each individual 1 foot apart in the rows. The plants showed great variability in their characters and in seed production.

In cooperation with the Department of Agronomy about 100 of the seedlings were selected for future studies. The selected plants will be increased by cuttings and then evaluated for their disease reaction and agronomic characters.

In regard to the second objective—the effect of cultural methods on the disease—it should be stated that the disease's most destructive period is usually from February to the end of April and that for its spread the fungus needs moist surface of the ground and thick stand of the plants.

Hence, for control of the trouble it seems worth while to test pasturing of alfalfa during late fall and early winter which would keep the ground exposed to sun and air and thus be unfavorable for the disease. Also since the stands of fall-sown fields usually are denser and the plants more succulent they are likely to be more susceptible to the trouble than the spring sown fields.

The fungus causing crown rot lives in the soil and sporulates for at least two years. Since the most effective source of infection is the one produced right in the same field, alfalfa should be grown only in fields which were not in the crop or any other legume for at least four preceding years.

The parties interested in alfalfa culture may contribute greatly to a successful control of the disease if they would see to it that the above mentioned methods of cultural practices affecting the disease be given thorough testing by the growers.

APPLE SPRAY PROGRAM

The effectiveness of certain changes in the apple schedule. such as the use of some different fungicides and/or omission of certain sprays on varieties sufficiently resistant to a disease which the sprays are expected to control, was tested for the second year at Jackson.

The orchard on the grounds of West Tennessee Experiment Station was used in this test. These are 15 different varieties of apples, some very susceptible to scab, some to bitter rot, to blotch, to fire blight, and some like Ben Davis to practically all of them.

The following schedule was used in the test in 1949:

Dormant: Oil emulsion 3 gals. actual oil; and DN-Dry No. 2, 1½ lbs.

Pre-pink: Lime-sulphur 2 gals.

Pink: Wettable sulphur 5 lbs. and Fermate 1 lb.

Full Bloom: Bordeaux 2-6-100.

Calyx: Wettable sulphur 5 lbs., Fermate 1 lb., and lead arsenate 3 lbs.

First Cover (1 week after Calyx): Bordeaux 4-6-100. The spray is for control of blotch and hence was omitted in all varieties which are more or less resistant to the disease.

Second Cover (1 week after First Cover): Fermate 1½ lbs., lead arsenate 3 lbs., DDT 3 lbs.

Third Cover (2 weeks after Second Cover): Fermate 1½ lbs., DDT 3 lbs., N-111, ¾ lb. (for red mite control).

Early varieties were not sprayed after the Third Cover stage.

Later cover sprays were applied at 2-week intervals using Fermate 1½ lbs. and DDT 3 lbs.

In all of the above sprays the amounts are given for 100 gallons of water.

The data obtained from the test are given in table 26.

TABLE 26.—*The results of the test of the apple spray schedule at Jackson, 1949.*

	Percent of fruits showing codling moth stings	Black rot	Bitter rot	Scab	Presence of fire blight
Ben Davis	8[1]	1	3	0	Slight
Black Twig	18	0	0	0	Some blossom
Kinnard	3	1	0	0	0
Stayman	5	1	0	0	0
Winesap	6	0	0	0	0
Red Delicious	20	0	0	0	0
Rome Beauty	5	1	0	0	0
Early Harvest	1	0	0	0	0
Yellow Transparent	1	2	1	0	Some twig
Lodi	1	2	1	0	0
Red June	10	4	5	0	0
Early Ripe	1	0	0	0	0
Golden Delicious	2	0	0	0	0
Red Bird	8	0	0	0	0

[1] There were very few wormy fruits in the orchard. The percents given are for stings and wormy.

CONCLUSION

The orchard produced the cleanest and best crop of fruit this year that has been seen in this orchard. There were practically no rots of any kind and the fruit was excellent. The rains made it rather difficult to keep the spray materials on during the summer. It should be remembered that several of the varieties had from 50 to 80 percent of the fruits showing codling moth worms in 1948.

From this test it appears that the materials, rates, and time of application have given good control of diseases and insects in the Station orchard.

THE EFFECTIVENESS OF SOME PROPRIETARY ORGANIC FUNGICIDES ON CONTROL OF BROWN ROT OF PEACHES

During 1949 season Mr. Epps compared the effectiveness of Phygon and Zerlate with sulphur in a spray schedule for control of brown rot of peaches. The schedule was the same as that adopted by the Tennessee Horticultural Society for 1949, for commercial orchards. In the test some blocks of the trees were sprayed with

Phygon, 1 pound to 100 gallons, or Zerlate, 2 pounds to 100 gallons, while the others were sprayed with sulphur as in the regular schedule.

The results show no advantage of using either of the two organic fungicides in place of sulphur. It may be added also that neither of the three fungicides give entirely satisfactory control of brown rot, indicating the necessity of certain modifications in the schedule—probably the need of some additional sprays.

PEACH LEAF CURL CONTROL TEST

Sometimes a question is asked whether some prepared copper fungicide, such as "tribasic" copper, can be used for control of peach leaf curl as effectively as freshly-made Bordeaux.

To answer this question Mr. Epps conducted a test at Jackson, in 1949, in an orchard where the disease, and scab, were serious in 1948.

In the test 4-4-50 Bordeaux and Tribasic, each with 3% oil emulsion, were used on old and young trees. The applications were made February 23, 1949. Each treatment contained the same copper content.

The trees were examined during the summer months to determine the effectiveness of the two different copper spray materials. The treatment with Bordeaux and oil was by far the outstanding, giving excellent control of leaf curl on all treated trees. The tribasic copper sulphate-treated trees did not show effective control of leaf curl, many leaves showing disease on the treated trees. The untreated trees were severly injured. There was apparently no difference in scale control.

FUNGICIDES TEST FOR CONTROL OF STRAWBERRY FRUIT ROT

Mr. Epps at Jackson and Mr. Felix at Knoxville tried the following fungicides in spraying strawberry plants, to control fruit rot: Copper naphthenate emulsion, 4 gals.; DN-289, 1 qt.; Puraturf 177 plus Armour Sticker, 10 lbs.; Puratized, 1 pt.; Copper zinc chromate plus Armour Sticker, 4 lbs.; and lime sulphur solution, 10 gals.; all per 100 gallons of water.

In neither of the tests was there any definite indication that any of the fungicides reduced fruit rot of strawberry, under the conditions of the two tests.

POULTRY

O. E. Goff, H. Patrick, B. J. McSpadden, D. E. Cooperrider, J. T. Tumlin, R. L. Tugwell, G. J. Mountney

MORTALITY AND LIVABILITY

Mortality and the problems of mortality have been the causes of failure in many poultry enterprises. In a study involving cause of death in the station flocks all chickens that died or were observed in a morbid condition were submitted to the station veterinarian for anti-mortem and post mortem examination. From December, 1947, through December, 1949, 540 growing chickens and 229 mature birds were autopsied. In the mature specimen the cause of death or principle manifestations observed with frequency of occurrence was lymphomatosis 38.43 percent, salmonella infections and enteritis 13.54 percent, reproductive disorders 10.04 percent, cholera 5.24 percent and peritonitis 4.80 percent. These conditions appeared in 72.05 percent of the cases. Other conditions noted in mature stock included pneumonia, coryza, cannibalism, ruptured liver, and heat prostration.

Of the 540 young birds examined 26.85 percent exhibited non-specific lesions. Toxemia, septicemia and nephritis appeared in 12.59 percent of the cases, pneumonia in 5.74 percent, Newcastle 5.74 percent, coccidiosis 4.81 percent, constipation and impaction 4.63 percent, lymphomatosis 3.89 percent, while enteritis was observed in 2.22 percent of the chicks. These manifestations and non-specific causes accounted for 61.84 percent of the 540 specimen examined.

The greatest percent mortality occurred in chicks during the first three weeks of brooding. The greatest mortality occurred in old birds during the late summer and fall months.

The mortality curve in Tennessee-produced chicks for 1949 was essentially the same as for 1948. This information was secured from cooperating Tennessee flock owners and hatcherymen.

During the year reports were secured from 357 chick buyers involving 61,584 baby chicks. At three weeks of age 93.71 percent of the Tennessee U. S. Pullorum-Controlled chicks were alive while 98.26 percent of the Pullorum-Passed and 96.07 percent of the Pullorum-Clean chicks were alive at three weeks of age. The difference in livability of the Passed and Clean chicks is probably of little significance as only 2,471 Pullorum-Clean chicks were involved compared to 31,756 Pullorum-Passed chicks and 27,357 Pullorum-Controlled chicks. The percent livability of all chicks started in this cooperative project during 1949 was 96.19 percent compared to 97.85 percent livability in 1948. The heavier mortality in 1949 was apparently due to more frequent outbreaks of Newcastle disease. An effort to reduce losses from this disease is being made by Tennessee poultrymen through vaccination programs.

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VITAMIN B_{12}

Studies involving vitamin B_{12} or the Animal Protein Factor were continued during 1949. Production, fertility, and hatchability of eggs from hens fed a ration high in soybean oil meal but an inadequate level of B_{12} was equal to production, fertility and hatchability from hens receiving a control ration abundantly supplied with this vitamin.

All hens in these studies were maintained on a built-up litter that had been used for the preceeding six months by growing stock. The ability of hens and chicks to secure B_{12} from a built-up litter has been reported by other stations. Rations containing a minimum adequate level of B_{12} may cause fluctuations in hatchability. It was found that the transfer of B_{12} to the chick through the egg was greater when hens received B_{12} in the ration than when hens were forced to secure this vitamin from the litter.

Chicks fed rations high in soybean oil meal containing no animal protein concentrate and no supplementary source of B_{12} failed to grow at a satisfactory rate. At 5 weeks of age battery reared chicks receiving adequate levels of B_{12} in their diet were approximately one third larger than those receiving inadequate amounts.

At eight weeks of age the average weight of chicks receiving B_{12} was 1.50 pounds compared to an average weight of 0.26 pounds for chicks receiving a ration deficient in this nutrient.

Although hens secured vitamin B_{12} from a deep litter it is unwise to depend upon this source for all the B_{12} needed for breeding hens. This vitamin is responsible for rapid growth in chicks. Chicks make their most efficient gains early in life. The transfer of B_{12} to the chick by the dam and a dietary source of the Animal Protein Factor produces more economical gains. From 6 to 9 milligrams of B_{12} per ton of feed is required in poultry rations.

Battery-started turkeys poults failed to respond to vitamin B_{12} in their ration during the first six weeks of life. Either poults do not need a dietary source of B_{12} or they are able to manufacture their own body needs within their own system.

Growth of poults through the first six weeks of brooding was the same when fed an all vegetable protein ration, abundantly fortified with B_{12}, or fed a ration essentially free of this vitamin. It appears that vitamin B_{12} is not required in the diet for growth in poults.

REMOVAL OF INTERNAL PARASITES

Treatment of chickens for removal of intestinal parasites is a common practice. Of the numerous classes and species of parasites infecting chickens the common poultry round worm (*Ascaridia galli*), the cecal worms (*Heterakis gallinae*) and tape worms (the cestodes) are the most often seen by the poultryman.

Prevention of infections is the most desirable practice. In spite of attempts to prevent contamination of chickens, many owners suffer a considerable loss from internal parasites.

The value of drugs for the removal of internal parasites harbored by chickens have been studied at this station. During the study hens were confined to individual cages equipped with wire floors. After treatment, all droppings from each hen were saved and examined for the presence of worms. After a three day observation period, all hens were killed and the digestive tract examined for worms.

Capsules or pellets containing 6.67 or 7.5 grains of phenothiazine and 0.67 or 0.9 grains of nicotine sulfate removed 95.5 percent of all round worms and 75.2 percent of all cecal worms.

When phenothiazine was used as the only treatment (7.5 grains per hen), it removed 38.6 percent of all the roundworms and 66.3 percent of all the cecal worms from 21 infected hens.

Nicotine sulfate removed 88.6 percent of all roundworms and 12.9 percent of all cecal worms in 21 hens when 0.9 grains per bird was given.

Carbon tetrachloride in dosages of 4 cc per fowl removed 58.8 percent of the roundworms but only 8.3 percent of the cecal worms from 20 hens.

When n-Butyl chloride in dosages of 1.5 and 2.0 cc was administered to 19 hens, 65.3 percent of the roundworms and 0.65 percent of the cecal worms were removed.

A combination of phenothiazine and nicotine sulfate gave consistently better results in removing roundworms and cecal worms and appears to be satisfactory treatment. These drugs failed to remove other species of internal parasites.

The control of tape worm (cestode) infestation in chickens has been based upon control of intermediate hosts. The intermediate hosts responsible for infesting chickens with tapeworms include flies, snails, garden slugs and several species of beetles. Few drugs have value in the removal of a high percentage of tapeworms without adversely affecting the host.

Two products were tested as to their value as taenicides. Neither of these drugs were effective in removing all species of tapeworms of chickens. Of the seven species of tapeworms that infect chickens, five species were identified in over 100 chicks used in this study.

The tapeworms found most frequently were *Raillietina tetragona* and *R. echinobothrida*.

Hexachlorophene administered at the rate of 50 mg. per kilogram of body weight per hen eliminated 40.0 percent of the *R. tetragona* and *R. echinobothrida* infections while phenyl mercuric phthalate removed 72.0 percent of these two species of tapeworms. The occurrence of other species of tapeworms were in insufficient numbers to evaluate these two drugs against them.

Phenyl mercuric phthalate shows promise as a taenicide and appears to be of greater value than hexachlorophene for this purpose.

FERTILITY, HATCHABILITY, AND FEATHERING

In comparing the performance records of females used in breeding pens as pullets and the same individuals used in breeding pens during their second production year, it was found that in every case fertility was lower during the second year of production.

The percent hatch of all eggs set and percent hatch of all fertile eggs set decreased for all hens saved as compared with their performance as pullets.

The failure of hens to produce fertile eggs is a problem that demands consideration from all breeders. Inability of the male to fertilize eggs is only one of the problems involved.

Although preferential mating is undoubtedly involved in some cases, the frequent changing of males in breeding pens failed to increase the percent of fertile eggs produced by given hens.

Fertility is said to be a physiological condition and a characteristic of the individual. It has not been determined if fertility is a hereritary factor. Available data is inconclusive.

Hatchability is defined as the percent of all fertile eggs that hatch. Hatchability depends upon many factors including:

Age of the egg when set
Holding conditions prior to setting
Vigor of parent stock
Lethal genes present or absent.
Incubation conditions
Nutrition of the parent stock
Inbreeding (apparently inbreeding may increase or decrease hatchability depending upon foundation stock).

Hatchability is an over-all term which involves many factors. It is evident that high hatchability is possible only when stock is either free or relatively free from lethal genes. The number of abnormal embryos and conditions cited in the 1948 Station Report was increased in 1949. Abnormal conditions that increased in embryos during the 1949 season include short lower mandible, short upper mandible, and multi-jointed or multi-bent leg bones.

Through selection of inbred and outbred Barred Rocks, 8 week old chicks with long tails and fully-feathered bodies have appeared. It has not been determined if this condition is the sex-linked factor for early feathering as the length of wing feathers in one-day old chicks were not as pronounced as in other breeds and strains known to exhibit this trait. Tail feathers at two weeks were shorter than strains recognized as carrying the sex-linked gene for early feathering.

Through selection, additional chicks have been produced that were fully feathered at 8 weeks of age but without tail feathers. These chicks apparently carry the autosomal factor for early or rapid feathering.

Plans are made for further inbreeding and the crossing of inbred lines with non inbred Single Comb White Leghorn males. This procedure should indicate combining value of the stock and should provide additional data regarding position of chick embryos, anomalies and lethal characters.

FORESTRY EXPERIMENT STATION

MORGAN AND SCOTT COUNTIES

James S. Kring, Forester

The principal activity in 1949 was the sale of 625,000 feet of timber, by bid, to J. L. McNeal of Wartburg, Tennessee for $5,000. After logging had started, an additional 177,594 board feet of marked timber was sold for $959.58. The sale area comprised about 300 acres of land located in Morgan County.

In making this sale TVA Forestry Relations Division gave very valuable assistance in marking all trees to be sold and computing their volume according to the International ¼ inch Log Rule with suitable deductions being made for visible and hidden defects.

The sale area was divided into nine logging units based on topographic features such as streams, ridges, etc. Logging units 1, 2, 3, 4, and 5 were in the original sale. The timber on unit 6 was sold for $6.00 per thousand board feet, International ¼ inch Log Rule, while the timber on units 7, 8, and 9 was sold for $5.00 per thousand board feet on the same scale.

As cutting progressed the market for gum ties was closed so practically no gum was cut on units 4, 5, 7, 8, and 9. This will be sold for paper wood next spring along with other cull softwoods which were too poor for lumber.

Cutting began in April 1949 and was completed on the first four units by the middle of July. The remaining units were cut during the summer and fall and the operation was completed by early December.

BOUNDARY SURVEY

A survey was started in June to determine the boundaries of the two tracts of land on Little Brushy Mountain in Morgan County from which accurate maps will be made. Portions of these tracts had been surveyed by adjoining landowners but most of the boundary had not been surveyed in over 25 years. This made the job particularly difficult since many line and corner trees had either been cut or had died.

During the fall several miles of line were painted with orange paint and about 25 corners set. This work will progress just as fast as weather permits and agreement can be reached with adjoining landowners.

At the close of 1949 the survey of the Little Brushy Mountain tracts had been completed.

FIRE CONTROL

Adequate protection of timber from fire must be accomplished if any type of forest management or research is to be carried out.

For the past 12 years no attempt had been made to control forest fires and the woods show the results of many uncontrolled fires which have killed the young trees and damaged the older ones causing decay and insect injury to develop.

The Morgan County Court appropriated $1,000 for county wide fire protection and the State has matched this amount with additional funds. The Station now has the assistance of one of the mobile crews which is responsible for the suppression of all forest and grass fires in the part of Morgan County where our timber lands are located. Scott County has had organized fire protection for the past several years. In addition to help provided by the State, the Experiment Station employed three extra men to be responsible for the suppression of fires on Station land. The Station has also supplied these men with suitable tools for fire fighting. It is the duty of these men to report fires to the nearest mobile crew leader or fire tower and assist the crew in fighting fire on Station property.

During the fall there were no fires on the property although numerous fires occurred nearby. Due to the particular location of this property there should not be any fires, but a few will no doubt be caused by carelessness or incendiarism. Inadequate communication and poor roads are the limiting factors governing prompt suppression.

TREE PLANTING

In April a very hot fire burned over a portion of the property containing quite a laurel thicket. Since the laurel was pretty well killed it was decided to plant the area to pine. In early May, 5,000 shortleaf pine seedlings were obtained from TVA and planted in the openings left in the woods by the fire. With close supervision the planting crew did a good job and although it did not rain until the last of May, a fairly good survival resulted.

During the late summer an attempt was made to check on the number of trees that survived. It appeared that at least 75 percent of the trees were alive. Many of the trees that had seemed dead in June had put out new needles and were growing nicely. The late planting held back any rapid growth that should have taken place during the early spring. However, the remaining live trees should make good growth this next year since they are well established.

COAL LEASES

Several coal operators are interested in leasing some of our coal lands in Morgan County. They went over the proposed sites and made definite offers. So far nothing has been done toward leasing any of this land.

It would possibly be an advantage to the Station to lease some of this land in order to receive some income to defray the expenses of other operations such as survey work, fire control and road construction. From the experience of some of the residents of the area they are receiving around $1,200 per acre in strip mining royalties which is a much greater return than can be expected from timber growing on the same area. If natural regeneration does not take place the spoil banks could be planted for $25 or less per acre.

HOUSES ON PROPERTY

At the present time there are 13 houses located on the area. One house is located on the property in Scott County while the remainder are located on the two Morgan County tracts. The majority of these houses were built to provide homes for the coal miners who worked in the nearby mines.

Although the rent from this property is around $195.00 per year the majority of these houses are of no value to the property and are in such poor condition that as they become vacant they should be removed and the area planted to trees.

HIGHLAND RIM EXPERIMENT STATION

Springfield

Dennis H. Latham

WEATHER

Total rainfall for the year was 54.12 inches, which is 7.14 inches above the 6-year average for this Station, but only 4.46 inches above the 63-year average for the State. Rainfall for the month of June was above normal, which made it very difficult to control grass and weeds in the corn and tobacco plots. Some corn plots on low ground were seriously damaged by water standing on the area for several days.

TOBACCO

Dark Fire-Cured— Type 22.—The work with dark fire-cured tobacco was, in general, along the same lines as in 1948. About 70 different lines of dark tobacco were grown on the Station in 1949 for observation as to their comparative values or their resistance to one or more of the following diseases; black root rot, mosaic, and wildfire. Major emphasis was placed on the evaluation of a number of apparently homozygous, mosaic resistant lines of the dark fire-cured type.

Data covering a 3-year period for 9 of these lines in comparison with Madole No. 1, the mosaic susceptible check, are presented in table 27. All mosiac resistant lines in this test were field inoculated in 1947 and 1948 but were not inoculated in 1949. All resist-

TABLE 27.—*Mosaic resistant lines of dark fire-cured tobacco. The figures are the averages for 3 years, with 3 replications in 1947 and 5 replications in 1948 and 1949. All tobacco grown on Dickson silt loam soil.*

Variety or line	Percent stand	Yield per acre	Value per 100 pounds	Acre value
		Pounds		
Madole No. 1[1]	94	1646	$39.52	$660.19
Madole No. 1[2]	95	1570	38.26	600.84
DR716A	96	1690	36.71	621.30
DR751	95	1571	37.06	579.62
DR707	92	1540	35.72	553.57
DR751A	93	1569	35.30	553.01
DR712	94	1532	35.92	549.79
DR752	92	1443	34.85	505.83
D534A1	94	1443	33.98	491.95
DR752A2	91	1329	34.96	466.83
DR538A	92	1389	32.62	455.24

[1] Values for 1947, 1948 and 1949 with all plants free of mosaic.
[2] Values for 1947 and 1948 only, with all plants inoculated at topping.

ant plants remained free of mosaic each year. Madole No. 1, the mosaic-susceptible check, showed 100 percent infection following inoculation in 1947 and 1948.

The testing of the commercial variety of dark fire-cured tobacco, under uniform conditions, was continued in 1949. Table 28 gives a 3-year summary of the performance of 5 commercial varieties, plus one of the better mosaic resistant lines.

The black root rot resistant lines were grown for the second year on the same field, a Dickson silt loam soil. This field was limed ahead of the 1948 crop and manured at about 4 tons per acre ahead of both the 1948 and 1949 crops. Root rot failed to develop sufficiently to adversely affect any of the lines of Madole No. 1, used as the susceptible check. Selections were made from each line on basis of dark type only, since root rot failed to develop in the field.

The wildfire resistant lines were inoculated in the plant bed and in the field. However, little progress was made because the disease failed to develop to any appreciable extent following the inoculations, even on Madole No. 1. A new and more virulent culture will be used next year.

TABLE 28.—*Three-year average yield and value for 6 varieties or lines of dark fired tobacco. Three replications in 1947 and five replications in 1948 and 1949. All tobacco grown on Dickson silt loam soil.*

Variety or line	Percent stand	Yield per acre	Value per 100 pounds	Acre Value
		Pounds		
Madole No. 1	94	1646	$39.52	$660.19
DR716A	96	1637	37.10	609.06
Ozark	94	1579	37.78	595.18
Madole No. 3	91	1542	36.95	567.53
Madole No. 2	94	1514	37.53	567.17
Black Mammoth	91	1543	36.28	565.36

Black shank has not occurred in serious proportions on the Highland Rim, except in small areas on a few scattered farms. An observational planting of black shank resistant lines of tobacco, including two F_3 hybrids from crosses made on the Station, was made in 1949, in a known infected area on a farm about 18 miles from the Station. There appears to be considerable resistance in quite a few of the F_3 plants. A carefully controlled test in a known infected area suitable for plot work is planned for 1950.

Other work with dark fired tobacco includes; fertilization and rotation study, cultivation, height of topping and spacing.

In the tobacco fertilization and rotation study, all fertilizers were applied at rate of 600 pounds per acre and all manure at 10 tons per acre. Table 29 gives a 2-year average for the yield and value in this study.

TABLE 29.—*Two-year average yield and value of tobacco in the fertilization and rotation plots. Four replications each year,* 1948 *and* 1949.

Fertilizer	Percent stand	Yield per acre	Value per 100 pounds	Acre value
		Pounds		
0-12-0	100	1287	$33.90	$437.06
3-12-0	100	1437	36.25	523.77
6-12-0	100	1463	36.84	541.28
0-12-0 plus manure	100	1877	37.74	706.93
6-12-0 plus manure	100	1808	38.89	700.10
0-12-6	100	1424	35.47	506.60
3-12-6	100	1482	36.17	535.35
6-12-6	100	1566	37.46	583.91
0-12-12	100	1470	35.58	526.72
3-12-12	100	1514	36.69	556.45
6-12-12	100	1509	37.15	557.65
0-12-12 plus manure	100	1875	37.98	710.26

In the fertilization test, wheat and red clover are grown in the rotation with tobacco. Yields of red clover hay (1 cutting only) following the 1947 crop of tobacco, and wheat yields following the 1948 crop, were taken for the first time in 1949. The average acre yield of air dry hay ranged from 905 pounds on the 6-12-12 plots to 1377 pounds on the 0-12-12 plus manure plots. The average acre yields of wheat varied from 22.1 bushels on the 0-12-12 plots to 30.8 bushels on the 3-12-0 plots. There was considerable weather damage to the wheat while in the shock, and the yield data may be questionable.

The excessive rainfall during part of the growing season interfered with the cultivation test, by preventing part of the scheduled cultivations. In general, the 1949 data agree with that of earlier tests in that more than two deep plowings materially reduce the acre value of the tobacco. The plots which were worked only with a 14-tooth harrow gave the greatest average acre value.

In the height of topping test certain plots were seriously damaged by the soil becoming water-logged. Based on only two replications, the data indicate that, under conditions of this test, tobacco topped with 14 leaves for harvest is worth about $70.00 more per acre than tobacco topped with 10 leaves for harvest.

The two-year average for a spacing test with dark tobacco indicates that a spacing closer that the customery 42 inches would be more profitable.

The results from the spraying tests for the control of wildfire and downy mildew in plant beds were the same as in previous years —no wildfire developed on either the sprayed or unsprayed portions of the beds, nor did it develop in the fields set with plants from the test beds. In addition to spraying all of the approximately 1000 square yards of plant beds on the Station, about 1200 yards were sprayed on 9 farms, all in Robertson County.

In cooperation with the U. S. Department of Agriculture, a project on the curing of dark fire-cured tobacco was initiated in September 1949. The first season has been devoted largely to studying the conditions that are to be duplicated by the new curing process.

Burley.—Type 31.—The same area has been used for growing the burley varieties for 4 years. The acre yield on most varieties was higher in 1949 than in any of the 3 previous years when the same varieties were grown. Each tobacco crop has been followed by oats or wheat to be used as a green manure crop. In addition to the green manure crop, the area has received annual applications of manure at 3 to 5 tons per acre and a complete fertilizer at 800 to 1000 pounds per acre. The area has been limed once. Table 30 gives the 1948-1949 average yield and value per acre for 18 varieties or lines of burley. Burley No. 1, designated in table 29 under the original number Greeneville 21C, has the highest average per 100 pounds of any of the 18 lines tested.

TABLE 30.—*Burley tobacco variety test,* 1948-1949. *Two-year average, 3 replications in* 1948 *and* 4 *replications in* 1949.

Variety or line	Percent stand	Yield per acre	Value per 100 pounds	Acre value
		Pounds		
Greeneville 21	96	1756	$47.89	$840.73
Greeneville 17B	92	1714	46.93	805.12
Greeneville 21B	92	1692	47.36	803.19
Kentucky 22	95	1681	47.35	796.61
Greeneville 6	97	1715	45.74	783.37
Kentucky 16	98	1702	44.96	776.02
Greeneville 23B	96	1680	46.00	771.09
Greeneville 21C	95	1602	48.04	769.76
Kentucky 41A	97	1716	44.71	765.56
Greeneville 21A	92	1596	47.58	758.68
Greeneville 23A	96	1626	46.06	750.03
Kentucky 19	97	1717	44.61	742.46
Barnett	96	1701	43.52	742.03
Greeneville 18	90	1695	43.40	735.48
Greeneville 24	93	1603	45.48	728.63
Greeneville 13	96	1494	46.52	698.30
BR801	93	1509	45.39	693.61
Judy's Pride	90	1408	42.64	600.74

CORN

The uniform corn variety test, run under the general supervision of Sam McMurray who will give a detailed report in another part of the general report, was located on a Dickson silt loam soil.

With an adequate supply of water during the growing season, the yields at this Station were much better than they were last year. In 1949 the yields in the 36 varieties varied from 68 bushels to 106 bushels per acre. These tests furnished worthwhile information that will serve as a basis for recommendations to farmers of the area.

A nitrate and spacing test with corn was made on an Abernathy silt loam soil. This test, run under the general supervision of O. H. Long and reported in detail in another part of this report, included 3 rates of nitrate, 3 different spacings, and 2 varieties. In this test, nitrogen was used at rate of 60, 90, and 120 pounds of N per acre, 30 pounds of which was applied in form of mixed fertilizer before planting and the remainder as a wide-dressing. The varieties were Dixie 17 and Kentucky 103. The spacing was 9″, 12″, and 19″ to give a total of 16,000, 12,000, and 8,000 plants per acre.

The corn in this test was seriously damaged by water standing over portions of the area for several days.

SMALL GRAIN VARIETIES

The uniform variety test of small grains included 8 barleys, 8 oats, and 14 wheats. The barley and oats were grown in 4 replications and the wheat in 5 replications. All of the small grain varieties were grown on a Dickson silt loam soil. The average barley yields ranged from 17.8 to 30.4 bushels per acre. The oat yields ranged from 34.9 to 60.7 bushels per acre. The average wheat yields ranged from 21.6 bushels to 33.7 bushels per acre. The oat and barley varieties were adversely affected by wet weather. The Fulgrain oat and Carala wheat were both slightly damaged by a late freeze.

The nitrate applications on Thorne wheat were continued in 1949. The wheat was grown on Dickson silt loam soil and the nitrate applications were made on March 1. Table 31 gives a 5-year average for the nitrate applications on Thorne wheat. The same nitrate applications were made on Vigo, Carala, and Tenn. 47-1-20,

TABLE 31.—*Nitrogen applications on Thorne Wheat.*

Kind	Application per acre	Five-year average yield per acre (1945-1949)
	Pounds	Bushels
Ammonium nitrate (32.5% N)	None[1]	18.1
	50	24.7
	100	27.0
	150	28.5
	250	30.8
Nitrate of soda (16% N)	None[1]	18.1
	100	24.4
	200	27.0
	300	27.9
	500	26.9

[1]The check plot yields represent an average for 6 plots each year; all other yields are an average of 3 plots each year.

one of the new Tennessee lines of wheat. The yields with each of these wheats were in line with the yields on Thorne wheat, as given in table 30.

TOMATO

The tomato variety test, conducted for the Department of Plant Pathology, included 7 varieties and lines with 5 replications. The test was located on a Montview silt loam soil. Yields of number 1 fruits varied from 3 to 6.5 tons per acre.

BLIGHT RESISTANT PEARS

This Station is continuing to cooperate with the Department of Horticulture in an effort to develop a desirable variety of pear that will be highly resistant to fire blight.

The blight resistant pear trees that were set in March 1947, now designated as Pear Orchard No. 1, are making good progress. The orchard area has been seeded to barley and crimson clover as a winter cover crop each fall and followed with cowpeas as a summer crop. All crops are worked into the soil. It is anticipated that a few of the trees will produce fruit in 1950.

A second pear orchard was set early in December, 1949. There are 16 lines with a total of 144 plot trees in this orchard. This orchard is designated as Pear Orchard No. 2 and is located on the Russell farm. It is anticipated that another 200 or more plot trees will be added in 1950, making a total of about 6 acres in this orchard.

PEACH VARIETIES

The peach orchard, established in March 1948, is making excellent progress. There likely will be some fruit in 1950.

WALNUT VARIETIES

A black walnut planting containing 5 trees each of 5 varieties was made, in cooperation with Tennessee Valley Authority on April 19, 1949. All trees survived the first year.

PERMANENT PASTURES

The pasture fertilization study has been rather disappointing in that it has proven difficult to get a uniform sod established on the area. The average yields of air dry forage varied from 2669 to 3988 pounds per acre. A detailed report of the pasture fertilization study is made by O. H. Long, in another part of this report.

MIDDLE TENNESSEE EXPERIMENT STATION

Columbia

John A. Ewing, Superintendent

EFFLUENCE

The research program on effluence, aided by grants from the Monsanto Chemical Company and the Victor Chemical Company, has been expanded to include a survey of fluorine damage in the Columbia area of Middle Tennessee. A grid has been made using the Middle Tennessee Experiment Station as the center with lines extending in eight directions at 22.5 degree intervals. On each of these lines, at two-mile intervals, vegetation sample points were established. All the cattle kept on the farm at each point were checked and soil and water samples collected. The forage samples are collected bi-weekly and teeth and general conditions of the cattle are checked annually.

Individual feeding work with both dairy and beef cattle is under way to determine toxic levels of fluorine and to study the economic effects of fluorine. Comparative studies are also being made on the toxicity of the different fluorine carrying materials. A large number of different chemical materials are being fed to both sheep and cattle in hopes of finding a material that will alleviate the injury from fluorine.

WEATHER CONDITIONS

The 1949 crop season at Columbia was characterized by extremely wet and dry months. There were 10.05 inches of rain in June preventing cultivation of most crops. Because weeds were very bad in sorghum and corn for silage, the crop was sprayed with 2, 4-D and excellent yields were harvested. The wet weather made saving hay very difficult except where the hay was cured in the mow. Pastures were good throughout the entire grazing season. There was less than an inch of rain in September which delayed the seeding and retarded the growth of winter pastures. The warm, humid winter month of January made conditions ideal for *sclerotinia*. and the stand on over 40 acres of alfalfa, seeded in the fall of 1948, was lost.

The total rainfall for the year was 49.87 inches. The temperature ranged from 95 degrees F. in July to 8 degrees F. in February. There were 3 inches of snow January 31st.

MEETINGS

The Farmers' and Home Makers' Institute on May 9, 1949 was attended by some 3000 farm people. The following day over 600 attended the Negro Institute. A tour of the Station is one of the important features of these meetings. Staff members from the

University were present to discuss the different phases of the work. The Station was host also to a large number of other meetings, such as the District 4H-Club Camp; Farm Bureau Presidents' Conference; Farm Bureau Home and Community Leaders; Coop managers, and other organized groups. The work being done on the Station was shown to these groups. In addition to these, large numbers of county and community groups visit the Station annually.

IMPROVEMENTS

The North Burnes and Middle Carpenter pastures, containing a total of approximately 45 acres, were renovated. These pastures were unproductive and heavily infested with broomsedge. The fields were worked up with a bush and bog harrow, followed by a soil surgeon in July and this operation was repeated at regular intervals until a good seed-bed was established. The fields were limed, fertilized, and reseeded in September. The broomsedge was eliminated and good stands of desirable species were secured.

The dairy barn was painted and repaired; however, a new milking barn is badly needed. A small amount of fencing was replaced. Within the next few years practically all the fence, which has been in service for thirty years, on the Station will have to be replaced. The McFall house was repaired and painted. Shower baths were installed in four houses.

CROPS

The results of the various tests with crops and pastures at this Station are included in the report of the Agronomy Department.

ANIMAL HUSBANDRY AND DAIRYING

The results of the pasture and feeding test with beef cattle. sheep, hogs, and dairy cattle, on this Station, are included in the Animal Husbandry and Dairy Department reports. The work being done on the Jack and Jennet Breeding Farm is included in the Animal Husbandry report.

PLATEAU EXPERIMENT STATION

Crossville

John A. Odom, Superintendent

LAND IMPROVEMENT

The Crossville Prisoner of War Camp property acquired by the University in 1948, was taken over by the Plateau Station in 1949. It is composed of 194 acres of land, of which approximately 30 acres are in the camp building area reserved for a District 4-H Club Camp. The remaining acreage is suitable for development as grazing and

crop land. Fifty acres in idle crop land were fitted, limed, fertilized and seeded to clover and grass mixtures this year. A potential permanent pasture area approximating 80 acres was temporarily fenced and grazed, awaiting building clean up and field renovation. This farm is providing space for a unit of breeding beef cattle, and land for isolation in corn and potato work, in addition to many usable buildings, including surplus hay storage, equipped cold storage building for potatoes, grain storage and two dwelling units.

Twenty acres of woodland were cleared for pasture at Grassland farm (fig. 31), and six acres were cleared for test plot use at the main Station.



Fig. 31—Land being cleared on Grassland Station. All of this area is in process of becoming permanent pasture.

CONSTRUCTION

The partially constructed, original farm house at the War Camp farm was completed, with plumbing and hot water heating system. The two-room quarters, constructed for the commanding officer, was expanded into a neat 4-room cottage, with plumbing and shower bath.

The one-room unfinished office building at the main Station was enlarged to three office rooms, small laboratory and wash rooms.

FARM PONDS

Four farm ponds on the main Station were stocked with bass in the spring, following up the introduction of bream six months earlier. Measuring devices were installed, through cooperation of TVA, in pond No. 1 to check the inflow and outflow of water as an aid in studying the use of farm ponds for irrigation.



Fig. 32—Fertilization studies with clovers. Ladino clover on right and Louisiana White on left.

FIELD CROPS

Twelve varieties were carried in the burley tobacco trials in cooperation with the Tobacco Station at Greeneville. Burley 1, just released by the Greeneville Station, showed an average increase over Ky. 16 in these trials for 1948 and 1949, of approximately $100 per acre. Certain other experimental numbers show promise of being superior to Burley 1 under Plateau conditions, in results from the past two years of variety studies.

A small acreage of Maryland tobacco, Type 32, was grown this year. Burning tests showed satisfactory burning quality. The yield ran about three-fourths that of burley, grown under similar conditions.

Uniform variety tests were carried on with corn and small grains and legumes in cooperation with Sam McMurray. Fertility studies testing raw rock phosphate, calcium silicate slag and some other materials were carried on. Also fertilizer studies on permanent pasture, white clovers (fig. 32), alfalfa and corn were started or continued in cooperation with O. H. Long. Details of Agronomy work are reported in the Agronomy section.

LIVESTOCK

Ten registered Angus cows and a herd bull were placed on the Station as a foundation Angus herd to later be used in initiating further breeding and management studies. Seven heifers were raised from these and held for increase. Cattle studies were continued at Grassland farm with two Hereford bulls purchased to use on the herd of grade cows. Details of livestock studies are reported in the Livestock section.

FORESTRY

Fence Post Preservation.—With a growing scarcity of good post timber the investigations of chemical treating of native species holds possibilities. Many poor timber-producing species could be utilized for posts as they are cut in selective cutting, or in land clearing if they lend themselves to a preservative treating operation. Participating in a coordinated study by four states, sponsored by TVA, four species are now under study here. They are shortleaf pine, red maple, blackjack oak and scarlet oak. The project proposes cold soaking with a 5% solution of pentachlorophenol to an absorption of 6 lbs. per cubic foot and a similar study with copper-naphthenate. Other treating materials are to be selected for testing as the project progresses. Pine posts have absorbed the prescribed amount of pentachlorophenol in 1½ hours, while the oaks have generally reached near the maximum absorption of 4 to 5 lbs. per cubic foot in 60 hours. Penta treated posts have been placed in fence lines for annual checking on their period of serviceability, compared with untreated check posts.

Should service records be satisfactory, estimates based on cost of chemicals and labor tend to favor treated posts where farm timber can be utilized and serviceable species such as cedar and locust are not readily available.

A few acres of the Station's rough timberland is underplanted to white pine each year. Five acres were planted this year. Further test planting of evergreens for Christmas trees was made this season in cooperation with Tennessee Valley Authority.

TOBACCO EXPERIMENT STATION

Greeneville

J. Hugh Felts, Superintendent

BUILDINGS

A new administration building was completed and occupied about May 1. The new building is one and one-half stories and is 40 feet wide by 80 feet long. The walls are concrete to ground level and the balance is slag block with brick veneer (fig. 33). The building houses laboratories, offices, auditorium and rest rooms.

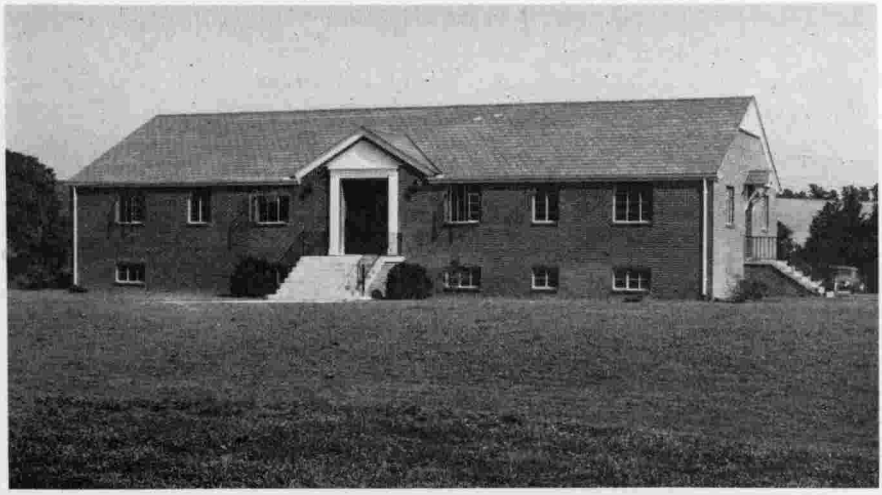


Fig. 33—Administration building at the Greeneville Tobacco Experiment Station.

The offices and main laboratory are on the first floor. The halls and offices are wainscoted with random width native red oak in natural color with a plaster finish above the wainscoting.

The building is heated by steam from the central heating plant in the greenhouse. The lighting is fluorescent throughout. The basement has a small auditorium, leaf laboratory, double garage, and toilet facilities.

The leaf laboratory is 20 by 32 feet, has humidity and temperature control and makes an ideal work room for handling leaf samples. All the leaf burning and sampling formerly done in the tobacco barns is now done in this room.

The occupation of the new building vacated the old office space at the greenhouse. This space has been converted into a room for drying and grinding tobacco samples. It also serves for a storage room for mixed fertilizers.

VISITATION

The 4-H Club Camp adjoining the Station was completed and started operation in June. The camp was named for Clyde Austin, local businessman and a trustee of the University of Tennessee. Mr. Austin was most influential in promoting the camp (fig. 34). 3000 boys, girls and leaders from 23 counties attended the camp in 1949 and toured the Station as a part of their camping program.

The annual Tobacco Field Day in August was attended by 1600 interested farmers. This group toured the Station during the morning. They inspected the plot work on tobacco and pasture, the cow-calf herd and the steer project. The afternoon session included talks by H. E. Heggestad on tobacco diseases, B. C. Nichols on tobacco

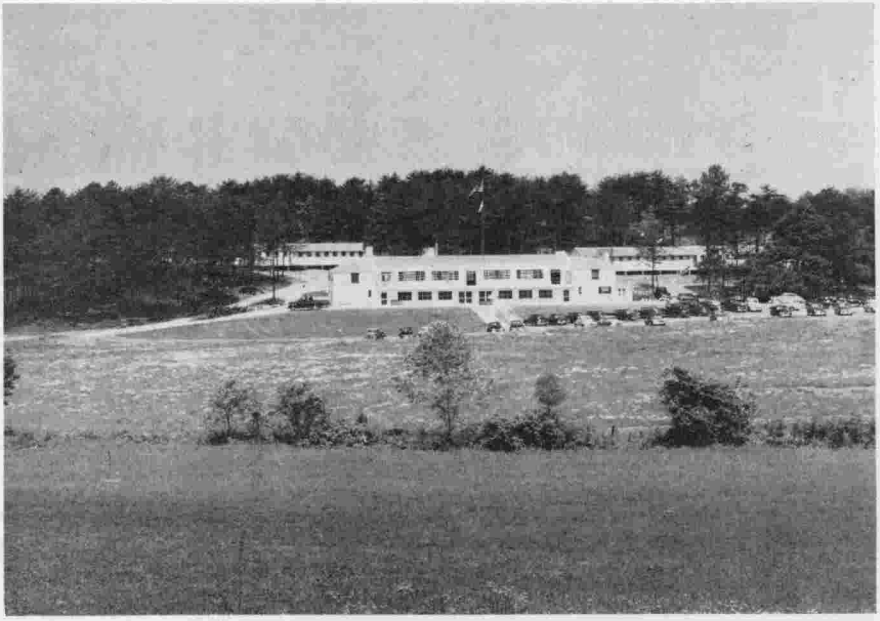


Fig. 34—View of Clyde Austin 4-H Club Camp, Tobacco Experiment Station, Greeneville, Tennessee.

fertilization, and F. S. Chance on the Tennessee agricultural research program.

Several G-I On-the-Farm-Trainee classes visited the Station during the year.

PROJECT WORK

Crops.—In addition to the work on tobacco the following projects are carried at the Greeneville Station and covered more fully elsewhere in the report: uniform variety tests on corn, barley, oats and wheat; experimental corn variety test; rates of nitrogen with spacing and varieties of corn; varieties of pasture, grasses and legumes; pasture fertilization on Decatur and Shackleton soils; and methods of seeding small grain on meadow sods.

Beef Cattle.—The beef cattle work is limited to an intensive study of better management of a commercial cow-calf herd as to production and time of selling. Comparing (1) calving in January and February to that of March and April, (2) grade Hereford cows bred to Hereford bull and grade Hereford cows to Angus bull, (3) selling calves at weaning time compared to later, (4) four lots of heifer calves finished for spring market, (5) steer calves and yearlings wintered in the barn on hay and silage or outside on pasture of orchard grass, blue grass, and white clover with hay, and (6) the finishing of yearlings and two year olds on grass vs. grass and grain. For results and more details refer to livestock report.

Sheep.—The sheep project is the improving of the Native Tennessee Mountain Ewe by breeding to a registered buck, also comparing the use of Hampshire vs. Dorsett ram.

WEATHER

The temperature for 1949 at the Greeneville Station was above normal for all months except April and November. The total rainfall for the year was 3.43 inches below normal. The driest months were January, February, March and December, with above normal rainfall for April, June and July. May and August were slightly below normal. The season was favorable for the growth of corn, hay and pasture but less desirable for the production of tobacco.

The tobacco was set about average time but with sufficient rain in June and an excess of over 2 inches for July the 1949 crop made a very rapid growth. From July 8 to 21 there were only two days without rain and a total of 4.85 inches was recorded during the thirteen days with 3.98 normal for the month of July. The excess rain at this time of the growing season leached out part of the nitrogen, and the tobacco broke down and forced early harvesting. Some of the Station tobacco was cut 74 days after setting when 90 to 100 days are normal time for maturity. The result was a light weight, thin bodied crop of tobacco. A very light rainfall in November and December furnished very little opportunity for handing off and preparing for early market. This poor handling season prevented the customary crowding on the market for early sales.

NEW PROBLEMS

The outbreak of the tobacco disease, black shank, in Greene County has greatly handicapped the work at the Greeneville Station. The danger of this disease and the precaution and sanitary practices which must be followed with all the work at the Station to prevent the spread of black shank has increased the labor and the time required to do the tobacco work.

BURLEY VARIETY IMPROVEMENT AND DISEASE INVESTIGATION*

H. E. Heggestad

Burley 1, a new root rot resistant tobacco of high quality was released to tobacco growers for 1950 planting. The new variety has been subjected to extensive field testing in Tennessee during 1947, 1948 and 1949 under the progeny numbers of Greeneville 21 and 21C. Average results of the 3 years' trials which represent a wide range of growing conditions showed that Burley 1 yielded as well as the most popular standard variety. Moreover, Burley 1 produced 76.9 percent of cigarette grades, flyings, cutters, and tan leaf; whereas, the yield of these grades with the standard variety was 68.5 percent.

*Cooperative with the U. S. Department of Agriculture

Due to good yielding ability and the increase of 8.4 percent in tobacco grades most in demand by cigarette manufacturers there has been an average increase in dollar returns per acre for Burley 1 of about 5.5 percent for the 3-year period. Greatest percentage increase in dollar returns per acre with the new variety was secured when growing conditions (moisture, soil, fertilization, etc.) permitted relatively high total yields per acre for all varieties.

WILDFIRE

Wildfire (*Pseudomonas tabaci*) was unusually prevalent and destructive in plant beds in 1949. Approximately 50 percent of the plant beds in Greene County and also in other East Tennessee counties were diseased. Unusual widespread occurrence of wildfire in plant beds has been associated with increased prevalence of the disease noted in fields in recent years (fig. 35).



Fig. 35—Severe outbreaks of wildfire in the field as shown above are usually due to use of infected plants in transplanting.

Experiments have been in progress for the past three years to determine whether or not fixed coppers[5] may be used as Bordeaux (bluestone-lime) substitutes in controlling wildfire in burley tobacco beds. These relatively new materials are easy to prepare for use as only one chemical is mixed with water; whereas, to prepare Bordeaux mixture two chemicals are required.

[5] Fixed coppers or "low solubility coppers" such as Copper A, Tennessee Tri-Basic, and Microgel each bearing approximately 50 percent metallic copper.

Results to date show that fixed coppers and Bordeaux, when properly applied either as a spray or drench, control wildfire satisfactorily. Prepared dusts with these materials were inferior to sprays and drenches. Rates of application should be adjusted to provide metallic copper with the fixed coppers equivalent to that provided with Bordeaux treatments. One half pound of approximately 50 percent copper bearing fixed copper is equivalent to one pound of copper sulphate[6] in actual copper content.

The first treatment should be made as soon as the plants are up—"two-leaf stage" and a second treatment applied 10 days later. Control of wildfire has been satisfactory using ¾ pound of any one of the previously mentioned fixed coppers in 25 gallons of water applied with a sprinkling can to 100 sq. yds. of plant bed. Both first and second treatments should be made through the cotton cover and efforts should be made to secure thorough even coverage of the soil including any framing material used.

Continued progress was made in the development of wildfire resistant burley tobacco. Improved resistant material has been furnished for the past three years by Dr. E. E. Clayton (U.S.D.A.). Successive artificial inoculations made with wildfire bacteria in the plant bed and field revealed that there were several segregating lines which produced a high percentage of immune plants and one immune line in the 1949 material.

Cured leaf data are shown in table 32 for five of the most promising lines. Data are based on 3 replications with 50 plant row plots.

TABLE 32.—*Cured leaf data on wilfire resistant burley lines.*

Line or variety	Wildfire resistance	Black root-rot resistance	Yield per acre	Smoking tobacco	Grade index	Crop index
			pounds	percent	number	number
49-408	very good	fair	1758	83	.695	1225
49-410	fair	fair	1748	93	.742	1296
49-412	immune	poor	1740	83	.614	1069
49-414	fair	good	1976	91	.677	1339
49-431	good	fair	1899	84	.712	1352
Kentucky 16	susceptible	fair	1682	74	.649	1089

The data show that yields of all lines and grade quality of all except the immune line are better than that produced by Kentucky 16. Lines 49-414 and 49-431 are most promising considering crop indicies. It is anticipated that excellent wildfire-immune lines may be developed from this material. In addition, new lines with combined resistance to wildfire, tobacco mosaic, and black root-rot will be tested in 1950 trials.

BLACK SHANK

Black shank (*Phytophthora parasitica var. nicotianae*) was observed in eastern Tennessee for the first time in 1949. This destructive

[6] Copper sulphate, commonly known as bluestone or "blue vitriol."

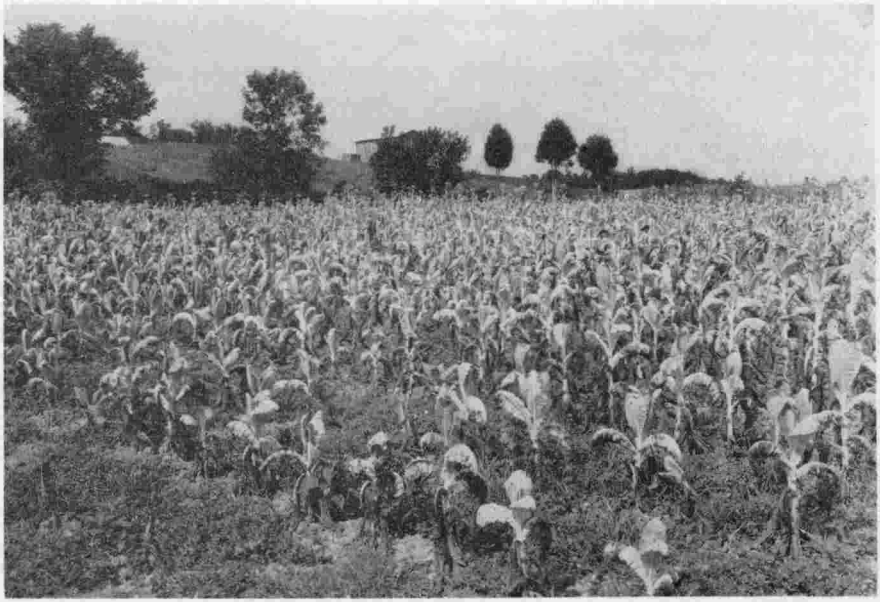


Fig. 36—A portion of a 2½ acre field destroyed by black shank. Field was abandoned when photographed August 4, 1949.

stalk and root rotting disease was found on approximately 35 farms in Greene County. One grower had nearly total loss of 2½ acres (fig. 36). In 1948, the same field produced more than one ton of leaf per acre averaging 55 cents per pound. The disease was also known to be present and destructive on burley tobacco on at least one farm in Williamson County, Middle Tennessee.

It may be possible for a few years to avoid serious losses with 5-year or longer rotations. However, necessary sanitary measures must also be taken to avoid spread of any infested soils to other fields. The developments of the year, plus experience in other areas, strongly suggest that spread of the disease will be rapid in eastern Tennessee.

An intensive breeding program is now in progress.

BLACK ROOT-ROT

In 1940, rotation studies were initiated to determine the effect of various preceding crops on black root-rot development. A report of progress is made at this time.

Judy's Pride, a root-rot susceptible variety of burley tobacco, is grown every third year after two successive years of the following crops; alfalfa, red clover, Korean lespedeza, vetch, timothy, barley, corn, resistant tobacco—Kentucky 16, and susceptible tobacco—Judy's Pride.

To measure root-rot development, disease indicies were calculated based on careful examination of washed root systems. Yields and quality were also determined for each of the duplicate plots of the different rotations.

Results to date show that the disease is maintained at the highest level by continuous culture with the susceptible variety. In general, root-rot is more severe following legume crops than following grasses. The disease following lespedeza has been about as severe as with continuous culture of a susceptible tobacco. Root-rot has also been quite prevalent following alfalfa. Least root-rot was present following the barley and corn rotations.

Lespedeza appears to be a very poor crop to be grown just preceding tobacco, especially if the varieties are susceptible or only moderately resistant to this root-rot disease.

TOBACCO PLANT-BED TREATMENTS FOR WEED AND DISEASE CONTROL

Studies on the effect of cyanamide and uramon, used singly and in combination, for weed and disease control have been in progress since 1947.

One experiment conducted for two years on Dunmore silt loam and at the same location included 25 treatments replicated 4 times comparing different rates of chemicals with and without mulching. No fertilizer or manure was added the first year; however, ½ lb. per sq. yd. 0-9-6 and manure at the rate of 5 tons per acre were applied the second year in the fall just prior to making the chemical treatments. Untreated plots averaged 368 and 570 weeds per square foot in 1948 and 1949, respectively. Approximately 90 percent weed control was secured during both years with all treatments having one to two pounds per square yard of cyanamide and/or uramon.

Important differences in growth and stand of plants between treatments was noted during the two years. Uramon at 1½ and 2 lbs. per sq. yd. rates produced the greatest number of transplantable plants in 1948. However, the plants produced were quite succulent and their root systems were relatively poor. Cyanamide at the same rate permitted good stand of plants but they grew very slowly in the plant beds. None of the combination treatments produced as many plants in 1948 as produced by uramon alone.

In 1949 yields of transplantable plants with cyanamide treatments at 1½ and 2 lbs. per sq. yd. rates were good. Yield and quality of plants from uramon treatments were relatively poor. Combination treatments when containing a greater proportion of cyanamide than uramon also produced a satisfactory yield of plants.

Mulched cyanamide treatments were about the same as unmulched treatments; however, mulched uramon treatments were inferior to unmulched treatments.

Thirty-seven other chemical treatments for weed and disease control were also tested during the past two years. Allyl alcohol,

.06 quart in 1 to 1½ gallons of water per square yard, applied either in the fall or spring as a drench gave about 90 percent weed control and permitted good stand of plants. Methyl bromide gas 1 pound per 100 square feet was used as a soil fumigant in 1949. Excellent weed control resulted and good stands of healthy well rooted tobacco seedlings were produced; however, the treatment is rather difficult to apply and quite expensive.

FERTILITY AND CULTURAL EXPERIMENTS WITH BURLEY TOBACCO*

Beryl C. Nichols

Fertility and cultural work with burley tobacco in 1949 was principally a continuation of tests reported in preceding years. In addition to experiments already established, however, work was begun on plant bed fertilization and the new variety, Burley 1, was compared with the variety commonly grown under several conditions of culture and fertility.

TOBACCO PLANT BED FERTILIZATION

Sixteen different fertilizer treatments were applied to each of two tobacco plant beds. Four sources of nitrogen, namely, nitrate of soda, ammonium nitrate, ammonium sulfate, and uramon were tested separately and in combination. Provisions also made for determining general responses to nitrogen, phosphate, and potash. On the basis of past observations, one half pound per square yard of 3-9-6 fertilizer, using a combination of nitrogen sources was considered to be a standard treatment; other fertilizer rates tested were one fourth and one pound per square yard of this same fertilizer formula. Three pullings of plants were made. In evaluating the treatments, much emphasis was placed upon early plant production.

On Cumberland silt loam soil, a mixture of nitrogen sources, at the one half pound per square yard of 3-9-6 fertilizer rate, was definitely superior in early plant production to any of the nitrogen sources used alone. This mixture produced an average of 188 usable plants per square yard at the first pulling as compared with about 120 plants per square yard for single nitrogen sources. The one fourth pound fertilizer rate was inferior to the one half pound rate in early plant production, but there was no essential difference in the effects of the one half pound and the one pound rates. No plants were of usable size at the first pulling where phosphorus was omitted from the fertilizer, and only a negligible number was obtained where no nitrogen was used. There was only a slight response to potash in early plants produced, but the lack of this material was not nearly so restrictive on plant growth as where either of the other two elements was lacking. Total plant production for the entire season,

*Cooperative with the U. S. Department of Agriculture

however, was similar for all three rates of complete fertilizer used. The absence of either nitrogen or phosphorus greatly lowered the total number of plants obtained from the three pullings made.

On Nolichucky silt loam soil, early tobacco plant production was similar for all nitrogen sources, whether used alone or in combination. Fertilizer rate was important on this soil, usable plants at the first pulling being 23, 95, and 173 per square yard for the one fourth, one half, and one pound 3-9-6 fertilizer rates, respectively. Again, only a negligible number of plants were usable where either no nitrogen or no phosphorus was present in the fertilizer, but plants were of fair growth where no potash was added. Plant totals for three pullings showed no significant differences between any of the nitrogen sources.

The rate of fertilizer continued to be noteworthy, though, total plant production being 331, 407, and 432 per square yard, respectively, for the one fourth, one half, and one pound fertilizer rates. No significant response was obtained from potash on this bed, but the omission of either nitrogen or phosphorus in the fertilizer reduced the total number of usable plants obtained to about one half of that produced by a complete fertilizer.

RATES AND SOURCES OF FERTILIZER MATERIALS

Table 33 summarizes the results achieved in a test dealing primarily with rates and sources of potash with and without manure. This was the second crop of a proposed continuous culture system. Without manure, yield, grade index or quality, crop index or equivalent acre value, percent smoking grades, and fire-holding capacity of tobacco tended to rise as the amount of potash in the fertilizer was increased. Three hundred pounds of K_2O was about as effective

TABLE 33.—*Results of rates and sources of potash experiment on tobacco*, 1949.

Fertilizer treatments	Yield per acre (lbs)	Grade index	Smoking tobacco (%)	Crop index	Time of holding fire (seconds)
30-90-0	1101	.386	59.9	425	2.2
30-90-60	1307	.528	63.9	690	4.9
30-90-300	1442	.584	69.3	841	20.6
30-90-540	1448	.597	72.5	865	15.9
30-90-60M	1291	.489	63.4	625	3.1
0-90-60[1]	1555	.660	72.1	1025	8.8
0-90-300[1]	1598	.659	75.4	1053	8.9
0-90-540[1]	1664	.624	74.2	1037	7.4
0-90-60M[1]	1578	.597	70.1	941	5.8
30-90-60[2]	1187	.380	60.8	452	1.3
30-90-60[3]	1398	.601	74.7	839	22.0
30-90-300[4]	1389	.601	77.3	835	16.6
L. S. D. (.05)	154	.045	8.6	114	4.9
L. S. D. (.01)	207	.060	11.5	153	6.6

M—Muriate used as K_2O source.
[1] Manure applied at rate of 10 tons per acre.
[2] Sulfur applied at rate of 555 lbs. per acre.
[3] This plot received 540 lbs. K_2O in 1948.
[4] 240 lbs. K_2O sidedressed. All K_2O above 60 lbs. in other treatments broadcast.

Soil Type—Ooltewah silt loam.

as 540 pounds K_2O. Ten tons of manure per acre was beneficial in augmenting yield, quality, percent smoking grades, and crop index, but was definitely damaging to the burning properties of the tobacco. In the presence of manure, muriate as a source of potash brought about a highly significant repression in tobacco quality as compared with sulfate of potash. The residual effect of 450 pounds K_2O applied in 1948 was appreciable, particularly as it favorably affected tobacco quality and burning properties. The addition of 555 pounds per acre of sulphur in expectation that native soil potash would thereby be released resulted only in a general depression of all the evaluations made, especially in regard to tobacco quality.

Results of high nitrogen fertilization with varying amounts of phosphate and potash are given in table 34. One treatment includes manure in addition to the maximum amounts of fertilizers used. The outstanding feature of this test is the improvement in tobacco quality brought about by the higher rate of potash used. Also, 180 pounds per acre of P_2O_5 gave better quality tobacco than 90 pounds of this fertilizer constituent. The addition of manure to the 100-180-300 treatment gave the highest yield and crop value represented in the experiment. Tobacco receiving the higher rate of potash generally possessed more desirable burning properties than that grown at the lower rate of potash. Manure showed its usual tendency to repress the burn of tobacco.

TABLE 34.—*Results of test using high rates of nitrogen in* 1949.

Fertilizer treatments lbs/A	Yield per acre (lbs.)	Grade index	Smoking[3] tobacco (%)	Crop index	Time of holding fire (seconds)[3]
100-90-60	1636	.603	65.7	986	3.7
100-90-300	1700	.682	70.7	1157	6.6
100-180-300	1723	.742	76.7	1279	5.0
100-90-60[1]	1582	.569	64.0	904	3.6
100-180-300[2]	1852	.734	81.0	1359	3.8
60-90-60	1530	.588	65.3	901	4.9
L. S. D. (.05)	137	.047	7.2	141	1.9
L. S. D. (.01)	190	.065	10.0	196	

[1] Enough muriate of potash included to supply 20 lbs. Cl per acre.
[2] 10 tons manure per acre was also added to this treatment.
[3] Includes X, C, and BF grades.

Soil type—Ooltewah silt loam.

PRECEDING COVER CROPS

The effects of several cover crops on burley tobacco production were tested for the second year. These crops were turned under about six weeks prior to setting plants in the field. Results are shown in table 35. Both Crimson clover and vetch used as cover crops produced superior yields and crop values to those given by barley and fallow treatments, but the latter two treatments were slightly superior to crimson clover and vetch in producing good burning tobacco.

TABLE 35.—*Effects of cover crops on burley tobacco production in* 1949.

Cover crop[1]	Yield per acre (lbs.)	Grade index	Smoking[2] tobacco (%)	Crop index	Time of holding fire (seconds)
Crimson clover	1403	.478	57.7	670	3.9
Vetch	1435	.491	53.1	703	3.4
Barley	960	.448	66.8	435	5.0
Fallow	1049	.444	59.3	470	5.5
L. S. D. (.05)	174	N. S.	N. S.	138	

[1] All plots fertilized at rate of 100 lbs/A 3-9-6
[2] Includes X, C, and BF grades.

Soil type—Nolichucky silt loam.

CULTURAL TEST

Since it was anticipated that the new variety of tobacco, Burley 1, would be released to growers for general planting in 1950, a test was established to compare this variety with the variety commonly grown, under several cultural conditions. Table 36 summarizes the results obtained. The two varieties were not significantly different in yield, but Burley 1 was the superior variety in quality and in percentage of smoking grades. Kentucky 16 produced better burning tobacco than did Burley 1.

TABLE 36.—*Results of cultural treatments comparing Kentucky* 16 *and Burley* 1 *in* 1949.

Cultural treatment	Yield per acre (lbs)		Grade index		Percent[3] smoking grades		Crop index		Time of holding fire (sec.)	
	Ky. 16	Burley 1	Ky. 16	Burley 1	Ky. 16	Burley 1	Ky. 16	Burley 1	Ky. 16	Burley 1
Fertilizer[1]										
750	1710	1594	.604	.642	58.6	65.5	1035	1026	6.7	3.9
1500	1664	1674	.598	.653	58.4	65.5	1000	1096	4.0	2.3
Spacing[2]										
15 inches	1778	1716	.600	.645	59.0	66.5	1066	1112	5.2	3.0
18¾ inches	1596	1552	.603	.650	58.0	64.4	969	1010	5.5	3.2
Topping										
20 leaves	1687	1549	.601	.662	58.5	66.8	1017	1030	5.3	3.2
25 leaves		1719		.633		64.0		1091		3.0
Average	1687	1634	.601	.648	58.5	65.5	1017	1061	5.3	3.1

[1] Pounds per acre 3-9-6. All plots received 10 tons manure per acre.
[2] In rows; 3½ ft. between rows.
[3] Averages for flying, cutter, and smoking leaf grades.

Soil type—Ooltewah silt loam.

PRIMING

Burley 1 is a high-leaf-number variety and is well adapted to priming. Results of a test comparing three field primings with no priming at all are given in table 37. By priming three times before cutting the stalk, over 600 pounds per acre in yield was gained over the non-primed treatment. Priming also greatly improved quality and equivalent crop value, but there was no essential difference in the percentage of smoking grades produced by these two treatments.

TABLE 37.—*Results of priming test with Burley 1 in 1949.*

Treatment	Yield per acre (lbs)	Grade index	Smoking tobacco (%)	Crop index
Primed 3 times	1836	.631	71.5	1160
Not primed	1219	.544	72.1	663
L. S. D. (.01)	212	.058	N. S.	184

Soil type—Ooltewah silt loam.

UT-AEC AGRICULTURAL RESEARCH PROGRAM

Oak Ridge

C. L. Comar, Laboratory Director and Research Coordinator
J. M. Bird, Farm Superintendent
D. P. Land, Manager, Administrative Services

ORIGIN AND PURPOSE

The origin of the UT-AEC Agricultural Research Program may be said to stem from a request in early 1948 from Dr. A. H. Holland, Chief, Office of Research and Medicine, Oak Ridge Operations, U. S. Atomic Energy Commission, to the University of Tennessee, for the services of technical personnel, as consultants, to aid in developing a management program for the cattle at Oak Ridge which had been accidently exposed to the effects of the first atomic bomb explosion, in July 1945, near Alamogordo, New Mexico. President C. E. Brehm who was Director of the University of Tennessee Agricultural Experiment Station at the time of the request, designated Dr. Charles S. Hobbs and Prof. R. H. Lush to work with Dr. Holland on this program.

It was soon very clear to both the University and the Atomic Energy Commission that these cattle, the available land, and its proximity to other AEC facilities and to the Agricultural Experiment Station, collectively, presented a great opportunity for a scientific program in the use of radioactive isotopes in agriculture, a field in which both the University and the AEC could participate to their mutual benefit. Vice Director F. S. Chance appointed Dr. C. S. Hobbs to work out the details of the program with the Atomic Energy Commission and assume the initial responsibilities for carrying them out. A tentative program, which was prepared in consultation with Dr. C. L. Comar, was submitted by the University, and on May 11, 1948 the University entered into a formal contract, No. At-40-1-Gen-242, with the AEC to conduct an extensive research program on the use and effects of radioactive isotopes and of radiation on domestic and laboratory animals, parasites, crops, and insects.

The urgency and necessity for the initiation of a program of this type were indicated as follows:

1.—Certain cattle and their offspring which had been accidentally exposed to the Alamogordo test bomb in July 1945 were located at Oak Ridge. These cattle represented important scientific material from the point of view of biological effects of radiation, and it was in the National Interest that facilities be provided to enable a scientific study of these animals.

2.—Due primarily to the expense involved, there were no facilities existing in the United States for an intensive program of agricultural and biochemical studies, using atomic energy techniques with large animals. Thus, investigations of many important biological problems concerned both with the effects of radiation and the development and improved health through radioisotope studies were being neglected.

3.—It was considered that these same facilities, in addition to providing for the research as indicated above, would also be invaluable for required studies in the National Interest should future emergencies result in the widespread dissemination of radioactive materials.

4.—Location of these facilities within the Oak Ridge area was considered essential and economical since proximity to the center of isotope production would allow the use of short lived radioisotopes, pile irradiation techniques, already existing radioactive waste disposal systems, and cooperation of mutual benefits with other AEC Divisions. It was also necessary that land be available from which the public could be excluded.

5.—It was desirable that opportunities be provided for qualified scientists and Graduate Students to study atomic energy applications in this field by undertaking short term research projects or thesis problems.

This program was organized under the administration of the Agricultural Experiment Station in such a way that any other department of the Experiment Station with problems that could be advantageously approached through the use of radioactive material could establish collaborative projects. It was considered that this arrangement would be of mutual benefit in that the collaboration of the faculty members would bring a great breadth of experience and background to the Program, while, on the other hand, the Program could provide facilities which are not usually available to the various departments.

Development of physical and administrative facilities, necessary to adequately and economically prosecute the program, was the first work to be started. Immediately following agreement in principle upon the program, Prof. H. R. Duncan of the Animal Husbandry Department selected some 5000 acres of land along the Clinch

River, located within the Oak Ridge Reservation, as the most feasible location for the farm. The land needed reclaiming, pasture had to be established, fences built, barns repaired and new barns built. Laboratories and office space had to be provided and dwellings made livable for personnel required to live on the farm. Providing these physical facilities has been no little job, and has not been entirely completed. Nevertheless, it was possible to initiate certain phases of the more technical part of the program from the beginning, while other phases had to be delayed until either permanent or temporary facilities were made available. Investigations are now underway in collaboration with the Departments of Animal Husbandry, Agronomy, Chemistry, Dairying, and Poultry. The details are reported by projects in a later section.

FARM

Some of the more important accomplishments on the farm are: Approximately four miles of new fence has been built and five miles repaired; a soil map of the entire area has been made; approximately 700 acres of land has been limed; soil samples were taken from all fields that have seen seeded, for analysis by the Agronomy Department; 400 acres have been seeded to perennial grasses and clovers for hay and pasture (fig. 37); three barns have been extensively remodeled and a new feeding barn 28 x 100 has been built;



Fig. 37—A portion of the herd on land reclaimed and seeded to oats, rye grass, and crimson clover, September 1948. Exposed and control cattle are maintained under identical conditions.

a concrete barn lot 36 x 200 was built at one facility; two trench silos, with a total capacity of approximately 500 tons, were dug and filled in 1948 and again this year; a concrete stave silo, 16′ x 45′, was built this year; two dwellings were converted into grain storage units and one unit was equipped with a drier; a concrete block shop and machine shed, 26′ x 100′, was built; four deep wells were drilled; three livestock scales were installed (all cattle are weighed every twenty-eight days); three houses were moved from the control area for use by employees; and seven houses have been modernized with running water and bathroom facilities.

Livestock on hand at end of year were: Cattle 315; Hogs 30; Horses 3.

LABORATORY

The Scarboro School building, containing about 22,000 square feet of floor space, and located within the Oak Ridge controlled area,



Fig. 38—This calf has received an intravenous injection of radioactive calcium, and is being led into the posting room for sacrifice and to be autopsied.

was allocated to this Program for conversion to laboratories and offices. Detailed plans were drawn for the special facilities needed and construction was initiated. These facilities included a room for autopsy of animals, (fig. 38), a tissue dissection room, a laboratory for preparation of samples for radioassay, a radio-chemical laboratory, a Geiger counting room and a radio-biological laboratory. These laboratories were placed in operation during September of 1949. At this time, plans were drawn for additional necessary facilities to include the Nutrition Barn with bullpens, hot rooms, small animal rooms, additional laboratories, a darkroom, stockrooms, and offices. It is anticipated that construction on these latter items will be completed before the winter of 1950.

Procurement and placing into service of equipment and supplies for general laboratory operation was a major effort which is now basically completed. Radioisotopes of elements such as calcium, phosphorus, iodine, zinc, sulfur, cobalt and iron were obtained, used to establish counting procedures and employed in preliminary biological work. Radiation-monitoring equipment was tested and calibrated, and Health Physics procedures established for the building (fig. 39). Methods for the handling and transportation for burial of radioactive large animal wastes have been worked out. Labora-

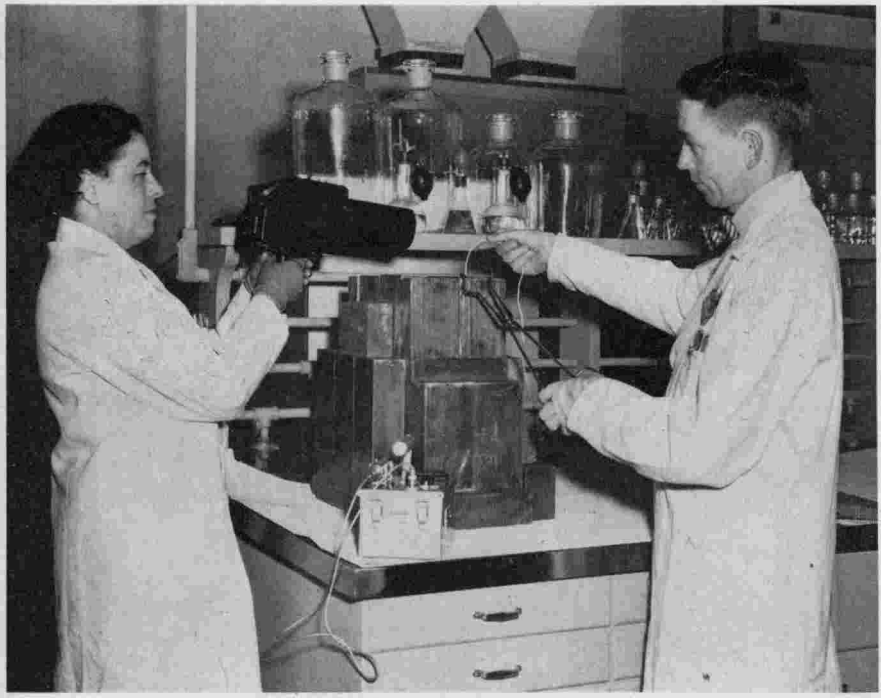


Fig. 39—A sample of radioactive material is being removed from behind a lead barricade. Radiation monitoring equipment is being used to see that personnel are not exposed to dangerous amounts of radiation.

tory assistants have been trained for the special duties necessitated by the type of work.

Contract negotiations have been completed under which this Program has made certain animal and laboratory facilities available to the Medical Division of the Oak Ridge Institute of Nuclear Studies.

UT - AEC PROJECTS

PROJECT 1: BOMB RADIATION EFFECTS UPON FARM ANIMALS

In Collaboration with Department of Animal Husbandry and Veterinary Sceince

C. S. Hobbs, R. L. Murphree and S. L. Hansard

This study represents one of the original phases of the UT-AEC Projects and has as its primary objectives the investigation of the general and specific effects of exposure to the Alamogordo test bombing on the general health, growth, breeding efficiency, and relative fertility of the exposed Hereford cattle, and their offspring, (fig. 40).

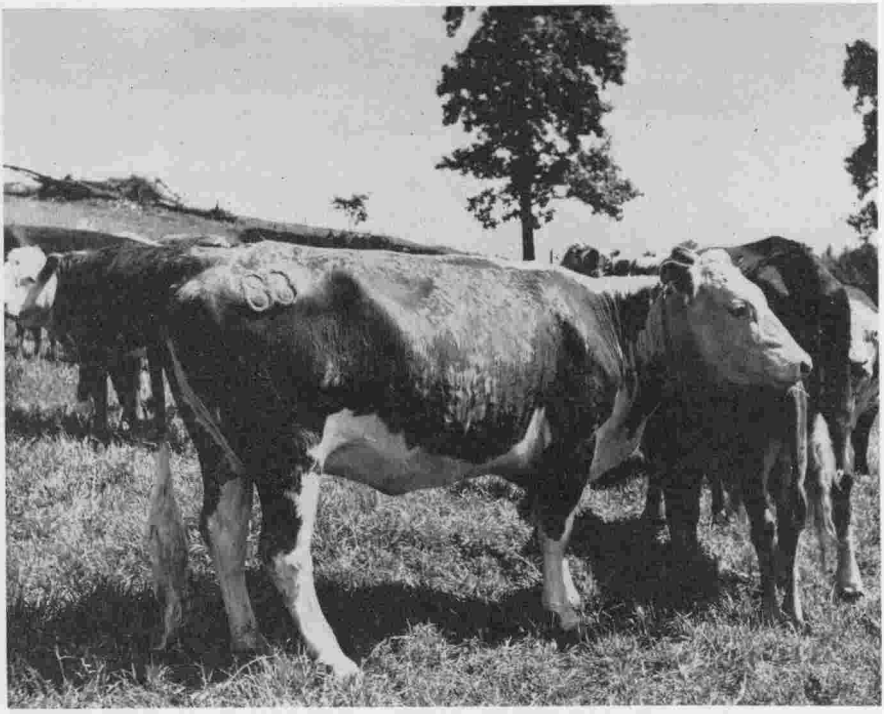


Fig. 40—Cow Brand No. 88 was exposed to radiation from the "first" atomic bomb. Performance of exposed cattle is being carefully checked against control cattle.

In addition to the exposed animals that were brought to Oak Ridge from New Mexico, others were purchased in New Mexico to be as comparable as possible to the exposed animals. A few purebred animals were purchased later in South Carolina for inclusion in the breeding studies.

The breeding program for 1948 was set up as follows:

Group	Bull to be used	Oak Ridge Cows	N. M. Cows	S. C. Cows
1	3-yr-old A-1, Oak Ridge	6	15	8
2	2-yr-old A-2 Oak Ridge	6	15	
3	2-yr-old A-3, Oak Ridge	6	15	
4	Lewis Hereford A-4	6	15	
5	Polled Hereford A-5	6	15	8

The cows were alloted as uniformly as possible between lots based on origin, type, condition, whether nursing a calf or not, weight, and any other factor which was considered important for the allotment.

For the 1949 breeding season certain cows were switched for breeding between A-1 and A-5, and between A-2 and A-4, leaving the same cows with A-3. Each animal was identified with a tattoed number and hot iron brand numeral. The cows and calves were weighed monthly. An additional group of exposed cows received from Alamogordo in 1948 were divided between A-1 and the bull received from Alamogordo, A-6, in 1948. Control cows were selected and mated with A-6. All calves born in 1949 were weighed at birth and monthly thereafter to determine their growth rate in order to give a comparison between exposed and control cows. The progeny sired by each bull was weaned in the fall and put on progeny test studies to determine if there is a measurable difference in growth response between bulls and between exposed and control cows. The progressive breeding plans and growth study procedures will follow the general plan of 1948-49, and will be revised as any new and available data indicate.

The following records will be maintained on all these cows: individual identity, pedigree, color marking, birth weight, monthly weights until 900 pounds, type and condition at weaning, and other morphological and physiological characteristics. Records will be kept on estrus, breeding dates, and fertility, insofar as possible. A veterinary description of the bomb effects and body surface diagram drawing and picture has been made of each exposed animal. These will be rechecked and studied in detail at periodic intervals. Detailed histological and pathological studies will be made of all exposed animals that are slaughtered or die. A preliminary summary of the weights of the exposed, control and purebred cows from July 1948 (the date the University began the study and started taking weights) are as follows:

Average Weight According to Periods

	July 1948	Nov. 1, 1948	Apr. 1, 1949	Nov. 1, 1949	Jan. 1, 1950
Radiated	721	834	864	949	955
Control	685	777	809	958	917
Purebred	957[1]	1042	1081	1222	1251
Radiated Steers	923	1083	1175	1272	1314

[1]August weight.

PROJECT 2: FISSION PRODUCT METABOLISM IN ANIMALS

C. L. Comar, S. L. Hood, C. S. Hobbs, and S. L. Hansard

The primary objective of this project was the study of the animals exposed at Alamogordo to the fall-out of fission products, particularly in connection with the retention of any radioactivity in the tissue or organs, and the study of any internal or external pathological changes which might have occurred. Two of the exposed steers which showed the greatest skin effects were selected and autopsied. Photographs were taken and a complete necropsy protocol recorded. About 140 microscopic sections from each animal



Fig. 41—The sample of radioactive material from an animal tissue is being measured quantitatively, within a 1½ inch lead shield by means of a Geiger counter.

were taken, and a pathological study has now been completed through the cooperation of the Armed Forces Institute of Pathology. Samples of organs and tissues from these two animals were measured (fig. 41) for any retained alpha, beta, or gamma activity.

Biopsies for microscopic study were taken from typically affected areas of the skin of six other animals; these were taken to include both normal and affected skin. The rate of healing will be observed, and future biopsies from the same lesions will be taken to indicate any degradative changes which may be in progress.

Blood studies on representative exposed animals were started as soon as possible, and have been continued to-date.

PROJECT 3: CALCIUM METABOLISM IN ANIMALS; (I) ABSORPTION AND INTERNAL DISTRIBUTION

S. L. Hansard, C. S. Hobbs, C. L. Comar, S. L. Hood, and M. P. Plumlee

This project was initiated to:

(1) Determine the normal tissue distribution of soluble calcium administered orally and intravenously to cattle (fig. 42) as representative of the ruminant species and to single stomached animals as represented by swine, rabbits, and rats.

(2) Study the normal absorption and utilization of dietary calcium by the above animals, with particular emphasis on cattle.

(3) Study the effect of factors such as age, pregnancy and lactation on calcium utilization and its internal metabolism.

(4) Study the relative availability to the animal of calcium administered in various forms.

Pending completion of the Nutrition Barn, a temporary cattle shed, 16′ x 20′, with an adjacent covered lot 16′ x 16′ was constructed for the initiation of the cattle metabolism studies. Three digestion stalls with adjustable feed bunks equipped with stainless steel feces pans and steer urinals were procured and adapted with splatter boards and depository facilities for contaminated excretions. Complete facilities and procedures have been formulated for quantitative isotope administration, management and feeding, excretion sampling and handling during the experimental periods. A basic cattle ration of natural feedstuffs was formulated and analyzed by means of which predetermined calcium and phosphorus levels could be fed. Several animals have been placed upon these known rations for the conditioning phase of this work. The distribution of radioactive phosphorus orally administered to one calf has been studied. Similarly, a complete study of radioactive calcium orally administered to one animal has been completed, and also one calf has been used for a study in which the radioactive calcium was intravenously injected.

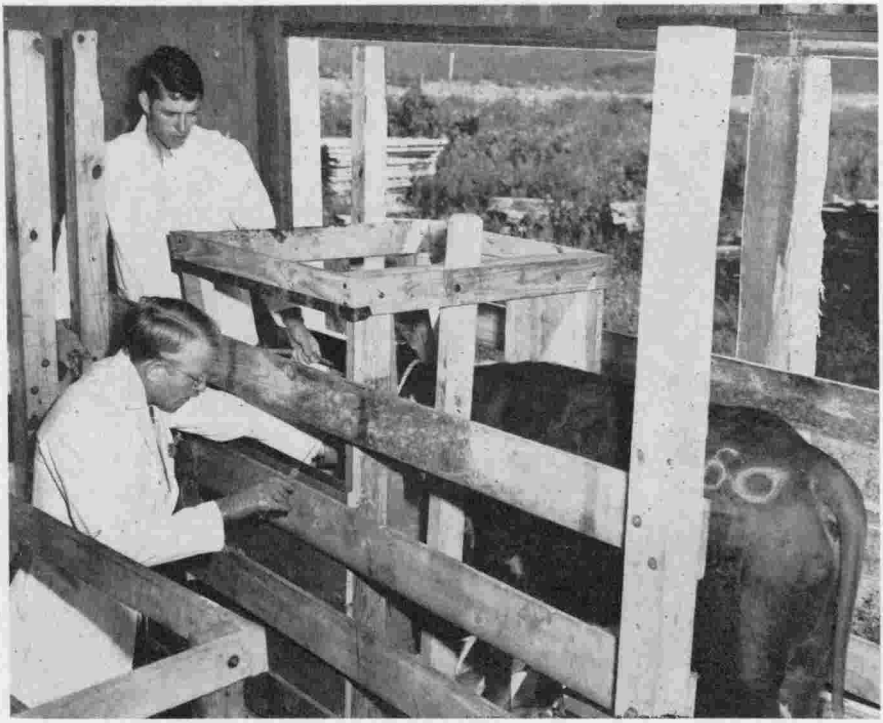


Fig. 42—This calf has received an intravenous injection of radioactive calcium and is being kept in a metabolism stall so that the feces and urine can be collected quantitatively for analysis. Research workers are about to take a blood sample.

PROJECT 4: CALCIUM METABOLISM IN ANIMALS; (II) INTERRELATIONSHIP WITH MINERALS, VITAMINS, HORMONES AND OTHER FACTORS

S. L. Hansard, C. S. Hobbs, S. L. Hood, and C. L. Comar

The objective of this study was to investigate and separate out the effects on calcium metabolism of certain important factors, or combination of factors, which are known to influence the behavior of this element in the animal body. Some of these conditioning factors include such elements and compounds as magnesium, phosphorus, Vitamin D, estrogens, parathormone, citrates, phytates, oxalates, fluorine, beryllium, and others. It was necessary that the initial work on this project be done with small laboratory animals, rats, since this type of experiment requires the use of a large number of animals in a statistical design. It is intended that this work will be carried to the larger animals as soon as simplification becomes possible from the results of the small animal pilot studies.

The rat colony has been established with a thrifty, highly inbred strain, of Wistar rats obtained from the University of Tennessee Home Economics Department. Operational details for the small animal colony have been established. A basic experimental rat ration nutritionally adequate and adjustable for variable mineral and vitamin content has been formulated for this work. Techniques and procedures for the quantitative administration of radioactivity and the handling of samples have been developed. Sixteen metabolism cages with urine and feces separation units have been constructed. Data have been obtained on the calcium metabolism in rats as a function of variable calcium levels in the ration, and also as a function of variable phosphorus level in the ration.

For studies on the affect of age, seventy-two weanling rats have been started on experiments for sacrifice at intervals up to three years. For studies of placental transfer, several lots of female weanling rats have been established. Other rats have been started on various rations for investigation of the interrelationships between Vitamin A, calcium and phosphorus, (fig. 43).



Fig. 43—This rat is being weighed prior to the oral administration of radioactive phosphorus in a nutrition study.

PROJECT 5: RADIATION EFFECTS ON REPRODUCTIVE FUNCTIONS IN FARM ANIMALS—SPERM PHYSIOLOGY STUDIES: (I) USE OF RADIOISOTOPES, (II) EFFECTS OF RADIATION

R. L. Murphree, C. S. Hobbs, C. L. Comar, and S. L. Hood

The primary purpose of this project was to study the physiology of sperm by means of radioisotopes. The initial approach has been to investigate the rate of uptake by sperm of the radioisotopes of various elements, and to attempt to correlate this rate of uptake with the usual physical criteria. The appearance of intravenously administered radioisotopes in the semen and its fractions is also being studied. Temporary facilities have been constructed to make possible the convenient collection of semen from bulls and boars. Several Hereford bulls have been trained for the collection of semen by use of the artificial vagina. One boar has been purchased for this study, and training begun to accustom the animal to the use of the artificial vagina. Techniques are being developed for semen and sperm analysis. Initial trials have shown that the egg yolk material in egg yolk diluters can not be separated from the sperm and this has necessitated a search for some other type of diluter.

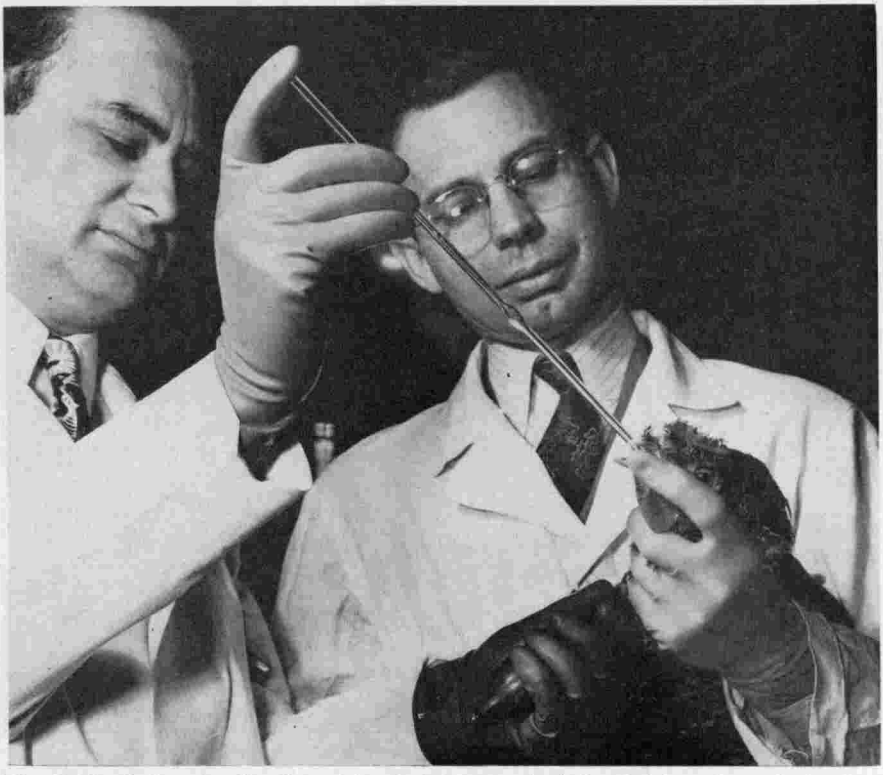


Fig. 44—A solution of radioactive calcium is being quantitatively administered to a laying hen.

Preliminary studies have been made on the uptake of Phosphorus 32 by jack and bull sperm suspended in Tyrode's solution. Preliminary studies have also been made in which the radioactive phosphorus was injected into the bull and the transfer of this element to the seminal fluid and the semen is being followed.

PROJECT 6: RADIOISOTOPES IN POULTRY NUTRITION STUDIES

In Collaboration with the Poultry Department

O. E. Goff, H. Patrick, E. O. Essary, R. L. Tugwell, C. L. Comar, S. L. Hood, and R. A. Monroe

The initial objectives of this project were to determine the calcium distribution and metabolism in birds which characteristically produce thin-shelled eggs and in those which produce thick-shelled eggs, to determine the environmental effect of temperature on the calcium metabolism of the hen and chick, and to study the physiology of calcium transfer in the development embryo. As the work proceeds, it is also considered important to study the metabolism of Vitamin B_{12} labeled with radiocobalt and also to obtain labeled anthelmintics and thereby study their mode of action.

The information obtained under this project, when considered in the light of the mineral metabolism data obtained from the other projects, will be of great importance in contributing to the overall understanding of skeletal metabolism in general. Techniques for the analysis of the different parts of the egg have been developed. A series of birds have been set up and radioactive calcium has been quantitatively administered (fig. 44) to them. The eggs are being collected and analyzed (fig. 45).

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

E. Swanson, T. W. Albrecht, C. E. Wylie, C. L. Comar, S. L. Hood, and R. A. Monroe

The initial objective of this project was to obtain a quantitative picture of calcium and phosphorus economy in the lactating dairy cow. This phase of the work is considered very important in understanding mineral metabolism under conditions of lactation stress. Temporary facilities have been constructed for the accommodation of two dairy animals which have been made available to this Program by the Dairy Department. It is anticipated that the isotope studies will be initiated with these animals in the near future.



Fig. 45—Radioactivity in an egg from a hen which was fed radioactive calcium is being demonstrated with a portable Geiger counter.

PROJECT 8: BEHAVIOR AND FATE OF RADIOACTIVE CALCIUM AFTER THE INCORPORATION AS $CaCO_3$ and $CaSiO_3$ IN THE SOIL—AS REGISTERED BY LYSIMETER LEACHINGS, BY NEUBAUER TESTS, BY PLANT UPTAKE, AND THROUGH LABORATORY EXTRACTIONS

In Collaboration with the Chemistry Department

W. H. MacIntyre, W. M. Shaw, S. H. Winterberg, C. L. Comar, S. L. Hood, in collaboration with H. C. Harris, Oak Ridge Institute Fellow, assigned to this Program

The primary purpose of this project was to determine the fate of radioactive calcium after its incorporation as carbonate in the soil in relation to the behavior of the calcium native to the soil. Approximately 1300 grams of calcium carbonate labeled with calcium 45 was prepared by precipitation from calcium chloride. This material was incorporated at five rates in each of two typical Tennessee soils at Knoxville. These two soils were Hartsell loam and Claiborne silt.

Twelve lysimeters, containing 100 lbs. of soil each, and seventy-two pots (2 gallon) were charged with this soil on November 11,

1949. The pots were used for triplicated cultures of two crops (rye grass and red clover). The initial collections of rainwater leachings, the early growth plants, and the final harvested plants have been analyzed for both total calcium and labeled calcium. A second crop of plants has been started in the pot cultures. From consideration of the specific activities of the added calcium and that found in the leachings and plants, it has been possible to establish the contribution to these samples of both the native calcium in the soil and the added calcium. These findings will be of scientific interest and of practical value in the art of liming.

PROJECT 9: THE RELATION OF SOIL TYPES TO THE AVAILABILITY OF NUTRIENTS

In Collaboration with the Agronomy Department

E. Winters, L. F. Seatz, J. K. Leasure, C. L. Comar, S. L. Hood, in collaboration with H. C. Harris, Oak Ridge Institute Fellow, assigned to this Program.

The initial objectives in this project were to determine the rate of fixation and release of soil phosphorus in representative Tennessee soils and to study the factors affecting its uptake by plants. Studies have been initiated with soils and clay fractions from representative Tennessee soils in which the soil samples were equilibrated with solutions of radioactive phosphorus. It has been necessary to establish techniques for the separation of the soil fraction from the supernatant solution and for the measurement of the radioactive phosphorus in the supernatant.

WEST TENNESSEE EXPERIMENT STATION

Jackson

Ben P. Hazlewood, Superintendent

WEATHER

Weather at this Station was mild and moist. The lowest temperature, 6° F., occurred February 1 and caused considerable damage, due to the generally mild weather that had prevailed earlier. Fourteen inches of rainfall occurred in late May and June. This condition caused general failure of cultivated crops on low lands. Total rainfall for the year was 59.70 inches, compared with the average of 47.96 and 61.64 inches in 1948.

VISITATION

The Spring Field Days and Farmers' and Home Makers' Institute were well attended. All agricultural agencies working in West Tennessee cooperated in making these meetings beneficial.

Many groups used the facilities of the Station for meetings. Approximately 2000 people were in attendance at the annual meeting of the Madison County Farm Bureau. This is one of many groups which uses the Station each year for annual meetings.

SEED PRODUCTION

The production of pure seed of certain crops developed by Station workers is an important part of this Station's work. The major part of the operating funds is derived from this source. The first LeConte oats, developed by N. I. Hancock, were distributed to growers for increase. These oats were placed with ten farmers and the Tennessee Seed Producers. The Tennessee Seed Producers in turn contracted with twenty-four farmers to increase this new variety, in order to have a 1950 supply of foundation seed for certified growers.

The Station likewise grows seed of Forkedeer oats, Jackson No. 1 barley, Jellicorse corn, Ogden soybeans, and Tennessee 241 cotton.

NEW BUILDINGS

Such funds as were available from Station sales were devoted to the erection of two new buildings; one a combination farm shop and machine storage, and the other housing facilities for experimental work with livestock. These buildings are contributing to a more efficient operation of the Station. Figure 46 shows a picture of the farm shop and machine storage building, and figure 47 shows the livestock building.

FENCING

The fencing, on the land added to the Station in 1942, has progressed far enough that this area is now available for pasture experiments. The fencing arrangement, making all pastures readily accessible to the barns and cattle pens, has simplified pasture work considerably.

LIVESTOCK

Beef Cattle.—Much more detailed work was begun with beef cattle. Calves are being used instead of yearlings, as in previous years. The objectives of the work are: (1) a comparison of methods for wintering and finishing heavy steer and heifer calves for spring and early summer markets, and (2) a comparison of methods of wintering and summering medium weight steer and heifer calves to be sold in the summer or fall.

Dairy Cattle.—The use of this Station's herd for the study of mastitis in dairy cattle has been discontinued. The project of establishing a Jersey herd is being continued with special emphasis



Fig. 46—New Machine Shop, West Tennessee Station, Jackson.

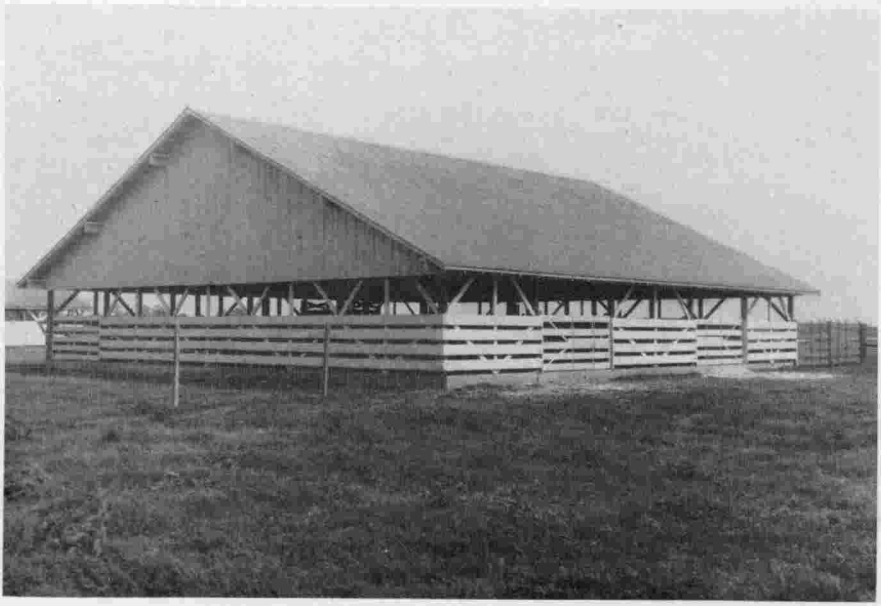


Fig. 47—New Livestock Shed used to house sheep at West Tennessee Station, Jackson.

on developing as many female offspring as possible from the proven bull, Pansy Signal Observer, Reg. No. 394638.

Swine.—A herd of purebred Durocs is maintained. Selection of the most efficient producing females has been followed for several generations.

Detail reports of the animal husbandry experiments at this Station may be found elsewhere in this report under Animal Husbandry at the West Tennessee Experiment Station.

AGRONOMY, PATHOLOGY AND HORTICULTURE

Detail reports of agronomy, pathology, and horticulture may be found in the report of the respective department.

LIBRARY

Sarah C. Currell

Volumes in Agricultural Library, 1948		23,699
Experiment Station and College Additions, 1949		786
Experiment Station	237	
College	549	
Total volumes		24,485
Uncatalogued pamphlets		49,066

Periodicals received, 1949

	Purchase	Gift	Exchange	Total
Experiment Station	60	53	35	148
College	124	192	12	328

Volumes bound, 1949		144
Books and pamphlets circulated		26,059
Reference questions answered		1,429
Inter-Library Loans		
Volumes sent to other libraries	310	
Volumes borrowed from other libraries	32	

CHANGES IN STAFF

APPOINTMENTS

R. P. Moorman, Asst. An. Husb., Jan. 1
William E. Goble, Asst. Agr. Econ., Jan. 3
R. G. Garner, Asst. Gen. Chem., Feb. 1
T. W. Albrecht, Assoc. Dairy Husb., Apr. 1
J. B. McLaren, Asst. in Chem., Apr. 1
R. L. Murphree, Assoc. An. Husb., Apr. 1
James S. Kring, Forester, June 1
Fairy Clapp, Asst. Chem., July 1
E. O. Essary, Asst. Poultry Husb. July 1
Glenn D. Folmar, Jr., Asst. An. Husb., July 1
Winnifred Hester, Asst. Chem., July 1
LaRue McCrary, Asst. Chem., July 1
Mary Ellen Tubb, Asst. Chem., July 1
M. B. Badenhop, Asst. Agr. Econ., July 11
Joe C. Dunn, Asst. Agron., Aug. 1
R. B. Hughes, Asst. Agr. Econ., Aug. 1
Bonnie B. McDonald, Asst. Human Nutr., Aug. 11
Eleanore Hardcastle, Asst. Textile Analyst, Sept. 1
W. W. Overcast, Asst. Dairy Husb., Sept. 1
Elinor Pearson, Human Nutr., Sept. 1
Charles C. Chamberlain, Asst. An. Husb., Sept. 15
John B. Liljedahl, Assoc. Agr. Eng., Sept. 16
Harold J. Smith, Assoc. An. Husb., Sept. 16
Jack K. Krum, Assoc. Hort., Sept. 20
George J. Mountney, Asst. Poultry Husb., Sept. 21
John A. Ewing, Asst. Director, Nov. 1
E. J. Chapman, Supt., MTES., Nov. 1

RESIGNATIONS

Geraldine C. Coleman, Asst. Gen. Chem., Feb. 28
M. C. Hervey, Assoc. An. Husb., May 9
Arthur Meyer, Assoc. Hort., June 30
Echo Price, Asst. Hlman Nutr., Aug. 10
Mary P. Shelton, Textile Chem., Aug. 31
E. R. Barrick, Assoc. An. Husb., Sept. 20
J. T. Tumlin, Asst. Poultry Husb., Sept. 20
Donald E. Cooperrider, Assoc. Parasitologist, Nov. 30

RETIREMENTS

F. H. Broome, Sept. 1
C. D. Sherbakoff, Dec. 31

ON LEAVE

Dorothy Williams

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211	Cotton Varieties and Related Studies.	N. I. Hancock	May	55
212	The Conservation of Calcium and Magnesium from Inputs of Burnt Lime, Limestone, Dolomite, and Dicalcium Silicate, as Influenced by Rate and Frequency of Liming and by Zone of Incorporation.	W. M. Shaw W. H. MacIntire H. H. Hill	July	95

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PUBLICATIONS

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Development of Available Magnesium.	W. H. MacIntire L. J. Hardin H. S. Johnson, Jr.	Ind. Eng. Chem. 41:1079-1082, May, 1949	4
A Volumetric Method for the Determination of Magnesium.	L. J. Hardin W. H. MacIntire	Jour. A.O.A.C. 32:139-143, Feb. 1949	5

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The Determination of Exchangeable Hydrogen and Lime Requirements of Soils.	W. M. Shaw	Jour. A.O.A.C. 32:437-452, May, 1949	16
Report on Soils and Liming Materials.	W. H. MacIntire	Jour. A.O.A.C. 32:368-369, May, 1949	2
Migrations of Phosphorus and other Elements from Variously Phosphates Soils, with and without Calcium Fluoride and Liming Materials.	W. H. MacIntire W. M. Shaw Brooks Robinson	Soil Science 67:377-394, Nov., 1949	10
A Comparison of Olivine, Serpentine, Magnesite, Dolomite, and Selectively Calcined Dolomite as Sources of Magnesium for Red Clover.	W. H. MacIntire S. H. Winterberg A. J. Sterges L. B. Clements	Soil Science 67:289-297, April, 1949	9
Effects of Fluorine in Tennessee Soils and Crops.	W. H. MacIntire and Associates	Ind. Eng. Chem. 41:2466-2475, May, 1949	10
Report on Exchangeable Hydrogen in Soils and on Liming Materials.	W. M. Shaw	Jour. A.O.A.C. 32:369-370, May, 1949	2
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STATION OFFICERS

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L. F. SEATZ, Associate Agronomist
D. M. SIMPSON, Associate Agronomist (Cotton Breeding).*
L. N. SKOLD, Associate Agronomist

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H. R. DUNCAN, Assoc. Animal Hubandman
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R. P. MOORMAN, Asst. Animal Husbandman
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DENNIS SIKES, Veterinarian
HAROLD J. SMITH, Assoc. Husbandman

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J. K. UNDERWOOD, Associate Botanist

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LaRUE McCRARY, Assistant Chemist
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BROOKS ROBINSON, Asst. Soil Chemist
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A. J. STERGES, Associate Soil Chemist
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J. B. YOUNG, Assistant Soil Chemist

DAIRY HUSBANDRY

C. E. WYLIE, Dairy Husbandman, Chairman Dairy Committee
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W. W. OVERCAST, Asst. Dairy Husbandman
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THOMAS J. WHATLEY, Asst. Agr. Economist

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H. A. ARNOLD, Assoc. Agr. Engineer
A. L. KENNEDY, Assoc. Agr. Engineer
J. B. LILJEDAHL, Assoc. Agr. Engineering
ARTHUR H. MORGAN, Mechanical Engineer

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S. MARCOVITCH, Entomologist
W. W. STANLEY, Associate Entomologist

FORESTRY

JAMES S. KRING, Forester, Harriman

HOME ECONOMICS

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JEAN GIBSON, Assistant Textile Chemist
ELEANORE HARDCASTLE, Asst. Text. Chem.
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BERNADINE MEYER, Food Economist
RUTH MOORE, Assistant Food Economist
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ELINOR PEARSON, Human Nutritionist
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DOROTHY E. WILLIAMS, Human Nutri. (on leave)

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INFORMATION

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JANE WHITTLE, Asst. Agr. Librarian

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REBA LAWSON, Assistant in Physics

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E. S. BROWN, Asst. in Plant Pathology
JAMES M. EPPS, Assoc. Plant Path., Jackson
E. L. FELIX, Assoc. Plant Pathologist
H. E. HEGGESTAD, Assoc. Plant Path., Greeneville*
DENNIS H. LATHAM, Assoc. Plant Path., Springfield
H. E. REED, Assoc. Plant Pathologist

POULTRY

O. E. GOFF, Poultryman
E. O. ESSARY, Asst. Poultry Husbandman
B. J. McSPADDEN, Poultry Husbandman
GEO. J. MOUNTNEY, Asst. Poultry Husb.
HOMER PATRICK, Poultry Nutritionist

SUBSTATIONS

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E. J. CHAPMAN, Superintendent, Middle Tennessee Experiment Station, Columbia
JOHN A. ODOM, Superintendent, Plateau Experiment Station, Crossville
E. L. BOHANAN, Assistant Superintendent, Plateau Experiment Station, Crossville
J. HUGH FELTS, Superintendent, Tobacco Experiment Station, Greeneville
J. M. BIRD, Farm Superintendent, UT-AEC Agricultural Research Program, Oak Ridge
B. P. HAZLEWOOD Superintendent, West Tennessee Experiment Station, Jackson

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