1969

88 Years of Agricultural Research in Tennessee

University of Tennessee Agricultural Experiment Station

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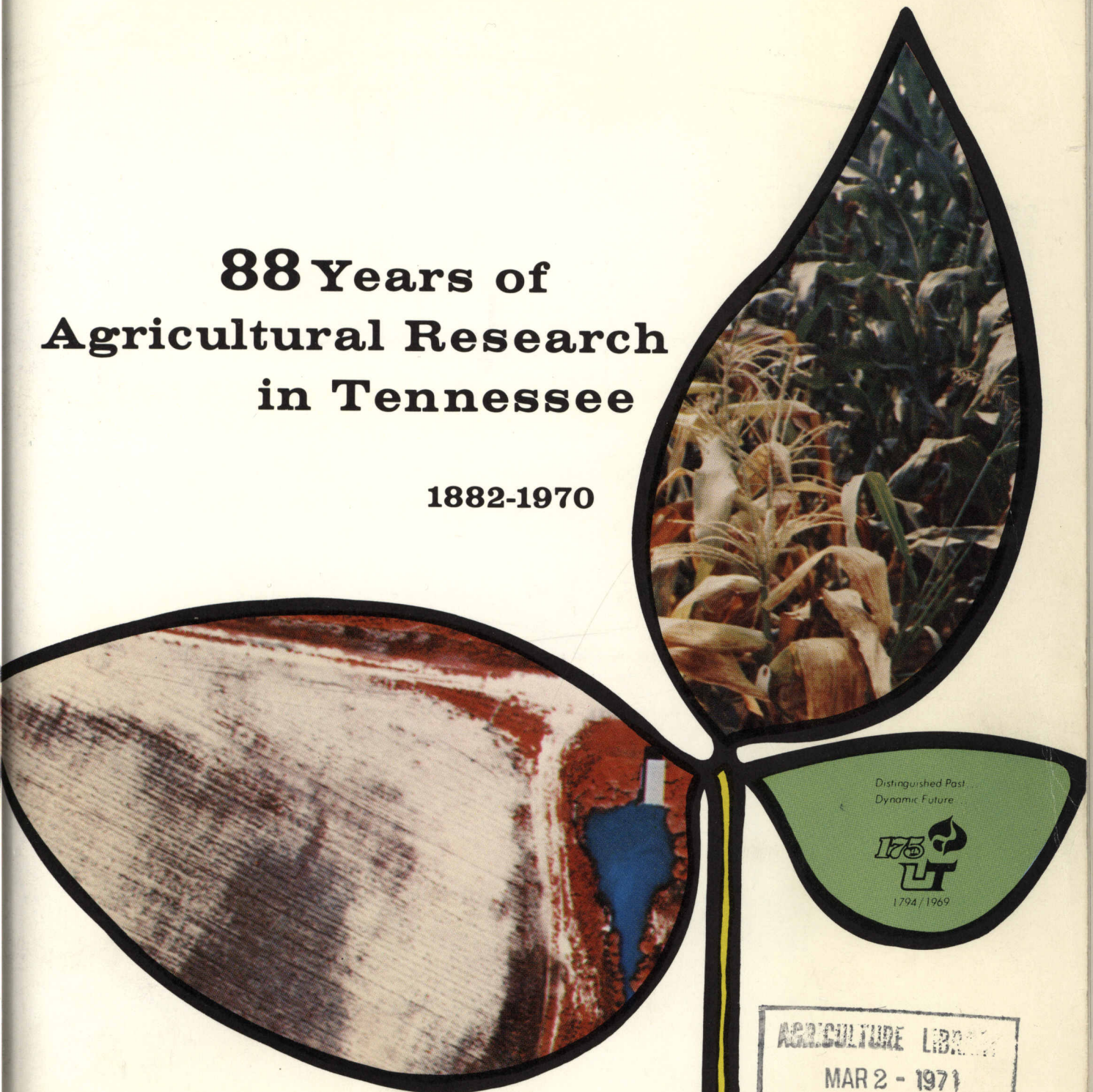
1882-1970



Distinguished Past
Dynamic Future
175 LT
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1969 ANNUAL REPORT / The University of Tennessee Agricultural Experiment Station / Knoxville

ON THE COVER:

Left: This aerial photo of a field at the West Tennessee Experiment Station was taken with special camera equipment using infrared film in a research technique called remote sensing. The photo shows different characteristics of the landscape in the varying colors and varying shades of the same colors. The blue at right is water; the red at left and lower right represents vegetation; the light gray areas represent drier soils and the dark gray areas, damper soils. The contrast in soil color results because drier areas were more reflective and warmer than damper areas.

Top right: The corn on the right is resistant to a virus disease first identified in the state in 1964. This corn is a hybrid developed through joint research between The University of Tennessee and the U.S. Department of Agriculture. In one series of experiments, it produced four times the yield of the susceptible variety on the left.

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LETTER OF TRANSMITTAL

Knoxville, Tennessee
January 2, 1970

To His Excellency, Buford Ellington
Governor of Tennessee

SIR: I have the honor of transmitting 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 1969.

This report is submitted in accordance with the law requiring that such a report be submitted annually by the administrators of the Experiment Station to the Governor of the State.

Respectfully submitted,
Andrew D. Holt, President

East Tennessee Farmer's Convention, 1916.

Through The Years ....

The administrative structure of the Agricultural Experiment Station has been quite varied in the Station's 88-year history. The actual administration of the research program has not always been vested in the person named as titular head.

A director was named upon establishment of the Station in 1882. John W. Glenn, of the Agriculture Department, was the first Director. He served in this capacity until June, 1887.

Dr. Charles W. Dabney, named president of the University in early July, 1887, was also named Director of the Station on July 24 of that year. He held the title of Director until April, 1890, along with the office of President. In July, 1890, F. Lamson-Scribner was listed in Station bulletins as Director. From April, 1893, until 1898, Station publications bore the name of Dr. Dabney, President; but no separate Director was listed.

Andrew M. Soule was designated as Agriculturist in 1898, and apparently he had direct charge of the research program. In 1902 Soule was listed as Vice Director and Agriculturist; and in 1903-1904 he was Director and Agriculturist. The position was unfilled from the summer of 1904 until 1905, when Dr. H. A. Morgan was appointed Director.

Dr. Morgan served as Director until 1923, although he was named President of the University in 1919.

C. A. Mooers, chemist and agronomist, served as Vice Director from 1919 until he was named Director in 1923. He continued in this top administrative post until his retirement in 1946.

F. S. Chance became Assistant Director in 1943. Upon the retirement of Director Mooers, the title of Director was conferred upon Dr. C. E. Brehm, who also was Director of the Extension Service and Dean of the College of Agriculture. Administration of the research work was under direction of F. S. Chance, who became Vice Director in 1946. Mr. Chance continued in this position until his retirement at the end of 1956. Meanwhile, Dr. J. H. McLeod was Dean and Director from 1948 until 1957.

Dr. John A. Ewing came into the administrative staff in 1949 as Assistant Director; he became Senior Vice Dean and Director in 1955. In February, 1957, Dr. Webster Pendergrass was named Dean of Agriculture, and Dr. Ewing became Director of the Experiment Station. He held this title until July, 1968, when he became Dean of the Agricultural Experiment Station in the newly created Institute of Agriculture.

Foreword

What is the purpose of agricultural research? The objective of the Tennessee Agricultural Experiment Station is to conduct investigations and experiments that bear directly on and contribute to establishing and maintaining a permanent and effective agricultural industry in Tennessee and in the United States.

These investigations are intended to deal with problems of agriculture in its broadest aspects as well as problems concerning the development and improvement of the rural home and rural life so that agriculture may make the maximum contribution to the welfare of the consumer.

Under these objectives, agricultural research makes contributions to broad segments of society: increased technology for producers; a bountiful supply of high-quality, reasonably-priced food for consumers; and increased opportunities for sales by industry of necessary production inputs such as machinery and fertilizer.

Agricultural experiment stations throughout the United States have these same general objectives which are part of the Hatch Act (as amended in 1955). This Act authorizes the appropriation of Federal funds to the states for agricultural research.

Solving problems of local significance is the responsibility of the Agricultural Experiment Station in each state. Several state stations and the United States Department of Agriculture often cooperate to study problems of regional and national scope.

Brief History of The Tennessee Agricultural Experiment Station

Agricultural research became a national concern in 1887 when the Congress of the United States passed the Hatch Act, which provided support for Agricultural Experiment Stations in each state. Tennessee had become interested in agricultural research before this time, however. The Tennessee Agricultural Experiment Station, established in 1882, was one of the first five in the United States.

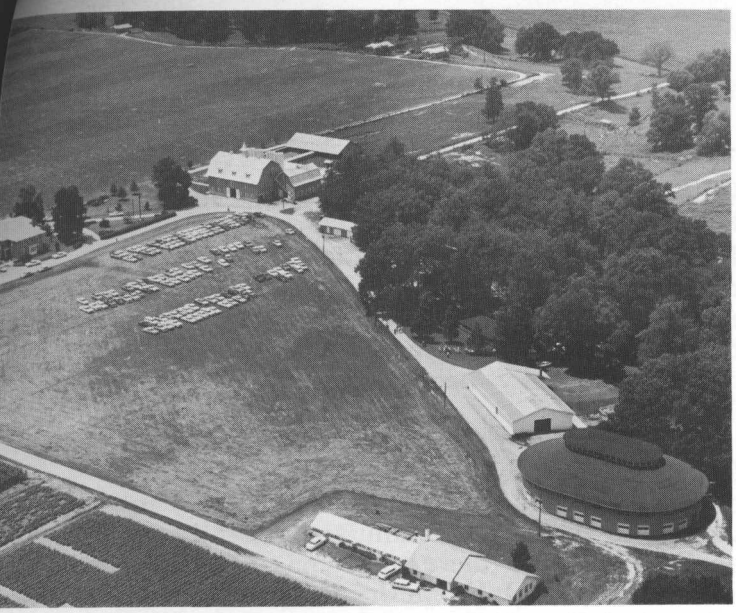
Many interesting developments preceded the creation of the Station, however. For example, during his tenure as President of East Tennessee University from 1853 to 1857, George Cooke recommended the establishment of a Department of Agriculture and appointed a committee to consult with the various agricultural societies. The Morrill Act, passed by the United States Congress in 1862, provided funds to establish a College of Agriculture in each state. In 1869 East Tennessee University was designated to receive the funds available under the Morrill Act and thereby became the Land-Grant institution in Tennessee. Ten years later East Tennessee University became The University of Tennessee.

The East Tennessee Farmers' Convention, founded in 1872, looked upon The University of Tennessee as its favorite meeting place. These visitors to the campus stimulated interest in the agricultural work there and some research was started in 1878. John McBryde joined the agricultural staff in 1879, and his development of the program in agriculture, including construction of the first silo in the state, received widespread recognition.

Thus by 1882 enough interest had developed so that the University Board of Trustees established an Agricultural Experiment Station to be devoted to research. In 1883, the Tennessee General Assembly provided financial support for the Station through fertilizer testing fees.

Even so, funds for research in agriculture were still small. However, the Hatch Act, passed by the U. S. Congress in 1887, provided $15,000 per year to each state for the establishment and operation of an Experiment Station. Money under this authorization first became available in 1888. The Tennessee Station, having been in operation for six years, was able to use the Hatch funds very effectively. Part of the money was used to construct an Experiment Station building, which was completed in time to host a national meeting of Experiment Station administrators in 1889.

As the Experiment Station program developed, field experiments were established throughout the state in cooperation with individual farmers. Research workers recognized that results of field experiments at Knoxville could not be applied to the entire state because of the great differences in climate, soils, and farming systems across Tennessee. The value of these outlying cooperative experiments was widely appreciated and efforts were made by groups of farmers to establish permanent research centers in several areas of the state. The first Branch Station was established at Jackson on land provided by Madison County in 1907. Another Branch Station was established at Columbia in 1918, on land provided by Maury



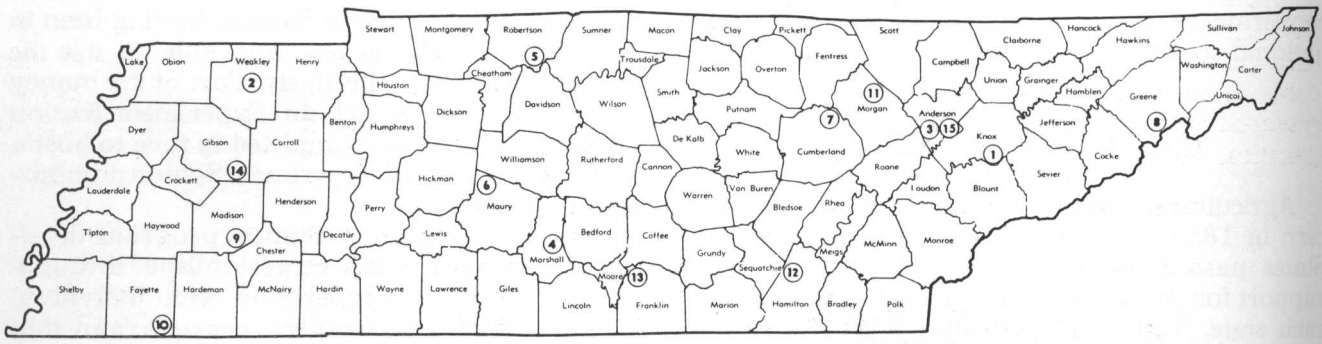
The West Tennessee Experiment Station at Jackson was the first Branch Experiment Station of The University of Tennessee. Land for the Station was provided by Madison County, in 1907.

county. Subsequently other outlying research centers were established and at present six Branch Stations and seven Field Stations are in operation (see map).

At the same time facilities at Knoxville were being expanded. Land for the present Agricultural Campus was acquired in 1869 and was used as the College farm. Morgan Hall was constructed on this farm in 1921 and laboratories of the Experiment Station as well as agricultural teaching and extension activities were transferred there from the Main Campus at "The Hill." Subsequently, additional buildings have been added at the Agricultural Campus and additional land for field research has been acquired near Knoxville.

Development of the research program received a boost during the late 30's and 40's with the establishment of Tennessee Valley Authority and subsequent initiation by TVA of an agricultural development program in cooperation with the State Experiment Stations in the Tennessee Valley.

The University of Tennessee Agricultural Experiment Station



1 Main Station
2 University of Tennessee at Martin
3 U-T/AEC Agricultural Research Laboratory

Branch Stations

4 Dairy Experiment Station
5 Highland Rim Experiment Station
6 Middle Tennessee Experiment Station
7 Plateau Experiment Station
8 Tobacco Experiment Station
9 West Tennessee Experiment Station

Field Stations

10 Ames Plantation
11 Cumberland Forestry Field Station
12 Friendship Forestry Field Station
13 Highland Rim Forestry Field Station
14 Milan Field Station
15 Oak Ridge Forest and Arboretum

Program of The Tennessee Agricultural Experiment Station

OVER the years the agricultural research program in Tennessee has been revised continuously in light of changing conditions.

There have been a number of outstanding accomplishments in the history of the Station. These accomplishments reflect credit on the scientists and the University and have made noteworthy contributions to the agriculture and economy of the state. A number of these contributions in the several fields of science are described briefly in this report.

As the problems facing agriculture have become more difficult in our complex society, research procedures to solve them have become more sophisticated than those of the past. Scientists are now more highly trained and specialized. Because of great specialization, some of today's problems, such as resource conservation or pollution control, require the bringing of the skills of several different specialists to bear in cooperative projects. Even more significant contributions than those of the past can be expected from the present capable staff. Some of the major current research activities of this staff are described under each field of science.

Research activities of the Station are carried out in the various departments of the Institute of Agriculture and the projects under way in each department are listed in the latter portions of this publication. For the purposes of this report, however, the work of the Station is described according to five general fields of agricultural science: Plant Science, Animal Science, Engineering Science, Social Science, and Food Science and Human Nutrition.

Animal Sciences

INVESTIGATION of problems in livestock production has been a part of the Station's program since the beginning. The first bulletin of the Station in 1888 reported work on cattle dehorning. Since then, a wide range of research has been conducted including breeding, genetics, feeding, pest control and physiology.

RESEARCH CONTRIBUTIONS

Animal Breeding

Dairy Cattle. A herd of high-producing Jerseys has been developed at the Dairy Experiment Station, Lewisburg, in cooperation with the United States Department of Agriculture. This

One of the highest producing Jersey herds in the United States has been developed at the Dairy Experiment Station at Lewisburg. This station is operated in cooperation with the U. S. Department of Agriculture.

herd has the highest production record of any Jersey herd in the United States in which the number of cows being milked exceeds 100.

A ten-year study in this herd indicates that, within the range of management conditions expected in Tennessee, sires whose progeny perform well in one environment would be expected to produce progeny which would perform well in other environments.

Swine. A rotational cross-breeding program was developed at Ames Plantation. With this program, litters were larger and pigs gained faster than with conventional breeding programs. The overall advantage ranged from 20 to 35 percent more pork per litter. Also, these crossbred pigs had less back fat, a desirable trait in today's market.

Mules. A major breeding and selection program for Jacks and Jennets to serve as breeding stock for mule production was carried out at the Middle Tennessee Experiment Station, Columbia, in cooperation with the United States Department of Agriculture. Good progress was made in the development of superior breeding stock until the project was closed because mules were being replaced by tractors. The closing of this project is an excellent illustration of the need for constant appraisal and revision of the research program to meet the needs of a rapidly changing agriculture.

PHYSIOLOGY

Photoperiodism in animals. S. Marcovitch found that the rosy apple aphid produced a generation with wings when exposed to a short daylight period (long nights). This was in contrast to the wingless generations produced under a long daylight period (short nights). His report on these experiments in 1925 was one of the first, if not the first, published evidences of a "photoperiodic" response in animals.

Recently, poultry have been subjected to varying periods of light and darkness to determine the effect on growth and egg production. Either continual darkness or continual artificial light produced an eye enlargement somewhat similar anatomically to glaucoma in humans. Alternating periods of light and dark during the usual 24-hour cycle prevented the development of this abnormal condition.

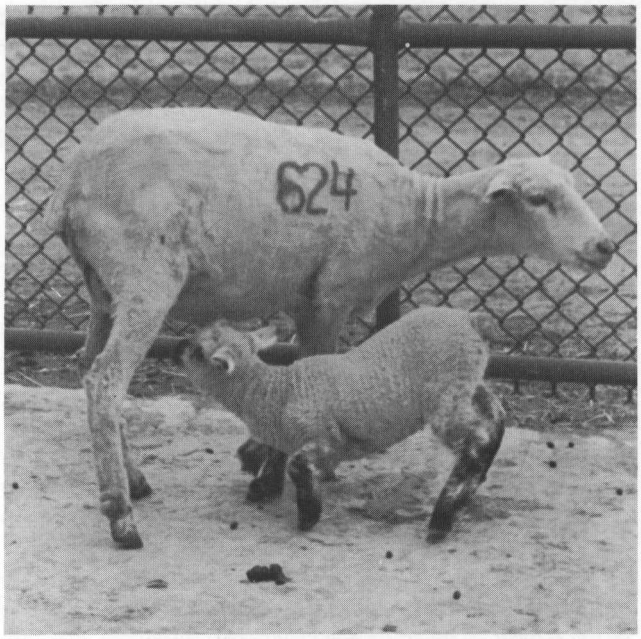
Cattle fluorosis. Certain soils in the state have unusually large amounts of fluorine in them. Also, fluorine compounds are present in the fumes from certain industrial operations. Cattle in such areas may take in enough fluorine through grazing to produce fluorosis symptoms, which are particularly noticeable on the teeth of young animals. With partial financial support of industry, exhaustive studies were undertaken in the late 1940's. Large numbers of plant, soil and feed samples were analyzed. Both young and mature cattle were fed calibrated levels of fluorine in the barn, and were maintained in pastures where the fluorine levels were continuously monitored. Levels of maximum intake without producing fluorosis symptoms were determined for young and mature animals under conditions of confined feeding and of grazing. Several bulletins were published to record the definitive results, including colored photographs of cattle teeth. The findings have been used nationwide to set recommended tolerances for fluorine intake.

Radiation damage to the developing embryo (in cooperation with the Atomic Energy Commission). Pregnant animals of several species, including rats, sheep and cattle, have been subjected to ionizing radiation at various times

These cattle were irradiated when they were 18 months of age to study the effects of radiation on their reproductive performance. Now 11 years old, they have not shown any marked effects of this radiation.

during gestation. This work at the UT-AEC Agricultural Research Laboratory has led to a better understanding of the sensitivity of the developing embryo to radio-biological damage. The particular time in the gestation cycle when the radiation is applied determines the kind of damage that will result. These critical periods for radiation damage coincide with the critical periods for other types of stress, such as chemical treatment. For example, stress applied before the fertilized egg is implanted in the uterus may result in loss of the embryo. During the period of development of the organs, the result can be a deformity, the nature of which will depend on the stage of the gestation cycle.

Mineral metabolism of chicks (in cooperation with the Atomic Energy Commission). Using radioactive isotopes to trace movement, scientists have studied how the balance and levels of minerals in the diet affect the uptake of selenium, calcium, cobalt and strontium. A better understanding of the mineral uptake by poultry and other classes of livestock should lead to more efficient feeding practices.



Work at the UT-AEC Agricultural Research Laboratory has led to a better understanding of the sensitivity of the developing embryo to radio-biological damage. The particular time in the gestation cycle when the radiation is applied determines the kind of damage that will result. The ewe shown here was irradiated on the 23rd day of pregnancy, resulting in damage to the forelegs of her one lamb.

Animal Feeding

Annual Experiment Station reports of the 1890's and later describe performance of cattle fed various rations. This work has been continued and expanded in order to evaluate new crops and new ways of harvesting and storing forages. Also the market demands for livestock have changed and require changes in feeding procedures.

Pastures for cattle. Much of the land in Tennessee is rolling and not well suited to cultivated crops, thus making long-term or semi-permanent pastures important sources of forage.

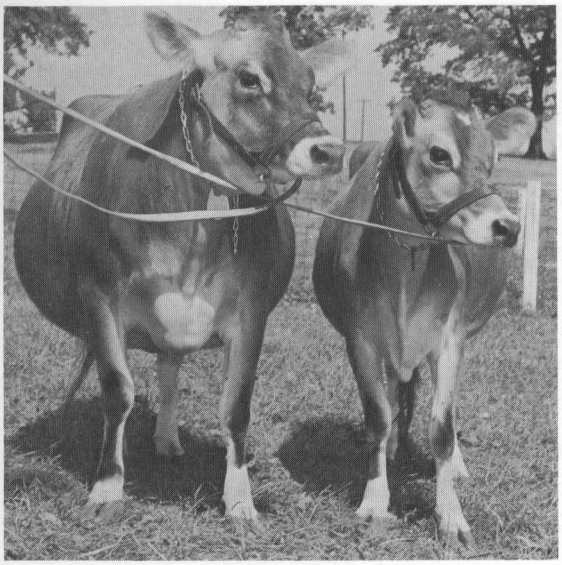
A large amount of work has been done to evaluate bluegrass, orchardgrass and tall fescue, alone and in combination with clover for beef cows, steers and dairy cattle. One important finding has been the close correlation of clover in the pasture mixture with cattle performance. Performance improved as the proportion of clover increased up to 40 and 50 percent of the pasture mixture.

Forages for dairy cattle. As the level of milk production of a cow rises, "quality" of pasture and forage in the ration becomes increasingly important. Extensive evaluation of forages has been done at several locations with high-producing cows. Milk production improved when low-moisture alfalfa or grass silage was used to supplement corn silage. The studies also showed that the stage of maturity at harvest had a great effect on the quality of hay, green chop and grass silage. When harvest is at a late stage of maturity, forage quality is reduced which results in a decrease in the amount the animal eats; consequently milk production drops.

Feed requirements for lactation. Research has shown that, even with high levels of milk production, energy requirements can be met more efficiently by feeding good forages free-choice, supplemented liberally with concentrates, than by restricting forage intake in order to increase concentrate consumption.

A minimum of 18 percent protein in the concentrate mix was needed when corn silage was the only forage fed to milking cows. Additional vitamin A above the minimum level required to support reproduction was not needed for milk production.

Feeding levels for raising dairy herd replacements. The rapid turnover of milking animals in the herd makes the raising of replacement heifers an important part of an efficient dairy program. The effect of feeding practices on developing the full lactation potential of the heifer was studied for several years. (Many animal studies require several years because of the long reproduction cycle). Identical twin calves were used for some of these studies so that the feeding practices could be evaluated more accurately. Very liberal feeding often resulted in poor development of the mammary glands because of the deposition of fatty tissue.



These two Jersey heifers are identical twins. The large, fat heifer, typical of others in the experiment, produced less milk in the first two lactations than her twin which was grown at a moderate rate.

Availability to cattle of iodine from different compounds (in cooperation with the Atomic Energy Commission). The need to add iodine to the diet of farm animals in certain areas is well known. Usually, supplemental iodine compounds for cattle have been added to salt. Several years ago, 3,5-diiodosalicylic acid (DIS) was highly recommended and extensively used for livestock because of its stability under field conditions. Work at the UT-AEC Agricultural Research Laboratory, Oak Ridge, using simultaneous within-animal comparison of the ^{131}I and ^{125}I labeled compounds demonstrated that the nutritional availability of iodine from DIS was only 20 percent of that of iodine from sodium iodide. As a result of this work, the use of DIS in salt for cattle was discontinued. Subsequent work at Oak Ridge showed that another iodine compound, pentacalcium orthoperiodate, combines the physical stability of DIS with the nutritional availability of sodium iodide. Iodized salt containing pentacalcium orthoperiodate is now on the market.

CURRENT RESEARCH

The growing consumer preference for leaner meat is expected to continue. Rising production costs will make efficiency in animal production a matter of increasing importance. Both of these needs are already being reflected in the direction of animal research at Tennessee.

Animal breeding. Emphasis in selection of swine is on "meatiness"; in beef cattle, it is on rate of gain after correction for fat accumulation. In dairy cattle, the current emphasis is on determining the maximum progress possible by selecting for milk production only, and what problems may develop under such a program.

Animal feeding. The levels of protein and energy required for optimum performance are being re-evaluated for beef and swine. The "meatier" type of animal may require a higher protein-energy ratio than was recommended for the fatter types. More emphasis is being given to use of less expensive protein substitutes such as urea in both beef and dairy cattle rations. Study has begun to determine the optimum time to market slaughter beef animals in terms of total feed cost for both dam and offspring. Research is continuing on the evaluation of pasture and other forages for cattle. Factors limiting voluntary feed intake of lactating cows are being studied as possible causes of restriction of milk production.

Physiology. A better understanding of the physiological processes that affect animal metabolism, growth and reproduction is being sought. The following studies are providing information that should lead to better management practices and more efficient livestock production.

A major problem in economical beef and milk production is maintaining an efficient reproduction rate. Causes of reduced cow fertility and ways to increase conception and calving rates are being studied.

Imbalance of minerals in the ration may be an important factor affecting reproductive performance of animals. Basic studies of mineral nutrition of swine during gestation have been started. The minerals needed in trace quantities are receiving special emphasis, using radioisotope techniques.

The relation of iodine metabolism to thyroid activity and milk secretion is being explored.

Full development of the mammary gland has shown to be a requisite for maximum lactation. This does not always occur. A project to determine the relationship of pregnancy and the associated hormones to mammary gland development is being started, in an effort to establish the fundamental causes of some of the variations in initial stages of lactation.

Research is underway on the causes and effects of "cage layer fatigue" of hens. Density of the leg bones is being measured "in vivo" (in the live animal) with a special densitometer, in order to follow the skeletal changes under selected dietary regimes. Also research is continuing on the photoperiodic response of chickens, described earlier.

The physiologic effects at the cellular level

induced by a deficiency of vitamin E and by selected levels of phosphate insecticides are being studied with the use of rats.

The effect of restricting total feed intake during growth and after maturity is being studied, using rats. The restricted diets are adequate in regard to protein, minerals and vitamins. Longevity and kidney function will be the criteria used. Results may prove suggestive for regulation of human diets.

Food Science and Human Nutrition

AS agriculture has grown from the more or less direct selling by farmers to consumers to an industry having specialized segments such as production, processing, distribution, etc., scientists have been giving attention to problems in areas other than agricultural production.

One such area of research at the Tennessee Agricultural Experiment Station is that of food science and human nutrition. Food scientists concern themselves with such problems as processing of plant and animal products for human consumption; consumer acceptance of foods produced or prepared in different ways; and nutritional requirements of people.

RESEARCH CONTRIBUTIONS

The presence and significance of streptococci in foods during processing. The presence of the streptococci class of micro-organisms in food products has been regarded as evidence of human contamination. However, in a Tennessee study, streptococci were found in processing plants in cases where it seemed very unlikely they could have been from human sources. This finding prompted research to learn whether these organisms could be found on the growing crop and on wild plants. The study showed that in isolated areas, such as the Great Smoky Mountain National Park, where no human source of contamination was present, streptococci were found in a significant number of cases. The same was true in field crops being grown where human contamination seemed very unlikely. These findings question whether these organisms can be considered as indicators of contamination in food processing plants. In the course of the study, a number of new strains of streptococci were also identified and characterized.

The effect of cooking temperature on the tenderness and palatability of beef and pork roasts. Roasts were cooked at conventional oven temperatures and at temperatures as much as 100° lower than conventional. The roasts were brought to the same internal temperature which meant that those cooked at the lower temperatures required a considerably longer time in the oven. However, a taste panel found these lower temperature roasts of both beef and pork to be more tender and more juicy. (Taste panels made up of men and women are often used in evaluation phases of food studies). Total electric energy consumption for cooking was about the same at either temperature.

Factors affecting mineral requirements of children and adults. Studies were begun some years ago with college-age women to determine the mineral balance in their bodies at various levels of mineral intake and in relation to different levels of protein in what they ate. In cooperation with other state experiment stations in a regional nutrition project, the work was expanded to include pre-adolescent children. Findings showed that the level of any one mineral needed to maintain physiological balance varied not only by age group but also with the level of other minerals and protein in the diet.

With this special instrument, a bone densitometer, nutrition scientists are developing normal standards for bone density in children and young adults. Aim of this work is to learn more about mineral requirements and how mineral nutrition is related to bone structure.

Eating quality of meat from different breeds and crosses of cattle. A seven-year study supervised by J. W. Cole involved 171 steers representing eight breeds and breed crosses from British, zebu, and dairy types of cattle. Taste panels found little difference in the quality of

meat from Angus, Hereford, or Jersey steers, in spite of the much smaller amount of marbling in the meat from the Jerseys. Meat from steers of zebu parentage or from crosses including zebu animals was significantly less tender. Interest in the results of this study has been worldwide and the World Association of Animal Production asked to have this work reported at its conference.

Improved quality of dairy products. Tennessee consumers have better tasting and higher quality milk and cottage cheese as a result of the application of research discoveries on the milk lipase system, on the development of psychrophilic bacteria which can grow at refrigeration temperatures, and on the relationship of calcium to cooked flavors.

Methods were developed in Tennessee for removing radioactive materials from milk without decreasing its nutritive value, and when applied at other laboratories resulted in a system that would be commercially feasible if the need should ever arise.

Fatty acids in food. Deep frying procedures as used in the laboratory and as observed in food service systems resulted in minor changes in frying fats and in the lipids extracted from fried foods. Re-use of fat decreased polyunsaturated fatty acids with greatest changes in oils of highest degree of polyunsaturation.

CURRENT RESEARCH

How to process and use the abundant supply of food products to assure adequate nutrition with a tasty and appealing diet for our citizens is a continuing challenge.

Quality of frozen vegetables. New varieties which are superior in yield, disease resistance or adaptation to mechanical harvest, may not always give a frozen product of high quality. Samples from the regular variety trials are processed and the frozen product evaluated for consumer acceptance.

Blanching of vegetables by microwave, hot water, and combinations of both is being studied to develop procedures that will give higher quality frozen products.

Quality of dairy products. Desirable cheddar cheese flavor depends on the type of fermentation used in cheese curing. Current work is directed toward developing cultures and techniques which will enhance the production of this flavor. Studies are underway to improve flavor and keeping quality of cottage cheese so that people will want to eat more of this protein-rich food.

Fortification of milk. Whey, a by-product of cheddar cheese manufacture, is high in lactose. The effect on consumer acceptance of adding small amounts of lactose which is recovered from whey to regular and skim milk is being studied.

Anemia due to inadequate iron in the diet is fairly widespread, particularly among children under five. Scientists are seeking ways to add iron to milk without affecting flavor and palatability.

Mineral requirements. Work continues concerning calcium, magnesium, phosphorus and other mineral requirements of young adults, including pregnant women. The bone densitometer, a special instrument developed at Tennessee, is being used to relate mineral nutrition to changes in bone structure.

Palatability of meat. How does the amount of fat in roasts, steaks, and ground meat affect consumer acceptance? The cooked products are being analyzed for fat content and the results related to scores given by taste panels.

Radiation effects. Soybeans, rice and other unprocessed foods are being exposed to radiation in an electric discharge tube. The treated materials are being analyzed to determine what changes are produced in composition that might affect nutritive value.

Cooking properties of elaidinized fats. "Unsaturated" fats tend to be liquid at room temperature. Certain chemical treatment (elaidinization) will cause these fats to solidify without altering their "unsaturation." How these treated fats affect quality of food products when they are used as shortening or as frying fat is being evaluated.

Engineering Science

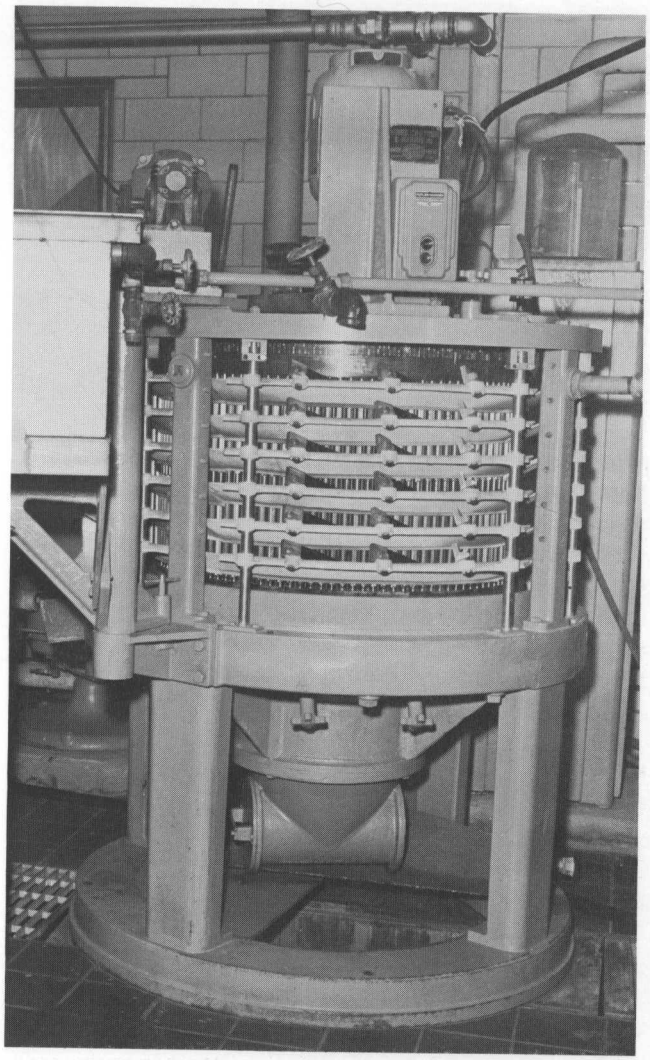
ENGINEERING SCIENCE has been brought to bear on a great range of problems in research programs of the Agricultural Experiment Station. One of the most striking changes in agriculture since the founding of the Experiment Station has been the replacement of humans and animals with machinery. In agricultural research, studies have included design and construction of farm buildings; development, evaluation and opera-

tion of farm machinery; handling of feed, fertilizer and harvested crops on the farm; waste disposal; drainage, land grading and reservoir development; development and operation of instruments and equipment for evaluating both natural and processed farm products.

RESEARCH CONTRIBUTIONS

Measurement of cotton fiber properties. Traditionally, the length and quality of cotton fibers have been estimated by the cotton classer as he examined the bales at the market. In the mid-1930's Kenneth Hertel and his colleagues began work on instruments to give a quantitative measure of cotton fiber length, as well as strength and fineness. The instrument for cotton fiber length, the "Fibrograph," was developed first, and has been modified several times to reach its present design. Now produced commercially, it is widely used throughout the world. This work also resulted in the development of two other instruments; the "arealometer" measures fiber fineness and maturity and the "stelometer" measures fiber strength. These three instruments are making a major contribution to the systematic marketing of cotton.

This computerized production fibrograph measures the length of a cotton specimen in less than 10 seconds. The measurement is presented visually and is also printed on tape. The instrument shown here is an advanced development from an initial instrument developed in 1933 by Dr. Kenneth Hertel at the Agricultural Experiment Station, which determined fiber length from seed cotton. This model now allows the industry to have length information on all samples in both marketing and processing as desired.



This machine, developed by a University of Tennessee agricultural engineer, removed the caps from strawberries mechanically at processing plants. It was used successfully to remove caps from berries with extended calyxes, the type of berry for which it was designed. Most varieties currently being grown have recessed calyxes and are not adapted to the capper.

Strawberry capper. A machine was developed and patented which will remove the calyx from strawberries mechanically at the processing plant. The conventional procedure has been, and in many places still is, to have the picker remove the caps in the field. This slows picking and also gives more opportunity for the berry to spoil between picking and delivery to the processing plant. The strawberry capper works successfully only on varieties in which the calyx, or cap, is not recessed into the top of the berry. The capper was made commercially for a period, but it is not widely used now because many of the strawberry varieties now being grown have a recessed calyx and are not adapted to the capper.

Many Tennessee farmers must rely on ponds for water supply, but leakage is a frequent problem. Agricultural engineers have improved methods for treating floors of these ponds with chemicals to prevent leakage (above). The effectiveness of the seal on this pond had not decreased 6 years after treatment (below).

Pond sealing. On many farms in Tennessee wells are expensive to drill and frequently do not provide enough water for farm needs. Thus, ponds are very common in the state. Many of these ponds leak and the water runs out in dry periods when it is most needed. By using certain sodium compounds during the preparation of the pond bottom, this leakage has been prevented. This method was used successfully in ten experimental ponds and should be useful to farmers who have a leaky pond.

The hose pump. One of the first hose pumps to be used in farming operations was developed by H. A. Arnold at Tennessee. This kind of pump is particularly well adapted to handling corrosive liquids, such as liquid fertilizer. Previously, pumps used in agriculture were entirely metal.

Application of low volumes of pesticides with ground equipment. Spraying crops with ground equipment requires large volumes of water, measured in tens of gallons per acre. Spray nozzles that apply as little as one pint per acre by airplane were adapted to ground equipment in work begun several years ago in Tennessee. This equipment has been used successfully to apply as little as a quart per acre of undiluted pesticide.

Bone Densitometer. In early animal and human studies, attempts were made to evaluate the calcium and phosphorus status of the body by "in vivo" (in the living organism) measurement of bone density using X-ray film. While this method showed promise, small variations in density could not be measured using available equipment. Investigators then designed an instrument using a radiation counter as a detector. By coupling the detector to a recorder, they were able to obtain an absorption curve directly, from which the calcium and phosphorus status could be inferred. The instrument eliminated the use of film which had inherent variations because one batch of film might be different from another. It also gave greater accuracy and reproducibility and reduced the amount of radiation to which the subject was exposed. This work was supported in part by grants from the National Institute of Health and the National Aeronautic and Space Administration.

Evaluation of textile performance. Durable press fabrics consisting of different proportions of cotton and polyester fibers were made into shirts and used by a test panel of men. The reaction of the test panel indicated that those fabrics with relatively high proportions of cotton were more comfortable than those with high levels of polyester fibers and maintained equally good appearance while they were being worn.

CURRENT RESEARCH

The increasing cost and scarcity of farm labor will encourage the mechanization and streamlining of as many farming and processing operations as possible. Any research results that will increase efficiency and reduce costs will be welcomed by farm operators and agricultural processing plants.

Application of pesticides. Work on improving equipment for applying very small volumes of chemicals is continuing. For instance, imparting an electric charge to spray particles as they leave the nozzle should cause better adherence of the pesticide to crop and insect. If this is successful, perhaps lower rates of the active ingredient could be used for effective control. Lower rates would reduce chances of soil contamination.

Evaluation of cotton production systems. Scientists are studying how reducing total oper-

ations in seed bed preparation and planting affects cotton growth and yield under different soil conditions. Mounting several implements on the same tractor to reduce travel over the field and eliminating "bedding" (plowing in narrow lands) are examples of treatments being used.

Two different types of harvesting machinery, the "stripper" and the spindle picker, are being compared to learn how each affects yield and quality of lint. The major varieties grown in the state are being used in the tests.

Waste disposal systems. As dairy herds have grown larger, the sanitation problem around the milking parlor has become more complex. The design and operation of manure holding pits are under investigation at several branch Experiment Stations as well as at the Main Station. Results from this work should also help solve waste disposal problems at cattle feeding lots.

Watershed studies. Small experimental watersheds equipped with measurement devices have been established at twelve locations in the state. Data are being collected to determine how soil properties, plant cover, cultural practices and rainfall patterns affect water yields and erosion.

Fiber and textile evaluation. In cooperation with the United States Department of Agriculture, Tennessee research workers are studying properties of fibers (cotton and other kinds) thought to be significant in fiber processing and textile performance. In order to carry on these studies, it is first necessary to design instruments for measuring these properties rapidly and accurately. In many research projects, the design of necessary measurement devices is the first problem the researcher must solve. Other fiber research is evaluating certain flame-retardant finishes on cotton blends of certain apparel fabrics.

Remote sensing. The acquisition of an airplane equipped with devices which measure radiation from the land surface at different wave lengths has made possible the start of research on a new way to determine land use and productivity. This method is called remote sensing. Work is under way to learn whether the radiation data obtained from this remote sensing procedure can help determine soil differences, crop differences, incidence of crop disease and other factors of the landscape which relate to land use and productivity.

The Plant Sciences

AMONG the earliest agricultural experiments carried out at The University of Tennessee was a series of field experiments with wheat from 1879-1882. The success of these experiments and of some experiments in livestock feeding led to the establishment of the Agricultural Experiment Station as a separate department of the University in 1882. In 1883, the Tennessee General Assembly required the Station Chemist to make analyses of fertilizers for the State Department of Agriculture.

Research in the plant sciences has continued to be a major part of the Agricultural Experiment Station program since that early start. Presently, the field of plant sciences is concerned with problems relating to fruit, vegetable and field crop production. Cultural practices, varieties, soils, fertilization and plant pest control are examples of these problems.

RESEARCH CONTRIBUTIONS

Crop Improvement

Variety evaluation was one of the first activities of the Experiment Station. Today the annual publication giving the results of the crop variety trials has by far the greatest circulation of any Experiment Station Bulletin. Over the years, the work has been expanded to include more varieties of more crops and the procedures changed to give more precise results. This program has given producers of all kinds of crops in Tennessee a steady flow of information about relative adaptation of both new and standard varieties to changes in diseases, fertilization, market demand and harvesting.

Corn - In 1919, the Station Report stated that Neal's Paymaster was the outstanding variety being grown in Tennessee. In 1927, L. S. Mayer initiated an intensive breeding program in cooperation with the United States Department of Agriculture. In 1939, Tennessee 10, the first high-yielding white hybrid adapted to the South was released. F. D. Richey was Mayer's successor and the work still continues. A number of superior hybrids have been developed, some with high resistance to corn virus diseases.

Tobacco - Several outstanding Burley varieties have been released as a result of cooperative research between Tennessee and the United States Department of Agriculture. Burley 21, the

first variety resistant to both wildfire and mosaic, has been widely grown throughout the Burley belt in the United States and Canada. Burley 11A and 11B were the first varieties having resistance to black shank. Other superior releases include Burley 1, 2, 37, and 49. Currently, breeders are selecting lines for multiple disease resistance, high leaf quality, and desirable chemical composition. Work to improve varieties of dark tobacco is also underway. Two varieties have been released, DF-300, which has resistance to black shank, and DF-516, which has resistance to mosaic and wildfire.

Small Grains - The mild winter temperatures of Tennessee are favorable to winter grain crops and Tennessee plant breeders have developed a number of varieties for Tennessee farmers to grow. Balbo rye, released by C. A. Mooers for growing in 1933, is still the most widely grown variety in the Mid-South area. Forkedeer oats, developed by N. I. Hancock, was released in 1939. It, too, is still grown because of its winter hardiness. Other varieties developed by Hancock include Tennex, Fulwin, LeConte, and Blount oats, and Holston and Watauga barley.

Soybeans - The Ogden soybean was released in 1939. H. P. Ogden selected it from a cross between Tokyo, a current variety then, and a plant introduction from the United States Department of Agriculture. This variety proved to be adapted for production throughout the Mid-South and was widely grown for several years because of its superior productivity.

Strawberries - Brooks Drain and his associates developed the Tennessee Beauty, a variety well adapted to Mid-South conditions. It has been a popular variety in Tennessee and nearby states.

White pine - This species is valuable both for timber and as a Christmas tree. However, its growth and its color are adversely affected by atmospheric pollutants occurring in various areas of Tennessee and other states. Some trees show resistance to air pollution, however. Scientists are grafting cuttings from these trees onto rootstocks and growing them in an area with significant air pollution. These grafted trees are now producing small amounts of seed for further testing and for ultimate use by the State Division of Forestry to produce resistant white pines for the land owners of Tennessee.

Mutations induced by irradiation - Mutations in plants can increase the variations available to the breeder for later selection and backcrossing. In cooperation with the Atomic Energy Commission, investigators are seeking the best procedure for inducing mutations in seeds. Radiation is also being used to produce bud sports which can be propagated vegetatively. Vegetative mutations are particularly useful with ornamental plants where variations in color and size of flower and leaves may produce plants more desirable for the market.

Irradiation is being used to produce variations in color and size of plant flowers and leaves as shown by these forsythia bud sports. The upper two plants are semi-dwarfs, the center plant is a full dwarf while the plant at lower left is normal.

Predicting seed damage from irradiation. In cooperation with AEC, a study was made of the amount of cell damage suffered by different species of seeds subjected to gamma and neutron irradiation. Microscopic examination revealed that the degree of damage was proportional to the volume of the cell nucleus. This information increases the reliability of predicting the level of radiation to use in irradiating seeds in order to produce the optimum number of mutations.

CROP PROTECTION

Control of nematodes — As early as 1889, the Tennessee Station reported studies of the potato nematode. Work has been continuing with other crops to obtain more information and develop control methods for these microscopic worms which are shaped like eels. Scientists have found a promising control method by adding relatively large quantities of oat straw, alfalfa hay, and other crop residues to surface soils. This procedure has reduced nematode populations significantly, but it may be useful only in specialized truck crop or garden areas on a practical basis. However, it may point the way to other nonchemical ways of controlling this very injurious group of pests.

Insect control—The use of cryolite (sodium aluminum fluoride) to control the Mexican bean beetle was proposed by S. Marcovitch in 1923. It proved very effective and went out of use only when the newer synthetic insecticides became available.

Cultural Practices

Cultivation of corn–As early as 1914, C. A. Mooers reported experiments which showed no benefit from the cultivation of corn except as it helped control weeds. This was a surprising conclusion because deep cultivation of crops to conserve moisture and increase crop growth was widely recommended at that time.

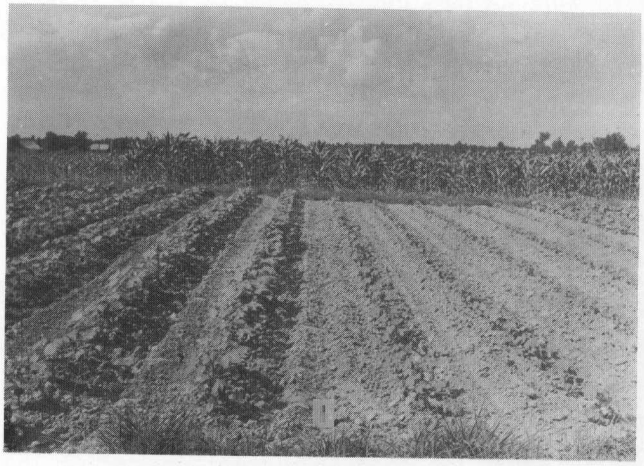
Corn population in relation to yield–During the period of 1909 to 1918, C. A. Mooers carried on some experiments in which he related the plant population to the expected corn yield. He concluded that there should be approximately 100 plants per acre for each bushel of expected yield. This is close to the current recommendations and was contrary to the generally accepted rate of planting in the earlier years when populations often were less than 5,000 plants per acre.

Soils

Soil inventory of Tennessee–In 1897 C. F. Vanderford wrote a bulletin on the soils of Tennessee which was a classic for that period. It contained detailed profile descriptions and chemical analyses of the several horizons for the major soils of the state. Later, much effort was given to an inventory of the soils of the state. This work was in cooperation with the Tennessee Valley Authority, which wanted detailed soil maps of the Valley area to use with its development program. A large field survey staff worked for a number of years and mapped many of the Valley counties in detail. Since termination of the Tennessee Valley Authority support, an aggressive soil survey program has continued in cooperation with the United States Department of Agriculture. There are probably as many, or perhaps more, up-to-date county soil maps available for Tennessee than for any other southern state.

Soil Fertility Studies

Lysimeter studies of mineral losses–In 1909, C. A. Mooers initiated a study with a research installation called a lysimeter. This is a device for measuring the percolation of water through soils and determining the soluble constituents removed in the drainage. When W. H. MacIntire joined the staff in 1912, he took over this research and expanded the installation considerably. Information gained from the careful measurement of the mineral outgo in the lysimeter leaching water was some of the earliest ever obtained on the addition of sulfur to the soil in the rainfall, the rate of potassium outgo from limed and unlimed soils, the rate of calcitic and dolomitic limestone reaction in acid soils, and the rate of nitrification of organic matter. These extensive studies continued for a long period of years and became widely known throughout the world.



Phosphate is needed as a fertilizer on perhaps 90% of the agricultural soils of Tennessee. The response that crops will make to an application of phosphate is illustrated here by this research photo of cotton on a Lawrence County farm. Both plots received equal amounts of nitrogen and potash but the plot on the left received an appropriate amount of phosphate.

Crop response to fertilization–In cooperation with Tennessee Valley Authority, many statewide field experiments were established to answer a wide range of questions relating to fertilizer usage such as the relative efficiency of the different phosphate fertilizers. Other experimental treatments used were aimed to produce information for obtaining optimum yields under various soil conditions. Soil samples collected from these plots were tested in the laboratory for the so-called "available nutrient content." Because these field experiments continued for several years and under a great range of seasonal weather conditions, they have produced basic information for making sound fertilizer recommendations. These data serve as the basis for interpreting tests of soil samples sent in by farmers. In addition, these extensive field experiments laid the groundwork for determining the need of corn for zinc in certain soil areas of the state and the need of alfalfa for borax.

Shade tree fertilization–Fertilization experiments with several species of shade trees have yielded some very significant results. Under most soil conditions, the trees seem to respond

Fertilization experiments with several species have shown that under most soil conditions the trees seem to respond more to nitrogen than any other nutrient. The 8-year-old pin oak tree in the foreground received the equivalent of 120 pounds of nitrogen per acre each year. Compare the size of this tree with those in the background which did not receive any nitrogen.

more to nitrogen than any other major nutrient. Tree growth has more than doubled in many cases and the form of the fertilized trees is just as good as that of the unfertilized trees.

CURRENT RESEARCH

Crop Improvement

The Tennessee Station is maintaining a broad program for developing improved varieties of forest trees, field and vegetable crops and ornamentals. Modern plant breeding techniques, including the use of radiation and chemicals to produce mutations, are used in this program. For most crops, improving yields ranks high in research priority, but researchers are now giving more attention to market preferences, adaptation to mechanization, resistance to pests, and capacity to respond favorably to high fertility levels. Using improved varieties is one of the most effective ways farmers can reduce unit production costs.

Crop Protection

It is not possible to produce many crops economically without using herbicides, fungicides and insecticides. As new pesticides become available, scientists are evaluating their effectiveness under Tennessee conditions. These workers study the effect of herbicides on the physiology of both the crop and the target weed in order to develop better methods of use. Also being measured are the amount and persistence of any pesticide residues in crops and soils.

Physiology

Mechanical harvesting of a crop is usually a once-over operation. Ideally, the crop should mature all at one time. In an attempt to control maturity, plant scientists are applying plant growth regulators to such crops as tomatoes and peppers. In other experiments, these regulating chemicals are being used for the control of form and size of ornamental plants.

Cultural Practices

Minimizing the number of tillage operations is one way to reduce the cost of producing a crop. Various minimum tillage programs, including seeding the crop directly in sod, are under investigation to learn whether they can be used in Tennessee.

Other research is relating yield and quality of crops to such practices as plant population, row spacing, and row direction.

Turf. Turf is an important part of the environment around homes, parks, public recreational areas, playgrounds, and golf courses, and comprehensive research is underway to determine how various turf species are adapted to Tennessee. Cutting height, fertilization, watering, and pest control are among the management problems being studied.

Ecology. Tennessee scientists are measuring the microclimate (climate immediately surrounding the plant) as part of a study to determine how various environmental factors influence plant growth. Soil temperature and moisture at the soil surface and at various depths under different types of plant cover influence germination, early growth, and root development. More precise information on critical periods in the growth cycle should result from this work.

Soils

Formation and classification of Tennessee soils. Both field and laboratory studies are in

Continued on page 25

Work of the Agricultural Experiment Station in cooperation with industrial plants relating to the effects of air-borne fluorides on both plant and animal life has been very significant.

These pictures show some effects of such fluorides upon forages. Panel A shows results of experimentally applied hydrogen fluoride vapor; and B and C show the dying condition of corn leaves in the vicinity of industrial operations formerly emitting fluorides. Relating the injury to plant symptoms was instrumental in bringing pollution under control.

These two sets of tomatoes came from plants of the same age. Plants which produced the set on the right were treated with a chemical four weeks before the photo was taken. This chemical hastened maturity and ripening and could help commercial growers have tomatoes ready for earlier marketing.

The yellow streaks in this field of dark fire-cured tobacco show where black shank disease has damaged a commonly-grown but susceptible variety. Not affected by black shank and appearing here as dark green between the yellow streaks is a new resistant variety DF-300, developed by The University of Tennessee.

The difference in growth of these two varieties of soybeans illustrates what scientists can do in developing crop varieties that are resistant to plant pests. These plants were growing on soil infested by the soybean cyst nematode, a microscopic eel-like pest. The vigorous, thriving plants on the left are resistant to nematode attack. Those on the right are not, but are of a variety that does well where nematodes are not present. This resistant, late-maturing variety was developed cooperatively by the U.S. Department of Agriculture and the Tennessee Agricultural Experiment Station. Another resistant variety that is early-maturing was also developed in this joint research effort.

By using chemicals as well as cultivation to control weeds, cotton growers have nearly eliminated the need for hand labor. In experiments like the one shown here, Agricultural Experiment Station scientists evaluate these chemicals to determine which ones are suitable for use and what rates of application are most effective.

Pollutants in the atmosphere affect the color and growth of white pine as the bottom photo shows. Note that the tips of the needles have turned brown. Some trees, like the one in the center photo, show resistance to this pollution. Scientists have identified these trees, grafted cuttings from them on to rootstocks and are growing these grafted trees in a breeding orchard. Seed from these trees will be used to grow seedlings which will then be planted in areas where air pollution is a problem.

An effective attack upon one serious problem of atmospheric pollution was begun by the Agricultural Experiment Station some 20-odd years ago; and through cooperative action with industry, the problem has been greatly reduced.

This was the problem of atmosphere-borne fluorine, which escaped from certain manufacturing and processing operations. The studies centered upon fluorosis (fluorine poisoning) of livestock in areas surrounding certain industrial operations. As a result of the studies, means have been devised to reduce the pollution to a minimum.

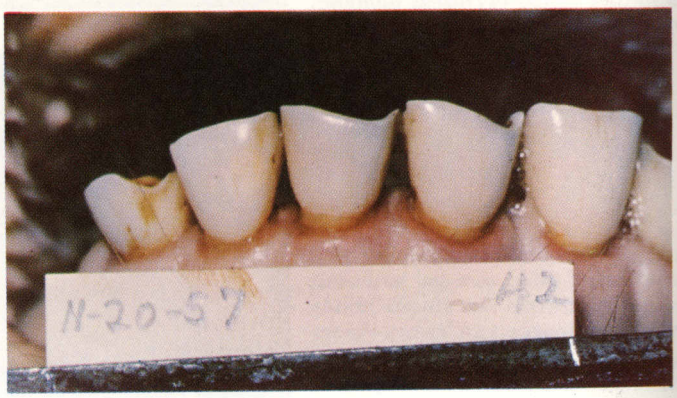
These pictures show the effects of different levels of fluorine upon the teeth of livestock.

The top picture shows teeth of Cow No. 42, which was fed daily a normal ration containing 7 parts per million of fluorine. The pictures were made in 1952, when the cow was five years of age (left); and in 1957, (right) when the cow was 10 years of age.

Teeth pictures of Cow No. 48 were taken at the same ages; but this animal received the normal ration plus 30 parts per million of fluorine (total of 37 ppm fluorine.)

The two lower pictures show the teeth of Cow No. 2, at the same intervals and ages as the other animals. This cow, however, received the normal ration plus 70 ppm of fluorine, or a total of 77 ppm.

COW NO. 42



COW NO. 48

COW NO. 2

progress to provide more knowledge for making effective use of Tennessee soils. Field studies encompass soil type distribution and profile characteristics, while laboratory work includes a comprehensive evaluation of chemical, physical and mineralogical properties.

Fertilization practices. Chemical properties of soils are being related to fertility levels and to how the fertilizer needed for optimum production of quality crops can be added without causing water pollution.

Pesticide residues. Relationships of soil properties to variations in the retention, loss and degradation of insecticides and herbicides by soils are under investigation.

Management practices. Tillage operations and structural changes under selected cropping systems are being related to physical soil properties.

Data on water consumption of selected crops, the water-supplying capacity of soils and seasonal probability of rainfall are being used to develop optimum soil management systems in major areas of the state.

The Social Sciences

FARMERS and their families are not concerned only with the physical aspects of producing food and fiber. They must live in and produce for a complex society in which a great number of individuals and human institutions have important interrelationships with agriculture.

The field of social science is concerned with problems of these interrelationships, and research dealing with such problems has been a part of Experiment Station work for more than 50 years.

Examples of Agricultural Economics problems under study are farm management, farm credit, agricultural marketing and agricultural policy. In Rural Sociology, research covers such problems as population changes, farm labor, rural social institutions and rural families. Much of the early social science work at Tennessee was to accumulate and organize background data describing the physical, human and institutional resources of the state. This background of data served as a basis for later work in developing alternative methods of organizing and utilizing the resources, and for explaining and understanding the direction of agricultural change and development.

RESEARCH CONTRIBUTIONS

Human and physical resources of Tennessee. Soon after the Department of Agricultural Economics was formed in 1920, C. E. Allred initiated a series of studies bringing together for the first time information on the soils, climate, topography, population and other resources of the state related to agricultural development. This information has become a part of the working vocabulary of the social scientists in Tennessee.

Types of farming areas in Tennessee. In cooperation with the United States Department of Agriculture, S. W. Atkins led work which delineated the types of farming areas in the state on the basis of similarities such as soils, climate, crops produced, and major marketing centers. The original study has been updated and is very useful in current studies in agricultural production and marketing.

Optimizing income on individual farms. For a number of years, the Tennessee Experiment Station has been cooperating with the Tennessee Valley Authority to study alternative methods of farm organization and management. These studies make use of data collected in other studies concerning plant and animal production obtained through the use of varying kinds and amounts of resources. Alternative ways of organizing the resources on the individual farm were developed through the use of budgeting and linear programming techniques.

Different patterns of organization have been established on eight farms at the Ames Plantation Field Station in West Tennessee and the net income followed over a period of years. Similar programs have been developed with cooperating farmers in other areas of the state, with TVA furnishing incentives in the way of fertilizer, and with the Experiment Station staff providing planning services. The programs on private farms and on the Ames Plantation have served as patterns of organization for other farmers with similar resource bases.

Factors affecting the market demand for cotton. About 1930, a study was begun on cotton marketing, including the relationship of

At Ames Plantation Field Station in West Tennessee, different patterns of resource organization have been established on eight farm units. Over a period of years, the net income resulting from each organization pattern will provide information that will be helpful to other farmers who have similar resources.

price trends to total cotton production and to such quality factors as length, strength, fineness and grade. Also, the quantities of cotton of different qualities preferred by mills have been related to total production and the usage trends in recent years. The results have been reported to the entire cotton industry in several publications.

Vocational goals of rural youth. Tennessee has participated with several other Southern states in a regional project to learn in what ways parents influence the vocational goals of their sons and daughters. The results of these studies help in organizing Extension programs to motivate rural youth to obtain the education and training they need in order to adjust satisfactorily to current job conditions.

Migration patterns of rural people. Several studies have been made of the movement of people in and out of selected counties. Factors related to both in- and out-migration such as age, training, and education have been evaluated in relation to the movement patterns.

CURRENT RESEARCH

The increasing cost of all production inputs and the relatively low prices for products sold makes it mandatory to increase efficiency in farm organization and operation. Another major problem is to help rural areas with their social and economic development so that they will be more attractive to present and future citizens.

Optimum enterprise combinations. Cooperative work with Tennessee Valley Authority on the development of alternative combinations of production enterprises to fit a given set of land, labor and capital resources continues. Input-output data used in this work are continually revised so that results will apply to current conditions. Cooperating farmers select one alternative for adoption, and Tennessee Valley Authority provides certain incentives to help the farmers establish the system. The degree of success of each cooperator is being evaluated for his own use and for adding to knowledge about various enterprise combinations and resource uses.

Marketing research. Study is underway of present, prospective, and theoretically optimum marketing systems for the major agricultural products, such as cotton, grain, ornamentals, livestock, poultry and dairy products. Because marketing activities in adjacent as well as in more distant states affect market performance in Tennessee, most of this research is in cooperation with other states under regional research programs.

Rural development. Tennessee and six other southern states are cooperating to study the factors influencing the occupational goals of rural youth.

Migration in and out of selected counties is being studied to learn what migrants are like and why they decide to move.

Investments in natural resources may affect economic activity, employment and income distribution. Effects of such investments are being evaluated in research involving selected TVA dams, reservoirs and steam plants.

Economics of air pollution. Pollution of the air may have a number of effects. A study is estimating the value of residences in various neighborhoods relative to the accompanying level of air pollution. Also included will be estimates of the cost of reducing pollution levels by changing fuels or heating methods.

The Eighty- Second Annual Report of the Tennessee Agricultural Experiment Station 1969

Projects, Publications, and Staff

Included in this report are listings by departments of the following information:

Research projects active as of December 31, 1969; research projects terminated during the calendar year 1969; bulletins, articles, and reports prepared by Experiment Station staff members and published during the calendar year 1969.

In addition, this report contains the financial statement for the Agricultural Experiment Station covering the period July 1, 1968, to June 30, 1969. Also included is a list of the Experiment Station personnel for the calendar year 1969.

ACTIVE PROJECTS

As of December 31, 1969, there were 139 Hatch projects, 2 special grant projects, and 25 state projects. Active Hatch and special grant projects are supported in part with Federal grant funds made available by Congress to the Agricultural Experiment Stations of the country under the Hatch Act Amended. State projects are supported entirely by University funds.

In addition, there were 10 McIntire-Stennis and 28 University of Tennessee-Atomic Energy Commission projects active. Federal grant funds made available by Congress under the McIntire-Stennis Act are designated for research in forestry. The UT/AEC projects are operated under contract with the Atomic Energy Commission.

The headquarters of the Tennessee Agricultural Experiment Station is located on the agricultural campus of The University of Tennessee at Knoxville. The UT/AEC Agricultural Research Laboratory is located some 20 miles distant at Oak Ridge, Tennessee. In addition, there are other research centers which represent soil and climatic conditions in the major regions of Tennessee. These other research centers are listed at the end of this report, and the locations are shown on the map on page 8.

PROJECTS TERMINATED

During 1969, twenty projects were terminated. Reports on these projects have either been published or are being prepared for publication.

PUBLICATIONS

Published reports on research of the Tennessee Agricultural Experiment Station appear in Station Bulletins, in Tennessee Farm and Home Science, as well as in professional and technical periodicals and in various popular publications. There were 17 Station Bulletins published during the year. The number of technical, semi-technical, and popular articles prepared by staff members and published during 1968 was 169. In addition, staff members published 6 Extension-type publications, and 2 regional bulletins. Also, two patents were granted by the U.S. Patent Office.

FINANCIAL STATEMENT

July 1, 1968-June 30, 1969
The University of Tennessee Agricultural Experiment Station

Activity	Federal					Non Federal	Totals All
	Hatch Act - Amended		Co-op Forestry Research	Research Facilities	Specific Grants		
	Regular	Regional Res.					
Receipts:	$1,252,942.00	$222,022.00	$93,427.29		$47,044.66	$3,381,302.83	$4,996,738.78
Expenditures: Personal Services	$1,216,836.47	$209,592.92	$77,481.03		$25,324.87	$1,216,788.95	$2,746,024.24
Travel	3,963.64	2,475.48	536.47		64.65	67,944.03	74,984.27
Equipment	8,182.88	3,856.96	2,807.53		4,300.00	236,284.21	255,431.58
Lands and Structures	7,900.00				8,263.00	25,221.74	41,384.74
Personnel Benefits						249,686.94	249,686.94
Supplies and Materials	4,784.45	1,895.73	5,663.30		935.17	592,336.19	605,614.84
All Other	11,274.56	4,200.91	104.00		487.46	403,132.06	419,198.99
Unobligated			6,834.96		7,669.51	589,908.71	604,413.18
Totals	$1,252,942.00	$222,022.00	$93,427.29		$47,044.66	$3,381,302.83	$4,996,738.78

Project No.	Research Project Titles
Hatch 98	Life History, Ecology, and Control of Major Cotton Insects.
Hatch 132	Breeding Disease-Resistant Tobacco.
Hatch 138	Biology and Control of Plant Parasitic Nematodes; cooperative with the U. S. Department of Agriculture.
Hatch 139	Associations Among Soil Microorganisms as Related to the Incidence and Severity of Plant Diseases (contributing to Regional Proj. S-26).
Hatch 140	Evaluating New Fungicides.
Hatch 174	Breeding Strawberries for Tennessee Markets with Emphasis on Climatic Adaptability and Disease Resistance; cooperative with Horticulture Department.
Hatch 203	Control of Insects Attacking Nursery Plants.
Hatch 213	Biology, Distribution, and Control of Corn Insects.
Hatch 239	Factors Influencing Survival and Pathogenicity of Plant Parasitic Nematodes (contributing to Regional Proj. S-19).
Hatch 241	The Disposition of Pesticides in the Soil (contributing to Regional Proj. S-62).
Hatch 251	Diseases of Small Grains.
Hatch 260	Diseases of Ornamentals and Associated Nursery Crops.
Hatch 263	Snap Bean Diseases.
Hatch 264	Distribution, Biology, and Control of Tobacco Insects.
Hatch 280	Remote Multispectral Sensing in Agriculture; cooperative with Agronomy, Agricultural Engineering, and Forestry Departments.
Hatch 289	Cotton Diseases.
Hatch 292	Forage Crop Insect Control.
Hatch 299	Relation of House Dust Mites to Allergic Reactions in Humans.
Hatch 302	Viruses and Mycoplasma-like Organisms (MPLO) Causing Diseases of Corn; cooperative with the U. S. Department of Agriculture (contributing to Regional Proj. S-70).
State 47	Biology of Farm Ponds.

PROJECT CONCLUDED IN 1969

Project No.	Research Project Title
Hatch 253	Investigation of an Unidentified Corn Virus Disease Occurring in Tennessee; cooperative with the Agronomy Department and the U. S. Department of Agriculture.

Bulletins, Articles, and Reports — 1969

Bennett, Stelmon E.
Flaming vs. Dormant Oils for Alfalfa Weevil and Weed Suppression. Proceedings: Sixth Annual Symposium on Thermal Agriculture, p. 10, January 1969.

Bennett, Stelmon E., Robert P. Hornsby, and Nabil Shamiyeh
Could Your Allergy Be Caused by House Dust Mites? Tennesse Farm and Home Science Progress Report 71, September 1969.

Chambers, A. Y.
Soybean Seedling Diseases (Seed-and Soil-borne Organisms). Fungicide-Nematocide Tests Results of 1968 24: 116-117, 1969.

Chambers, A. Y.
Relationship of Weather Conditions to Occurrence, Severity, and Control of Stem Anthracnose of Lima Beans. Phytopathology 59:1021, 1969.

Chambers, A. Y. and C. H. Hadden
Cotton Seedling Disease Control. Plant Diseases in Tennessee. Extension Agricultural Biology Mimeo Series 420 (Revised), 1969.

Chambers, A. Y. and C. H. Hadden
How to Control Cotton Seedling Diseases. The Tennessee Farmer, West Edition, 16(3):6-7, 1969.

Chambers, A. Y. and W. G. Russell
Cotton Seedling Diseases (**Rhizoctonia solani, Pythium** spp., **Fusarium** spp.) Fungicide-Nematocide Tests Results of 1968 24:70-71, 1969.

Chambers, A. Y., W. G. Russell, J. R. Overton, and H. Andrews
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AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

Project No.	Research Project Titles
Hatch 205	An Economic Appraisal of Agricultural Credit Used by Tennessee Farmers.
Hatch 212	Increasing Efficiency in the Tennessee Vegetable Industry (contributing to Regional Proj. SM-30).
Hatch 226	Income Potentials from Alternative Farm Organizations in Various Types of Farming Areas.
Hatch 227	Optimum Location of Livestock and Meat Marketing Facilities in the South (contributing to Regional Proj. SM-27).
Hatch 231	Optimal Adjustments of Southern Grain Marketing Facilities to Present and Future Conditions (contributing to Regional Proj. SM-29).
Hatch 249	Human Resource Development and Mobility in the Rural South (contributing to Regional Proj. S-61).
Hatch 252	Demand for Food (contributing to Regional Proj. SM-34).
Hatch 259	Egg Marketing Systems for the South (contributing to Regional Proj. SM-37).
Hatch 262	Civil Defense and Food Stocks.
Hatch 270	The Management of Insurable Risk in Tennessee Agriculture.
Hatch 272	Vertical Integration in Tennessee Agriculture.
Hatch 274	Migration Patterns of the Tennessee Population.
Hatch 281	The Economic Impact of the Wholesome Meat Act on Tennessee's Livestock Industry.
Hatch 283	Potentials of the Beef Production Industry in the South (contributing to Regional Proj. S-67).
Hatch 285	Farm Labor in Tennessee.
Hatch 286	Relationship of Fiber Test Data and Other Factors to Prices Paid for Cotton (contributing to Regional Proj. SM-39).
Hatch 290	Golf Associations in Tennessee.
Hatch 295	Efficiencies in Grocery Wholesaling in Tennessee.
Hatch 303	Regional Income and Employment Effects of Investments in Natural Resources (contributing to Regional Proj. S-71).
Hatch 304	Marketing Organization, Power, Policies, and Programs in the Dairy Industry (contributing to Regional Proj. SM-40).
T 2	Reducing the Cost of Producing Cotton through the Management and Application of Technology (USDA, CSRS Grant 616-15-23).
State 44	The Woody Ornamental Nursery Industry in Tennessee; cooperative with the U. S. Department of Agriculture.

PROJECTS CONCLUDED IN 1969

Project No.	Research Project Titles
Hatch 223	The Impact of Changing Market Structure upon the Competitive Position of the Dairy Industry in the South (contributing to Regional Proj. SM-28).
Hatch 225	The Demand for Outdoor Recreation in Tennessee.
Hatch 236	The Marketing and Utilization of Pesticides in Tennessee.
State 34	Sales Value of Cotton Allotments in Tennessee.
State 43	Impact of Agriculture on the Agri-Business Complex of Metropolitan Trade Areas in Tennessee.
State 46	Causes of Lag in Increase in Net Income Per Farm in Tennessee.
State 54	Effects of Investments in Water Resources on Regional Income and Employment.

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AGRICULTURAL ENGINEERING

Project No.	Research Project Titles
Hatch 32	Chemical Weed Control; cooperative with the Agronomy and Horticulture Departments.
Hatch 131	Genetics and Cytology of Cotton: Evaluation of Cotton Fiber Properties for the Plant Breeder (contributing to Regional Proj. S-1).
Hatch 188	Measurement of Standard Cotton Fiber Properties.
Hatch 204	Factors Affecting Water Yields from Small Watersheds in Tennessee; cooperative with the Agronomy Department, U-T/AEC Agricultural Research Laboratory, and the Soil Conservation Service (contributing to Regional Proj. S-53).
Hatch 209	Development of an Okra Trimmer.
Hatch 214	Behavioral Responses of Chickens to Environmental Factors; cooperative with the Poultry Department.
Hatch 228	Snap Bean Production Mechanization; cooperative with the Horticulture, Food Technology, Agricultural Biology, and Agricultural Economics Departments.
Hatch 240	Cotton Production Mechanization.
Hatch 277	Farm Waste Disposal; cooperative with the Dairy, Food Technology, and Sanitary Engineering Departments.
Hatch 280	Remote Multispectral Sensing in Agriculture; cooperative with the Agronomy, Agricultural Biology, and Forestry Departments.
Hatch 294	Engineering Systems for Cotton Production (contributing to Regional Project S-69).
T 3	Quality of Humid Region Cotton Harvested by Mechanical Stripper (USDA, CSRS Grant 816-15-06).
State 7	Electric Treatment of Plant Materials; cooperative with the Agronomy and Food Technology Departments and the U. S. Department of Agriculture.
State 25	Land Forming for Drainage and Furrow Irrigation; cooperative with the West Tennessee Experiment Station and the Soil Conservation Service.
State 48	Purification of Pond Water.
State 50	Cotton Production Studies; cooperative with the Agricultural Biology and Agronomy Departments and the Tennessee Farm Bureau.

PROJECTS CONCLUDED IN 1969

Hatch 246	Applications of Ultra Low Volumes of Insecticides with Ground Spraying Equipment; cooperative with the Agricultural Biology Department.
State 51	Improved Distribution and Placement of Concentrated Pesticides with Ground Equipment; cooperative with the Cotton Producers Institute.

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Project No.	Research Project Titles
Hatch 28	Moisture Sorption Characteristics of the Major Soils of Tennessee and the Relation of Moisture Tensions to Plant Growth and Fertilizer Utilization; cooperative with the U. S. Department of Agriculture.
Hatch 32	Chemical Weed Control; cooperative with the Departments of Agricultural Engineering and Horticulture.
Hatch 33	Evaluation of the Performance of Varieties of Field Crops.
Hatch 34	Corn Improvement; cooperative with the Department of Agricultural Biology and the U. S. Department of Agriculture.
Hatch 38	The Comparative Value and Relative Efficiency of Various Phosphate Fertilizers under Different Soil and Cropping Conditions.
Hatch 42	Potassium Fertilization of Farm Crops on Different Soil Series in Tennessee.
Hatch 45	Movement and Persistence of Herbicides in the Soil (contributing to Regional Proj. S-18).
Hatch 47	Establishment and Maintenance of Turf.
Hatch 48	Soil Survey of Tennessee to Help Determine Crop Adaptation and Management Requirements; cooperative with the U. S. Department of Agriculture.
Hatch 56	Trace Elements in Tennessee Agricultural Crops.
Hatch 79	Production and Improvement of Cotton Varieties Suitable to Tennessee Conditions; cooperative with the U. S. Department of Agriculture.
Hatch 163	Culture of Dark Tobacco.
Hatch 164	Nitrogen Fertilization of Farm Crops.
Hatch 183	Crop Response to Liming.
Hatch 184	Effects of Environmental Factors on Ladino Clover and Orchardgrass Persistence.
Hatch 186	Forage Crops Management: Establishment, Persistence, Productivity.
Hatch 208	Breeding for Improvement in Small Grain (wheat, oats, barley, and rye); cooperative with the Department of Agricultural Biology.
Hatch 211	Breeding and Genetics of Forage Crops.
Hatch 224	Physiological Responses of Forage Crops to Management and Environment.
Hatch 237	The Disposition of Pesticides in the Soil (contributing to Regional Proj. S-62).
Hatch 238	Controlling Southwestern Corn Borer by Cultural Practices and Resistant Hybrids; cooperative with Department of Agricultural Biology and the U. S. Department of Agriculture.
Hatch 245	Effects of Pesticides on Turf Pests and Turfgrasses.
Hatch 250	Influence of Mineralogy of Southern Soils on Certain Chemical and Physical Reactions (contributing to Regional Proj. S-60).
Hatch 255	Fertilization, Soil and Crop Management Systems, Cultural Practices, and Plant Bed Management Systems for Burley Tobacco; cooperative with the U. S. Department of Agriculture.
Hatch 256	Burley Tobacco Breeding; cooperative with the U. S. Department of Agriculture.
Hatch 279	Selectivity and Mode of Action of Herbicides.
Hatch 280	Remote Multispectral Sensing in Agriculture; cooperative with the Departments of Agricultural Biology, Agricultural Engineering, and Forestry.
Hatch 287	Effectiveness and Efficiency of Physical and Chemical Mutagens; cooperative with the U-T/AEC Agricultural Research Laboratory.
Hatch 291	Plant Constitutents Controlling Cotton Fiber Initiation, Growth and Maturation; cooperative with the U. S. Department of Agriculture.
Hatch 293	Phenology and Physiology of Soybeans.
Hatch 296	Environment-Management Interactions in Forage Crops Ecological Systems.
Hatch 301	Viruses and Mycoplasma-like Organisms (MPLO) Causing Diseases of Corn (contributing to Regional Proj. S-70); cooperative with the U. S. Department of Agriculture.
State 50	Quality Cotton Varietal Adaptation.

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ANIMAL HUSBANDRY-VETERINARY SCIENCE

Project No.	Research Project Titles
Hatch 52	The Evaluation of Different Pasture Species in Various Combinations and at Varying Rates of Nitrogen Fertilization as Reflected in Beef Cattle Gains and Forage Yields.
Hatch 61	The Improvement of the Producing Ability of Beef Cattle; cooperative with the U. S. Department of Agriculture, the U-T/AEC Agricultural Research Laboratory, and the Aluminum Company of America (contributing to Regional Proj. S-10).
Hatch 63	Mineral Metabolism in Animals: I. Absorption, Distribution, and Physiological Behavior of Calcium and Phosphorus in Farm Animals; cooperative with the U-T/AEC Agricultural Research Laboratory.
Hatch 66	The Effects of Radiation on Reproductive Physiology in Farm Animals; cooperative with the U-T/AEC Agricultural Research Laboratory.
Hatch 68	Carcass Value Investigations with Beef; cooperative with the Food Science and Institution Management Department.
Hatch 71	Factors Affecting Feed Utilization by Ruminants.
Hatch 72	Evaluation of Roughages for Beef Cattle.
Hatch 73	The Improvement of the Producing Ability of Swine Through Performance Testing and Breeding Methods.
Hatch 176	Performance of Growing-Finishing Swine on Concrete and Pasture.
Hatch 218	Performance of Beef Cows as Affected by Initial Winter Condition and Level of Winter Feeding.
Hatch 222	Pasture Management Systems for Beef Cow Herds.
Hatch 244	Effect of Cooking Temperature on Yield, Palatability, and Microbiology of Meat; cooperative with the Food Science and Institution Management Department.
Hatch 254	Ante-Mortem Treatment Effect on Pork Carcass Characteristics.
Hatch 257	Effects of Levels of Fatness on Beef Carcass Quality.
Hatch 266	Reproductive Capacity of Beef Cows as Related to Germ Cell Complement.
State 2	Swine Testing; in cooperation with the U-T Agricultural Extension Service.
State 3	Effects of Fluorine Levels of Soil and Water on Grazing Cattle Under Different Systems of Management.
State 20	Evaluation of Methods of Producing Beef.
State 39	The Effects of Feedlot Design on the Performance of Slaughter Cattle.
State 40	Frequency of Winter Feeding of Beef Cows.
State 41	Improvement of Producing Ability of Beef Cattle.
State 42	Beef Cattle Improvement.
State 52	Evaluation of Meat from Animals Exposed to Lethal Radiation Levels.
State 55	Maternal Nutrition (Mn-Cu) and Placental Transfer in Ewes (NSF-7676).

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CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

Project No.	Research Project Titles
Hatch 265	Influences on Occupational Goals of Young People (contributing to Regional Project S-63).

DAIRYING

Project No.	Research Project Titles
Hatch 92	Effects of Maximum Selection Pressure for Milk Production on Rate of Improvement in Production and Its Effect on Other Dairy Cattle Traits; cooperative with the U. S. Department of Agriculture (contributing to Regional Proj. S-49).
Hatch 161	Efficient and Economical Use of Forages in Dairy Cattle Rations; cooperative with the U. S. Department of Agriculture.
Hatch 165	Quality and Shelf Life of Dairy Products in the Marketing Channels.
Hatch 200	Effect of Processing Methods on Dairy Product Quality.
Hatch 221	Effect of Whole-Body Gamma Irradiation on Milk Cows and Milk Production; cooperative with the U-T/AEC Agricultural Research Laboratory.
Hatch 247	Factors Affecting Voluntary Feed Intake by Ruminants, (contributing to Regional Proj. S-45).
Hatch 248	Factors Related to the Freezing Point of Milk.
Hatch 268	The Identification and Control of Factors Affecting Reproductive Performance in the Bovine Female.
Hatch 276	Early Physiological Development of the Fetus in the Cow, Pig, and Sheep; cooperative with the U-T/AEC Agricultural Research Laboratory.
Hatch 278	Relationship Between Lactose Concentration and Flavor in Dairy Products.
Hatch 282	Studies on the "Lack Freshness" Flavor of Cottage Cheese.
Hatch 284	Factors Affecting the Rate of Genetic Improvement of Dairy Cattle.
Hatch 297	Feed Requirements for Growth of Heifers.
Hatch 298	Bovine Mammary Gland Development During Gestation and Initial Stages of Lactation.
Hatch 305	Fortification of Milk with Iron.

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Project No.	Research Project Titles
Hatch 150	Feeds and Feeding for Dairy Calves.
Hatch 235	Chemical Residues in Milk.

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FOOD SCIENCE AND INSTITUTION ADMINISTRATION

Project No.	Research Project Titles
Hatch 244	Effect of Cooking Temperature on Yield, Palatability, and Microbiology of Meat; cooperative with the Animal Husbandry-Veterinary Science and Food Technology Departments.
Hatch 269	Effect of Elaidinization on Functional Properties of Fat.

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Project No.	Research Project Titles
Hatch 173	Group D. and Other Streptococci in Frozen Foods.
Hatch 177	Flavonoid Pigments and Their Degradation in Processed Fruit and Vegetable Products.

Hatch	193	Enzymes as Related to Chemical and Physical Characteristics of Vegetables for Freezing.
State	7	Electric Treatment of Plant Materials; cooperative with the U. S. Department of Agriculture.
State	83	Evaluation for Freezing of Fruit and Vegetable Varieties Adapted to Production in Tennessee.

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FORESTRY

Project No.		Research Project Titles
Hatch	102	Forest Management.
Hatch	103	A Study of Tree Species Adapted to the Different Forest Regions of Tennessee.
Hatch	107	Relationship of Soil and Other Site Factors to Forest Composition and Productivity.
Hatch	185	Forest Tree Genetics (contributing to Regional Proj. S-23).
Hatch	207	Forest Tree Fertilization; cooperative with the Hiwassee Land Company.
Hatch	271	Forest Tree Breeding.
Hatch	280	Remote Multispectral Sensing in Agriculture; cooperative with the Agricultural Biology, Agricultural Engineering, and Agronomy Departments.
MS	2	Effects of Fertilization and Irrigation on Tree Growth.
MS	3	Quail Management on Forest and Associated Lands in West Tennessee.
MS	4	Determinants of Forest-Management Intensity of Private, Nonindustrial Owners in the Tennessee Valley Counties of Tennessee.
MS	5	The Recreation Resources of Large Private Forest Ownerships in Tennessee.
MS	6	Wood Duck Ecology on Rivers and Impoundments in East Tennessee.
MS	7	Blight Resistance in American Chestnut.
MS	8	Christmas Tree Breeding.
MS	9	Characteristics of Juvenile and Branch Wood in Hardwoods.
MS	10	Economics of Alternative Timber-Growing Practices in Tennessee Hardwood Stands.
MS	11	Physiological Response of Wildlife to Different Forest and Associated Habitats.
MS	12	Ecology and Behavior of the Black Bear (**Ursus americanus**) in the Great Smoky Mountains National Park.
State	8	Wood Preservation.
State	12	Fertilization of Shade Trees on Lawns; cooperative with the Horticulture Department.
State	30	The University of Tennessee Arboretum.
State	49	Control of Vole Damage to Virginia Pine; cooperative with the Hiwassee Land Company.
State	53	Quality and Yield of Flooring from Graded Red Oak; cooperative with the U. S. Department of Agriculture.

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HOME MANAGEMENT, EQUIPMENT AND FAMILY ECONOMICS

Project No.	Research Project Title
Hatch 217	Economic Provisions for Old Age Made by Rural Families (contribution to Regional Proj. S-56).

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HORTICULTURE

Project No.	Research Project Titles
Hatch 32	Chemical Weed Control; cooperative with the Agronomy and Agricultural Engineering Departments.
Hatch 123	Mineral Nutrition of Vegetable Crops.
Hatch 125	Mineral Nutrition of Fruit Crops.
Hatch 126	Vegetable Variety Investigations; cooperative with the School of Agriculture, The University of Tennessee at Martin.
Hatch 127	Fruit Variety Investigations.
Hatch 128	Propagation of Fruit and Ornamental Plants.
Hatch 154	Kind and Variety Investigations of Ornamental Plants.
Hatch 157	Management and Evaluation of Plants for Hedges, Screens, and Windbreaks.
Hatch 174	Breeding Strawberries for Tennessee Markets with Emphasis on Climatic Adaptability and Disease Resistance.
Hatch 187	Storage and Handling of Evergreen Nursery Stock.
Hatch 273	Cell Specialization in Shoot Apical Meristems as Related to Radiosensitivity and Histogenesis; cooperative with the U-T/AEC Agricultural Research Laboratory.
State 12	Fertilization of Shade Trees on Lawns; cooperative with the Forestry Department.
State 27	Studies in Crop Ecology; cooperative with the U.S. Department of Commerce, Weather Bureau, and the West Tennessee Experiment Station.
State 57	Evaluation of New Plants (contributing to Regional Proj. S-9).

PROJECTS CONCLUDED IN 1969

Project No.	Research Project Title
State 16	Development of Lima Beans Having Specific Seed Coat Colors.

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NUTRITION

Project No.	Research Project Titles
Hatch 108	Measurement and Interpretation of Bone Density.
Hatch 234	Effect of Organo-Phosphorus Insecticides on the Fixation of Sulfate by Mucopolysaccharides.
Hatch 267	Nutritional Interrelationships of Minerals and Other Nutrients (contributing to Regional Proj. S-64).
State 18	Mucopolysaccharides and Cellular Lipoprotein in Vitamin E Deficiency.

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Project No.	Research Project Titles
Hatch 144	Influence of Environment on Performance of Hens.
Hatch 155	Photoperiodism and Physiological Functions of Chickens.
Hatch 160	Improving Diets for Broilers and Roasters.
Hatch 214	Behavioral Responses of Chickens to Environmental Factors; cooperative with the Agricultural Engineering Department.
Hatch 216	Xanthophyll in Poultry Pigmentation.
Hatch 233	The Nutrition of Egg-Production-Type Chickens.
Hatch 258	The Pathogenicity of Selected Salmonellas for Chickens.
Hatch 261	The Effects of Gumboro on Chickens.
Hatch 300	Role of the Ultimobranchial Gland in Avian Osteoporosis.
State 1	Random Sample Testing of Chickens Available to Tennessee Poultrymen.

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Hatch 288	An Evaluation of Certain Flame Retardant Finishes on Selected Apparel Textiles (contributing to Regional Proj. SM-38).

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Project No.	Research Project Titles
UT-AEC 1	The Effect of Radiation on Prenatal Development.
UT-AEC 2	Effects of Prenatal Irradiation on Growth.
UT-AEC 3	Transfer of Materials Across the Maternal-Fetal Membranes and Fetal Development in Domestic Animals.
UT-AEC 4	Effects of Radiation on the Reproductive System.
UT-AEC 5	Effect of Radiation on Lifetime Reproduction.
UT-AEC 6	Early Physiological Development of the Fetus in the Cow, Pig, and Sheep.
UT-AEC 7	Clinical Effects of Irradiation: Late Effects of Whole-Body Gamma and Mixed Neutron-Gamma Irradiation on Large Animals.
UT-AEC 8	Clinical Effects of Irradiation: Late Effects of Whole-Body Gamma Irradiation on the Work Performance and Related Physiology of Shetland Ponies.
UT-AEC 9	Kidney Transplantation in Dizygotic Cattle Twins.
UT-AEC 10	Tissue Culture in Large Animals.
UT-AEC 11	Metabolic Alterations in Irradiated Animals.
UT-AEC 12	Radiation Studies in Livestock Under Simulated Fallout Conditions.
UT-AEC 13	Effect of Dose Rate on Acute Response in Large Animals.
UT-AEC 14	Correlation of Depth Dose Distribution Patterns with Biological Effects in Swine for ^{60}Co Gamma Rays, 14 MeV Neutrons, and Fission Neutrons.
UT-AEC 15	Clinical Effects of Irradiation: Early Effects of 14 MeV Neutron Irradiation in Swine.
UT-AEC 16	Pathology.
UT-AEC 17	The Metabolism of Fission Products and Related Nuclides in Poultry.
UT-AEC 18	Metabolism of Trace Elements.
UT-AEC 19	Absorption of Minerals in Relation to Gastrointestinal Tissue and Ingesta Characteristics in Dairy Cattle.
UT-AEC 20	Metabolic Effects of Gastrointestinal and Skin Radiation.
UT-AEC 21	Ion Exchange in Clay Systems.
UT-AEC 22	Diffusion in Non-Ideal Systems.
UT-AEC 23	Soil Chemistry: Fixation Reactions.
UT-AEC 24	Control and Modification of Seed Radiosensitivity.
UT-AEC 25	Plant Studies: Mutagenic Effectiveness and Efficiency.
UT-AEC 26	Radiosensitivity in Shoot Apical Meristems.
UT-AEC 27	Induction of Bud Sports in Ornamental Plants.
UT-AEC 28	Fallout Radiation and Crop Productivity.

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Effects of Neutron Irradiation on Blood and Cerebrospinal Fluid Pressures in the Burro **(Equus asinus)**. American Journal of Veterinary Research 30(1):73-76.

THE UNIVERSITY OF TENNESSEE AT MARTIN

Project No.	Research Project Titles
Hatch 33	Evaluation of the Performance of Varieties of Field Crops; cooperative with the Agronomy Department.
Hatch 38	The Comparative Value and Relative Efficiency of Various Phosphate Fertilizers Under Different Soil and Cropping Conditions; cooperative with the Agronomy Department.
Hatch 47	Establishment and Maintenance of Turf; cooperative with the Agronomy Department.
Hatch 71	Factors Affecting Feed Utilization by Ruminants; cooperative with the Animal Husbandry-Veterinary Science Department.
Hatch 72	Evaluation of Roughages for Beef Cattle; cooperative with the Animal Husbandry-Veterinary Science Department.
Hatch 92	Effects of Maximum Selection Pressure for Milk Production on Rate of Improvement in Production and Its Effect on Other Dairy Cattle Traits; cooperative with the Dairying Department.
Hatch 126	Vegetable Variety Investigations; cooperative with the Horticulture Department.
Hatch 161	Efficient and Economical Use of Forages in Dairy Cattle Rations; cooperative with the Dairying Department.
Hatch 183	Crop Response to Liming; cooperative with the Agronomy Department.
Hatch 184	Effects of Environmental Factors on Ladino Clover and Orchardgrass Persistence; cooperative with the Agronomy Department.
Hatch 186	Forage Crops Management: Establishment, Persistence, and Productivity; cooperative with the Agronomy Department.
Hatch 211	Breeding and Genetics of Forage Crops; cooperative with the Agronomy Department.
Hatch 213	Biology, Distribution, and Control of Corn Insects; cooperative with the Agricultural Biology Department.

Bulletins, Articles, and Reports — 1969

McLaren, J. B., H. J. Smith, G. Srinivasan, and E. J. Chapman
Performance of Spring Lambs in Tennessee. Tennessee Agricultural Experiment Station Bulletin 444, 1969.
Graves, Charles R., Joe Overton, Tom McCutchen, B. N. Duck, and John Connell
Performance of Sunflower Varieties Grown at Several Locations. Tennessee Farm and Home Science Progress Report 70, June 1969.
Pless, C. D. and B. N. Duck
Control of Southwestern Corn Borer with Furadan Insecticide. Tennessee Farm and Home Science Progress Report 70, June 1969.

Station Personnel
The University of Tennessee
Agricultural Experiment Station
Knoxville, Tennessee
1969

Agricultural Committee

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Clyde M. York, Chairman
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Webster Pendergrass, Vice Chancellor
Institute of Agriculture

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Eric Winters, Associate Dean

O. Clinton Shelby, Director of Business Affairs

W. H. Jones, Accountant

Agricultural Biology

Stelmon E. Bennett, Head of Department
Beverly S. Ausmus, Assistant in Agricultural Biology
Edward E. Burgess, Assistant in Agricultural Biology
Albert Y. Chambers, Assistant Professor, Jackson
Edward T. Cherry, Assistant in Agricultural Biology
J. M. Epps, Associate Professor, Jackson.[1]
Elvis A. Heinrichs, Assistant Professor
James W. Hilty, Associate Professor
Leander F. Johnson, Associate Professor
Dennis H. Latham, Associate Professor, Springfield
Ellis L. Matheny, Jr., Assistant in Agricultural Biology
Jimmy E. Pendergrass, Assistant in Agricultural Biology
Charles D. Pless, Assistant Professor
William J. Powers, Assistant in Agricultural Biology
Marshall F. Priest, Assistant in Agricultural Biology
Howard E. Reed, Associate Professor
William G. Russell, Assistant Professor, Jackson
Richard C. Sievert, Assistant Professor, Greeneville[1]
Carroll J. Southards, Associate Professor
W. W. Stanley, Professor (on leave)

Agricultural Economics and Rural Sociology
T. J. Whatley, Head of Department
M. B. Badenhop, Professor
H. E. Barnhill, Instructor[1]
L. L. Bauer, Assistant Professor
Bennie E. Beeson, Assistant in Agricultural Economics
D. W. Brown, International Professor of Agricultural Economics
Billy Joe Byerley, Assistant in Agricultural Economics
C. L. Cleland, Professor of Rural Sociology
Donald L. Cline, Assistant in Agricultural Economics
Sam T. Cooper, Assistant in Agricultural Economics
C. M. Cuskaden, Assistant Professor
Irving Dubov, Professor
W. E. Goble, Assistant Professor
R. J. Goddard, Assistant Professor
Charles D. Griggs, Assistant in Agricultural Economics
John P. Jordan, Assistant in Agricultural Economics
L. H. Keller, Associate Professor
F. O. Leuthold, Associate Professor of Rural Sociology
J. A. Martin, Professor
B. D. Raskopf, Associate Professor
Robert M. Ray, Assistant Professor
C. B. Sappington, Assistant Professor
J. G. Snell, Assistant Professor
B. J. Trevena, Instructor
Ronald D. Weddel, Assistant in Agricultural Economics

Agricultural Engineering Department
J. J. McDow, Head of Department
W. H. Allen, Assistant in Agricultural Engineering
J. C. Barker, Assistant in Agricultural Engineering
D. O. Baxter, Assistant Professor
B. L. Bledsoe, Associate Professor
C. L. Brasher, Assistant in Agricultural Engineering
L. E. Brown, Assistant in Agricultural Engineering
J. D. Davenport, Assistant in Agricultural Engineering
K. E. Duckett, Assistant Professor
F. D. Evans, Assistant in Agricultural Engineering
P. R. Ewald, Associate Professor[1]

[1] In cooperation with the U. S. Department of Agriculture.

D. A. Fugate, Assistant in Agricultural Engineering
Z. A. Henry, Associate Professor
A. L. Infante, Assistant in Agricultural Engineering
R. S. Krowicki, Assistant Professor [1]
Reba Lawson, Assistant Professor [1]
A. H. Morgan, Associate Professor
J. A. Mullins, Associate Professor
J. I. Sewell, Associate Professor
R. C. Shadden, Instructor
C. H. Shelton, Assistant Professor
R. B. Stone, Associate Professor [1]
L. J. Thompson, Assistant Professor

Agronomy
Lloyd F. Seatz, Head of Department
William Alexander, Assistant in Agronomy
Elmer Ashburn, Assistant in Agronomy
William D. Barber, Assistant Professor
Frank F. Bell, Professor
George J. Buntley, Associate Professor
L. M. Callahan, Associate Professor
Harold Carpenter, Assistant in Agronomy
Bob V. Conger, Assistant Professor
John T. Connell, Assistant Professor, Grand Junction
Ned C. Edwards, Assistant in Agronomy
Jerry D. Frady, Assistant in Agronomy
Henry A. Fribourg, Associate Professor
Jimmy M. Gass, Assistant in Agronomy
Charles R. Graves, Assistant Professor
C. L. Gupton, Assistant Professor [1]
Tommy Henard, Assistant in Agronomy
P. E. Hoskinson, Assistant Professor, Jackson
John Jared, Assistant in Agronomy
Larry S. Jeffery, Assistant Professor
L. M. Josephson, Professor [1]
H. C. Kincer, Assistant Professor
Samuel Kincheloe, Assistant in Agronomy
William A. Krueger, Assistant Professor
Charles R. Leslie, Assistant in Agronomy
Gary M. Lessman, Assistant Professor
Russell J. Lewis, Associate Professor
T. J. Longwell, Assistant Professor [1]
Buford Maner, Jr., Instructor [1]
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B. C. Nichols, Associate Professor, Greeneville [1]
J. R. Overton, Assistant Professor, Jackson
W. L. Parks, Professor
Vernon H. Reich, Assistant Professor
J. H. Reynolds, Associate Professor
Brooks Robinson, Assistant Professor
Joe Rule, Assistant in Agronomy
K. B. Sanders, Assistant Professor
L. N. Skold, Professor
H. C. Smith, Assistant Professor
Marshall Smith, Assistant in Agronomy
M. E. Springer, Professor
James McD. Stewart, Assistant Professor [1]
Richard L. Tabor, Assistant in Agronomy
Smith Worley, Associate Professor [1]

Animal Husbandry-Veterinary Science
C. S. Hobbs, Head of Department
K. M. Barth, Associate Professor
M. C. Bell, Professor
S. P. Bertsch, Assistant in Animal Husbandry
W. T. Butts, Jr., Assistant Professor [1]
C. C. Chamberlain, Associate Professor
J. A. Corrick, Assistant Professor
H. M. Crowder, Assistant Professor
G. Eisele, Assistant in Animal Husbandry
M. E. Fryer, Assistant Professor
S. A. Griffin, Associate Professor
S. L. Hansard, Professor
H. M. Jamison, Associate Professor
D. A. Kaufman, Assistant in Animal Husbandry
F. D. Kirkpatrick, Assistant in Animal Husbandry
E. R. Lidvall, Jr., Associate Professor
J. B. Loy, Assistant in Animal Husbandry
J. E. Martin, Livestock Manager, Blount and Alcoa Farms
J. B. McLaren, Assistant Professor
G. M. Merriman, Professor
R. L. Murphree, Professor
J. B. Neel, Assistant in Animal Husbandry
R. A. Reynolds, Assistant Professor
R. R. Shrode, Professor
P. E. Shumway, Assistant in Animal Husbandry
J. D. Smalling, Assistant Professor
R. Q. Snyder, Farm Manager, Blount Farm
J. R. Strange, Assistant in Animal Husbandry

Child Development and Family Relationships
Ruth L. Highberger, Professor
Lois Ellen Southworth, Instructor

Dairying
J. T. Miles, Head of Department
D. B. Batson, Assistant in Dairying
H. D. Baxter, Assistant Professor, Lewisburg [1]
B. J. Bearden, Assistant Professor, Spring Hill
R. L. Cowsert, Assistant in Dairying
R. G. Cragle, Professor
B. J. Demott, Associate Professor
D. N. Hamilton, Assistant in Dairying
S. A. Hinton, Associate Professor
C. R. Holmes, Farm Manager
W. M. Hopper, Assistant Professor, Jackson
R. C. Jordan, Assistant in Dairying
D. B. Longmire, Assistant in Dairying
M. J. Montgomery, Associate Professor
E. D. Moore, Assistant Professor, Lewisburg [1]
W. W. Overcast, Professor
J. R. Plummer, Assistant in Dairying
D. O. Richardson, Associate Professor
E. W. Swanson, Professor

Food Science and Institution Administration
Grayce E. Goertz, Head of Department
Barbara Bayne, Instructor
Amelia Brown, Assistant in Food Science
Ada Marie Campbell, Professor
Marilyn Haga, Assistant in Food Science
Bernadine Meyer, Professor
Dianne Ruff, Assistant in Food Science
Judy Simmons, Assistant in Food Science

Food Technology
M. R. Johnston, Head of Department
J. L. Collins, Associate Professor
I. E. McCarty, Assistant Professor
B. P. Moss, Assistant in Food Technology
J. O. Mundt, Professor
Dennis R. Roop, Assistant in Food Technology

Forestry
J. W. Barrett, Head of Department
W. H. Baker, Assistant in Forestry
E. R. Buckner, Assistant Professor
J. H. Collier, Assistant in Forestry

[1] In cooperation with the U. S. Department of Agriculture.

H. A. Core, Professor
M. L. Countess, Assistant in Forestry
R. W. Dimmick, Assistant Professor
R. M. Evans, Assistant in Forestry
H. R. Large, Assistant in Forestry
M. R. Pelton, Assistant Professor
G. Rink, Assistant in Forestry
K. F. Schell, Associate Professor
E. Thor, Associate Professor
G. R. Wells, Assistant Professor
F. W. Woods, Professor
N. S. Yoho, Assistant in Forestry

Home Management, Equipment, and Family Economics
Phyllis Ilett, Associate Professor
Helen M. Reed, Assistant Professor

Horticulture
Barzillai S. Pickett, Head of Department
Joe S. Alexander, Assistant Professor
Robert J. Black, Assistant in Horticulture
Stephen A. Black, Assistant in Horticulture
James F. Brown, Assistant Professor, Jackson
David L. Coffey, Assistant Professor
Charles W. Marr, Assistant in Horticulture
Charles A. Mullins, Assistant in Horticulture, Crossville
William E. Roever, Associate Professor
Alvin D. Rutledge, Assistant in Horticulture
James G. Staley, Assistant in Horticulture
Homer D. Swingle, Professor
Hendrik van de Werken, Assistant Professor

Information
R. L. Hamilton, Head of Department
F. E. Berggren, Assistant Editor
C. E. Bible, Assistant in Information
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Nutrition
Mary Rose Gram, Head of Department
Roy E. Beauchene, Associate Professor
Gail W. Disney, Instructor
Rossie L. Mason, Assistant Professor
Elise Morrell, Assistant Professor
Frances A. Schofield, Professor
John T. Smith, Professor
Betty Whittle, Assistant in Nutrition

Textiles and Clothing
Anna Jean Treece, Head of Department
Elva Marie Heidle, Assistant in Textiles and Clothing

Poultry
O. E. Goff, Head of Department
J. K. Bletner, Associate Professor
C. D. Leeper, Assistant in Poultry
L. H. Littlefield, Assistant in Poultry
R. J. Mackin, Assistant in Poultry
G. C. McGhee, Research Technician
H. V. Shirley, Associate Professor
R. L. Tugwell, Professor

The University of Tennessee at Martin
H. J. Smith, Dean, School of Agriculture
E. W. Counce, Assistant Professor of Agronomy
E. W. Culvahouse, Assistant Professor of Dairying
B. N. Duck, Assistant Professor of Agronomy
H. A. Henderson, Farm Manager
N. W. Robinson, Associate Professor of Animal Husbandry

The University of Tennessee Atomic Energy Commission

Agricultural Research Laboratory
N. S. Hall, Laboratory Director
M. C. Bell, Professor
W. B. Bell, Consultant
J. M. Bird, Superintendent
J. T. Brennon, Consultant
D. G. Brown, Professor
W. F. Byrne, Assistant in Dairy Science
G. W. Casarett, Consultant
B. V. Conger, Assistant Professor
M. J. Constantin, Associate Professor
R. G. Cragle, Professor
T. J. Cunha, Consultant
K. B. Deshpande, Consultant
G. R. Eisele, Assistant in Animal Husbandry
B. H. Erickson, Associate Professor
R. G. Gast, Associate Professor
G. M. Gorman, Assistant in Dairy Science
E. T. Graham, Assistant Professor
S. A. Griffin, Associate Professor
R. F. Hall, Assistant Professor
D. F. Johnson, Jr., Professor
D. D. Killion, Assistant Professor
W. D. Klobe, Assistant Professor
R. L. Lovvorn, Consultant
A. F. McFee, Associate Professor
W. C. Magrane, Consultant
J. B. Mailhes, Assistant in Animal Husbandry
Polly G. Martin, Assistant Professor
J. K. Miller, Associate Professor
R. J. Monroe, Consultant
F. R. Mraz, Professor
R. L. Murphree, Professor
T. R. Noonan, Professor
W. C. Patrick, Assistant to the Director
R. A. Reynolds, Assistant Professor
W. L. Sanders, Assistant Professor
L. B. Sasser, Assistant Professor
J. C. Souto, Professor
G. E. Spalding, Assistant Professor
D. L. Stoddard, Assistant Professor
J. R. Strange, Assistant in Animal Husbandry
Marilyn L. Swatzell, Research Technician
L. Wade, Jr., Assistant Professor
J. L. West, Professor
M. H. Wykoff, Associate Professor

Main Station, Knoxville

J. N. Odom, Superintendent of Farms

Branch Stations

Dairy Experiment Station[1], Lewisburg, J. R. Owen[1], Superintendent
Highland Rim Experiment Station, Springfield, L. M. Safley, Superintendent
Middle Tennessee Experiment Station, Spring Hill, J. W. High, Jr., Superintendent
Plateau Experiment Station, Crossville, J. A. Odom, Superintendent, E. L. Bohanon, Manager

[1] In cooperation with the U. S. Department of Agriculture.

Tobacco Experiment Station[1], Greeneville, J. H. Felts[1], Superintendent
West Tennessee Experiment Station, Jackson, B. P. Hazlewood, Superintendent

Field Stations

Ames Plantation, Grand Junction, James M. Bryan, Manager
Cumberland Forestry Field Station, Wartburg, J. S. Kring, Manager
Highland Rim Forestry Field Station, M. T. Seay, Manager
Milan Field Station, Milan, Tom C. McCutchen, Manager
Oak Ridge Forest and Arboretum, Oak Ridge, J. S. Kring, Manager

Appointments, Terminations, Leaves

Appointments

William Alexander, Assistant in Agronomy, January 1, 1969
W. H. Allen, Assistant in Agricultural Engineering, January 1, 1969
Elmer Ashburn, Assistant in Agronomy, August 1, 1969
Beverly S. Ausmus, Assistant in Agricultural Biology, March 1, 1969.
William H. Baker, Assistant in Forestry, September 1, 1969
W. D. Barber, Assistant Professor of Agronomy, May 1, 1969
Steven P. Bertsch, Assistant in Animal Husbandry, January 1, 1969
Elvin E. Birth, Assistant in Forestry, February 1, 1969
B. L. Bledsoe, Associate Professor of Agricultural Engineering, June 9, 1969
Amelia Brown, Assistant in Food Science, September 1, 1969
L. E. Brown, Assistant in Agricultural Engineering, September 16, 1969.
Harold Carpenter, Assistant in Agronomy, September 22, 1969
James R. Chapman, Assistant in Agronomy, September 1, 1969
Donald L. Cline, Assistant in Agricultural Economics, January 1, 1969
Jack H. Collier, Assistant in Forestry, September 1, 1969
Michael L. Countess, Assistant in Forestry, September 16, 1969
R. L. Cowsert, Assistant in Dairying, August 1, 1969
J. D. Davenport, Assistant in Agricultural Engineering, September 1, 1969
F. D. Evans, Assistant in Agricultural Engineering, December 1, 1969
Jerry D. Frady, Assistant in Agronomy, September 1, 1969
Jimmy M. Gass, Assistant in Agronomy, September 8, 1969
Rhetta Sensintaffer Goebel, Assistant in Textiles and Clothing, September 1, 1969
Charles D. Griggs, Assistant in Agricultural Economics, June 16, 1969
Gordon B. Idol, Assistant in Animal Husbandry, March 17, 1969
Larry S. Jeffery, Assistant Professor of Agronomy, July 1, 1969
John P. Jordan, Assistant in Agricultural Economics, June 9, 1969
R. C. Jordan, Assistant in Dairying, July 1, 1969
Dwight A. Kaufman, Assistant in Animal Husbandry, July 1, 1969
Donald D. Killion, Assistant Professor, UT/AEC, July 1, 1969
Samuel Kincheloe, Assistant in Agronomy, September 1, 1969
Hollis R. Large, Assistant in Forestry, June 16, 1969
C. D. Leeper, Assistant in Poultry, July 1, 1969
Charles R. Leslie, Assistant in Agronomy, September 22, 1969
Gary M. Lessman, Assistant Professor of Agronomy, January 1, 1969
D. B. Longmire, Assistant in Dairying, September 16, 1969
John B. Loy, Assistant in Animal Husbandry, October 1, 1969
John B. Mailhes, Assistant in Animal Husbandry, September 1, 1969
Richard H. Martin, Assistant in Forestry, September 16, 1969
George C. McGhee, Research Technician, October 1, 1969
J. D. Nash, Assistant in Dairying, January 1, 1969
James B. Neel, Assistant in Animal Husbandry, September 1, 1969
Linda Pile, Assistant in Food Science, March 1, 1969
George Rink, Assistant in Forestry, July 1, 1969
Dennis R. Roop, Assistant in Food Technology, September 16, 1969
Dianne Ruff, Assistant in Food Science, September 1, 1969
Morris T. Seay, Manager, Highland Rim Forestry Field Station, August 11, 1969
Peter E. Shumway, Assistant in Animal Husbandry, January 1, 1969
Marshall Smith, Assistant in Agronomy, March 16, 1969
L. E. Thompson, Assistant Professor of Agricultural Engineering, September 1, 1969
B. J. Trevena, Instructor in Agricultural Economics, July 1, 1969
Ronald D. Weddel, Assistant in Agricultural Economics, July 1, 1969
Betty Whittle, Assistant in Nutrition, September 1, 1969
Frank W. Woods, Professor of Forestry, September 1, 1969

Terminations

Curtis W. Absher, Assistant in Animal Husbandry, March 25, 1969
Henry Andrews, Assistant Professor of Agronomy, March 31, 1969
James A. Atchison, Assistant in Agricultural Economics, March 31, 1969
Mary Elizabeth Athearn, Assistant in Textiles and Clothing, August 31, 1969
Jerry Barker, Assistant in Agronomy, June 30, 1969
Paul E. Barnett, Assistant in Forestry, June 30, 1969
Bennie E. Beeson, Assistant in Agricultural Economics, December 31, 1969
Elvin E. Birth, Assistant in Forestry, September 30, 1969
D. R. Bowman[1], Associate Professor of Agronomy, November 5, 1969
E. K. Boyce, Assistant Professor of Agricultural Engineering, March 31, 1969
William L. Brown, Assistant in Animal Husbandry, November 30, 1969
Billy Joe Byerley, Assistant in Agricultural Economics, December 31, 1969
John E. Chandler, Assistant in Animal Husbandry, June 11, 1969
James R. Chapman, Assistant in Agronomy, December 31, 1969
Richard U. Clark, Assistant in Agronomy, April 23, 1969
Richard P. Clarisse, Assistant in Animal Husbandry, July 31, 1969
John P. Cooper, Assistant in Agricultural Economics, December 31, 1969
Sam T. Cooper, Assistant in Agricultural Economics, December 31, 1969
Donald J. Davis, Assistant in Animal Husbandry, June 30, 1969
Roger E. Deitrick, Assistant in Forestry, June 30, 1969
H. H. Dowlen, Assistant in Dairying, January 24, 1969
Thomas R. Eubanks, Assistant in Forestry, October 20, 1969
Raymond N. Gallaher, Assistant in Agronomy, September 15, 1969
J. L. Goodenough[1], Instructor of Agricultural Engineering, July 31, 1969

[1] In cooperation with the U. S. Department of Agriculture.

Robert Granger, Assistant in Agronomy, July 31, 1969
Larry Heatherly, Assistant in Agronomy, March 15, 1969
Harry A. Henderson, Assistant in Agricultural Economics, May 31, 1969
R. D. Holder, Assistant in Dairying, July 31, 1969
Paul J. Huffman, Jr., Manager, Highland Rim Forestry Field Station, Tullahoma, July 31, 1969
Gordon B. Idol, Assistant in Animal Husbandry, September 10, 1969
Jay W. Johnson, Assistant in Agronomy, June 30, 1969
John P. Kuehn, Assistant in Agricultural Economics, September 23, 1969
Maxine Lyle, Assistant in Food Technology, September 30, 1969
Michael D. Martin, Assistant in Forestry, June 30, 1969
Stanley G. Miller, Instructor of Animal Husbandry, September 9, 1969
Jayne Tigert Morris, Assistant in Nutrition, August 31, 1969
Lynn E. Murray, Assistant in Horticulture, June 1, 1969
J. D. Nash, Assistant in Dairying, June 9, 1969
Billy W. Nelms, Assistant in Agricultural Economics, March 31, 1969
Linda Pile, Assistant in Food Science, July 31, 1969
David W. Porter, Assistant in Animal Husbandry, August 31, 1969
William J. Powers, Assistant in Agricultural Biology, August 31, 1969
Marshall F. Priest, Assistant in Agricultural Biology, December 31, 1969
Patricia Read, Assistant in Food Science, August 31, 1969
John R. Roper, Assistant in Agronomy, April 5, 1969
Leonard Wayne Russell, Assistant in Food Technology, September 30, 1969
Eugene G. Seimer, Assistant Professor, UT/AEC, September 1, 1969
Billy Sellers, Assistant in Agronomy, March 15, 1969
Gopalsamy Srinivasan, Assistant in Animal Husbandry, December 31, 1969
Marilyn L. Swatzell, Assistant in Animal Husbandry, July 1, 1969
Ellen Willis, Assistant in Food Science, February 28, 1969
Max J. Young, Assistant in Forestry, June 15, 1969

Change of Title

L. N. Callahan, to Associate Professor of Agronomy, July 1, 1969
C. L. Cleland, to Professor of Rural Sociology, July 1, 1969
James W. Hilty, to Associate Professor of Agricultural Biology, July 1, 1969
Jackie E. Martin, to Livestock Manager, Blount and Alcoa Farms, September 1, 1969
George C. McGhee, from Manager, Poultry Unit, to Research Technician, Department of Poultry, October 1, 1969
M. J. Montgomery, to Associate Professor of Dairying, July 1, 1969
Jimmy E. Pendergrass, to Assistant in Agricultural Biology, September 16, 1969
John H. Reynolds, to Associate Professor of Agronomy, July 1, 1969
R. C. Shadden, to Instructor of Agricultural Engineering, April 1, 1969
O. Clinton Shelby, from Assistant to the Dean, Agricultural Extension Service, to Director of Business Affairs, December 1, 1969
Marilyn L. Swatzell, from Assistant in Animal Husbandry, to Research Technician, UT/AEC, July 1, 1969

On Leave

A. C. Blake, Assistant Editor, Department of Information (India assignment)
O. H. Long, Professor of Agronomy (India assignment)
W. W. Stanley, Professor of Agricultural Biology (India assignment)

Returned from Leave

R. G. Cragle, Professor, UT/AEC, September 1, 1969

Retirement

James L. Anderson, Budget Officer, October 31, 1969

Upper left: Equipment for applying ultra-low volumes of insecticides has been under development in order to permit more careful control of amount of materials being applied, to reduce quantities needed and to reduce amount of water necessary to transport. This equipment can satisfactorily distribute volumes as low as a pint per acre.

Bottom: The Agricultural Experiment Station has continually reported results of its research work through a variety of methods such as printed bulletins and field days at its Branch Stations. In 1965, the Middle Tennessee Experiment Station at Spring Hill hosted the Second National Grassland Conference and Field Days.

Upper right: Climatic conditions in the immediate vicinity of the cotton plant have a great influence upon cotton yields. In the experiment pictured here reflectors are increasing the amount of light within the cotton row and the weather station at right center is measuring and recording soil and air temperatures. Yields per plant are increased when cotton is planted in wider rows because there is more light available to the plant, the temperature is higher within the plant environment and there is more carbon dioxide available to the plant because of greater air circulation.