

# Agricultural Research Builds Up New Efficiency in Farming

Annual Report of the Missouri Agricultural  
Experiment Station



Plant Breeders Are Restoring Winter Barley Crop. (See page 2.)

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

Bulletin 584

J. H. LONGWELL, *Director*

July, 1952

## LETTER OF TRANSMITTAL

President F. A. Middlebush  
University of Missouri  
Columbia, Missouri  
Sir:

I am submitting herewith the report of the Agricultural Experiment Station for the year ending June 30, 1951. This report is submitted in accordance with the Federal law requiring such a report, a copy of which is to be submitted to the Governor of the State and to the Secretary of the Treasury of the United States.

Respectfully submitted  
J. H. LONGWELL, *Director*  
*Missouri Agricultural Experiment Station*

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**Cover Picture.** A plant breeder at the Missouri Experiment Station is shown applying the inoculation test to discover smut-resistant strains of winter barley. The best of these are crossed with high-yielding, winter-hardy strains. This long-time fight to produce new varieties strong in resistance to winter kill and naked smut is nearing success—restoring to Missouri a major source of feed grain, pasture, and soil cover.



# **AGRICULTURAL RESEARCH BUILDS UP NEW EFFICIENCY IN FARMING**

**Annual Report of the Missouri Agricultural  
Experiment Station**

J. H. LONGWELL, *Director*  
S. B. SHIRKY, *Associate Director*

## **INTRODUCTION**

For sixty-five years the Agricultural Experiment Station at the University of Missouri has carried on a continuous program of research in problems of farming and country life. Results of this work have built up into tremendous gains for agriculture and the state. Furthermore, these gains are growing and dependably recurrent year after year.

Well known is the story of the Station's early efforts to cope with the Hessian fly, which reached its peak numbers in 1916 and destroyed \$9,000,000 worth of Missouri wheat. By the end of the following year, however, the Station had worked out a method of control that has since saved from \$5,000,000 to \$8,000,000 worth of wheat a year.

A staggering problem of the early 1920's for Missouri meat and milk producers was the midsummer gap in grazing due to the seasonal failures of so-called permanent pastures under the scorching heat of July and August. To fill this breach the Station seized upon the uncertain possibilities of a tiny sample of seed of a small annual legume imported from the Orient. At the end of six years of multiplication and selection, the Station was able in 1927 to introduce lespedeza as the missing link in Missouri's supplementary pasture system. The speed with which farmers throughout the state accepted this crop attests to its adaptability to our soil and climate. It became within two decades the state's most extensive and most valuable crop, most economical to produce, and worth at conservative estimate \$100,000,000 a year.

Another research project at Missouri has been the long and tedious search for growth promoting substances essential for thrifty and disease-resistant chicks and other young animals. This work in agricultural chemistry demonstrated the importance of riboflavin and choline for poultry. These vitamins were not commonly found in poultry feeds prior to this discovery, but now they are added as a matter of reliable economy. Their use adds no less than \$10,000,000 a year to the state's poultry income.

Missouri feeding trials with beef cattle have demonstrated repeatedly that good to choice animals weighing up to 1100 pounds can be produced chiefly on grass and roughage with less than 15 bushels of corn used to add the market finish. Application of this discovery to the cattle on feed in Missouri during any recent winter season could save the beef producers \$10,000,000 without reducing the acceptability of their product for the consumer.

Terracing and water management systems adapted to Missouri's hilly farmlands have been established on some 800,000 acres to hold soil, moisture and fertilizer. Such protection increases the productivity of the land about \$20 an acre—a total annual gain of \$16,000,000.

Revolutionary changes in corn production have been wrought by agricultural research. Missouri corn yields have risen in recent years from an average of 28 bushels to 43 bushels an acre. This basic change was due chiefly to the general introduction of corn hybrids and more specifically to the development of hybrid strains adapted to Missouri conditions. Practically all of the state's corn acreage now is planted to hybrid seed, and at least 60% of it is grown from seed of hybrid varieties developed by the Missouri Station and growers cooperating with the Station. On this portion of the crop the annual gain due to the superior hybrid performance is not less than 22,500,000 bushels.

Even more significant are the gains made in corn yields by more liberal and intelligent use of fertilizers. After 58 years of fertilizer inspection and improvement the Missouri Station is able to recommend fertilizer treatments to meet every plant requirement and to compensate for each soil deficiency as revealed by tests. Many years of research at this Station also has compared various modes and measures of fertilizer application, as well as variations in spacing and population of corn plants per acre. Guided by this research, Missouri corn growers are producing yields up to 150 bushels an acre. Yields of 100 bushels or more are commonplace.

These instances are only a few of the contributions made by the Experiment Station over the years. In addition, there have been countless smaller gains in the efficiency of farming and homemaking. Every one of them has made some additional saving in cost of production, some reduction of loss or waste, some saving of time and human energy, some addition to comfort or safety, some enlargement of opportunity for the rural family.

Knowing this, we can well understand that it is not by accident that America has food in abundance to share with distressed peoples around the world.

This good fortune is rather the fulfilment of the deliberate plan of the United States Congress in 1862, when it established the land-grant

agricultural colleges. That provision of ninety years ago became an endowment policy for the enrichment and prolongation of our national life.

And this policy pays off in knowledge, a commodity that does not depreciate with use. The more widely it is applied the more it earns for us and the more securely we possess it.

The Missouri Experimental Station in the year ending June 30, 1951, reported work done on 170 research projects. The methods used and the results obtained are given by the department chairmen in the following pages.

## AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

**Chemical Analytical Service** (Charles W. Gehrke, E. W. Cowan, Jacqueline Hearne, Edward Martin, Roscoe Pearce, Lewis Ferguson, August Haselhorst, Jack Browne, Charles Runyon and T. H. Barrett, Jr.). Chemical analyses made for projects and departments of the College of Agriculture and its cooperators throughout Missouri reached a total of 19,874. More than half of these were made in carrying out the provisions of the Missouri Fertilizer Control Law.

The following is a summary of the samples of material analyzed and the number of single analyses involved in this service.

Fertilizer Samples .....	2,007
Limestone Samples .....	2,695
Samples from College Research Projects .....	465
Miscellaneous Samples .....	124
Total Number of All Samples .....	5,291
Single Fertilizer Analyses .....	10,860
Single Limestone Analyses .....	5,454
Single Analyses for College Departments .....	3,146
Single Miscellaneous Analyses .....	414
Total of All Single Chemical Analyses .....	19,874

**Unrecognized Nutrients Required by Poultry** (A. G. Hogan and J. E. Savage). The search for nutrient factors still unknown that may speed the growth of newly hatched chicks was continued. In eleven feeding trials 43 different rations were compared.

Chicks grew fairly well on a ration that contained casein as the only source of dietary protein, but when liver protein replaced a part of the casein growth was speeded up. Chicks on a ration containing soybean oil meal as their only protetin source made faster growth than those on the casein mixture. Exceptional growth was made on feed containing protein from both casein and soybean oil meal.

A similar comparison was made between a ration containing alpha-protein prepared from soybeans and another in which liver protein replaced a part of the alpha-protein. This addition gave exceptional growth while the alpha-protein alone produced only fair results.

Another trial sought to correct the amino acid deficiency of chick feeds containing casein and gelatin. Instead of the usual 0.3% of methionine added for this purpose, the amount was increased to 0.8%. By this change the growth rate was definitely improved.

Another attempt to correct the amino acid deficiency of chick diets depending on casein for their protein was made, comparing three additions for this purpose: (1) 0.8% methionine, (2) 0.3% arginine and 0.8% methionine, and (3) 0.6% arginine and 0.8% methionine. In this trial 0.8% methionine alone was ineffective. The second supplement was a definite improvement but still unsatisfactory. The third was much superior to the other two. All three of these diets contained glycine.

Other findings made in this series of chick feeding trials are reported briefly.

Lactalbumin used with gelatin was found seriously deficient in at least one other amino acid.

Both calcium gluconate and gum arabic were again tried in various combinations as possible sources of non-specific growth factors. Results with calcium gluconate were only slightly encouraging, while those from gum arabic were more pronounced but difficult to explain.

Results from using the antibiotics including aureomycin, penicillin, streptomycin and terramycin were inconclusive. The investigators' comment: "The usefulness of antibiotics in poultry feed requires additional study."

Still another feeding trial sought to offset or overcome the well known toxic properties of thyroxin and iodized casein (protamone) when used to excess. It was found that the ill effect of protamone at the 0.3% level was entirely overcome by the addition of B<sub>12</sub> at a concentration of 0.05%. When the ration included all three supplements, vitamin B<sub>12</sub>, protamone and liver protein, the rate of growth was excellent.

**Nutrients Required for Growth, Gestation and Reproduction of the Guinea Pig** (A. G. Hogan, W. B. House and H. S. Bull). When infectious enteritis broke out among the animals in this experiment it defeated original plans by destroying nearly half of the animals, but the investigators quickly turned this outbreak into an opportunity to test penicillin and streptomycin as controls for this disease.

Animals receiving both antibiotics in addition to their basal ration grew at a fair rate, but those without these supplements began dying by the fourth week and only one survived through the eighth week. Additional tests indicated that the curative effects were due not to penicillin

but to streptomycin used at the strength of 40 mgs. per 100 gms. of the ration.

**Relation of Nutrition to the Occurrence of Arthritic-Like Symptoms in Experimental Animals** (A. G. Hogan, W. B. House and H. S. Bull). The main objective was to find a source of an organic factor that will prevent joint stiffness and the formation of calcareous deposits in the soft tissues of laboratory animals. These symptoms are produced experimentally by increasing the phosphorus content of the diet.

A secondary objective of the experiment was to learn whether or not a high phosphorus level and an unfavorable calcium-phosphorus ratio are the sole cause of arthritic-like abnormalities.

The investigators first developed a new way to measure the severity of these symptoms. The old method had been to test wrist stiffness by manipulating the arm of the guinea pig. Besides lacking in precision, this test was slow and also subjected the animal to severe pain.

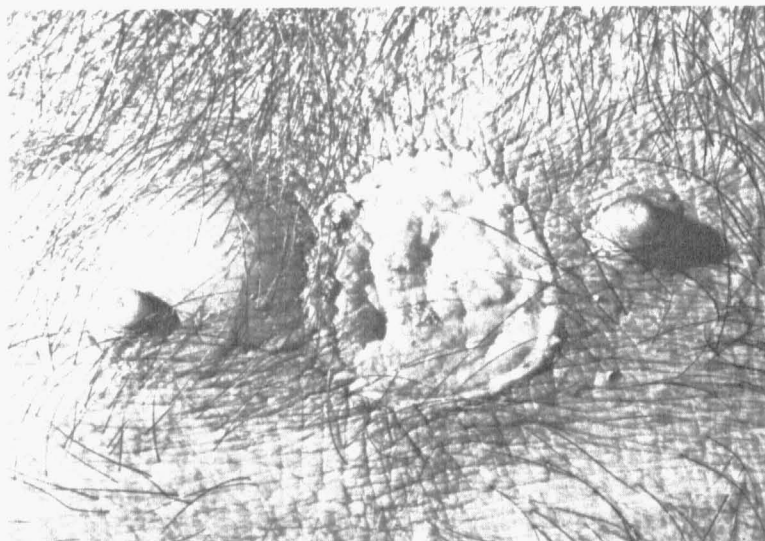
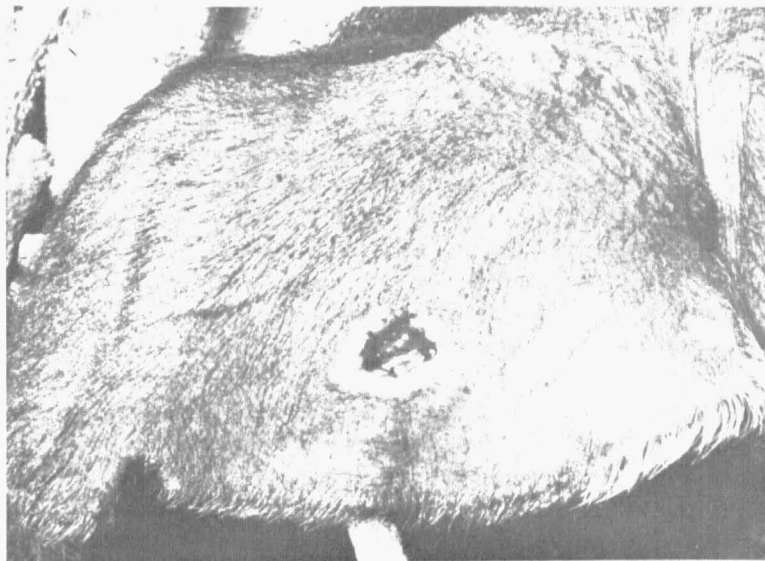
The Missouri workers during the current year replaced the old (van Wagtendock) assay with a blood test for inorganic phosphorus. Since this required only a small (0.05ml.) sample of blood for analysis, the animals were tested frequently and without discomfort. This test measures accurately the effect of preventive agents added to the diet.

The experimental diets included a series of fresh vegetables—cabbage, carrots, turnips, spinach, tomatoes, and beans—as alternative supplements to a synthetic basal ration. Only the animals that ate the spinach were free from joint stiffness. All other lots had either mild or severe arthritic symptoms.

Another series of diets was devised to test the effects of variations in the ratio of calcium to phosphorus. Previous work had shown that a change in this ration from 1.31:1 to 0.68:1 in the stock ration resulted in 50% retardation of growth together with joint stiffness and calcareous deposits. This was followed during the current year by feeding a limited number of animals on diets containing calcium and phosphorus varying widely in both amounts and ratios.

In a synthetic basal diet the salt mixture was varied to produce the desired contrasts. Both the inorganic phosphorus in the blood and mobility of the wrist joint were used as a basis for assay. The Ca:P ratio ranged from 1.75:1 to 0.63:1. The ration having the lowest relative calcium content resulted in the highest blood phosphorus content and was associated with the only case of severe stiffness in the five-lot test.

**Study of Physiological and Biological Phenomena Associated with the Hemophilia-Like Condition in Swine** (M. E. Muhrer). In bleeder hogs there is a coagulation impediment which may be associated with other defects. This study had three objectives: (1) Learn more of the nature of the defect, (2) investigate the causes of hemorrhages in general, and (3)



Experiments with injections of formaldehyde as a control for excessive bleeding in swine indicated that this practice is both ineffective and harmful. The upper photograph above shows a lesion which formed on a pig's ear, while the lower photograph shows a lesion and mammary abscess—all resulting from formaldehyde injections. Such lesions appeared not only near the point of injection but also in other parts of the animal's body.



search for substances that may prove useful in hemorrhage control.

It was found that in normal animals the prothrombin time of the blood serum increases rapidly after coagulation, while in the hemophiliac the prothrombin time remains short for a considerable period after coagulation. This slow rate of prothrombin in bleeder animals has a parallel in human hemophilia. The slow rate of prothrombin conversion results in a decrease in clot strength.

Several other causes of bleeding were found.

A western Missouri farmer who had lost several head of cattle from hemorrhage sent in samples of sweet clover hay and silage. The hemorrhagic factor was found in three samples of the hay and in one sample of moldy sweet clover silage.

Another farmer, during the recent widespread use of Warfarin for poisoning rats, brought in a dog which he believed had been poisoned by this preparation. But it was not possible, with present techniques, to detect any of this poison in the animal for his stomach was empty by the time he reached the laboratory. It is well known, however, that Warfarin produces a hemorrhagic condition in most farm animals and pets. New tests are needed to identify the delayed-action effects of this poison in animal bodies.

The search for substances capable of controlling hemorrhage in farm animals included tests of swine blood globulin submitted by Armour & Company. In these tests, Armour's fractions I, II, and IV were not found useful. Fraction IV shortened the coagulation time of the bleeder for a few hours but after that the animal reverted to its original condition and became an even worse bleeder than before treatment. Fraction III, while unsuitable for administration by injection, was effective when used externally to reduce bleeding of pigs and lambs following castration.

Testing formaldehyde as a control for bleeding offered little encouragement. Its reduction of saline bleeding ended too quickly and the decrease in coagulation time was too slight.

**Maternal Nutrition and Congenital Infant Abnormalities in Rats** (A. G. Hogan, B. L. O'Dell, and J. R. Whitley). Purposes of this experiment: (1) Test protective factors, (2) determine the time when damage to the embryo occurs, and (3) measure the biochemical defect in offspring from dams deficient in vitamin B<sub>12</sub> and folic acid.

Hydrocephalus was found in about 30% of the offspring from dams fed a ration containing 70% soybean meal and all known vitamins required by the rat except B<sub>12</sub>. The addition of a B<sub>12</sub> concentrate supplying 2.2 micrograms of vitamin B<sub>12</sub> per 100 grams of ration prevented the abnormality. The same effect was obtained by injecting crystalline B<sub>12</sub>.

Both folic acid and B<sub>12</sub> were required to prevent abnormalities in the offspring. Hydrocephalus was induced by feeding the dams purified soy-

bean meal, peanut meal, linseed meal or cottonseed meal. The cottonseed meal was most deficient in protective factors.

Female rats fed a casein ration deficient in folic acid produced about 2% hydrocephalic offspring. Adding vitamin B<sub>12</sub> alone did not prevent this abnormality but a combination of B<sub>12</sub> and folic acid completely prevented it.

**Conservation of Nutritive Value of Foods** (Laura M. Flynn, A. G. Hogan, Robert B. Grainger, Raymond A. Schroeder, and Marcus S. Zuber). This work was done by four departments; Agricultural Chemistry, Animal Husbandry, Horticulture, and Field Crops.

The effect of fertilizers upon the nutritive value of crops was the object of one section of this study. Three crops were studied; New Zealand spinach, snap beans and lima beans. Each crop was grown for comparison on three plots of varying soil fertility; (1) a poor soil unfertilized, (2) the same soil fertilized, and (3) the same soil with still better fertilizer treatment. Dry matter analyses did not show marked differences in the composition of the crop from the three levels of soil fertility. In both spinach and green lima beans the data indicated slight increases in protein and slight decreases in crude fiber on the fertilized plots. These apparent increases, however may have been related to the comparative maturity of the crops.

Another section of this study was a statistical analysis of microbiological assays of nicotinic acid and several essential amino acids in corn. Reported here are the assays of methionine and cystine in the corn samples. The correlations between percentage of nutrients and of crude protein were found to be highly significant. When the protein content in whole corn increased 100% (from 8 to 16%) the tryptophan increased 27%, the lysine 74.2% and the methionine 68.3%. The cystine and the nicotinic acid in whole corn decreased 18.8 and 34%, respectively, as the protein was doubled. These studies indicate that if plant breeders attempt to increase the protein content of corn their prime interest should be in protein quality.

A third part of the general inquiry was a study of the retention of ascorbic acid in strawberries, corn and peaches held in frozen storage with variation of temperature in storage. Determinations of dry matter and ascorbic acid were made of the materials when fresh and newly frozen and again after each had been stored for six months or one year. All lots of strawberries—whether stored at 0°, 10°, or at variations between 0° and 10°F., and whether stored six months or a year—retained ample amounts of ascorbic acid. In fact the ascorbic acid in a 100-gram serving of even the poorest berries and syrup was roughly equivalent to that furnished in the same weight of fresh tomatoes.

Best retention of ascorbic acid in frozen sweet corn was found in the

sample stored at 0°F. throughout the storage period. No variation in content of this vitamin was found in the other lots except that which was stored six months at 0°F. with temperature raised to 35°F. three times within that period. It showed unusually low ascorbic acid content at the end of the test.

The frozen peaches tested in this study were packed in syrup containing the commercial ascorbic acid concentrate ACM, a mixture of citric and ascorbic acids. This addition made the syrup acid and caused excellent retention of the ascorbic acid added in the commercial mixture. Variation in the temperature during storage had little effect on vitamin retention.

## AGRICULTURAL ECONOMICS

O. R. JOHNSON, *Chairman*

**Wages and Working Conditions for Farm Labor in Missouri** (O. R. Johnson). The data were gathered by interviews with sample employers in Audrain and Ralls Counties. Of the workers studied, 35% were under 30 years of age, 32% were 30 to 44, 23% were 45 to 59, and 10% were 60 or older.

All of the farms studied were fairly large; 17% being of 1000 acres or larger, 43% between 1000 and 500 acres, and only 5% smaller than 250 acres.

Of the total number of workers, 52% were married, and the average size of these families was 4.03 persons. For housing, 52% were furnished with a house and other accommodations, while 13% were provided with room, board and laundry service.

All who had a house were also given a garden plot, 38% were permitted to keep poultry, 78% were furnished with meat, all with a milk cow or milk from the farm herd, and 50% with fuel cut from the farm at the employer's expense.

The average estimated yearly values of these perquisites were: Milk \$205, fuel \$25, meat \$71 and garden \$4: total \$305. Average rent value of the houses (averaging 4.7 rooms each) was \$25.

As to wages, the average pay of all full-time workers was about \$140 a month, including perquisites. Ninety-two per cent of the workers said their jobs were satisfactory.

**Marketing Feeder Livestock** (Elmer Kiehl). Country dealers were found to be the most important channels for selling feeder livestock by the producers. Direct purchases by feeders from producers ranked second. Public stockyard markets tended to be less important than either country buyers or direct purchases as marketing channels for all types of feeder livestock.

Nearly 85% of the hogs handled at auctions were feeder pigs. Of other types of livestock sold at auctions, 78% of the cattle and 55% of the sheep were classified as feeders.

Producers who sold feeder livestock reported that nearly 90% of the animals sold were inspected by buyers before sales were completed. It was the conclusion of the investigators that practical, accurate classification of feeder animals usable at all levels within the marketing channels would contribute to lower costs.

**Developing Objective Carcass Grade Standards for Slaughter Hogs** (Elmer R. Kiehl and James W. Reynolds). With the cooperation of a packing company, 592 hog carcasses were classified in 12 weight groups ranging from 95 to 215 pounds. The study centered on four lean cuts; hams, loins, picnics and butts. Their percentage weight as related to the whole carcass was calculated and correlated with the length of body and length of legs, as well as to single backfat thickness.

Using Chicago wholesale prices of these cuts, a statistical analysis was made to determine the validity of the proposed grade standards in practical use. A summary of these data was submitted to the Regional Technical Committee of the North Central Experiment Stations.

**Developing Objective Carcass Grade Standards for Slaughter Cattle** (Elmer R. Kiehl and D. E. Brady). Data were collected on 529 beef steer and heifer carcasses in weights from 350 to 900 pounds. Selected carcass measurements were obtained on all carcasses by grades and weight groups. Measurements taken were those believed to be significant in obtaining possible relationships of such measurements to federal carcass grade standards. A detailed subjective evaluation of each carcass was made by a representative of the Bureau of Animal Industry of the U. S. Department of Agriculture.

Further analysis is underway to determine which objective measurements have value in predicting the grade of the carcass.

**A Study of Cotton Marketing in Missouri, Including Marketing Channels, Services, Charges, and Effect of One-Variety Program** (J. Wendell McKinsey and Fred Anderson). Preliminary work on this project was completed, including the schedules of information on cotton marketing channels. This information was obtained by personal interviews with 45 Missouri ginner (first buyers). Similar information was obtained from 10 second buyers. The data are now being tabulated and summarized to be transmitted to the Regional Committee and for use at the Missouri Station.

**The Influence of Farm Handling and Marketing Processes on Egg Quality** (John D. Miller). What percentage of Missouri farmers actually use the best known methods of handling and marketing their eggs? To get an answer to this question an Experiment Station worker interviewed 171 producers. Of this number 56% gathered their eggs two or more

times a day, as the College of Agriculture has recommended. Equally responsive to scientific advice, 21% gathered their eggs in wire baskets. In contrast 11% used wooden baskets, 64% solid metal containers, and 3% used "aprons, caps or anything that is handy."

Storage and marketing practices showed similar variation. As to place of storage; 44.76% in cellar or cave, 25.32% on the porch, 12.2% in the house, and 15.6% in various farm service buildings. And only 33.5% of the interviewed producers marketed their eggs at least twice a week in warm weather.

**Obstacles to Rapid Expansion of Conservation Measures in Missouri** (Frank Miller and Hugh Denney). This study includes an examination of the factors that work against expansion of soil conservation measures, together with a discussion of remedial measures that should be undertaken to speed the removal of the obstacles to progress.

Factors that may well be classed as obstacles to speedy expansion are listed by the investigators as the following:

Limitation of funds to pay the cost of making the changes in farm organization to hasten conservation.

The time that must elapse between cash outlays for conservation work and the returns from such improvements.

The desire of owners and operators to get quick income.

Uncertainty as to future prices and weather conditions, and the risk of losing a good part of the money invested in the livestock needed to convert pasture and roughage into readily salable products.

Management problems on small farms where intensive crops are used to keep the family labor force profitably employed.

Land holding and renting practices that restrict the interest of owners or renters to periods shorter than the time required to carry out a conservation plan.

Reluctance of farm operators to change old methods of farming, and lack of accurate information on costs and benefits.

The proposals for solving conservation problems suggest five major avenues of attack: (1) Improvement of credit and financing arrangements; (2) Less costly, alternative plans for conservation farming; (3) Adjustments lengthening the tenure of tenants on land undergoing the renovations necessary for conservation; (4) Education and technical assistance; and (5) Public assistance and land-use regulations.

**Farm Power and Machinery Costs in Northeast Missouri** (James E. Dillion and O. R. Johnson). Data were obtained on the operation costs on combines, corn pickers and hay balers from 91 different farmers in four Northeast Missouri counties; Lincoln, Monroe, Montgomery and Warren. Records on the operation of 62 combines, 38 corn pickers and 15 hay balers were analyzed. The average size of the farm covered by this study

was approximately 350 acres, as compared to the Missouri statewide average of 145 acres.

The average investment in machinery per farm in Missouri as a whole had been reported to be \$772 in 1944, while this study (1950) found the average investment in machinery per farm in Northeast Missouri to be approximately \$6000.

Custom work was a very important part of the operation of these machines, amounting to about 50% of the total use of combines and corn pickers and 75% of the total use of the hay balers.

The 6-foot combines averaged more acres of use than the 5-foot machines, but were used fewer hours. The average amount of use of the 6-foot combines was 201 acres and 133 hours, while the 5-foot machines were used an average of 156 acres and 147 hours. The average efficiency rate of operation was 1.14 acres per hour for the 5-foot machines, and 1.33 acres for the 6-foot machines.

The 1-row corn pickers were used to harvest an average of 83 acres and were used an average of 111 hours. The average use of the 2-row pickers was 193 acres and 193 hours. Average acres harvested per hour were 0.79 for the 1-row machines and 1.00 for the 2-row machines.

The hay balers were used to bale an average of 9789 bales, though use of the 15 machines varied from 1100 to 25,000 bales.

Average annual cost of operation on the 5-foot combines was \$181.01 and on the 6-foot machines \$304.48. Depreciation accounted for 55% of the annual cost of the combines.

Corn picker operation costs per year averaged \$133.48 for the 1-row pickers and \$224.72 for the 2-row machines.

The average annual cost of hay balers was \$308.17.

Average annual cost per unit of work done was another measure used in this study. This cost for each type of machine involved is reported in dollars per acre of grain harvested or in cents per bale of hay baled as follows:

The 5-foot combine cost \$1.47 per acre, the 6-foot combine \$1.72. The 1-row corn picker cost \$2.10 and the 2-row picker \$1.44 an acre. The average annual cost of the hay balers was 6.3 cents per bale.



## AGRICULTURAL ENGINEERING

M. M. JONES *Chairman*

**Power and Labor Costs of Farm Machines** (C. L. Day, B. J. Butler and M. M. Jones). The report covers three sections of the study; (1) hay and ensilage harvesting costs, (2) methods of seedbed preparation for wheat, and (3) comparing liquefied petroleum with gasoline as a tractor fuel.

For small acreages where hay is to be fed on the farm where grown, the cheapest and most satisfactory method of harvest still appears to be some combination of buck rake, hay stacker, hay wagon, hay loader, hay fork and pitchfork. Per ton costs of baling and chopping hay were about equal. Baling costs more for labor, but chopping and blowing require more machinery.

For harvesting ensilage the field ensilage harvester and forage blower have some decided advantages over the corn binder and stationary chopper. The field harvester reduces the average size of the working crew from 13 or 14 to only 5 or 6 men. Tables 1 and 2 give summaries of the comparative costs.

TABLE 1--Average Cost Per Ton for Various Haying Operations

Operation	Machine	Labor	Machine <sup>2</sup>	Tractor <sup>3</sup>	Total
		Costs	Costs	Power	Cost
		Per Ton	Per Ton	Per Ton	Per Ton
<b>Mowing (42)<sup>1</sup></b>	7 ft. tractor mower	\$ .25	\$ .17	\$ .17	\$ .59
<b>Raking (34)</b>	Side delivery rake	.20	.15	.13	.48
<b>Baling Hay (33)</b>	Automatic-tie, pick-up baler with engine	.19	1.61	.15	1.95
<b>Baling Hay (27)</b>	Automatic-tie, pick-up baler without engine	.21	1.15	.18	1.55
<b>Baling Hay (16)</b>	Hand tie, pick-up baler with engine	.64	1.28	.15	2.07
<b>Hauling &amp; Storing baled hay</b>	Wagons & tractors (12)	1.05	.04	.20	1.29
	Trucks (2)	1.12	.70	--	1.82
<b>Chopping Hay (6)</b>	Field Chopper with engine	.28	1.56	.22	2.06
<b>Chopping Hay (11)</b>	Field Chopper without engine	.31	1.26	.31	1.88
<b>Hauling Chopped hay (6)</b>	Wagons & Tractors	.43	.07	.25	.75
<b>Storing Chopped hay (6)</b>	Blower	.34	.28	.19	.81

(1) Number of reports included in the study.

(2) Includes cost of gasoline, oil, grease for auxilliary engines and the cost of twine or wire for balers.

(3) Includes cost of gasoline, oil, and grease.

TABLE 2--Average Cost Per Ton for Various Ensilage Harvesting Operations

Operation	Machine	Labor Costs Per Ton	Machine Costs Per Ton	Tractor Costs Per Ton	Total Costs Per Ton
Cutting (5) <sup>1</sup>	Corn binder	\$ .12	\$ .30	\$ .07	\$ .49
Loading and hauling fodder(5)	Wagons & Tractors	1.04	.05	.19	1.28
Chopping & stor- ing fodder (5)	Stationary ensilage cutter	.22	.22	.10	.54
Chopping (13)	Field ensilage cutter with engine	.10	.58	.08	.76
Chopping (29)	Field ensilage cutter without engine	.11	.45	.11	.67
Hauling chopped silage	Wagons (16)	.20	.04	.12	.36
	Trucks (8)	.24	.46 <sup>2</sup>	--	.70
Storing (24)	Forage blowers	.27	.12	.10	.49

(1) Number of reports included.

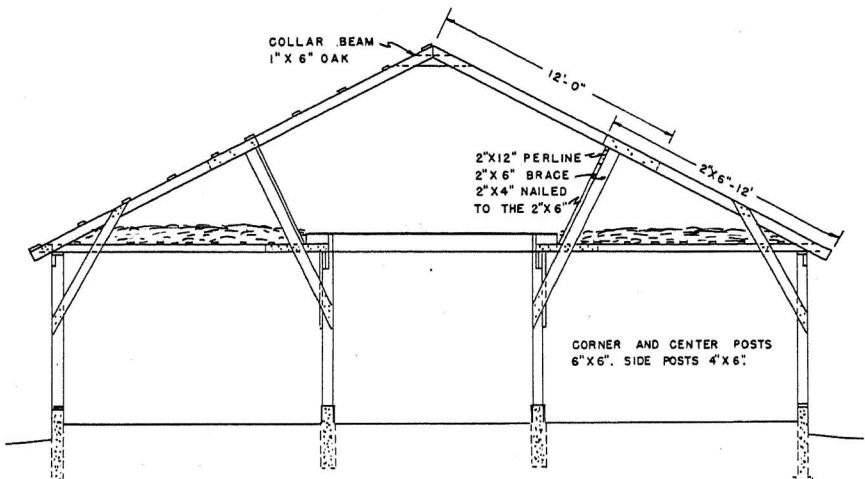
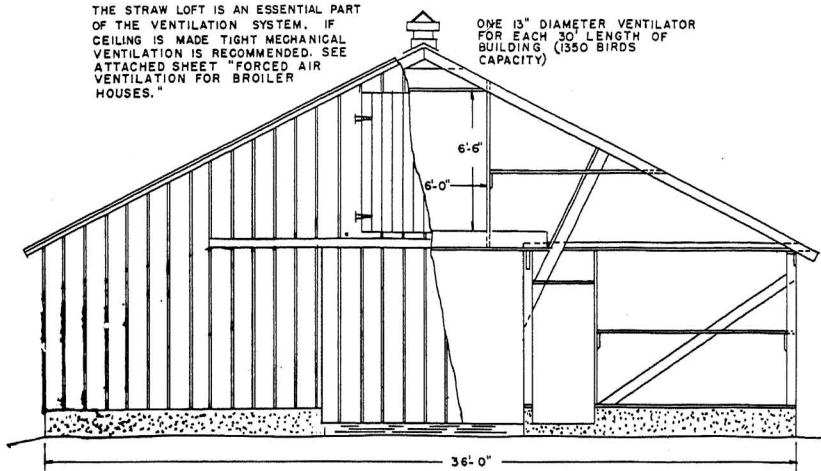
(2) Trucks were charged at the rate of \$1.75 per hour.

The experiment with different methods of preparing the seedbed for wheat has been completed. The highest average yield of wheat was obtained on seedbeds prepared with both plow and field cultivator. There were also fewer weeds and less cheat in the plowed plots than in the plots prepared with the field cultivator alone. It was concluded that using only the field cultivator year after year will encourage weeds and cheat, but that this disadvantage may be overcome by plowing the land once in two or three years.

A survey was made in the summer of 1950 to determine the extent to which Missouri farmers were using LP gas (liquefied petroleum) instead of gasoline for tractor fuel. Between 100 and 150 tractors in the state that summer were being fueled with LP gas.

The main advantages of this new fuel were found to be lower fuel cost, less wear on engine parts, lower oil cost and elimination of valve sticking, along with greater pulling power and efficiency. The disadvantages were cost of conversion for use of the new fuel, the necessity for keeping the tractor ignition system in top working order, and the inconvenience in handling LP gas since it must be kept and handled under pressure.

**Design of Farm Buildings** (J. C. Wooley). Based on analysis of research to date in design of farm buildings, detailed plans were prepared for eight farm service buildings. These were completed and added to the list of plans available to Missouri farmers through the Experiment Station's Plan Service, as follows:



Gable-roof broiler house designed for natural ventilation. The straw loft is an essential part of the ventilation system. For every 30 feet of the house's length a 13-inch roof ventilator is recommended. Ventilating doors under the eaves of the house open inward. The house is 36 feet wide.

Loafing Barn with Hay Storage Overhead, Plan No. 13-A-723-C3. This plan provides for a 28-cow dairy herd with a bedded area occupying the first-floor level of the main building. A shed on the west is a straw-loft, attic-ventilated section for maternity and young stock uses. Hay is fed in the open shed on the east, while silage is fed on a protected yard also on the east side.

Loafing Barn, Hay Storage to Ground, Plan No. 15-723-C3. Here is a simple structure with movable mangers to reduce labor. In early fall a bedded area 12' by 72' is available for cows, and its size increases as the hay is used and the mangers moved back.

Loafing Shed for Dairy Cows, Plan No. 16-723-C3. This is an open front shed with storage space for enough baled straw for one-third of the season's needs. Hay is to be fed outside. Any milking parlor can be used in this building.

Feed Storage and Processing Building, designed for a 30-cow herd. This plan provides ground-floor storage for corn and oats needed for the year, as well as space in the central drive for grinding and mixing feeds.

Gable-Roof Broiler House, Plan No. 18-727-C2. This is a straw loft broiler house designed to use natural ventilation.

Broiler House (48-foot width), Plan No. 17-727-C2. This building has a low-pitched gable roof designed for forced mechanical ventilation.

Central Farrowing House, Plan No. 9-726-C2. This is a north-and-south house with straw loft and attic ventilation. Has windows on east and west sides and south end. It has insulated concrete floor and electric pig brooders. Alley partitions are permanent, while those between pens are removable. Central section of attic holds enough bedding for entire season.

Insulated Pump House. Designed to meet the State Board of Health ruling against well pits and requiring above-ground installation of pumps. Provides for a building 6' by 8' in size.

**Design of Dairy Barns and Related Structures to Provide for Best Management and Use of Space, High Labor Efficiency, and Production of Quality Milk** (R. E. Stewart, Carl Reeves and K. B. Huff). Analysis of the data collected on loose housing of dairy cattle was completed and the results published in Research Bulletin 468, December 1950. Some of the more important findings were:

The typical loafing area allows 50 to 60 square feet of space for each cow. Many operators make no provisions for calves or young stock in the loafing barn.

The trend is definitely toward open loafing areas with no attempt to control temperature. Building embodying this principle are open to the south or east, or both.

In loose housing management, the accumulation of manure and bedding, called manure pack, is usually cleaned out twice yearly by power equipment. The pack at time of cleaning varies in depth from 1½ to 3 feet.

It is not customary to separate the roughage feeding area from the loafing area. The floor of the loafing area is commonly of earth, cinders, or gravel.

In applying these findings and other recent research to the publication of specific working plans for general distribution, new plan folders have been made available in addition to those described in the report on Design of Farm Buildings, the following have been issued by the Extension Service:

Plan No. 17-723-C1, Elevated Platform Combination Milk House and Milking Barn—Tandem Type.

Plan No. 18-723-C1, Elevated Platform Combination Milk House and Milking Barn—U-Type.

**Low Cost Home Construction and Improvement Through Use of Farm Labor and Materials** (Carl Reaves, R. E. Stewart, K. B. Huff, J. C. Wooley and L. H. Tempel, Jr.). Oil-fired circulating heaters were tested with various aids to circulation of the heated air in small, one-story dwellings. With gravity circulation, under-floor ducts proved of no great value over use of the circulator alone. Small fans placed in wall openings between rooms improved circulation greatly. Most effective use of a small fan for heat transfer was obtained when fan intake was directly above heat source and its discharge extended to the colder parts of the house.

**Influence of Humidity on Physical Reactions of Dairy Cattle** (M. M. Jones, K. B. Huff, R. E. Stewart, R. M. McCroskey, Denver Baxter and Arthur Muehling). Work to date included mainly the development of instruments for measuring moisture evaporation from various parts of the stall and from the body surface of the cow. For this work an instrument known as a "dewcel" was developed by the investigators and used successfully for the accumulation of data.

**Economic Value of Farm Water Management** (R. P. Beasley, L. H. Tempel, Jr., and J. C. Wooley). This study included two problems; (1) comparative costs of crop production before and after terracing, and (2) effect of irrigation on yield of corn.

Ten Missouri farms were found where comprehensive records had been kept on crop production both before and after terracing. On 8 of these the cost of production was greater after terracing, and on 2 farms the cost was less.

Corn and alfalfa were irrigated by rotary sprinklers during the 1950 growing season on a farm on Perche Creek near Columbia. Since there was a lack of natural moisture only during the first half of July, irrigation was applied only once. Comparisons were made between yields of corn without irrigation, with 1 inch of water applied, and with 2 inches. Average results, including a variety of fertilizer treatments, showed an average gain of 6 bushels an acre (from 96 to 102 bushels) from 2 inches of water as compared to no irrigation. In a similar comparison, alfalfa



Two inches of irrigation water applied to well-fertilized alfalfa at the beginning of dry weather in July, 1950, increased the yield of hay 426 pounds per acre. The percentage of protein in the irrigated hay was lower, however, than that of the unirrigated.

receiving 2 inches of water yielded 426 pounds more per acre than the non-irrigated alfalfa.

At 1950 prices, the cost of applying 2 inches of water was about \$12 per acre.

### **ANIMAL HUSBANDRY**

L. A. WEAVER, *Chairman*

**Swine Breeding** (G. E. Dickerson, J. F. Lasley, L. A. Weaver, K. E. Gregory, R. L. Arthaud, L. F. Tribble and N. R. Gyles). This work compared the performance of three inbred lines in linecrosses and in topcrosses on non-inbred Durocs, together with three closely related studies. These included (1) a study of the effects of inbreeding and crossbreeding on the economy of pork production under full and limited feeding, (2) a test of the performance of nine new lines or stocks, and (3) a continuation of studies of crossing and line influences on ovulation rate and embryonic mortality.

Topcrossing Poland and Hampshire lines on Durocs greatly improved yields and quality of preferred carcass cuts compared with the Durocs and maintained litter size and economy of gains. The topcrossing with Poland lines also improved rate of growth.

Comparison of crosses with average of inbred parent lines, under full feeding, showed a 20% increase in rate of growth, a 7% reduction in feed



requirements, and an increased proportion of muscle in the carcasses for crosses involving the Durocs.

When inbred crosses among Poland and Hampshire lines were limited to the same feed intake per unit live weight as the average of the full-fed parent lines the crosses gained 14% faster, required 10% less feed per unit gain, and had similar carcass composition compared with average of parent lines. Poland-Duroc and Hampshire-Duroc crosses limited to the same feed intake as the inbred Poland or Hampshire parent line gained 24% faster, with 18% lower feed requirements but produced slightly fatter carcasses as compared with the inbred Poland or Hampshire strain.

Limiting feed intake to 86% of full feed reduced daily gains by 8%, but also reduced feed requirements per unit gain by 7%, and improved the carcass quality (of reduced yields) by reducing fatness. The improved economy from limited feeding was obtained by reducing energy stored per pound of gain and by lowering energy losses for metabolic processes such as digestion and activity.

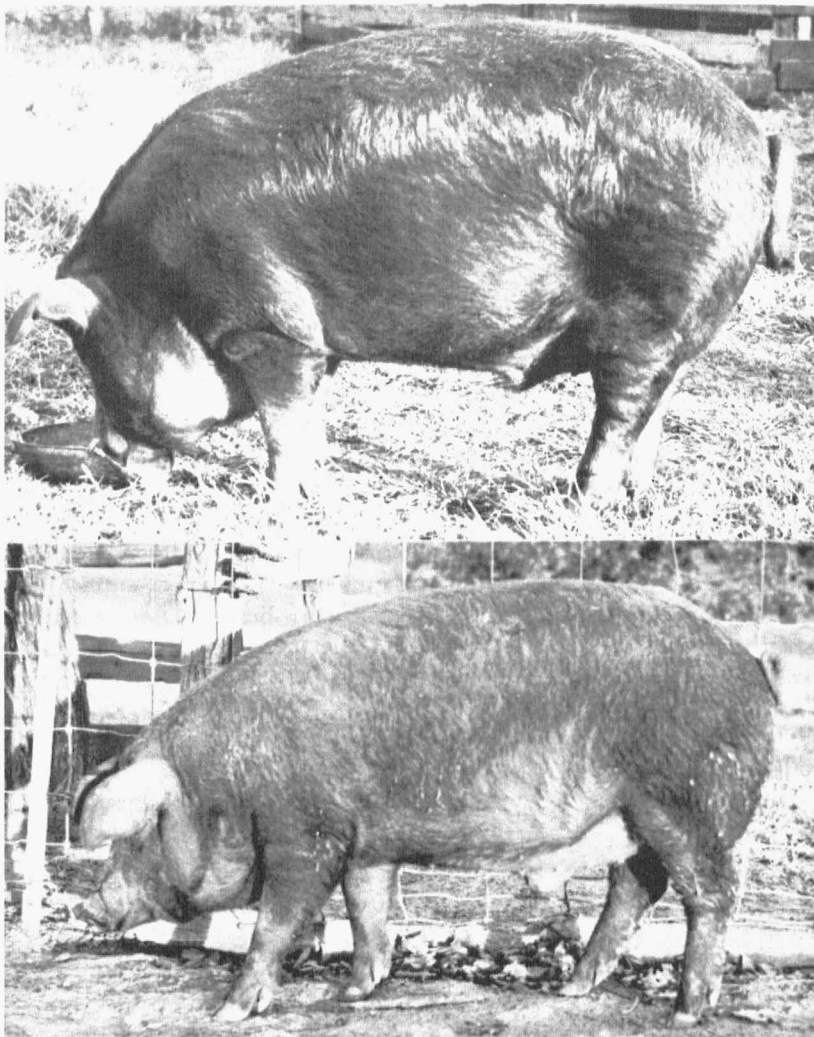
Crossing of strains and limiting feed consumption offer opportunity to approach maximum efficiency in producing top quality hog carcasses.

Crosses of 2 Poland strains, 2 Duroc, 2 Hampshire, 2 Landrace, and 1 Yorkshire, each with 2 inbred Poland lines, produced several interesting results. Linecrosses within the Poland breed were inferior in rate of growth but required less feed per pound of gain as compared with most crossbred groups. The very short-bodied Hampshire-Poland and the longest-bodied Landrace-Poland crosses produced top quality carcasses. Crossing of strains improved sow performance as indicated by a marked increase in the number of ova produced and the number of embryos present in early pregnancy, as compared with intra-bred crosses or with parent strains.

**Influence of Rate of Growth and Manner of Feeding on Carcass Desirability in Swine** (J. F. Lasley, D. E. Brady, L. A. Weaver, A. G. Hogan and G. E. Dickerson). This experiment was set up to help producers meet present-day consumer preference for leaner cuts from hogs marketed at weights of 200 to 225 pounds. Sixty spring pigs were divided into six lots of ten pigs each. Comparisons were made between feeding on pasture and on concrete floors. One group of pigs was full-fed throughout the experiment, another was full-fed till the pigs weighed about 125 pounds each and then placed on limited feed till they reached market weight, and a third group was on limited feed throughout. Those on limited feed all the way gained 77% as fast as those on full feed from first to last. Production costs, however, were slightly higher on limited feed. Comparisons between the pasture-fed lots and those on concrete feeding floors indicated that, even with this higher cost of feed, early farrowed pigs on good quality pasture and limited grain ration might reach market sufficiently early

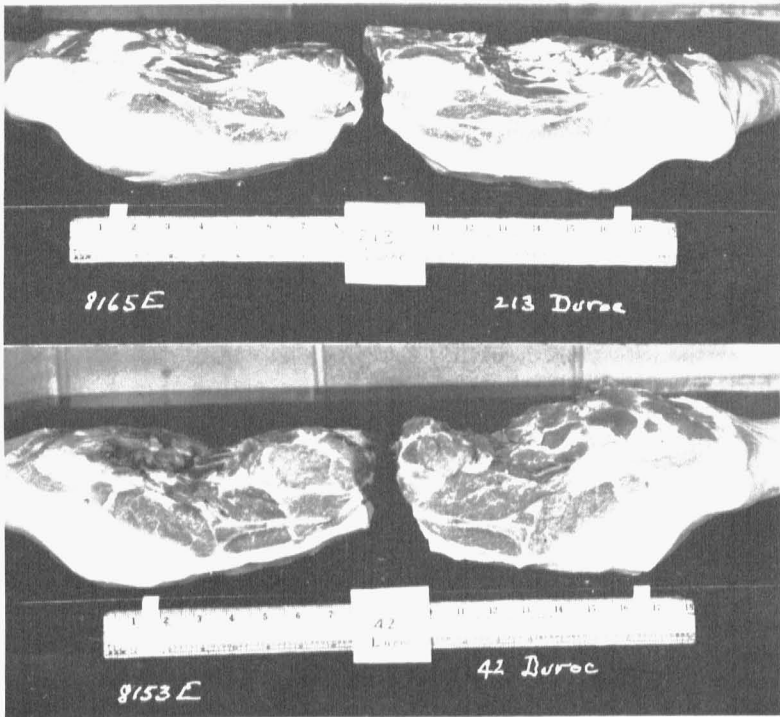
to command peak prices and prove most economical—all factors considered.

The disadvantages of both full feeding and limited feeding were overcome, at least in part, by full feeding pigs up to 125 pounds and then limiting their feed for the remainder of their fattening period. Under this latter method, the carcass quality of the pigs was about equal to that of the



Comparison of barrows on full feed and limited feed. The upper picture shows Barrow 213, which was full-fed throughout the experiment. Lower, Barrow 42 had limited ration and required 33 days longer to reach market weight (214 pounds).

limited-fed pigs while production costs were but slightly higher than when pigs were full-fed throughout the experiment.



Shoulder cuts from Barrow 213, full-fed, are shown in upper picture. Lower picture shows the shoulders from Barrow 42, limited fed, with less fat and more lean meat.

TABLE 3--The Influence of Rate of Gain and Manner of Feeding on Production Costs.

Treatment	Full fed	Full limited-fed	Limited fed
Number of pigs	19**	20	20
Avg. initial weight	58.8	58.8	58.8
Avg. final weight	214.0	213.8	213.3
Avg. daily gain	1.50	1.39	1.16
No. of days to reach market wt.	102.1	111.2	135.0
Feed per 100 pounds gain	389	395	415
Total cost of feed per pig*	\$19.63	\$19.75	\$20.65
Total return per pig*	\$31.95	\$31.00	\$29.74
Net return per pig	\$12.32	\$11.25	\$ 9.05

\* During the experimental period only.

\*\* One pig in this group died and was not included in final results.

TABLE 4--The Influence of Rate of Gain and Manner of Feeding on Carcass Quality.

Treatment	Average Score of*			
	Ham	Loin	Shoulder	Belly
Full-fed	6.7	5.2	6.2	7.6
Full-limited fed	8.4	7.4	8.8	9.0
Limited fed	8.7	8.0	9.0	9.5

\* Based on a scale ranging from 1 to 15 with the higher score being most desirable.

**Antibiotics and Unrecognized Vitamins in Swine** (A. G. Hogan, G. C. Anderson, J. F. Lasley and L. F. Tribble). These studies were continued through the year, confirming earlier indications that vitamin B<sub>12</sub> is required for the growth of young pigs and for normal reproduction in mature sows. The current year's study was designed to find a supplement which would accelerate the growth of newly born pigs reared on fortified cow's milk or similar synthetic diet. For this purpose a basic diet was used consisting of 30 parts casein, 30 parts sucrose, 5 parts cornstarch, 30 parts lard, and 5 parts mineral mixture. Four lots of pigs received this mixture supplemented as shown in columns A, B, C and D of Table 5.

Inspection of this data indicates that neither the antibiotic nor the liver extract improved the nutritional status of the pigs. In comparison, pigs that received cow's milk fortified with a mineral mixture grew more rapidly and weighed about one-fourth more at 8 weeks of age. The mineral mixture consisted of 60 gms. sucrose, 271 mg. iron, 51 mg. copper, and 37 mg. manganese per liter of total diet. It is still uncertain, however, whether or not the slower growth on the synthetic diet is due to a deficiency of some important nutrient or to intestinal irritation by some constituent of the diet.

TABLE 5--Aureomycin and a Water Extract of Liver in the Nutrition of the Pig

Group	A	B	C	D	E
Diet & Supplement	327 50 Mcg. B12*	327 10 mg. % Aureomycin	327 50 Mcg. B12* 10 mg. % Aureomycin	327 2.5% Liver Ex- tract†	Cow's Milk
No. of pigs	3	3	2#	3	2
Avg. Weight at 8 weeks, lbs.	32.4	32.8	36.3	33.6	45.2

\* Intramuscular injection. 50 mcg. per pig during first 28 days

† Replaced equal weight of casein

# One pig died.

Two brood sows that had been kept through the preceding year on synthetic rations deficient in vitamin B<sub>12</sub> were carried through a second reproductive year with slightly larger additions of the antibiotic than in the earlier tests. This year's results indicate that each kilogram of feed for the bred sow should contain about 12 mcg. of vitamin B<sub>12</sub>.

Another phase of this experiment used sows from dams that had received no vitamin B<sub>12</sub> in their rations. These young sows in turn were carried through their first pigging season on diets containing soybean oil meal and supplemented by a mineral mixture with and without vitamin B<sub>12</sub>, and in another comparison with and without rye pasture. The results were greatly improved when either the green rye or the vitamin B<sub>12</sub> was added. Weaning weights were 37.7 lbs., numbers of pigs were satisfactory and losses negligible.

A feeding trial was conducted comparing the effect of aureomycin (4.3 mg. per pound of ration) and a low level of penicillin on an animal protein (corn-tankage) and an all vegetable protein (corn-soybean oil meal) ration. The addition of aureomycin to the ration containing tankage increased growth rate by 11 per cent with a saving of 7 per cent in feed unit of grain. When aureomycin was added to the corn-soybean oil meal ration, the rate of gain was increased by 19 per cent with the same amount of feed (7 per cent) being saved per unit of gain as when tankage was fed. The addition of the lower level of penicillin to the corn-tankage ration did not give as beneficial results as aureomycin. In fact, the penicillin did not increase the rate of gains although there was a saving of feed amounting to 12 per cent in this single feeding trial.

**Producing Fat 2-Year-Old Steers from Light Weight Yearling Feeders—Winter Phase** (A. J. Dyer, R. K. Leavitt and Paul Guyer). From December 6, 1950 till April 20, 1951, the Station used 40 head of short yearling feeders in a winter feeding test. At the beginning of the comparison, the cattle were in medium condition of good to choice feeder grade averaging around 600 pounds each. In the test, 30 were fed corn silage and red clover hay in dry lot, and 10 were fed a limited amount of red clover hay on bluegrass pasture. All had access to a mineral mixture of salt and bonemeal in equal parts by weight. Results are shown in Table 6.

From these data it is seen that excellent quality corn silage and red clover hay produced an average daily gain of 1½ pounds a head and the cattle were fleshy when turned to pasture. Bluegrass pasture supplemented by limited feeding of red clover hay produced a very small gain but the cattle were thin and thrifty when they went on spring grazing. The fleshy cattle lost 40 pounds during the first 10 days on grass and required 30 days of grazing to gain back their loss, while the thin steers gained consistently all the way.

TABLE 6--Producing Fat 2-Year-Old Steers with Roughage and Pasture and Minimum Amounts of Grain (Preliminary Results)

	Lot 1	Lot 2	Lot 3	Lot 4
A. Winter Phase--Dec. 6 to April 20				
(Average per head)				
1. Feed Fed				
Corn Silage	1.4 Ton	1.4 Ton	1.4 Ton	None
Red Clover Hay	.4 Ton	.4 Ton	.4 Ton	.4 Ton
Bluegrass Pasture	None	None	None	All winter
2. Beginning wt. (lbs.)	605	606	605	606
3. Wt., April 20 (lbs.)	812	811	801	622
4. Total winter gain (lbs.)	207	205	196	16
5. Avg. daily gain (lbs.)	1.5	1.5	1.5	.1
B. Grazing Phase, April 20 to August 29				
1. April 20 to 30, Bluegrass Pasture	Lost 42 lbs.	Lost 41 lbs.	Lost 40 lbs.	Gained 14 lbs.
2. April 30 to August 29				
Alta Fescue-Ladino (lbs. gain)	--	145.0	169.0	213.0
Wheat-Lespedeza (lbs. gain)	230	--	--	--
3. Net gain from pasture (lbs.)	188	104	129	227
4. Avg. daily gain (lbs.)	1.4	.8	1.0	1.7

**Factors Affecting Litter Size in Early Pregnancy in Certain Strains of Swine and Their Crosses** (C. D. Squiers, G. E. Dickerson, and D. T. Mayer). In applying this study to gilts, it was observed that for each additional ovum shed in estrus there was an increase of 0.6 of a pig in litter size as determined by slaughter on the 25th day of gestation. Associated with this increase in number of living embryos was a loss of 0.4 of an ovum. From this it is seen that litter size at 25 days after conception is determined by two variables; number of ova shed and total ovum mortality during the 25 days.

A study was made also of the effects of one service or two services on the conception rate and the litter size. Data were obtained on 98 gilts. Of 50 gilts bred once, 31 conceived and farrowed an average of 6.97 pigs per litter; and of 48 gilts bred twice in the same estrus period, 40 conceived and farrowed an average of 7.45 pigs per litter. The conception rate of the one-service group was 62 per cent, while that of the two-service group was 82 per cent.

**Factors Affecting the Viability and Fertilizing Capacity of the Spermatazoa of Farm Animals** (Dennis T. Mayer, Ralph Kampschmidt and H. A. Herman). Both stallion and bull spermatazoa were subjected to a series of tests in which their viability in storage was observed when diluted or buffered with various substances. These included egg yolk, glucose, isotonic sugars, sodium salts, phosphate salts, and sodium citrate.

On the basis of the results obtained, the investigators make the following comments:

The resistance factor present in egg yolk protects the spermatazoa from drastic temperature changes, adverse conditions such as changes in pH and osmotic pressure, and from harmful substances.



It was found also that the visible settling of egg yolks and semen plasma solids during storage and shipping had no apparent influence on duration of spermatazoan survival.

In general, it was observed that a reduction in the quantity of sodium-containing buffer salts promoted increased survival of bull semen in storage, and that isotonic sugar solutions were most satisfactory for replacing solutions of buffer salts. Common baking soda was a more efficient buffering agent than the commonly used mixtures containing phosphate salts or sodium citrate.

This past year's work included an intensive series of experiments directed toward the objective of identifying the specific substances and conditions necessary to meet the requirements for maximal maintenance of the fertilizing capacity of spermatazoa during a prolonged storage period. Results indicate that the answer may be found in the lipoprotein complexes of egg yolk.

**Wintering Ewes and Fattening Their Lambs for Market** (A. J. Dyer, Melvin Bradley and Max Shirky). In this experiment 57 Northwestern range-bred ewes were divided into two groups on the basis of their previous lambing records; that is, those which had produced early lambs the preceding year were again bred early, and those which had lambed late were again bred for late lambs. Both groups were bred to the same Hampshire ram and all grazed bluegrass pasture together through the winter. The lighter ewes and those with earliest conception dates in each group were fed grain in addition to pasture during the last six weeks of gestation. The others were without grain during gestation.

The late lambs, born in April, were much more profitable to the producer than those born in January and February.

The early breeding resulted in a 61-day lambing period, while the later breeding kept the lambing period down to 21 days, though the numbers of ewes in the two groups were approximately the same. It is believed that the ram was more fertile in November than in August and September, for the same thing had occurred in a similar experiment during the preceding year.

Feeding grain to some of the ewes in both groups during the last 6 weeks of pregnancy resulted in lambs that were 10 to 25% heavier at birth.

**Effect of Bone Deterioration in Frozen Storage on the Palatability of Pork Chops and Roasts** (D. E. Brady, C. W. Gehrke, L. N. Tucker and E. M. Funk). Chops and roasts from 24 pork loins were used in this study. The bones were removed from one half the cuts, then all cuts were placed in storage at 0°F. At the end of six months, the paired samples—bone-in and bone-out—were tested for evidences of deterioration.

In the roasts no differences were found between the bone-in and

bone-out samples. In the comparison of chops, no difference could be found in flavor but a 5% disadvantage as to odor was found in the chops with bone in.

**Improved Techniques for Evaluating Quality in Beef** (D. E. Brady, E. E. Pickett, H. D. Naumann and L. N. Tucker). A detailed study was made of two objective methods of meat quality evaluation; (1) using the Soxhlet apparatus (A.O.A.C.), and (2) a modified Babcock technique. No significant differences were found in the comparative efficiency of these two methods.

**Effects of Temperature Changes on the Quality of Frozen Foods** (D. E. Brady, C. W. Gehrke, Henry Ballou, Grace Hoover, and L. N. Tucker). Corn, peaches and strawberries, secured from the department of horticulture, were stored for 6 and 12 months at temperatures of 0°F., 10°F., variations from 0° to 10°F., and one to three defrostings from a low of -24° to + 10°F.

In frozen corn there was considerable loss of vitamin C in the samples that had been defrosted three times; yet the corn stored 12 months and held steadily at 10° had lost almost as much vitamin C as that subjected to defrosting. Deterioration in taste was marked in the corn thrice-thawed in 6 months. At 12 months there was no significant difference in quality with reference to various temperatures; yet all corn held at 10° for 12 months showed greater loss of quality than that stored for a shorter period.

Peaches were less desirable in texture after 6 months, especially those which had been thawed three times. There was wide variability in loss of vitamin C, but this may have been due, the investigators believe, to uncontrolled additions of ascorbic acid to prevent enzymatic browning.

Strawberries were low in vitamin C at 6 months in samples held at 0°, alternated weekly from 0° to 10°, thawed once, and thawed three times. At 12 months vitamin C was still low in the first two samples but slightly higher in the last two—due to an increase in acidity. Titratable acidity showed a moderate decrease at 6 months, with the greatest decrease in the berries stored at 10°. At 12 months all samples showed even further reduction except the one stored at 0°.

In general, it can be said that frequent variation in temperature is very detrimental to quality of frozen foods. Also, storage at a temperature as high as 10° for 12 months or longer is almost as detrimental as rough handling such as frequent thawing.

**The Effect of Different Levels of Soil Fertility on the Freezing Quality of Snap Beans** (R. A. Schroeder, Henry Ballou and D. E. Brady). A field study was made on the yields, soluble mineral content and freezing quality of green beans produced on different soil fertility levels. Dif-

ferences in flavor, texture and color of the frozen beans were scored by a six-member taste panel.

It was found that increasing the phosphorus content of the soil increased both the yield of beans and their soluble phosphorus content. It had a variable effect on flavor and no discernible effect on color or texture.

Increasing the magnesium level in the soil reduced the amount of nitrate nitrogen in the beans but lowered the eating quality.

Increasing the nitrogen supply increased the nitrate nitrogen but decreased the soluble phosphorus in the beans. The increase of soil nitrogen also improved the eating quality of frozen beans, as noted in better flavor, color and texture after 9 months of storage.

## BOTANY

C. M. TUCKER, *Chairman*

**Studies on the Mechanism of Resistance or Immunity to Infection by the Wilt Fungus, *Fusarium Lycopersici*, and the Methods of Their Inheritance in Tomato Hybrids** (A. M. Finley, J. P. Baumgardt and C. M. Tucker). It was found that races 1 and 2 of *Fusarium oxysporum f. lycopersici* differ in pathogenicity. Race 1 does not cause wilt in varieties with the *Lycopersicon pimpinellifolium* factor for resistance. Race 2 attacks *L. pimpinellifolium* and hybrids with its factor for resistance to race 1.

A comparative study was made on 3 isolates of each race. On most of the culture media used, the races were indistinguishable. On Richard's agar, the race 1 isolates produced more profuse aerial growth. On oat-meal agar, race 1 isolates produced considerably more aerial growth and a pigment differing in color from that produced by the race 2 isolates. There were no consistent differences between the races in the abundance of microconidia produced on various media. Race 2 isolates produced macroconidia and chlamydospores somewhat more abundantly than the race 1 isolates. Microconidia of race 1 isolates were somewhat shorter than those of race 2 isolates, but the difference in length was not great enough for use as a distinguishing character.

On agar media race 1 isolates produced slightly larger mycelial mats. In liquid media the race 1 isolates produced slightly more growth. The races responded similarly to the use of various compounds as sources of carbon in culture media. There were no significant differences in their growth rates at various temperatures.

There were no constant correlations between pathogenicity and behavior in culture, and the only valid criterion for the identification of the races is their pathogenicity.

In studies on the invasion of tomato plants by race 1 and race 2 isolates, sister progenies, one homozygous resistant to race 1, and the other

homozygous susceptible, were used. When mycelium of the fungus was placed on wounded susceptible seedlings, it grew into the vascular tissues and caused early death of the plants. When the race 1 isolate was placed on a resistant seedling, the plant responded by the production of a gum-like material in the vascular tissues which prevented the entry of the fungous hyphae. The response occurred only when race 1 isolates were placed on resistant plants. Race 2, capable of invading both hosts, did not induce the apparent plugging of the vascular tissues.

**Studies on Morphology and Physiology of the Genus *Phytophthora*** (C. M. Tucker). The Botany Department of the Missouri Agricultural Experiment Station maintains a collection of cultures of *Phytophthora* species, and serves as a center for their identification and study.

During the current year, 35 cultures were received from various parts of the world. In cooperation with Experimental Plantations, Inc., of Guatamala, a study was made on a collection of cultures isolated from *Cinchona* spp. Two definite types of infection caused by *P. cinnamomi* and *P. parasitica* were established. The causal agent of a root rot of safflower in Nebraska was identified as *P. Drechsleri*, and an isolate from the same host in Maryland proved to be *P. Cactorum*. Studies on groups of cultures obtained from tobacco and *Peperomia* in California are in progress.

**Investigation on Diseases of Forest and Shade Trees** (C. M. Tucker, T. W. Bretz and W. G. Long). The current year's work was marked by the termination of the project on elm disease and the beginning of similar studies on oak wilt.

A survey conducted during 1950 disclosed general prevalence of oak wilt in 29 Missouri counties, 6 Arkansas counties, and in areas of Ohio and Pennsylvania. About 3000 square miles of oak timberland in Missouri and Arkansas were surveyed for oak wilt by use of an airplane.

A culture laboratory was established for the diagnosis of suspected oak wilt infected samples, and 225 samples were cultured for further laboratory examination and experimental use.

Although this study still is in its early stages, the causal fungus of oak wilt was isolated from diseased Chinese chestnut trees in a Missouri plantation. Pathogenicity of this fungus was established by inoculation into healthy nursery trees, in which it resulted in the development of characteristic disease symptoms. This is the first known occurrence of this fungus causing a disease in species other than oak.

**Virus Diseases of Stone Fruits** (Daniel F. Millikan, C. M. Tucker and A. D. Hibbard). Attention was centered during the current year on the nurseryman's problem of finding dependable sources of disease-free root stocks on which to graft his own disease-free scions.

With the cooperation of the Wisconsin Station one block of 12 Ma-

haleb parent trees was indexed in Wisconsin and Missouri and found to be entirely free from ringspot for the second consecutive year. An additional block of 27 trees was also found to be entirely free from ringspot, and a third planting of 78 trees was found to be 30% infected. This work is being continued with emphasis on prompt removal of diseased trees and expanded plantings of ringspot-free seedlings.

Three ringspot-free scion blocks were established in the 1950 season. Two nursery scion blocks have been established at Louisiana, Missouri with the cooperation of the Illinois Station. A planting of all available ringspot-free sweet and sour cherry clones is maintained at Columbia to facilitate the establishment of additional nursery scion blocks and furnish ringspot-free clones to other workers. Three additional scion blocks were established in 1951.

Preliminary studies were made to determine the effect of virus upon growth of cherry and to evaluate the spread of virus through the understock or root stock. Bi-monthly measurements were made on 50 trees each of ringspot-free Montmorency on ringspot-free understocks, ringspot-free Montmorency on nursery run understocks, and nursery run Montmorency on nursery run understocks. Significant differences occurred early in the season but tended to become less significant as the season advanced. Very significant differences were noted in the stands and in uniformity of growth.

In order to study the symptomology and effect of virus infection on sweet cherry, 10 strains of virus containing ringspot alone, or in combination with yellows, were inoculated into five varieties of sweet cherry and two varieties of sour cherry. Nursery trees transplanted in pots in the greenhouse were used for all inoculations. Symptoms on Montmorency and Morello were of the usual ringspot type, with virulence expressed solely as varying degrees of chlorotic rings followed by shot-holing. Two varieties of sweet cherry, Meyer and Gold, reacted similarly. Napoleon, Bing and Black Tartarian reacted in a different manner. Strains S-16, Mo-1 and S-80, containing ringspot and possibly yellows, and Tatter leaf and Barn 1-12, containing ringspot alone, caused severe dieback in Bing, culminating in death. Strains known to contain yellows exhibited a milder reaction with symptoms expressed primarily as shot-holing and some killing of spurs. Strains S-16, S-5509 (persistent RS) and Barn 1-12 resulted in death of Napoleon trees, while the other strains caused much less severe reactions. On Black Tartarian the strains containing ringspot caused only a delayed but severe spur dieback, whereas other strains caused a milder reaction resulting only in ringspot patterns in the leaves.

**Identification of Plant Diseases** (C. H. Kingsolver and C. M. Tucker). As many as 500 letters were written in answer to requests for diagnosis of plant diseases and methods for their control. The unusually cool, moist

summer of 1950 resulted in the development of plant disease problems quite different from those ordinarily encountered in Missouri.

For example, potato late blight appeared in June in the Springfield area. The potato is not an important crop in that section, but tomatoes are widely grown there as a canning crop, and the late blight fungus spread in July to the tomato fields and caused complete destruction of many plantings. This is the first record of late blight of tomatoes in Missouri. In Stone County about 90% of the canning tomato acreage was lost. The fields there are so hilly that spraying is very difficult, and in the past very little spraying or dusting has been done.

In Southeast Missouri, cotton was damaged severely by *Verticillium* wilt, caused by a fungus favored by low temperatures. Cotton varieties resistant to the more common *Fusarium* wilt proved susceptible to infection by *Verticillium*. In addition, two areas of severe nematode injury on cotton were observed. This further complicated the problem since *Fusarium* wilt resistant cottons lose resistance under nematode attack.

Studies on the occurrence of wheat mosaic were continued. The constant appearance of the disease in some river bottom fields on wheat varieties known to be susceptible to the soil-borne type of wheat mosaic has prompted the belief that this type is most prevalent in Missouri. This has been confirmed by observations on plots of resistant and susceptible varieties. There was little evidence of damage by the western type of mosaic, which is not transmitted through the soil.

Anthracnose was severe on winter oats in Southeast Missouri this season and caused severe reduction in foliage. This fungus was also abundant on the lower leaves of wheat in this area and may have caused some reduction in yields.

Races of crown rust of oats which attack Bond derivatives were noted throughout the state. These races of crown rust may limit the use of varieties of Bond parentage, including Mo. 0-200. Fields of oats were observed which failed to head because of crown rust infection.

Smut was unusually abundant on corn this season. Leaf rust of corn also was more abundant than in the past several years, causing damage to some sweet corn plantings.

## DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

**The Effects of Inbreeding and Outcrossing on Milk and Butterfat Production in Dairy Cattle** (R. C. Laben and H. A. Herman). Analyses were made of all normal lactation records (up to the ninth record of each cow) in the Missouri Station Holstein-Friesian herd from its foundation in 1902 to January 1, 1950. There were 314 cows with a total of 933 lactation records. These cows were the progeny of 34 herd sires. Within the 34 sire progeny groups were 299 daughters with records and 270 daughter-dam pairs. All lactation records were standardized to a herd test, 305-day, twice-a-day milking, mature equivalent basis by means of factors derived from the data.

Estimates of the repeatability of contemporary production records were 0.41 for milk production, 0.36 for butterfat production and 0.61 for butterfat percentage.

Heritability estimates derived from the intra-sire regression of daughter on dam were found to be: 0.36 for milk production, 0.29 for butterfat production and 0.54 for butterfat percentage. Lifetime averages were used as the measure of each cow's producing ability but the heritability estimates were expressed on a single record basis. Variations of daughters' and dams' records were found to be essentially equal. When each cow's lifetime average was expressed as her "most probable producing ability" no increase was observed in the correlation between the records of daughter and dam.

The correlation between lifetime average milk and butterfat yield was found to be + 0.89, between milk and butterfat percentage — 0.10, and between butterfat yield and butterfat percentage + 0.35.

The effect of mild inbreeding was analyzed by the intra-sire regression of production on inbreeding. A significant decline of 66 pounds of milk and 2 pounds of butterfat per 1% increase in inbreeding was observed. There was no significant effect on butterfat percentage.

The performance of herd sires as indicated by daughter-dam comparisons is presented for 20 sires having at least 5 daughter-dam pairs. Ten of these sires increased milk production, 15 increased butterfat production, and 13 increased butterfat percentage of their daughters over their corresponding dams. No evidence of nicking was found in a tabulation of sires' daughters according to their maternal grandsires.

**Estimating the Transmitting Ability of Brown Swiss Sires** (Chase Wilson and H. A. Herman). A study is being made of the transmitting ability of 1,000 Brown Swiss bulls that have 5 or more tested daughters in Dairy Herd Improvement Association work. The average production of the daughters of these bulls is 404 pounds of butterfat calculated on a



305, twice-a-day milking, mature basis. The study has not progressed sufficiently to warrant conclusive estimates of progeny performance from the ancestors' production, which is the chief objective of the investigation. But 38% of the sires had daughters averaging 25 pounds more butterfat than their dams, 36% produced daughters equalling their dams, and 26% sired daughters whose production was more than 25 pounds of butterfat lower than their dams.

It is hoped to formulate prediction indexes for milk and butterfat production that will enable breeders to make more accurate selection of dairy herd sires.

**A Study of the Transmitting Ability of Certain Jersey Sires** (H. A. Herman and A. C. Ragsdale). A study of the transmitting ability of 24 Jersey sires proved in the Station herd has been continued. Over 1200 completed lactation records are being standardized and analyzed in an effort to determine the mode of inheritance of butterfat production. Four Jersey sires, of similar bloodlines, are being used in the Station and Hatch Farm herds in order to study the value of inbreeding and outcrossing in dairy cattle improvement.

**The Transmitting Ability of Sires Proved in Missouri Dairy Herd Improvement Associations** (W. H. Cloninger and H. A. Herman). A study has been made of the transmitting ability of 633 sires proved in Missouri Dairy Herd Improvement Associations from 1937 to the end of 1949. The proof on each sire is based on 5 or more daughter-dam comparisons with all records adjusted to a 305-day, twice-a-day milking, mature basis. There has been an average annual increase in butterfat of 4.06 pounds per cow for daughters of the sires proved since 1937. Moreover, 358 sires maintained or increased production, while 275 sired daughters producing less than their dams.

**A Study of Factors Affecting the Interval Between Parturition and First Estrus in Dairy Cattle** (H. A. Herman and J. E. Edmondson). The average length of the interval from parturition to the first subsequent estrus period for 968 parturitions in 347 dairy cows with normal gestation was found to be 57 days with a standard deviation of 28 days. There seems to be no relationship between season of the year and the length of time from calving to the first estrus period after calving. The average daily milk production for the entire lactation did not appear to affect the interval between calving and occurrence of first estrus, nor did the average daily milk production for the period extending from parturition to the first subsequent estrus period seem to be a factor.

The age of the cow is a factor influencing the interval from calving to the first estrus. The interval was longest, about 75 days, for first-calf heifers (1½ to 2½ years of age); shortest, or about 50 to 60 days, for cows from 2½ years to 7 years, and increased again to between 60 and 90 days



Some of the buildings and a few of the cows in the Jersey experimental breeding herd at the Hatch Farm of the Missouri Agricultural Experiment Station. This farm near Hannibal was the home of Col. Wm. H. Hatch, Missouri Congressman who was largely responsible for the passage of the Hatch Act of 1887 establishing the U. S. agricultural experiment stations. His heirs willed the farm to the State in 1924.

for cows past 7 years of age. The average length of the interval from calving to first heat of first-calf heifers, second-calf, third-calf, etc., followed a pattern similar to that associated with age. The similarity is not too pronounced after the fourth or fifth calf, due to selection, and in some cases a longer calving interval, in the older cows.

**A Histochemical Study of the Bovine Reproductive Tract** (H. J. Weeth and H. A. Herman). A histochemical study is being made on the reproductive tract of cows with known breeding histories. The relative amounts of glycogen, alkaline phosphatase, lipids, birefringence and connective tissue are being observed. Over forty sections have been studied to date. While the investigation is still in its initial stages it is believed that a basis for interpreting some of the normal and abnormal reproductive processes in cattle will be obtained. It is also hoped that further evidence on the cause of fetal deaths (often averaging 30 per cent) will be obtained.

**Increasing the Effectiveness of Artificial Insemination as a Means of Improving Dairy Cattle.** The factors involved in the increase of effectiveness of artificial insemination of dairy cattle include the use of sires capable of transmitting high milk and butterfat production and desirable type to their offspring. Other factors are the production of fertile, highly viable semen, together with the evaluation, processing, storage, transportation and effective use of semen under field conditions. This problem was investigated during the current year along the following lines:

*The Relationship Between Semen Quality and Conception Rate* (Howard J. Weeth, H. A. Herman and A. C. Ragsdale). The correlation between semen characteristics and the conception rate under field conditions was investigated by a study of semen characteristics such as motility, viability under storage conditions, and other quality measures on semen obtained from approximately 80 dairy sires used in Missouri artificial breeding organizations and 12 sires used in the Station herd. All conception rates are calculated on the basis of cows which do not return for service on a 60 day non-return basis. Over 4000 additional semen samples and the records of some 70,000 inseminations were studied this year. The relationship between survival time of spermatozoa under storage conditions and the sire's actual breeding record were found to be highly correlated ( $r = + 0.198 \pm 0.028$ ). Due to selection of fertile sires, an unusually cool summer with good rainfall, and improved field techniques the conception rate did not show the seasonal decline experienced during the summer months of all the preceding years this investigation has been underway.

*Improved Techniques for the Dilution and Preservation of Dairy Bull Semen* (H. A. Herman and H. J. Weeth). A comparison of six commonly used semen diluters was completed. In addition, a modification of

several diluters was made by varying the proportion of chemical constituents. Over 120 storage trials with experimental diluters and 75 trials with control samples (undiluted) were made.

The results indicate that a diluting fluid composed of sodium citrate salts and an animal source of lecithin is the most effective in prolonging the survival time of spermatozoa under storage conditions. A field investigation of this diluter is now underway in an effort to measure its possible value in improved fertility.

The effect of diluting fluids of hypertonic and hypotonic strength on the morphology of dairy bull semen was studied. Freezing point depression was used as a measure of osmotic pressure. The optimum range for the survival of dairy bull spermatozoa was found to be between  $-0.44$  and  $-0.61^{\circ}\text{C}$ . in terms of freezing point depression. Hypotonic solutions were found to have little detrimental effect on spermatozoa but hypertonic solutions were found harmful for semen under storage conditions. Solutions with a freezing point depression of  $-1.05^{\circ}\text{C}$ . preserved semen only 10.9 hours. Neither hypotonic nor hypertonic solutions produced morphological changes in the head dimensions of stored spermatozoa and it is concluded that bovine spermatozoa have a low permeability for salts.

*A Study of Factors Affecting the Conception Rate Where Artificial Insemination of Dairy Cattle Is Practiced Under Field Conditions* (H. A. Herman, A. C. Ragsdale, and W. H. Cloninger). Earlier investigations at this Station on 145 Missouri dairy herds with an efficient settling rate and 163 herds with an inefficient ratio using artificial insemination indicated that no specific factors in feeding, management, soil conditions, etc., could be singled out as affecting the conception. Diseased herds and those with poor owner-technician cooperation were distinctly inefficient. Efforts to improve breeding efficiency were directed toward the use of (a) anti-biotics in semen preservation and (b) the use of deep cervical semen deposition.

By adding 1000 units of penicillin, 1000 units of streptomycin per ml. to semen diluter solutions containing 0.3% sulfanilamide the storage time of semen containing highly motile spermatozoa was increased 5 to 8 hours. These trials were conducted on more than 2000 semen samples from 80 sires used in Missouri artificial breeding organizations.

The deep cervical or intra uterine method of semen deposition, as compared to the "speculum method" where semen is usually deposited only in the opening of the cervix, resulted in an increase of 13.1% greater "non-returns" for cows inseminated under field conditions with semen 24 to 36 hours old.

*Characteristics of Bovine Vaginal-Cervical Secretions During the Estrus Cycle* (H. A. Herman and D. B. Roark). A study of physiological and histological phenomena as they affect the properties of vaginal-cer-

vical mucus during varying stages of the estrual cycle was completed. Over 100 cows in the Missouri Station dairy herd were used. The average estrual cycle was 21.4 days in length, but ranged from 11 to 35 days. Eighty per cent of the cycles were between 18 and 24 days. The volume of mucus secreted, its elasticity, surface tension, and water content decreased as estrus progressed. Spermatozoa penetration rate of mucus was greatest during estrus (10 to 13 hours after the beginning of the period). These data further substantiate the finding that cows settle more effectively when inseminated at the middle of the estrus period to not over 6 hours after its cessation. The properties of mucus in post estrus may also account for the less efficient results obtained under field conditions when semen is not deposited directly in the uterine horns or the posterior part of the cervix.

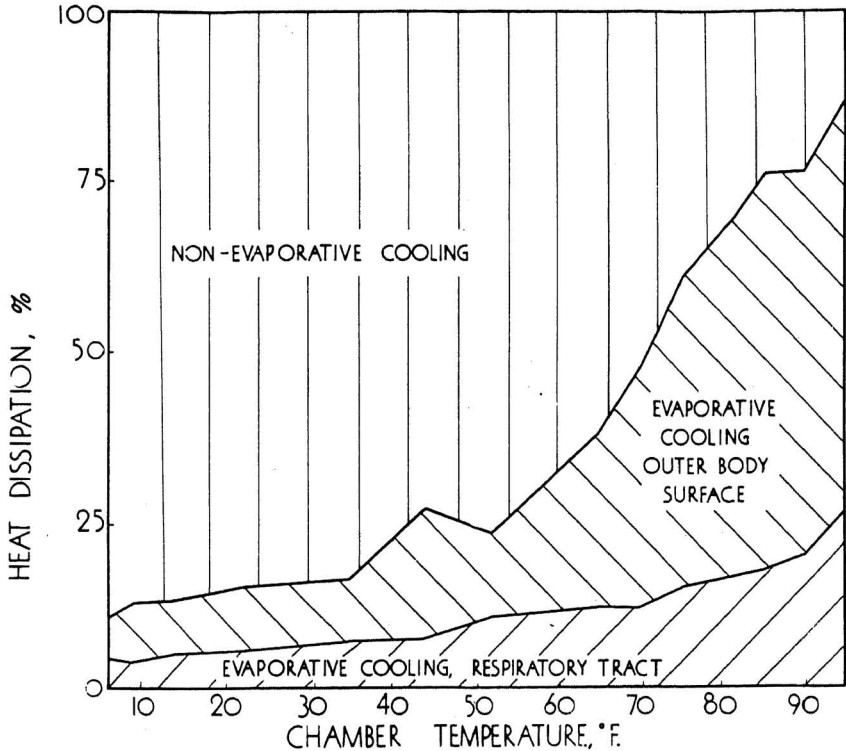
*A study of Bacteria Found in Bovine Semen and Their Effect Upon Livability of Spermatozoa* (J. E. Edmondson, H. A. Herman and K. L. Tallman). A high hemolytic bacterial content of dairy bull semen has been found to be associated with poor survival time of spermatozoa. Non-hemolytic bacteria seem to exert a favorable effect on spermatozoa survival. The nature of this phenomenon is being investigated further.

**Influence of Climatic Factors on Metabolism and Cardiorespiratory Activities with Special Reference to the Effects of Temperature and Humidity** (S. Brody, H. H. Kibler and O. J. Miller). These experiments are contributing new concepts in our understanding of the physiological mechanisms developed in cattle—or cattle breeds—evolved under widely different climatic conditions.

Take, for example, the study on the moisture vaporization (cooling process) in cows under controlled temperature and humidity. Attention was directed to the two-fold nature of this process, including evaporative cooling of the body surface and interior cooling by breathing and evaporation from the respiratory tract.

At a temperature range from 5° to 50°F., the vaporization by European cows through the outer skin was about the same as that accomplished through the respiratory tract. The relative contributions of these two parts of the cooling process were about equal. But, as the temperature rose from 50° to 80°, the same cows vaporized about four times as much moisture as they had done at the lower range; yet this increase was nearly all from the outer surface and only slightly more from the respiratory tract.

No further increase of vaporization occurred at temperatures above 80°, indicating that here the European-evolved cow had reached—and probably passed—the limit of her ability to make further adaptation to rising temperatures. This, of course, explains part of the difficulty in trying to raise European breeds in tropical or semi-tropical areas.



Partition of total heat loss (or heat production) in Holstein and Jersey cows into evaporative cooling from the respiratory tract, evaporative cooling from the outer body surface, and total non-evaporative cooling. The three shaded areas in the above graph indicate the relative magnitudes of the three categories of heat losses at different environmental temperatures averaged for Jersey and Holstein cows.

Data gathered in this study on both European and East Indian breeds of cattle have established the fact that the critical temperature at which natural physiological cooling reaches its limit is about 15 degrees higher in the Indian cow than in the European. Roughly, this means that the critical temperature for the European cow is 75°, while that for the Indian cow is 90°.

The study indicates also that the higher heat tolerance of Indian cattle is not due so much to their greater sweating ability as to their 12% greater surface area per unit weight, to their lower productivity, and to their lower heat increments associated with feeding and milking. Perhaps there is also some special insulating property in their skin and hair.

**Influence of Climatic Factors on Productivity and Physiological Reactions of Dairy Cattle with Special Reference to Heat Tolerance and**

**Humidity** (S. Brody, A. C. Ragsdale, H. H. Kibler, H. J. Thompson, C. R. Blincoe, K. L. Tallman, D. M. Worstell, Gloria Burge and O. J. Miller). When the physiological processes or dynamic states measured in this study were plotted against rising environmental temperatures, many of the resulting curves showed sudden changes in slope. The investigators call the temperatures at which these changes occur the "critical temperatures", or the temperatures at which the cow's ability to adjust to higher temperature breaks down or reaches its limit.

These breaks come for the European-evolved cows at about 75° and for the Indian-evolved cows at about 90°F. There were *increases* in rectal temperature and respiration rate and *decreases* in feed consumption, and these changes, presumably, through caloric under-nutrition, depressed the milk production, heat production and pulse rate. Also, presumably, as a result of the shift to endogenous nitrogen and fat catabolism, there was a decrease in the cows' blood content of alkali reserve, cholesterol and fatty acids, together with an increase in creatinine.

Indian cows lagged behind European cows about 15° in making these critical slope changes, but at an environmental temperature of 105° the curves of the Indian and European cows practically coincided. The Indian cows' lower sensitivity to "critical temperature" is apparently associated with their greater heat-dissipating surface area—pendulous dewlap, ears and navel flap and, *most importantly*, their lower milk production. They consumed much less feed than the higher producing European cows, thus lessening the thermal stress of the heat increments of these processes.

Increasing the environmental temperatures of the experimental cows above their critical levels seriously affected the animals, but no unfavorable effects were noted when the temperature in the laboratory was reduced to near zero Fahrenheit. But in contrast, this lowering of temperature to near 0° increased both feed consumption and heat production. The extent of these increases depended on the surface area and productivity of the animal.

Large cows having relatively small surface area per unit weight, as well as the high producers having high heat increments or SDA of feeding and milking, showed very little increase in feed consumption and heat production at a temperature near 0°. On the other hand the smaller cows, having large surface area per unit weight and the low producing Brahman cows, in near zero temperature, increased their feed consumption and heat production about 50% more than at the higher temperature of 50°.

**The Growth of Dairy Heifers Raised on Maximum Roughage Diets** (H. A. Herman, A. C. Ragsdale and O. T. Stallcup). Studies on the economy of growth in dairy heifers from 6 to 24 months of age have been con-



tinued with 70 animals. Where the diet consisted chiefly of pasture, dried roughages, silage, and limited grain, as previously reported, growth less than 3% below normal was attained. Normal growth rates were attained where 50 to 55% of the nutrients for growth were obtained from pasture. As a rule only 800 to 1,000 pounds of grain was required for supplementing the roughage diet in order to maintain normal growth in heifers from 6 to 24 months of age.

**The Influence of Diet on Growth, Lactation and Reproduction in Dairy Cattle** (H. A. Herman and A. C. Ragsdale). Holstein heifers have been raised on high, intermediate, and low planes of nutrition, in a study begun several years ago, in order to compare the economy of rapid, normal, and retarded growth. The effect of lactation, reproduction, and longevity are important considerations in this study. Data have been obtained on 50 animals.

Heifers grown at rates of 20 to 30% above normal were found to freshen from 5 to 30% heavier, and 5 to 10% higher at the withers than normal. While they calved 3 to 8 months earlier, they were nearly one-third more expensive to grow than normal and their production was no better than heifers raised after 9 months of age on a program of heavy roughage feeding.

The heifers fed wholemilk and skimmilk the first few months of age, adequate grain and roughage to 6 months, and from 6 to 24 months largely on roughages and pasture with sufficient grain to maintain normal skeletal growth were the most economical in growth costs and produced more satisfactorily.

Heifers grown on a low plane of nutrition did not attain normal size until 5 to 8 years of age and did not produce as well as those grown on an intermediate feeding program such as is found on most successful dairy farms.

**Factors Affecting the Nutritive Value of Missouri Grown Roughages** (W. H. Cloninger and H. A. Herman). In an effort to evaluate more accurately the nutritive value of typical dried roughages fed dairy cattle in Missouri, 73 samples of hay were secured from farms in 11 counties. The samples were obtained from farms where soil analyses had been made and complete records on methods of harvesting, stage of cutting, etc., were available.

The samples of hay were graded according to U. S. Department of Agriculture Standards and the percentage of leaf, stem, and foreign matter determined. Chemical analyses were made by the Department of Agricultural Chemistry for the content of: carotene, lignin, crude protein, dry matter, crude fiber, N.F.E., and ash. The ash is being further analyzed for the amount of calcium, phosphorus, potassium, magnesium, chlorides, iodine, manganese, cobalt, and copper.

**A study of the Birth Weight of Dairy Calves** (H. A. Herman and A. C. Ragsdale). A study of the normal birth weight of calves dropped in the Station dairy herd was made. Recordings were made by sex and breed as follows: Jerseys from January 1902 to January 1950, Holsteins from November 1910 to January 1950, and Guernseys from June 1928 to January 1950. The data are presented in Table 7.

TABLE 7--Normal Birth Weight for 1845 Dairy Calves--Missouri Station Herd--1950.

Breed	Sex	No. calves	Mean wt. (lbs.)	S.D. (lbs.)
Jerseys	Female	359	53.99	7.63
	Male	326	57.73	9.18
Holsteins	Female	521	85.20	11.81
	Male	503	89.07	13.84
Guernseys	Female	68	67.11	8.32
	Male	71	68.91	10.15

**A Study of the Influence of Environmental Temperatures and Humidity Levels on the Composition of Milk** (J. W. Cobble, H. A. Herman and A. C. Ragsdale). A total of 192 samples of milk from three Brown Swiss cows subjected to temperatures ranging from 50°F. to 105°F. were analyzed for total solids, solids-not-fat, butterfat, total nitrogen and lactose content. In addition, determinations were made for freezing point depression and specific gravity.

A marked change in milk yield and its composition was noted at approximately 90-105°F., with all constituents being increased except lactose, solids-not-fat, and specific gravity, which were decreased.

**Factors Affecting the Carotenoid and Vitamin A Levels in the Blood and Milk of Dairy Cattle** (O. T. Stallcup and H. A. Herman). The effects of dietary intake, the site of conversion of carotene to Vitamin A, and the effect of environmental temperatures, on the carotenoid and vitamin A content of blood plasma and milk fat of dairy cattle have been investigated.

Pregnant heifers fed Korean lespedeza hay had higher vitamin A and carotenoid levels in the blood plasma and in the colostrum than those receiving alfalfa of similar quality. The calves of the cows fed Korean lespedeza hay had higher carotenoid and Vitamin A blood plasma levels at birth and at the end of the colostrum feeding period than calves from dams fed alfalfa hay. The carotenoid and vitamin A content of milk fat was appreciably higher when cows were grazed on good pasture than when fed hay and silage under dry lot conditions.

Alfalfa silage, preserved by the additions of blackstrap molasses, retained a higher percentage of carotenoid materials after a six-month storage period than any of the hays studied. Korean lespedeza hay lost less

carotenoids during storage than either alfalfa or red clover hays. Tocopherols do not appear to prevent the destruction of carotenoids in hays. Laboratory studies involving the incubation of calf intestine with a colloidal carotene solution indicate that the intestinal wall is a site of the conversion of carotene to vitamin A in the bovine. Minced liver tissue, obtained from vitamin A-depleted calves, was also found capable of converting carotene to vitamin A in the bovine.

**The Effects of Mastitis on Milk Production, Causative Organisms, Reliability of Diagnostic Tests and Efficiency of Therapeutic Measures** (H. A. Herman, C. P. Merilan, J. E. Edmondson, K. L. Tallman and O. S. Crisler of the School of Veterinary Medicine). A study of the incidence of mastitis and its control was made on the Missouri Station dairy herd from 1942 to the present time. In 1942 a survey showed that 24.13% of the lactating quarters were infected. *Streptococcus agalactiae* organisms were found predominating in 75.6%, *Staphylococcus aureus* in 15.3%, and other organisms including *Pseudomonas aeruginosa* in 9.1% of infected quarters.

A comparison of the relative efficiency of various diagnostic tests to detect mastitis, with the Hotis test and the microscopic examination of the milk used as a standard, was made. The Hotis test and the microscopic test were found to be the most reliable for diagnosis of mastitis.

Udder infusions using sulfanilamide-in-iodized mineral oil were made on 82 quarters. An average of 75 to 80% of the treated quarters were found to be free of *S. agalactiae* 12 to 14 days following treatment and about 70% free 58 days after infusion. Penicillin was used in the treatment of 186 quarters. Dosages of 25,000 to 50,000 units of penicillin injected in 2 doses over a 12- to 24-hour period resulted in 46 to 85% recovery with an average of approximately 75%.

Many cows affected with mastitis, undergo "natural recovery". A recovery rate of 39.02% was noted for animals which had passed through a dry period between diagnostic tests but had not been treated. The average time elapsed between tests was 162 days. During lactation, non-treated animals showed a natural recovery rate of 37.3% within 48 days. Within 87 days after having been classed positive, 39.8% had undergone recovery. Several older cows with a long history of *S. agalactiae* infection in the udder were not freed of the organisms by any of the treatments given. A practice of running diagnostic tests on the milk of each cow in the herd; the dividing of the milking strings into groups based on negative, suspicious, and positive reactions, and milking the cows in that order has resulted in the reduction of mastitis to occasional flare-ups, even though some animals are not free of *Streptococcus agalactiae*.

**Causative Mechanisms in Mastitis** (C. P. Merilan and H. A. Herman). A study is being made of bacterial products and cellular substances on the

metabolism of bovine mammary tissue in an effort to determine the mechanism whereby *S. agalactiae* and other organisms produce harmful effects in the udder. The effect of bacterial-free-filtrates and group specific polysaccharides on the aerobic metabolism of tissue slices is being studied by means of the Warburg apparatus. The results thus far indicate no harmful effects on aerobic tissue metabolism by these substances. The investigation is being expanded to include anerobic metabolism and isolation of substances produced. In addition the effect of various hormones upon the growth of organisms associated with mastitis will be studied.

**The Effect of Bacterial Development on the Nutritive Value of Milk Constituents** (J. E. Edmondson, K. L. Tallman, C. P. Merilan, J. H. Gholsen and R. G. Jensen). A synthetic test medium approximating the fat, protein, carbohydrate, mineral and vitamin content of milk was made as follows: Ether extracted milk fat 3.8%, casamino acids (Difco vitamin free amino acids) 3.3%, lactose 4.8%, mineral mixture 1% and vitamins (as micro-grams per 100 ml. of solution); biotin 3.5, folic acid 0.29, niacin 85.0, pantothenic acid 350.0, pyridoxine 48.0, riboflavin 158.0, and thiamine 42.0.

The synthetic medium was inoculated with the following test organisms: *Bacillus subtilis*, *Escherichia coli*, *Lactobacillus casei*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus lactis*. After a period of growth (18 to 24 hours) the organisms were filtered from the medium and the medium assayed microbiologically for thiamine, riboflavin, niacin, pyridoxine and pantothenic acid. Vitamin free controls on each organism were also assayed to determine if any vitamin was synthesized. To date experiments on thiamine, niacin and pantothenic acid have been completed.

The strains of *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa* studied were able to utilize thiamine, niacin and pantothenic acid, however these three micro-organisms produced thiamine when it was not available in the medium. *Lactobacillus casei*, *Staphylococcus aureus* and *Streptococcus lactis* strains utilized all of the vitamins studied to date.

Tentative conclusions to date are (1) if the inoculum is heavy, the temperature optimum and the incubation time long enough, the niacin and thiamine content of milk may be reduced by 50% and (2) the pantothenic acid content of milk is reduced only slightly.

**Official Testing of Dairy Cows** (J. W. Cobble). In cooperation with the National Dairy Cattle Breed Associations, 2,997 cows per month have been officially tested in the herds of 160 Missouri breeders. Over a one-year period, this constitutes the largest number of cows ever to be entered in the official testing program in Missouri. During the year, 34 new herds discontinued the work, and 32 special and requested tests were conducted.

Through the two forms of official testing, Herd Improvement Registry and Advanced Registry, many completed records on proved sires and brood cows have made available for Missouri breeders important information, furnishing them a basis for improved selection and breeding practices.

The highest butterfat and milk producing cow for the year in the Advanced Registry program and winner of the 1950 Missouri State Dairy Council Trophy, was a Jersey, Pinn Bruce Estella 1394240 owned by the School of the Ozarks, Point Lookout, Missouri, with a 365-day record of 18,116 pounds of milk and 929 pounds of butterfat as a 6-year-old.

The Jersey cow, Goldenrod Blonde Arabella 1331899 owned by W. L. McCully, Callao, Missouri, was the leading butterfat producer of her breed on Herd Improvement Registry test with a record of 13,447 pounds of milk and 674 pounds of butterfat on 365-day 2x record.

St. Albans Grandee Jiggs 1102308 owned by St. Albans Farms, Inc., St. Albans, Missouri, was the high cow on Advanced Registry in the Guernsey breed. She had a record of 10,997 pounds of milk and 628 pounds of butterfat as a junior 2-year-old on 365-day 2x milking.

Clyde Hill Corona Lobelia Rock Lass 2524658 owned by Clyde Hill Farms, Clyde, Missouri, completed a 365-day record during the year of 29,230 pounds of milk and 1079.7 pounds of fat on 365-day 3x milking at 5 years of age. This cow is the 65th United States Holstein Friesian cow to make 1000 pounds of fat on Herd Improvement Test.

The herd owned by R. M. Edwards & Son, Cairo, Missouri, was the highest ranking Holstein Friesian herd on Herd Improvement Registry test during 1950. Twenty-five cows averaged 15,041 pounds of milk and 533.6 pounds of butterfat on three-time milking.

Through the official testing program encouragement and information are being given for the breeding of improved dairy cattle throughout the state.

**Hatch Dairy Experiment Station Farm Investigations** (Horace S. Peet and A. C. Ragsdale). A more uniform herd of improved type has been developed on the Hatch Farm by means of a line-breeding program using Sparkling Standard Pinn 481616, a 5-Star, Good Plus son of the Excellent Superior Sire, Sparkling Standard Sir, on daughters of Sparkling Dandy Royal 460160, a 5-Star, Very Good bull and Philidora Design 460505, a 4-Star bull classified Very Good. All eligible animals not previously classified were classified on October 28, 1950, resulting in a type rating of all females now in the herd of 5 Very Good, 18 Good Plus and 8 Good.

Improved bluegrass pastures, fertilized with manure annually, clipped twice a year, and using three fields in rotation grazing have increased yields and carrying capacity. The three bluegrass pastures consisting of 22.07, 20.29 and 14.65 acres, produced respectively: 194, 101 and 167 animal

pasture days per acre. Alfalfa and alfalfa-brome mixtures have provided excellent supplemental pasture in spring and fall. Improved bluegrass pasture and supplemental pasture provided adequate pasture from April 20 to October 20, 1950.

An outbreak of white scours occurred in October. Treating all calves under six months of age with sulfa preparations during the outbreak, moving cows to other quarters for calving during the next two months, and repeated cleaning and disinfecting the barns eliminated the disease. Sulfamethazine continued to be an effective remedy for common scours in calves.

Two animals developed mastitis during the year. One case was treated with udder infusion of penicillin and the other with udder infusion of aureomycin. In both cases the treatment was effective within 48 hours. Sanitary practices such as washing udders with chlorine, rinsing teat cups after milking each cow, use of strip cup, diagnostic tests (Hotis) and controlled milking order have kept the herd otherwise free of mastitis.

One animal reacted to the Brucellosis test in May, 1950. This animal was sold for slaughter. All other animals have been negative on two subsequent tests.

Raising dairy calves on a limited amount of whole milk, changing gradually to skim milk beginning the second week, supplemented with Missouri Experiment Station calf starter and good quality alfalfa hay has produced healthy calves.

The Hatch Farm continued to serve as a source of information for visiting agricultural groups. Fifteen Future Farmer groups, eight on-the-farm training groups of veterans and more than 400 other individuals visited the farm during the year.

**Relationships of Age, Temperature, Acidity and Butterfat Content to the Quality of Cream for Butter Manufacture** (W. H. E. Reid and J. H. Gholson). This study involved Missouri cream purchased for butter making. It was found that in summer 93.8% of the butter delivered by producers to buying stations was 4 days old or less, but by November the percentage of producers delivering their butterfat in 4 days or less had dropped to 76.9%. With the introduction of the 7-day limit program, however, all cream was received in 7 days or less.

For separating their cream from the milk, two-thirds to three-fourths of the producers used mechanical separators, 11% used water separators, and 12% used hand skimming.

The average size of all cream deliveries was 20½ pounds. Large producers marketed their cream oftener in order to get the higher price for No. 1 cream.

The average temperature of cream delivered in February was 48°, in June 69° and in November 51°F.

Most of the cream station operators were in favor of the Four-Day Grading plan because it had improved the quality of the cream received, had made grading easier, and had increased the number of deliveries made during the middle of the week.

**Methods of Manufacturing a Cultured Cream Salad Dressing** (W.H.E. Reid, J. H. Gholson and B. C. Hendricks). It was found that a cultured cream containing 22% fat seemed to be near the ideal. With 15% fat content the cream lacked richness, while cream with 30% fat was defective in body and texture. With increase in acidity there is a similar increase in aroma and flavor.

Single stage homogenization produced a cream with defective body conditions, and pressures above 3000 pounds produced an undesirable body. A pressure of 2500 pounds gave a cream with the desired firmness of body. It was observed also that 1% of inoculum was most satisfactory, but a good active culture was more important in the making of high quality cream than were the specific percentages of culture used.

Pasteurization at 170°F. produced a more desirable cultured cream than pasteurization at 180°. The latter temperature produced a less desirable body.

**The Endocrinology of Milk Secretion** (C. W. Turner, C. R. Hoover, J. R. Elliott, J. I. Raeside and Mei H. Wang). In this study of enzymes and hormones and their inter-relationships, attention was directed to the action of various hormones upon the metabolism of mammary cells and various enzyme systems in the mammary gland.

Our research has demonstrated that the actively growing gland (during pregnancy) elaborates an enzyme which, through liquefaction of the connective tissues makes possible the penetration of the tissue. The presence of the enzyme was indicated by the ability of a solution to spread in the subcutaneous tissue of experimental animals (spreading factor assay).

Extracts were made of the mammary glands of rats in various stages of pregnancy and the extent of spread indicated by the assay. Glands from castrate male and female rats showed little spreading action. Normal females were low, but with the advance of pregnancy the amount of enzyme present increased very rapidly up to the 12th or 13th day, when it dropped back to the non-pregnant level by the time of parturition. This enzyme was found not to be hyaluronidase and was inactivated by heat at 70°C. for 10 minutes.

It was observed that hormones which stimulate mammary gland growth to varying degrees also caused the elaboration or activation of the enzyme in comparable amounts.

The study of the mammogenic hormone was continued during the year in a cooperative project shared with Dr. John Trentin of Yale Uni-



versity. Moreover, the Missouri investigators discovered a source of pituitary extracts that are now obtainable as by-products in the preparation of ACTH. These pituitary extracts are also being assayed for the presence of the mammogenic hormone.

**Hormonal and Nutritional Methods of Maintaining the Persistency of Milk Secretion** (C. W. Turner, J. I. Raeside, C. R. Hoover, G. W. Pipes, W. R. Miller and M. H. Magrabi). An effort was continued to evaluate the role of gonadal hormones in the growth of the mammary gland during pregnancy in dairy cows. The corpus luteum was removed from several heifers at different stages of gestation, followed in some cases by an attempt to replace the luteus mass with crystalline progesterone dissolved in olive oil. Results indicated that the corpus luteum is an essential source of progesterone in the initial stages, but is of diminishing importance in the latter part of pregnancy.

A study of the nutritional requirements in hyperthyroidism was made with growing chicks. It was found that B-vitamins, animal protein factor supplement (APF), liver residues and pure antibiotics counteracted the effects resulting from feeding high levels of thyroprotein (0.04%). The age and the dosage of thyroprotein were found to be important factors. Feeding 0.01% thyroprotein to the two-week old chicks gave a significant increase in the growth rate over the control chicks.

**Use of Radio-Active Iodine and Phosphorus in Studying the Thyroid Hormone** (C. W. Turner, C. R. Hoover, Mei H. Wang, G. W. Pipes, M. H. Magrabi, Leonard Karroll and M. B. Behrens). In this project the investigators were seeking a better method of determining the thyroxine secretion rate in domestic animals. The methods used at present require sacrificing the animals; yet for the purpose of investigation a method is needed that may be applied repeatedly to the same animal at regular intervals during growth, pregnancy and lactation.

With the hope of devising such a method, the Missouri investigators started with the widely accepted scientific principle that thyroid secretion rate is governed by the thyroxine level of the blood. If this is true, maintaining the thyroxine level of the blood at or above the normal secretion rate should result in minimum activity of the thyroid gland.

To test this proposition, they gave rats dosages of thyroxine ranging from 0.5 to 10 ug./100 g. body weight, injecting each with 10 to 15 microcurries of  $I^{131}$ . In these preliminary experiments, the rate of collection of radioiodine by the thyroid and the formation of protein bound radioiodine (thyroxine?) in the blood indicated that thyroid function reaches a minimum as the thyroxine dosage reaches the normal secretion rate.

Another approach was made by using the phosphorus uptake assay of thyrotrophic hormone in day-old Hampshire chicks. It was found that after a dose of  $P^{32}$  (10 C) is given to each chick, 30 minutes are required

for a maximal collecting rate of radioactive phosphorus in the thyroid gland. Each group of chicks received different levels of Bergman-Turner thyrotrophin units, and the time has been searched for the maximal effect of thyrotrophin during periods of 1 to 24 hours each. The experiments demonstrated that a maximal effect 6 hours after administration could be obtained by giving 0.75 Bergman-Turner units. However, as little as 0.025 units gave a difference between experimental and control animals. Experimental data have shown the advantage of this assay; namely, that a small amount of thyrotropic hormone could be used for a short experimental period.

In summarizing these and earlier experiments on the same problem, the Missouri investigators report that protein-bound idoine levels in the blood progressively decline until a constant level is reached. It can be assumed, therefore, that the thyroxine secretion rate lies between the dosage rate necessary to reach this constant and the next lowest dosage. Radioactive iodine is rapidly converted into protein-bound iodine, because after 24 hours 70% to 85% of the total radioactivity in the blood is present in this fraction while the remainder is present as inorganic iodides.

Upon progressive administration of thyroxine the percentage of radioactive iodine in PBI declined until a constant level was reached at 10% to 25% under these conditions, the percentage of inorganic iodine increased, but total iodine decreased due, presumably, to increased excretion by the kidney.

Thyroid secretion rates estimated by this method gave results comparable or lower than those determined by the goiter prevention method in the rat, the chick, and the turkey.

In view of the present data it would seem that this technique shows considerable promise as a method for determining thyroid secretion rate without sacrifice of the animal.

## ENTOMOLOGY

LEONARD HASEMAN, *Chairman*

**Control of Codling Moth and Other Fruit and Vegetable Insects** (Lee Jenkins, Wilbur R. Enns and George W. Thomas). This series of investigations included tests of new insecticides and various methods of application to control pests of apples, peaches, grapes and garden vegetables.

### APPLE INSECTS

In work on apple insects, Parathion at  $\frac{3}{4}$  pound of wettable powder in 100 gallons of water gave excellent control of both Forbes and San Jose scale when applied in regular sprays in the last half of June and repeated at 14-day intervals. And 3 pounds of lead arsenate per 100 gallons in one calyx and two cover sprays controlled plum curculio on apples.

DN-111, which had been used as standard control for mites for three preceding years, failed to give satisfactory results in several orchards in 1950. During the same season, EPN 300 at 8 ounces per 100 gallons gave excellent control of mites.

Pestox III was very effective in controlling both mites and aphids on foliage, but this preparation is not safe for use on edible crops.

For control of the round-headed apple tree borer, various sprays were applied with a 3-gallon compressed air sprayer to the bases of 3-year-old apple tree trunks. Excellent control of the current year's generation of young borers resulted from each of the following sprays mixed in 100 gallons of water: 24 pounds 6% gamma BHC, 8 pounds 15% wettable Parathion powder, or 8 pounds 27% wettable EPN 300. A latter spray (September, 1950) using 8 pounds of 6% gamma BHC plus 4 pounds 15% wettable Parathion applied with a power sprayer killed all borers that were less than a year old.

#### PEACHES, PLUMS AND GRAPES

For peach insect control, experiments were conducted at Campbell, Cape Girardeau and Rocheport. These trials compared the effectiveness of six different materials currently available for control of curculio. Of these, Parathion was most effective with the others listed in order of their effectiveness as follows: Methoxychlor, Chlordane, Toxaphene, Dilan, and benzene hexachloride.

At Columbia and Mountain Grove, also, similar sprays used for insect control on plums indicated that several insecticides ranked in their effectiveness as follows: Methoxychlor, Parathion, Missouri Experiment Station general purpose spray, and benzene hexachloride.

For control of the grape berry moth, additions of DDT were tried successfully as a supplement to the regular spray program. The results are shown in Table 8.

#### VEGETABLE INSECT CONTROL

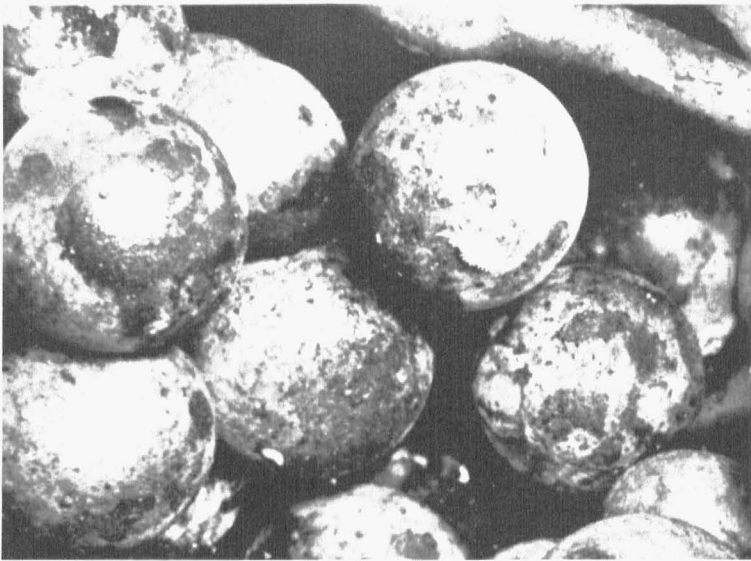
Preliminary tests were made on several of the newer controls for vegetable insects. Results indicated that Lindane dust was safe for the plants when used in concentrations no greater than 1%. Pyrocel was safe on plants but tended to encourage rotting of cauliflower heads and kale. Pyrocel was not effective against blister beetles. A general purpose dust submitted for test by the Standard Oil Company proved unsafe for most plants with the exception of potatoes, cabbage and equally tough plants.

In greenhouse experiments, Aramite applied in heavy concentrations for control of two-spotted mites caused russetting in tomatoes in the half-grown to mature stage. Aramite was safe on all other vegetables tested in the greenhouse and was effective against mites when used at the rate of 1 pound of 15% wettable powder per 100 gallons.

A new systemic poison known as Pestox III for greenhouse use was

TABLE 8--Improving Control of Grape Berry Moth by Additional Sprays of DDT Supplementing the Regular Applications.

Sprays applied	Percentage damaged fruit %	Percentage clean fruit %
Regular program (3 applications, each using 2 lbs. 50% DDT)	4.01	95.99
Regular program plus 1 application of same formula	1.59	98.41
Regular program plus 2 applications of same formula	.50	99.50



Grape mealy bug and the sooty mold it causes on the infested fruit.

found effective against aphids on roses, geraniums, coleus and African violets. It caused severe dropping of leaves when sprayed on hibiscus but not when fed to the plant by watering the soil. Pestox III did not control mealybugs nor waterflies.

**Influence of Different Chemical Fertilizer Mixtures on Insect Pests of Field and Garden Crops** (Leonard Haseman, Philip C. Stone and Harry E. Brown). An insect garden was planted on seven long plots representing six different fertilizer treatments and a check plot with no soil treatment at all. In rows crosswise of these plots seven kinds of vegetables were planted. All were cultivated to control weeds and to keep the soil

in good physical condition. Over this garden the insects were permitted to select their fare free-choice from the 49 combinations of vegetable species and soil treatments. No poisons nor other hindrance barred their search for the foods they liked best.

The purpose, of course, was to discover if possible a soil treatment that might make vegetables unacceptable to insect appetites or otherwise resistant to insect attack.

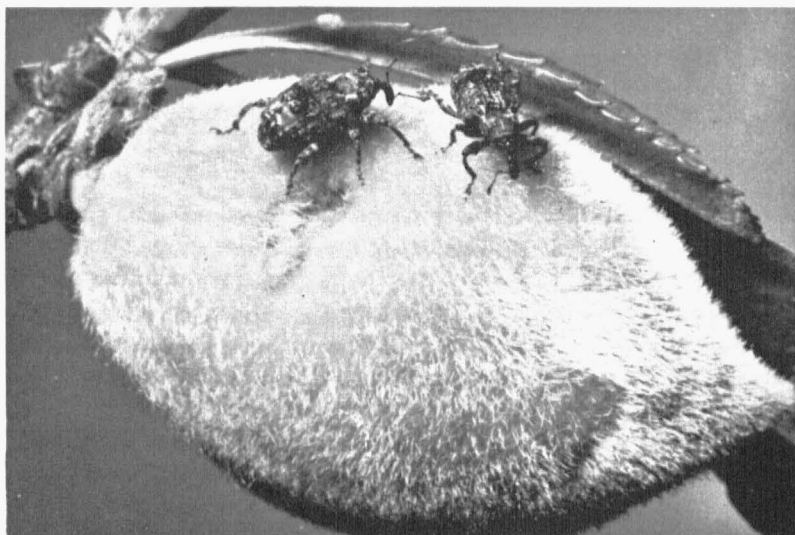
The seven variations in soil fertility were these:

- Plot 1. Barnyard manure, 20 tons per acre.
- Plot 2. Fertilizer, 200 lbs. 8-8-8, plus lime.
- Plot 3. Fertilizer, 200 lbs. 8-8-8, plus lime and trace minerals.
- Plot 4. No Fertilizer Treatment.
- Plot 5. Fertilizer, 200 lbs. 8-8-0, plus lime.
- Plot 6. Fertilizer, 200 lbs. 3-8-8, plus lime.
- Plot 7. Fertilizer, 200 lbs. 8-0-8, plus lime.

The insect preferences revealed at this green dining table 70 feet wide by 120 feet long were the following:

Leaf hoppers killed all the potato plants—regardless of soil treatment or lack of it—by the first week in August. Injury from this insect was somewhat less apparent in Plots 3 and 7 up to mid-July but by the end of July all potato plants were equally infested.

Colorado potato beetles were most abundant on Plots 1, 6 and 7 in mid-July, but thereafter only partly dead leaves were available for the



Plum curculio, serious pest of the peach orchard, was best controlled with sprays using Parathion.

beetles. The potato crop already was a complete failure because the leaf hoppers had not been controlled.

Squash bugs did not invade the garden until July 14—10 days after the summer squash crop had been harvested. But when the first generation of young squash bugs became abundant late in July they attacked plants on all plots and by the second week in August had destroyed every squash vine in the garden.

Because of intense infestation by flea beetles, aphids, potato stalk borers, *Tingidae* and other solanaceous insects, not one mature fruit was produced on the seven plots of eggplant.

Though cabbage plants on all plots were so badly infested with cabbage worms by August 2 that they appeared to be a total loss, many marketable heads were found beneath the ragged outer leaves on Plots 1, 2, and 3. Plot 3 cabbages looked the best. Plants grown on plots of low fertility were slower to mature and showed greater insect damage.

The sweet corn (Golden Cross Bantam) was harvested August 3. All corn was of poor quality. Each stalk was examined for infestation by corn earworm and European corn borer. Results are shown in Table 9. Very similar results were obtained on the planting of field corn.

TABLE 9--Infestations of Golden Cross Bantam Sweet Corn by Corn Earworm and European Corn Borer on Plots of Different Fertility Levels.

Plot	Number of stalks	Number of ears	Ears infested by earworm	Stalks infested by European borer
Plot 1	89	43	16	20
Plot 2	83	43	21	29
Plot 3	93	53	20	44
Plot 4	52	23	3	8
Plot 5	58	23	4	15
Plot 6	69	34	10	18
Plot 7	72	46	15	5

**Supplying Missouri Farmers with Timely Information on Insect Controls.** (Leonard Haseman, Lee Jenkins, Harry E. Brown, Philip C. Stone, C. W. Wingo, W. R. Enns and G. W. Thomas). Each week during the growing season a news letter was sent to all interested fruit growers. Thousands of personal letters, printed circulars and mimeographed leaflets were sent out.

With the help of Federal workers, surveys were made to determine the extent of infestations by grasshoppers, chinch bugs, army worms, European corn borers, garden webworms, and cotton insects. Farmers were given far more than the usual amount of help on the European corn borer situation, especially in North Missouri.

Bluegrass seed producers of Northwest Missouri requested and received help and advice in connection with an outbreak of "silver-top" disease spread by a microscopic mite.

**Investigation of the Biology and Control of Corn Earworms, Hessian Fly, European Corn Borer and the Bluegrass Silver Top Mite** (Harry E. Brown, Philip C. Stone and Leonard Haseman). Work was continued on the corn earworm in cooperation with the Department of Horticulture, and the findings of the preceding year were confirmed by the current year's results. Excellent control was obtained by proper timing of sprays with mineral oil and DDT.

This year's work with Hessian fly was limited to cooperation with the U. S. Department of Agriculture and the Missouri Station's Department of Field Crops. In a test of Chlordane, Clarkan wheat plots were planted late (November 1) after all chance of fall infestation was past. This means that the plots might be assumed to be free from fly at the beginning of the following spring. Two sprays of Chlordane were applied; one immediately after the first flies appeared and the other two weeks later. At harvest time samples were collected and the infestation on all plots ran very low, only 10% to 16%, and there was no difference between sprayed and unsprayed plots.

Although the crop year 1950 was expected to be marked by a heavy infestation of European corn borers due to the build-up of the preceding year, the situation was changed by weather conditions grossly unfavorable to borer development. The first 1950 generation of borers was drastically reduced, and the second was practically eliminated. Even so, the Missouri Station continued for the fourth consecutive year to distribute three important species of insects known to have been parasites of the corn borer in Europe. In the four year-period, the Missouri Station has released 26 colonies of these parasites at 15 locations in Missouri counties.

Greenhouse experiments with the mites that transmit the fungus causing "silver top" disease in bluegrass have pointed the way to eventual control. Several of the chlorinated hydrocarbon insecticides drastically reduced the number of mites under greenhouse conditions.

**Control of Beetles, Aphids, Squash Bugs, Pickle Worms and Vine Borers on Cucurbits** (Leonard Haseman, Wilbur R. Enns and Lee-Jenkins). Tests were made of the methoxychlor-plus-lindane combination sprays for cucurbit insect control. This type of spray was highly efficient when used at the right strength and frequency. The results indicated that this mixture should be used at the rate of 2 parts of 50% wettable methoxychlor to 1 part of 25% wettable lindane. The plants were not harmed by the spray.

Used as a dust this mixture worked best when composed of equal parts or 5% methoxychlor and 2% lindane. The lindane was still effec-



tive if cut down to 1% in the dust wherever there was no serious infestation of aphids.

**Investigation and Control of Livestock Lice, Mange Mites, Blood-sucking Flies and the Screwworm Fly** (Curtis W. Wingo and Philip C. Stone). A survey of the screwworm situation in Missouri, made in cooperation with the U. S. Department of Agriculture, found screwworm infestation in 55 of the state's 114 counties. The investigators also reported that community livestock sales were still the primary centers of distribution of this pest in the outlying districts of the state.

Tests of new controls for cattle grubs were made, although very few complaints have been received from stockmen concerning this pest in recent years. Two formulations were tested and found to be only 37% and 14% effective—in contrast the 95% kill of grubs resulting from the standard treatment with derris dust (1% rotenone).

Limited tests in the control of hog mange indicated that one application Aramite spray using 8 lbs. of 15% wettable powder per 100 gallons of water gives satisfactory control.

In experiments with horse flies, applications of Pyrenone using 1 to 15% emulsifiable concentrations gave complete protection up to 96 hours in some cases.

**Using Sulfathiazole and Related Sulfonamids for protecting Honey Bees from Foulbrood Disease** (Leonard Haseman). Besides testing simpler methods for applying the sulfa-drug treatments, this investigation sought to determine the length of time the treatment remains effective.

Eight strong colonies, four 2 lb. packages, and three nuclei of bees were used. Of the sulfa drugs only sulfathiazole in half gram tablets and powdered sodium sulfathiazole were used in the treatments. No antibiotics were used. Both forms of the drug were fed in sugar sirup; one half-gram tablet of sulfathiazole, or one-half teaspoon of the powdered sodium sulfathiazole, to a gallon of sirup.

All colonies new and old remained free of any sign of foulbrood throughout the year. Moreover, some of the colonies formerly treated in the Station apiary continued free from infection for the third year since treatment.

**Collecting and Identifying Mosquitoes in the Missouri River Valley** (Philip C. Stone and Wilbur R. Enns). Work done this year brought the total number of species and sub-species of mosquitoes found in Missouri to a total of 49. This total represents the combined collections and determinations of species made by the Missouri Experiment Station and the Missouri and United States Public Health Services.

**FIELD CROPS**W. C. ETHERIDGE, *Chairman*

**Outlying Experimental Fields** (W. R. Langford, E. M. Brown, J. M. Poehlman, C. V. Feaster, M. S. Zuber, J. D. Baldrige, C. A. Helm, W. C. Etheridge, Hale Fletchall and Lloyd Cavanah). Experiments involving a wide range of crop varieties, soil types and climatic conditions were carried through the year at outlying experimental fields in the southeast, northwest and southwest regions of the state.

**SOUTHEAST MISSOURI FIELDS**

*Cotton Variety Tests:* Cotton variety tests were conducted near Sikeston, Marston, and White Oak during the 1950 season. Tests were planted at three other locations, but they were not harvested because of poor stands. The tests at Sikeston and Marston were replanted and yields at these locations were much below the long-time average.

Plains and Empire were the most productive varieties at both Sikeston and Marston. They produced 336 and 298 pounds of lint per acre, respectively, at Sikeston; while each produced 405 pounds of lint per acre at Marston. During the three-year period, 1948-1950, Deltapine 15, Fox, and Empire were the leading varieties at Sikeston with yields of 577, 561, and 558 pounds of lint per acre respectively.

The test at White Oak was conducted on soil heavily infected with *Fusarium* wilt fungus. Coker 100 Wilt and Plains were superior to other varieties in both wilt resistance and yield. During the two-year period, 1949-1950, Coker 100 Wilt averaged 589 pounds, while Deltapine 15, a susceptible variety, made only 170 pounds of lint per acre.

*The Effect of Spacing on the Yield of Cotton:* Spacing of cotton plants within a population range of 12,000 to 40,000 plants per acre had no significant effect on the yield of seed cotton. Within this range the yield of cotton planted in checked rows was equal to the yield of hill dropped cotton. The yield from check-row plantings having 9,000 or fewer plants per acre was much lower than the yield from stands more dense.

*The Response of Cotton to Fertilizers:* Fertilizer studies with cotton were conducted near Sikeston, White Oak, and Deering during the 1950 season. On the sandy loam soils at Sikeston and White Oak the application of each of the three major plant nutrients increased the yield of seed cotton.

Highest increases in yield were obtained from the application of phosphorus. For example, 500 pounds of an 8-0-8 mixture produced 869 pounds of seed cotton on Lintonia sandy loam near Sikeston; whereas, 500 pounds of 8-12-8 increased the yield to 1425 lbs. This is an increase of 556 pounds of seed cotton per acre gained by the application of 60 pounds of  $P_2O_5$ . Furthermore, cotton that was well supplied with phos-

phorus on phosphorus-deficient soils opened earlier than cotton not supplied with phosphorus.

Increases in yield due to nitrogen and potash were smaller than those gained by using phosphorus. Forty pounds of nitrogen increased the yield 264 pounds per acre but 80 pounds increased it only 124 pounds. More than 80 pounds of nitrogen per acre in 1950 decreased the yield of cotton.

The placement of phosphorus in relation to the plant appears as important as the quantity of phosphorus to use, for 80 pounds of  $P_2O_5$  disked into the soil prior to planting cotton had little effect on the yield, but 60 pounds of  $P_2O_5$  placed in the row just below the seed hastened maturity and increased the yield from 1073 to 1643 pounds of seed cotton per acre.

*Defoliation of Cotton:* Calcium cyanamid at the rate of 25 to 40 pounds per acre was the most efficient defoliant tested in 1950. On very large but immature cotton 22 pounds of  $CaCN_2$  per acre removed 95% of the leaves in 12 days following its application.

Time of defoliation may have a pronounced influence on the quality of both fiber and seed. The yield of cotton defoliated 15 days after "cut-out" was reduced 24%.



Combining brome grass seed from brome grass-ladino pasture in Southeast Missouri June 30, 1950. The yield was 250 pounds of clean seed an acre. Steers were turned on this field immediately after the brome grass seed harvest and made excellent gains.

*Improvement of Cotton Varieties in Missouri:* A large population of  $F_2$  plants from each of eight crosses involving Coker 100 Wilt and eight varieties superior in yield, early maturity, or fiber quality were grown on wilt infected soil. Plants that appeared highly resistant to wilt were selected and will be tested for other desirable qualities. A few superior  $F_2$  plants from each of the eight crosses were backcrossed to each parent.

*Response of Corn to Fertilizer:* Adding nitrogen to the soil produced valuable increases in the corn yield on the Southeast Missouri Experiment Field, but potash and phosphorus had not effect on the yield. In these tests 50 pounds of nitrogen increased the yield from 49 bushels to 62 bushels per acre, 100 pounds of nitrogen increased the yield to 78 bushels, 200 pounds of nitrogen produced 88 bushels, and 300 pounds of nitrogen increased the yield to 101 bushels per acre.

*Response of Alfalfa to Fertilizers:* Phosphorus had a pronounced influence on the establishment and early growth of fall seeded alfalfa on the Southeast Missouri Experiment Field. Stands of alfalfa that received no phosphorus were much thinner and seedlings that survived were smaller than those treated with phosphorus. Four hundred pounds of superphosphate proved superior to 1,000 pounds of rock phosphate during the early growth of alfalfa.

*Studies of Soybeans:* A long list of established varieties was tested intensively for variations in yield and maturity. Newly bred strains not yet in variety status were observed for promising features. Tested also were variations in methods of planting rate, spacing, and timing.

The leading varieties produced in bushels of seed per acre as follows: Wabash produced 37 bushels, S-100 produced 36, and Ogden 35 bushels. Weather conditions were less favorable to Ogden than to the others. During the period 1943-50 inclusive, the average acre yield of Ogden and S-100 on this field were 32.3 and 26.4 bushels, respectively. Under large scale farming the non-shattering tendency and safe ripening of S-100 go far to offset this difference in yield.

*Studies of Hybrid Corn:* The studies included 49 hybrids of the closed pedigree, certified, and experimental classes. Average yield was 88.8 bushels per acre. Mo. 5365w was the leader here as it was also at Pierce City and Lathrop.

*Studies in the Production of Pastures:* The objective of pasture experiments on the Southeastern Missouri Experimental Field is to determine what grass-legume and what grain-legume mixtures will produce the most beef per acre, and how these pastures should be managed to produce maximum steer gains.

During the 3-year period, 1948-1950, steers have gained 315 pounds an acre annually on brome grass and alfalfa, 288 pounds on wheat and lespe-deza, and 280 pounds on winter oats and lespe-deza.

## BOTTOMLAND EXPERIMENT FIELD

This field of 30 acres near Elsberry is located on Wabash clay a soil extremely heavy and poorly drained but high in potential fertility. Cold and hard to cultivate, this Wabash clay usually is slow in becoming workable in the spring. It is difficult to handle, and previous to our development of rotations which have improved its physical properties, it was locally rated low in productivity and market value, farmed only in the better seasons and used to produce only a few "wet land" crops. This land now grows soybeans abundantly, is capable of growing every year extremely heavy yields of rice, and in favorable seasons good yields of corn, wheat and oats.

The season of 1950 was unfavorable to all crops connected with this project, except soybeans and rice. Wheat was winter-killed to a 15% stand. Tests of hybrid corn and of chemical sprays for the control of weeds in corn failed as a result of heavy rains at the planting stage and, intermittently, through the whole season.

The wheat-soybean succession was productive only on the soybean end, the wheat being lost through winter-killing, as already noted. Soybeans yielded 22 bushels an acre, larger production being prevented by late planting, due to wet weather.

Twenty-eight varieties of rice were grown in tests near Elsberry and Palmyra. Twenty-one of them gave fully matured yields of 60 to 97 bushels an acre. For the second consecutive year, Kinsi (195) has been the highest yielder. Other high yielding varieties were Colusa at 79 bushels and Cody at 77 bushels.

Grown also on this field in 1950 were 58 reselections of rice, which were tested for agronomic qualities. In this group, 16 showed improvement worthy of further testing. Rice varieties were hybridized in the greenhouse at Columbia and in the field near Palmyra. The purpose of these efforts in rice breeding is the development of high yielding varieties that will mature regularly on the heavy clay bottomlands of North Missouri. Rice and soybeans are the safest and most productive crops yet found for the profitable utilization of this extensive class of Missouri land.

## LATHROP EXPERIMENT FIELD

The principal objective of investigations in progress at Lathrop is to find out how to increase profitably the productivity of bluegrass pastures which occupy a large part of the farmland in Northwest Missouri. On this field 45 acres are divided into nine experimental pastures.

Average annual gains made by beef steers on six of these pastures during the 5-year period 1946 through 1950 were 305 pounds an acre on bluegrass plowed out and seeded to bromegrass-alfalfa-ladino, 222 on bluegrass renovated with lespedeza without plowing, 207 on bluegrass renovated with sweet clover without plowing, 210 pounds on bluegrass

renovated with lespedeza without plowing and without phosphate fertilizer, and 280 pounds an acre on wheat-lespedeza used entirely for pasture. The five most productive pastures during 1950 and steer gains made on them were tall fescue and ladino 516 pounds an acre, bluegrass fertilized with ammonium nitrate 419 pounds, bromegrass-ladino 359 pounds, wheat-lespedeza 331 pounds, and bluegrass-ladino 315 pounds an acre.

The local adaptation and yield of varieties and bred strains of corn, wheat, oats, alfalfa, red clover, birdsfoot trefoil, bromegrass, and bluegrass were also plot-tested here, on 5 acres of deep, fertile soil.

#### SOUTHWEST MISSOURI FIELD

This field, located near Pierce City, consists largely of Lebanon gravelly loam. The broad purpose of the work done here is to improve the low native fertility of the land to a level that will support higher yields of feed for the large and growing dairy industry of this region of Missouri.

Land betterment, therefore, is being given primary attention, though its progress is limited by inadequate funds. Terracing was completed, or nearly so, in 1950. Waterways and field roads were heavily fertilized and seeded, with good stands resulting. Lespedeza in all grain stubble was plowed under. Most of the fields have received large additions of fertilizers and organic matter.

Oats (winter and spring) and barley were grown successfully but wheat failed as a result of heavy and continued rains at harvest time. Soybeans yielded up to 20 to 25 bushels an acre. Approximately 1000 bushels of corn were grown on 11½ well-fertilized acres. A test of 24 hybrid varieties on land normally fertilized returned an average of 69.8 bushels per acre. Mo. 5365w was the leader and appeared to be a promising new hybrid for Southwest Missouri.

Grass-legume pastures, heavily fertilized, reached an abundance of yield seldom found on much better land without soil treatment. They were not grazed because division fences could not be built in time.

**Improving Permanent Pastures with Legumes** (E. Marion Brown). Results obtained in 1950 on experimental pastures at Columbia have been combined with the results of 5 years of similar experiments at Lathrop in order to compare the performance of ladino clover in the current year with that of other legumes from 1946 to 1950.

Table 10 shows the gains made by beef cattle in 1950 at Columbia, while Table 11 gives a similar summary of 5 years' results at Lathrop.

Field 8 (in Table 10) had been badly depleted by exhaustive cropping and erosion, but it was limed, fertilized, and seeded August 26, 1949, to tall fescue and ladino. The 293 pounds an acre gained by steers which grazed this pasture from May 7 to September 27, 1950, is high production.

Pasture 10, tall fescue and Korean lespedeza, produced 188 pounds

TABLE 10--Gains Made by Beef Cattle on Lathrop Pastures, 1946-1950.

Pasture	Pounds gain an acre	
	1950	5-year average
1. Wheat-lespedeza	331	280
2. Tall fescue-ladino	516	*
3. Bluegrass-sweet clover	239	207
4. Bluegrass-ladino	315	*
5. Bluegrass-lespedeza	290	222
6. Bluegrass-Nitrogen fertilizer	419	305
7. Bluegrass-lespedeza (no fertilizer)	237	210
8. Bromegrass-ladino	359	304**

\* 1950 only

\*\* Bromegrass-alfalfa 1946-47, bromegrass-lespedeza 1948, and bromegrass-ladino 1949-50. Other legumes sown in bromegrass sod after alfalfa died.



These steers, photographed September 16, 1950, gained 2.24 pounds a head daily on bromegrass-ladino pastures on the Lathrop experiment field. This pasture carried one steer an acre from April 27 to October 4 and made 359 pounds of beef an acre.

gain an acre on soil comparable to that of Pasture 8. The Korean lespedeza was injured severely by bacterial wilt.

The bromegrass-legume mixture and bluegrass fertilized annually with 200 pounds ammonium nitrate an acre (Table 11) were consistently high on yields of beef. The disadvantage of bluegrass pasture fertilized with nitrogenous fertilizer has been its inability to carry during summer



TABLE 11--Beef Cattle Gains Made on Columbia Pastures During 1950

Pasture	Pounds gain an acre
1. Bluegrass	216
2. Bluegrass-Kobe lespedeza	279
3. Bluegrass--fertilizer and lime	253
8. Tall fescue-ladino fertilized and limed	293
10. Tall fescue-lespedeza fertilized and limed	188

more than one-third of the cattle required to keep the grass grazed down during spring.

The high nutritive quality of bluegrass and lespedeza growing on soil of medium fertility is shown by the daily gain of 2.48 pounds a head made by the 3 steers that grazed unfertilized Pasture 8 continuously without other feed from April 27 to October 4. The comparatively small difference in average beef production between Pastures 8 and 5, which received a total of 300 pounds  $P_2O_5$  an acre in 3 applications of fertilizer from 1945 to 1949, shows, however, that lespedeza is not a satisfactory legume for the renovation of heavy fertilized pastures. The comparatively high production of the 3 pastures which included ladino (2, 4, and 9) shows its value for use in heavily fertilized pastures.

At Columbia, steers gained 279 pounds an acre on bluegrass in which Kobe lespedeza was seeded without soil treatment; 253 pounds an acre on bluegrass limed and fertilized but without lespedeza; and 216 pounds an acre on bluegrass which was neither limed, fertilized, nor seeded to lespedeza.

**Pastures for Southeast Missouri Lowlands** (E. Marion Brown and W. R. Langford). Four small grain and legume mixtures were tested at Sikeston. Grazed by yearling steers, these pastures produced the following gains in pounds of beef per acre: bromegrass-alfalfa 225 lbs., wheat-lespedeza 225 lbs., winter barley-lespedeza 214 lbs., and winter oats-lespedeza 225 lbs. These yields in 1950 were considerably lower than those made in the same experiment during the two years immediately preceding. For example, the average of gains made on brome and alfalfa in 1948-1950 was 315 lbs., and the average for wheat and lespedeza in the same three years was 288 lbs.

Twenty steers which grazed 30 acres of bromegrass-ladino pasture returned \$39.50 an acre, although the animals had been fed heavily enough to gain 1.5 lbs. a head daily from September to March and though one of the 20 steers bloated and died.

**Interaction Between Legumes and Permanent Pasture Grasses** (E. Marion Brown and Hale Fletchall). In the sixth year after nine legumes were sown in sods of four grasses, only ladino clover still maintained good

stands. On one section of this experiment, ladino was seeded with each of four grasses. Then, after these pastures were subjected to three different mowing treatments, a count was made of the percentage stands of both the ladino and host grass surviving on August 14, 1950. These counts are shown in Table 12.

TABLE 12--Percentage Stands of Grasses and Ladino Clover in the Sixth Year After the Legume Was Seeded in the Grass Sods.

Grass with which ladino was seeded	Percentage stands of grass or clover					
	Close mowing		Moderate mowing		Hay cut	
	Grass	Clover	Grass	Clover	Grass	Clover
Bromegrass	0	50	18	53	30	63
Bluegrass	97	59	95	67	81	92
Orchard grass	37	26	84	41	79	46
Redtop	35	57	64	62	53	68

**Breeding Superior Strains of Soybeans for Industrial Utilization** (Carl V. Feaster). These breeding experiments were continued on the Station's experiment fields at Columbia, Norborne, Laddonia, Elsberry, Sikeston, Deering and Pierce City. Floods prevented harvesting at Elsberry. These tests are carried on from year to year in cooperation with experiment station workers of other soybean growing states.

Immediately following are the notations made by the Missouri Investigator as he recognized here and there in his test plots the promise of a new and superior variety.

"Strains of Group II were too early for maximum yields.

"In Group III, strains L6-1152, L6-1503 and L6-2132 were similar to Chief in maturity but somewhat superior in yield.

"Strain L-6-5679 in Group IV yielded well, but it has a tendency to lodge under certain conditions and is lower in oil than C612.

"In Group V, a few strains yielded more than S-100. Of the new entries, only D517-4 was superior to S-100 in yield.

"In Group VI, none of the strains was superior to Ogden, Dortchsoy 2 or Hale-Ogden 2.

"Of the strains in the tests just mentioned, L6-1152, L6-1503, L6-2132 and C612 appear to be the only strains superior to the check varieties. At this Station, C612 is being multiplied for release to Missouri certified seed growers."

In addition to these group tests, the Missouri investigators this year made new crosses using two experimental strains, L6-1503 and D623-9 with two commercial varieties, Adams and Ogden, in all possible combinations. Their purpose was to provide breeding material differing widely in maturity. The varieties crossed were chosen because of their different origins, high yield, high oil content, and maturity grouping.



This field of tall fescue and ladino clover at Columbia was seeded August 26, 1949. The following year it was grazed from May 7 till September 27 and made 293 pounds of beef an acre.

Breeding soybeans for resistance to the bacterial pustule disease was continued. Previously, Clemson Nonshatter, a variety resistant to this disease, had been crossed with Lincoln, Boone and Ogden. Also, the first generation progeny had been backcrossed to their respective susceptible parent strains. In 1950, the second generations from these backcrosses were grown and inoculated with the bacterial pustule organism so that the susceptible segregates could be eliminated. The resistant segregates were further selected on the basis of agronomic characters. This procedure is expected to result in new resistant strains adapted to the various sections of Missouri.

**Breeding and Developing Superior Strains of Birdsfoot Trefoil** (Joe D. Baldrige). Three commercial varieties of birdsfoot trefoil, European, Empire and West Coast, grown and compared for yield and disease resistance. Sown in timothy, these trefoil varieties produced forage yields ranging from 6460 to 7680 pounds an acre. Red clover and timothy in the same trials yielded 5350 pounds an acre.

These trials indicated that good stands of birdsfoot trefoil were as

productive as red clover in the second year and may be expected to continue producing good crops long after the red clover has disappeared. Being longer lived than red clover in meadows and more persistent than lespedeza under certain pasture conditions, birdsfoot trefoil promises to be a useful dual-purpose legume for Missouri.

Some of the experimental plantings of birdsfoot trefoil were badly injured by the fungus *Rhizoctonia solani*. Because of this fact, Missouri plant breeders are looking for strains of trefoil showing pronounced resistance to this disease.

**Development of White and Yellow Corn Hybrids Adapted to the Various Areas of Missouri** (Marcus S. Zuber, Wm. A. Crane and C. O. Grogran). The 1950 crop season was very favorable for corn production. The estimated average yield for Missouri was 45 bushels to the acre, only a half bushel short of the record yield of 45.5 bushels established in 1948. These record yields were the results of favorable weather conditions, improved cultural practices and the use of hybrid seed. Of the total corn acreage in Missouri last year, 97% was planted with hybrid seed, and a conservative estimate of the amount of increase to the acre would be 15%, or 6.75 bushels per acre. The total increase for the four million acres planted with hybrid corn seed, therefore, could not have been less than 27 million bushels.

The 1950 corn investigations followed four main phases which are as follows: (1) Development of new white and yellow inbred lines, (2) Identification of the superior new lines by the means of top-cross tests, (3) Seed production and testing of single crosses among the newer lines and the better old lines, and (4) Seed production and testing of new double-cross hybrids.

The corn nursery was again located on Missouri River bottomlands near Huntsdale, where approximately 25,000 hand pollinations were made. Included in the nursery were seed productions from 70 experimental double-cross hybrids, single crosses among midseason and late yellow inbreds, and midseason white inbreds, seed increases of 80 yellow and 30 white inbred lines, and 3500 rows—15-plants to the row—of white and yellow germ plasm in various stages of inbreeding. In addition to the corn nursery, three isolated top-crossing blocks were used in the crossing of 110 new white inbreds, 70 new pipe-corn inbreds, and 210 new yellow inbreds with suitable testers. The top crosses will be grown year after year for the evaluation of these new inbred lines.

**Genetic Studies with Crop Plants** (L. J. Stadler and E. R. Sears). These investigations included a study by Stadler on the mechanism of heredity in corn and one by Sears on the genetics of polyploidy in wheat.

*Mechanism of Heredity in Corn* (Gene variability at the R locus in relation to seed control). The earlier studies of gene variability in this

project indicated that seedling type in various stocks of corn might be so distinctive as to provide an effective method for detecting mis-naming in commercial corn hybrids. Preliminary trials of this possibility, made at the request of W. A. Davidson, chief of the Seed Act Division of the Production and Marketing Administration, have given very favorable results, indicating that an effective technic for this purpose could be developed.

Spontaneous mutation of A. The "gene" A, long recognized as a unit of heredity on the basis of its transmission in inheritance, is shown by mutational analysis to consist of a complex of separate determiners. The gene R, similarly studied, also showed evidence of complexity. Such complexity may be characteristic of genic substance, for, if so, it would be detectable only in cases especially favorable for analysis. Various studies of the nature and inter-relationship of these components of A action are reported.

*Genetics of Polyploidy in Wheat.* Using the technic of nullisomic analysis developed at the Missouri Station, a gene for resistance to certain physiologic races of black stem rust has been located at chromosome VIII of the variety Hope. Genes for stem rust resistance had previously been located on particular chromosomes of Thatcher, Red Egyptian and Timstem.

Tetrasomes XIV and trisome XXI have been obtained, leaving only XV not identified in the addition series. Only nulli-XIV remains to be definitely identified in the deficiency series. Five groups of three chromosomes and one group of two have been found to show more or less genetic homology among themselves.

**Annual Testing of Wheat Varieties and New Selections** (J. M. Poehlman, W. P. Sappenfield, Ben H. Beard and Carl L. Koehler). Wheat variety nurseries were maintained at Columbia, Lathrop, Elsberry, Pierce City and Sikeston. The 1950 season was favorable and yields were relatively good.

Vigo and Royal were again, as in the preceding year, the high yielding commercial varieties, with one selection from a Clarkan x Vigo cross emerging as the highest yielding strain in the entire series of tests.

Early hybrid selections of Purplestraw-Chinese-Michigan Amber x Kawvale parentage were increased so that sufficient seed would be available for yield tests the following year. These selections are early, short-strawed, high yielding and highly resistant to leaf rust and loose smut.

Special nurseries grown in cooperation with the U. S. Department of Agriculture included winter and spring wheat-rust nurseries, an eastern soft wheat nursery, and a nursery of varieties resistant to Septoria blight. Approximately 3000 varieties were checked for resistance to Hessian fly.

Wheat quality studies were continued in cooperation with the Scott County Milling Company of Sikeston.

**Breeding of Winter Barley for Yield, Winter Hardiness and Resistance to Disease** (J. M. Poehlman, C. K. Cloninger, Carl L. Koehler and Donald D. Terhune). A new variety of winter barley, B-400, developed by the Missouri Station, was grown by farmers in 1950 for the first time. Fifteen Missouri farmers grew 280 acres, and from their harvests 6024 bushels of seed were certified.

Variety yield tests were grown at Columbia, Bethany, Perryville, Pierce City and Sikeston. These included standard varieties and experimental strains. Outstanding were the crosses Admire x Early Beardless, Ky. 2 x Early Beardless, and Ward x Early Beardless.

Special studies were conducted on varieties and strains offering possibilities of greater resistance to smut diseases. Excellent resistance to the smut known scientifically as *Ustilaga nuda* was found in the Tennessee hooded barleys, while strong resistance to *Ustilago nigra* was found in hybrid selections of Early Beardless parentage. Very promising resistance to *Ustilago hordei* was found in B637, a hybrid selection from the cross Michigan Winter x Early Bearless.

**Testing New Strains of Oats** (J. M. Poehlman, W. P. Sappenfield and Carl L. Koehler). Missouri O-200 oats, first distributed to farmers during the preceding year, was multiplied on 15,000 acres in 1950. In the Station yield tests this year, O-200 led all other varieties.

Seed of two new strains developed in Missouri from the cross Columbia x Victoria-Richland was increased this year for distribution to farmers in the following season. These will be known by one name, Mo. 01-205. Extremely vigorous and productive, this stiff-strawed variety also is resistant to smut, Septoria blight, and rust. It promises to be the most important new oats contributed by this Station since the introduction of Columbia oats in 1931.

Yield tests of many thousands of oats varieties and experimental selections were carried on at Columbia, Bethany, Lathrop, Elsberry, Pierce City and Sikeston. Mo. O-200 was closely followed by Andrew as the second highest yielding variety. Then came the Columbia x Victoria-Richland strains (since named 04205 and 04102) and Columbia x Marion as the top experimental strains.

**Seed Testing Laboratory and the Improvement of Missouri Farm Seeds** (Viola Stanway, C. A. Helm and Lloyd Cavanah). These two projects are carried on, year after year, to improve the quality and increase the supply of field crop seeds throughout the state.

Work in the laboratory is here reported for the year ending June 30, 1951. The number of seed samples received was 4879, and the total number of tests made was 7967.

Field inspections of seed in standing crops were made on 24,824 acres in 84 Missouri counties. The specialists making these inspections examined the standing crops for such qualities as varietal purity, freedom from disease and freedom from weeds. Making these inspections required 46,971 miles of travel. Acreages of various crops inspected were: barley 441, rye 327, wheat 3022, oats 3115, sorghum 20, soybeans 9,887, cotton 6124, hybrid corn 2668, legumes and grasses 150.

From these acres the yields of high quality seeds harvested, tested and finally certified were: barley 7830 bushels, rye, 652, wheat 23,750, oats 60,000 bushels, soybeans 110,000 bushels, hybrid corn 140,000 bushels, sorghum 59,000 pounds, and cotton 500 tons.

The immediate market value of these certified seeds was no less than \$1,000,000. Their ultimate value in terms of increased yields of crops resulting from their special productivity was several times that sum.

## FORESTRY

R. H. WESTVELD, *Chairman*

**The Value of Woodland Management in Missouri** (Paul Y. Burns). This study is an analysis of the woodland management methods used by five Missouri farmers representing different parts of the state, together with their records of financial returns from the sale and utilization of timber products.

The first of these farms was that of Frank Milde near Jackson in Cape Girardeau County. Mr. Milde's father, Albert Milde, had started handling his timber as a crop in 1918 and had trained his son in the same wise management practices. The woodland on this farm contains many large trees of yellow poplar, white oak, ash, elm, hickory and sugar maple. The Mildes made annual cuttings of fuelwood and posts. They harvested sawlogs several times—on the average about every five years. They did most of their own cutting and had the logs custom sawed. If, instead, they had sold their timber on the stump, their income through the years would have averaged only \$75 instead of \$303 a year. The difference is the net gain obtained by putting in 17 days of work a year.

In general, the experiment found authentic records indicating that the net value of the wood crop to the farmer can vary from \$100 to \$700 a year, depending mainly on the conditions of the woodlot, its extent, and the time the farmer spends in harvesting his own products.

**Direct Seeding of Oak** (J. M. Nichols and R. H. Westveld). This investigation included direct seeding of black oak and scarlet oak in December, 1950, followed in the spring of 1951 by examination of the seedlings to determine the relative efficiency of various protective treatments.

Eleven different practices were compared, including a check plot. In these the acorns were planted with ten types of seed treatment or pro-



tection. These were (1) raking the seed plots bare of litter, leaving no shelter for mice, (2) covering each seed spot with a cone of  $\frac{1}{4}$ -inch hardware cloth, (3) treating the acorns with dog dung sludge, (4) treating with hog dung, (5) with benzene hexachloride, (6) with potassium permanganate solution, (7) with ferric chloride solution, (8) with copper oleate emulsion, (9) with dehydroacetic acid, and (10) with red lead and linseed oil.

Weekly observations during the period of normal germination revealed that all acorns—regardless of treatment—had been destroyed by mice or other rodents. Even the acorns under hardware cloth covers had been dug up and opened on top of the ground by mice that obviously had burrowed under the edges of the hardware cloth.

Pine seedlings were also made in December, 1950 and early spring in 1951 to compare the results of fall and spring seeding. Results showed no significant difference, however, with stands from each method averaging about 50%.

**Growth and Yield of Missouri Timberlands** (Paul Y. Burns). In order to study the growth of timber year after year in different parts of the state, 25 permanent plots were laid out. Each plot was marked with a stake of cedar or creosoted pine and records on vegetation and site were made. Plots were located in the following counties: Boone, Bollinger, Butler, Callaway, Crawford, Dent, Maries, Pettis and St. Charles.

The records accumulated will be used as demonstrations for the guidance of farm woodland owners in the regions represented.

**Suitability of Missouri Woods as Fence Posts** (K. C. Compton and L. K. Paulsell). This experiment was established on the Weldon Spring area in St. Charles County. A seasoning shed 20 by 60 feet was built, with one end enclosed as a laboratory and the remainder left open at the side so that posts piled there are subject to the drying effects of freely circulating air yet not exposed to direct sunlight.

A treating tank was built with a swinging pole equipped with block and tackle for dipping and removing the posts from the tank. To provide a reliable means of measuring the penetration of the wood by the preservative, 1 pound of oil-soluble dye was mixed with each 500 gallons of the preservative.

Several hundred posts were cut, peeled, seasoned and treated, comparing native hard and soft woods including black oak, cottonwood, hickory, elm, black locust, and ash. The tests also compared the effects obtained with two preservatives; pentachlorophenol and cresote.

Effective penetration was obtained in this manner at a total cost of only  $\frac{1}{2}$  cent a post.

Similar comparisons of timber species used as fence posts were continued at Columbia, also. This experiment had been established in 1936

The latest check on this experiment (in 1950) found 146 posts still standing from an original setting of 322.

Untreated posts in this experiment, after 14 years in the ground, indicated that 64.6% of the posts had failed. Among all untreated posts the average useful life had been 1 year and 7 months for basswood, 11 years and 10 months for catalpa, and 11 years and 9 months for eastern redcedar.

Treated posts had numbered 238 at the beginning of the test, and of this number 123 have been removed because of decay or insect damage. The average natural mortality of the treated posts had been 51.3%. Species showing the highest percentage of failure were hackberry, shagbark hickory and American elm. Even these species, however, showed a life record 3 to 5 times as long as the untreated posts of the same species.

**Christmas Tree Culture** (R. Brooks Polk, Lee K. Paulsell and R. H. Westveld). During 1950, the Forestry Department moved into the advanced stages of its studies of Christmas trees as a potential crop from submarginal agricultural lands. This work was done on the Ashland Wildlife Area and Arboretum in Boone County. Plantings of 14 species of evergreens established there during the period 1937-1942 have been studied from the standpoints of survival and growth in order to select species best adapted to Missouri.

In more recent years, Christmas tree sales have been held annually to measure the marketability and buyer preference scores of the various species.

Results to date have shown Scotch pine to be the best of the 14 species studied. The stiffness of its lateral branches is a disadvantage in bundling and shipping, but an advantage when the purchaser sets it up in the home and begins to decorate it and place gifts in its branches. It is ideal for distribution in the area where it is grown.

Although jack pine, Virginia pine, shortleaf pine and pitch pine have survived as well or better than Scotch pine in the Ashland plantings, their percentage yield of marketable trees has been invariably low. Eastern redcedar has excellent shape and density but the browning of its foliage as winter comes on greatly reduces its marketability.

Poor survival when transplanted from the nursery has been a common disadvantage of balsam fir, Douglas fir, and white spruce.

A new planting of evergreen species for Christmas tree evaluation was made in the spring of 1950 on the Weldon Spring Experimental Farm in St. Charles County. Of a total planting of 13,720 seedlings in this experiment, 9604 were jack pine, 2940 were Scotch pine, and 1176 were of various other species. Detailed planting and survival records were made. Plots of Scotch pine that were mulched 1 inch deep with aged sawdust showed a survival of 100%, while that of unmulched plots was only 73%.

**Sprout Control of Inferior Forest Species** (J. M. Nichols and R. H. Westveld). Observations were recorded in October, 1950, showing the percentage of sprout control following sprays with various control preparations.

In one experiment a 5% spray of isopropyl ester of 2,4,5-T (acid equivalent 37%) was used in kerosene to test its seasonal effects on five forest species; hickory, sassafras, persimmon, white oak and black oak. Stems 1 to 3 inches in diameter were cut with axe or saw and the spray was applied to the freshly cut stumps and stems. A minimum of 10 stems of each species were given this treatment each month. The percentages of sprout control resulting from each treatment and each species are given in Table 13.

TABLE 13--Percentages of Sprout Control, by Months, Resulting from Sprays with Isopropyl Ester of 2,4,5-T.

Species	Percentage Reduction in Sprouting					
	January	February	March	April	May	June
Hickory (large)	90	100	100	100	100	100
Hickory (small)	100	70	97	76	96	90
Sassafras	80	93	88	97	100	100
Persimmon	100	100	100	100	100	100
White Oak	93	80	100	46	83	94
Black Oak	92	65	81	82	93	86

A similar test was made with the same spray material applied to the uncut stems of four species; hickory, white oak, black oak and sassafras. The sprays were applied to the standing stems and sprout clumps by saturating all sides of the stems to a height of about 18 inches from the ground. As in the preceding test, at least 10 stems of each species were sprayed each month. See Table 14 for the results.

TABLE 14--Percentage Sprout Control by Spraying Standing Sprouts with Isopropyl Ester of 2,4,5-T. (A) Percentage Reduction in Sprouting. (B) Percentage Stem Kill

Species	January		February		March		April		May		June	
	A	B	A	B	A	B	A	B	A	B	A	B
Sassafras	83	100	100	100	92	100	93	100	100	100	100	100
Hickory	72	90	94	91	100	85	93	100	100	100	100	44
White Oak	98	69	94	79	94	100	96	68	96	100	97	100
Black Oak	97	100	95	100	95	100	86	80	97	100	100	56

A third phase of this study tested the effects of seasonal sprays with 4 lbs. of ammonium sulfamate per gallon of water. This spray was applied to freshly cut stumps 2 to 5 inches in diameter of five species; hickory, sassafras, persimmon, white oak (including post oak) and black oak

(including scarlet oak and southern red oak). All cutting in this test was made with an axe, making a slanting cut 5 to 10 inches above the ground. The results are shown in Table 15.

TABLE 15--Seasonal Sprout Control by Spraying Freshly Cut Stumps with Ammonium Sulfamate.

Species	Percentage Reduction in Sprouting					
	January	February	March	April	May	June
Hickory (large)	30	70	30	70	80	90
Hickory (small)	14	47	35	53	79	100
Sassafras	37	77	38	75	88	100
Persimmon	30	60	60	80	60	70
White Oak	92	100	78	17*	5	100
Black Oak	73	33	17	42	36	100

\* Increase over check plot (not significant because less than 10 stems for basis)

**Pruning Oaks** (J. M. Nichols and R. H. Westveld). A total of 280 scarlet oak trees ranging from 3 to 10 inches in diameter at breast height were selected for trials to determine the effect on growth resulting from pruning up to 13, 17, and 21 feet from the ground—and from no pruning at all. The experiment also included both winter and summer pruning (August 1950 and January 1951).

The same comparison of pruning methods and lack of pruning was set up on each of two sites; one on ridge-top, the other on a slope facing north and east.

Measurements of growth taken year after year will be added to the detailed data already recorded concerning the number and size of branches removed in pruning and the labor required for pruning.

**Timber Harvest in Franklin, Gasconade and Osage Counties During 1950** (Ross Hortin and R. H. Westveld). The kinds and amounts of timber products harvested and sold in this three-county area were surveyed by visiting nearly all of the sawmill operators in the area. The resulting estimates of lumber produced per county are believed to be accurate within a 5% margin of error, but those for staves and headings are only rough estimates. Stave mill operators often go as far as 100 miles for a good truck load of stave bolts. They can only estimate the fraction of their total yearly output coming from any one county. Many stave bolts are also bought at the mill, and the operator does not know where the bolts were cut.

Under these conditions, the investigators reported the following estimates:

Franklin County: 4,547,000 bd. ft. of lumber,  
85,000 cord ft. stave bolts.

Gasconade County:	859,000 bd. ft. of lumber, 203,000 cord ft. stave bolts.
Osage County:	1,532,000 bd. ft. of lumber, 45,500 cord ft. of stave bolts, 6,200 cords of charcoal wood.

It should be explained that stave bolts and heading bolts are lumped together under the term "stave bolts". If each cord foot of staves and heading are considered the equivalent of 20 board feet of lumber, the total cut of timber products and the cut per acre by counties for 1950 may be given in board feet as follows:

Franklin County:	Timber cut, 4,717,000 bd. ft. Area in timber, 261,000 acres. Amount harvested per acre, 18.1 bd. ft.
Gasconade County:	Timber cut, 4,917,000 bd. ft., Area in timber, 183,000 acres, Amount harvested per acre, 26.9 bd. ft.
Osage County:	Timber cut, 2,442,000 bd. ft., Area in timber, 212,000 acres, Amount harvested per acre, 11.5 bd. ft.

These figures do not include timber cut for fuel and fence posts nor for charcoal wood. These products are seldom cut from trees of merchantable size. In general, it was found that conditions varied widely over the three-county area.

The larger portion of the timber cut in Franklin County went into car blocking and was not graded at all, despite the fact that car blocking is a relative low-value product and that the better timber was lumped off at the same price as the car blocking. This practice appears to have been accepted because there was so little of the better timber, and because it was easier to saw everything into car blocking and sell it all to one buyer who had contracted for it in advance.

It was also found that most of the timber cut in Franklin County was sold on the stump, while most of the timber cut for saw logs in Gasconade and Osage was custom sawed. The timber in these counties was of somewhat better quality and the owners were more accustomed to using native lumber or to selling it locally.

In western Osage County, around Argyle, Meta and Freeburg, the charcoal industry is more important than sawmilling. While it is only the cheap labor that permits the charcoal industry to survive in that area, it is an important factor in the economy of the people living there.

A market for charcoal wood could be an aid to good forest management, but the investigators found no one who had used the proceeds from the charcoal market to pay for woodland improvement cuttings. Most of the wood cut for the charcoal kilns was small sprout growth 4 to 10 inches in diameter and showing little promise of making good timber.

**HOME ECONOMICS**STARLEY M. HUNTER, *Chairman*

**Testing the Flours of New Varieties and Strains of Wheat for Baking Quality** (Leta G. Maharg and J. M. Poehlman). In order to evaluate more varieties and new experimental strains of wheat, these investigators made baking tests with nine varieties of wheat grown on experimental fields at Columbia, Lathrop, Sikeston and Elsberry.

Each composite sample of flour was made by using equal parts of grain from wheat grown at each of the four fields. The scores and volumes of cakes, as well as the cookie factors, were given in a previous report. This year's data compare the varieties and experimental strains on the basis of mixogram areas and viscosity values.

The results follow the same general trend found in similar previous experiments at the Missouri Station. Flours from soft wheats have produced cakes with higher scores and greater volumes, while cakes from hard wheats have been consistently lower in score and volume.

Early Premium wheat has, from the beginning of these experiments, produced the best cake volume and its flour probably is the best all-around cake flour thus far tested. In the current year's tests, Early Premium ranked first with excellent baking qualities and Clarkan second with good baking qualities. In contrast, Kawyale produced flour with poor baking qualities.

Quality, as used here, refers not to the suitability of the wheat for milling into flour for general use but for the specific purpose of baking cakes and cookies—types of baking for which the soft wheats have long been accepted as especially suitable. Neither does the term quality as used in this experiment refer to nutritive value.

The two commercial classes of wheat grown in Missouri are hard red winter and soft red winter. Of these two, the soft class has always been the more important, comprising in past years upwards of 90% of the Missouri crop. In the last three years, however, the amount of hard wheat has increased sharply.

The present wheat quality studies at Missouri were undertaken because of the alarming increase in the acreage of Kawyale in the state. This variety was originally classified as a soft wheat, though its baking qualities more nearly approached those of the hard wheats, thus making it totally unsuited for cake making and similar uses. Despite this failure of the variety to conform to the generally accepted standards of the soft wheat market, it quickly became popular with Missouri farmers because of its high acre yields. The confusion resulting from this situation can be cleared away only by a better understanding of the relation between qualities and market requirements.

A report of the entire series of the Missouri studies on this subject is now available in Missouri Research Bulletin 480, "Testing Missouri Soft Wheat Flours for Quality," by Ferne Bowman, Leta Maharg and J. M. Poehlman.

**Utilization of Processed Foods and Food Improvers** (Margaret Mangel and Leta Maharg). In this project the quick bread recipes have been standardized by substituting nonfat dry milk solids for fluid milk. In addition, recipes for these products have been developed making maximum use of nonfat dry milk solids.

In six different kinds of cookies, receipts were selected on the basis of their adaptability to greater amounts of dry milk solids and these were modified by such additions until the maximum additions consistent with a high degree of acceptability were determined.

This project will be continued another year or more and a bulletin will be published giving the most desirable recipes and their dietary values.

**Factors Influencing the Change of Hemoglobin to Methemoglobin in Beef** (Margaret Mangel and Mary Jenkins). This work included studies on: (1) the influence of the amount of fat in ground beef on the rate of pigment change, (2) the variation in pigment differences in market samples of ground beef, and (3) the rate of pigment change in ground and unground beef.

In addition a series of samples, presumably identical, were studied by means of the recording spectrophotometer. The results of this study revealed that the pigment involved must be nearly pure myoglobin rather than a mixture of hemoglobin and myoglobin as had been assumed. Consequently, results of the previous two years' study were re-examined using myoglobin constants rather than those of hemoglobin. Since no adequate constants for myoglobin were available in the literature, these were obtained by personal communication with Dr. William J. Bowen, Laboratory of Physical Biology, National Institute of Health, Bethesda, Maryland.

The use of myoglobin constants did not change the findings of this series of experiments in a relative sense. These findings are being reported together with a detailed study of the method as it is being used at present. Under the conditions of this experiment, variations in storage time and temperature and in the amount of fat present in meat from a given source appeared to be much smaller than variations due to the difference in samples of meat.

In meats, particularly in beef, changes in palatability are accompanied by darkening of cut surfaces. The major cause of this darkening is considered to be the conversion of the bright red pigment, oxyhemoglobin, which forms on exposure of the meat surface to air, through reduced



hemoglobin, into a brownish red pigment, methemoglobin. For this reason, some method of measuring the methemoglobin present in beef might be used as a measure of deterioration.

The problem is somewhat complicated by the fact that, even with modern methods of slaughter, meat pigments may be mixtures of *blood* hemoglobins conventionally referred to as hemoglobins, and *muscle* hemoglobins but also called myoglobins. Probably the meat pigment of the present study are chiefly of the latter type.

Ground beef was the product chosen for this study for several reasons. Since grinding exposes a maximum surface to the air, a more nearly complete conversion of reduced hemoglobin to oxyhemoglobin may be assumed in ground than in unground beef. Moreover, ground meats deteriorate more rapidly than piece meats and thus present a special storage problem.

In the study of unground and ground beef and the influence of fat on rate of pigment change, it was found that samples containing more than 15% fat showed higher methemoglobin content than those containing a lower percentage of fat. This tendency was not, however, related to storage time. No differences in methemoglobin formation between ground and unground samples could be observed.

**Retention of Calcium, Phosphorus and Nitrogen by Healthy Older Women** (Adelia Weis and Margaret Mangel). Calcium, phosphorus and nitrogen balance studies for two consecutive five-day periods were made on nine healthy older women. These subjects kept dietary records for an additional three weeks. Data for the first series, seven subjects, were tabulated and transmitted for incorporation with data from other stations in the North Central Region.

While no conclusion as to food intakes and habits of healthy older women of this area can be drawn from so few subjects, the data so far confirm the findings of other stations. These indicate that intakes of protein and calcium tend to be lower than the recommended dietary allowances of the Food and Nutrition Board of the National Research Council. As a matter of record, these subjects showed negative balances with respect to these elements.

**Thiamin, Riboflavin and Niacin Content of the Diets of Healthy Older Women** (Adelia Weis and Margaret Mangel). Thiamin and riboflavin intakes and urinary excretions, as well as intakes during two consecutive five-day periods, were studied for nine women between 50 and 70 years of age. During the fifth day of the second period, test doses of the vitamins were administered and urinary responses determined. Daily excretions of creatinine were determined also. Data for the first series of seven subjects were tabulated for incorporation with data from other stations in this region.

Although conclusions as to the food intakes and habits of healthy older women in this area can not be drawn on this small number of subjects, findings from this part of the investigation confirm findings of other stations that intakes of thiamin, riboflavin and niacin tend to be lower than the recommended dietary allowances of the Food and Nutrition Board of the National Research Council. In addition, the responses of the subjects to test doses of these nutrients, do not indicate food intakes high enough to saturate these subjects with the nutrients in question.

**A Curtain Serviceability Study of Marquissettes** (Adella Ginter, Mrs. Bernice Blue and Shirley Titus). Curtain marquissettes offer a problem to the homemaker in that they may shrink excessively and lose their crisp new appearance. To overcome these differences, the homemaker resorts to starching and stretching. The process of stretching may work satisfactorily on cotton fabrics, since cotton fibers are stronger wet than dry. On rayons and other synthetics, however, serious breaks may result from the stretching. The wet strength of rayon is about half of the dry strength.

Today, resin finishes are applied to textile fabrics to impart finishes which are more or less durable. Resin finishes may coat the fabric and yarn or penetrate into the interstices of the yarn and fiber. Such finishes may impart crispness, improve dimensional stability and produce effects upon strength, weight and other qualities.

Nylon has more recently entered the curtain field. Although special finishes may be applied to nylon, most nylon fabrics are "heat set" in their finishing which gives greater dimensional stability to the fabric.

Curtains with special finishes are not too plentiful, but, for this study it was possible to obtain 6 cotton and 5 rayon marquissettes with special finishes and 5 nylon marquissettes. All were plain marquissettes. They varied in price from 48 cents to \$1.11 per square yard. The nylons as a group were the most expensive. The fabrics were compared when new and after 1, 4, 8, 12, 16, and 20 launderings. The results were summarized as follows:

The nylons shrank the least and were high and well balanced in strength.

The cottons were very poorly balanced in strength; the filling yarns gave indications of wearing out much before the warp.

The wet strength of the rayons was decidedly less than the dry strength. This would necessitate extreme care in handling when washing and drying.

The crispness in all the fabrics decreased noticeably after one washing. On the whole, the cottons were crisper than the other fabrics.

As to effects produced by laundering on the fabrics in this study, it would seem that the nylon marquissettes were generally the most satisfactory.

**A Study of Home-Applied Finishes Giving Starch-Like Qualities** (Adella Ginter and Yolande Bennett). Two fabrics suited to clothing and household purposes, along with replicates, were laundered 10 times. Two home finishes were applied to one set, while another set was left unfinished. After 1, 4, 7, and 10 launderings each fabric was tested for changes in each of the following qualities: strain resistance, crispness, weight, shrinkage, yarn count, tensile strength and elongation.

Of the two finishes tested, one was of the wax type, the other of the plastic type. Both were easily applied. Both added some weight to the treated fabric but not to an undesirable degree. Both types increased the crispness of the fabrics, with the plastic type finish proving most satisfactory in this respect. The wax type treatment, on the other hand, was most resistant to stains.

## HORTICULTURE

R. A. SCHROEDER, *Chairman*

**Horticulture Experiment Fields** (Aubrey D. Hibbard, Victor N. Lambeth, H. G. Swartwout and Ray L. Christian). This section of the report covers work done on soil management in peach and apple orchards, fertilization of peach trees, and moisture conservation tests.

Experiments in orchard soil management indicated that fewer cultivations than formerly recommended gave lower production costs and reduced soil erosion. Mulches did not pay for the cost of applications even when the materials were available at cost of hauling. In peach orchards, mulches even proved detrimental to fruit quality.

A peach orchard study of various nitrogen carriers together with potassium and phosphorus was concluded after 12 years' observation. The data from the crop of 1950 again demonstrated the value of adding both potassium and phosphorus to the usual applications of nitrogen. Peach trees that had received these elements showed less winterkilling than those getting nitrogen alone.

The soil and moisture conservation tests at the Speas Horticultural Farm near St. Joseph were continued. These tests have been set up for long-time comparison of the effects of each of the following systems:

- (1) Trees on terrace berms with a terrace ridge for each tree row, and channels with 1-inch grade;
- (2) Same as No. 1 with every other tree row on a terrace berm;
- (3) Trees on terrace berms with a terrace ridge for each tree row, with channels with 3-inch grade;
- (4) Same as No. 3 with every other tree on a terrace berm;
- (5) Tree rows on true contour lines—with slight adjustments to make rows with even bends;
- (6) Trees on contour lines with a 3-inch grade;
- (7) Tree rows in conventional square pattern.

**Watermelon Breeding** (Aubrey D. Hibbard and Ray L. Christian). Selected lines of the Missouri Queen variety were grown into the 12th self-fertilized generation. These lines are maintained chiefly as a source of breeding materials for producing new hybrid strains. Several hybrids of the Missouri Queen have been purified to the point where they show great promise. Crosses with Klondyke show the Queen size and earliness combined with the deep flesh color and high sugar content of the Klondyke.

A wilt resistant watermelon of ice-box size appears to be emerging from crosses of the Missouri Queen and California Honey. Other crosses have produced types that are close to the market demands for a large, early, dark-skinned melon adapted for shipping.

Certain lines of breeding stock were also subjected to different applications of nitrogen fertilizer in order to observe the effects on marketable yield and quality of fruit. Both yield and quality were improved with additions of nitrogen up to 50 pounds of actual nitrogen per acre. Addition of nitrogen beyond this amount resulted in lower yields and inferior quality.

**Irrigation of Truck Crops** (Aubrey D. Hibbard and Victor N. Lambeth). At the Vegetable Experiment Field near Campbell, an irrigation system had been set up just prior to July 1, 1950. In the current year this system was used to pump water to rotary sprinklers covering a portion of the vegetable growing area.

Twelve kinds of common garden vegetables were grown under three different irrigation treatments, as follows:

- (1) Irrigation at weekly intervals.
- (2) Irrigation one week after a cumulative rainfall of 1 inch,
- (3) Irrigation whenever available soil moisture had fallen to 50% of field capacity.

Approximately 1 inch of water was given at each irrigation.

Excessive rainfall during the months of July, August, and September made supplementary irrigation unnecessary. The application of water at weekly intervals was detrimental because of the leaching of plant nutrients. The second treatment was needed only twice while the third treatment was never indicated throughout the season.

The only crops showing a favorable response to irrigation were carrots and head lettuce. The effect was almost entirely upon germination which resulted in doubling the yield of marketable carrots.

The most important problems in the use of supplemental irrigation on vegetable crops in southeastern Missouri appear to be time and rates of application to supplement natural rainfall.

**Home Orchard** (Aubrey D. Hibbard). The experimental home orchard at the Midway Experimental Orchards near Columbia this year came into production of all major fruits except pears. The orchard had been

established in 1942 for the purpose of securing data on the management of a fairly size orchard.

Two one-half acre orchards were designed and planted to the principal fruits which can be grown under central Missouri conditions. Varieties were chosen for desirability of season, ease of production and quality for home use. Records are kept on costs and labor as well as value of product produced and season of availability.

Spraying for the control of pests is one of the most difficult problems confronting the home fruit grower. During the first year an effort was made to develop a single spray material mixture which would give satisfactory control of all common fruit pests. The formula for a universal spray mixture as developed at this station is being mixed and distributed by a number of companies in the Midwest.

Also an attempt was made to work out a spray schedule so that all kinds of fruit could be sprayed on the same day. Considerable success was achieved in this direction.

**Nutrition of Strawberries** (Delbert D. Hemphill). Cooperative tests were established in Barry, McDonald, Crawford and Jackson Counties. Objectives of the study are to determine the optimum level of soil nutrients for strawberries and to correlate fertilizer recommendations with chemical soil tests. A starter application of complete fertilizer applied to new ground which had a relatively high level of major elements, increased early runner production. Plants grown on southern Missouri soils showed a marked response to phosphorus by increased vigor and runner production. Yield data will help determine optimum level of phosphorus and value of starter applications of complete fertilizer.

**Response of Green Leafy Vegetables to Fertilizer Applications Made in Accordance with the Saturation of the Clay Fraction** (Victor N. Lambeth, Ellis R. Graham, Henry Ballew and Fred G. Teubner). Under this heading are reported studies of dwarf blue curled Scotch kale, tampala, Bibb lettuce and bush green beans.

#### KALE

A study was made of the balance of soil levels of magnesium in relation to levels of nitrogen, phosphorus, potassium and calcium as evidenced by the growth of kale; and to determine to what degree changes in the levels of these nutrient elements affected the concentration of soluble mineral elements in the plant tissue. It would seem plausible to explain the effects of an unbalanced supply of nutrients on plant growth in terms of the absorption of these nutrients by the plants.

The results indicated that under high nitrogen and potassium fertilization a nutritive unbalance was created, and this in turn decreased crop yields. Depending on the levels of the soil nutrients, it was possible to make correction of the unbalanced condition by applying magnesium, cal-

cium or phosphorus or by decreasing the amounts of nitrogen and potassium applied.

#### TAMPALA

In greenhouse experiments with tampala, variations in the calcium level from 48 to 63% of the total base saturation produced little difference in the growth of this leafy vegetable. The most marked yield differences were in response to nitrogen and phosphorus. In general, increasing the increments of these two elements up to 90 milliequivalents per jar increased the fresh weight of the plants several fold. Some inhibition of growth in the seedling stage was noted at the 90 milliequivalent nitrogen level but this effect disappeared in the advance growth stages. The value of maintaining a high phosphate level (at least 200 lbs. an acre) in the fertilization of leafy crops was clearly established.

#### BIBB LETTUCE

Fertilizer applications were made to a sandy loam soil for Bibb lettuce plants in a greenhouse pot culture experiment. With the anionic elements nitrogen (N) and phosphorus ( $P_2O_5$ ) at two levels—100 pounds and 200 pounds per acre—the cationic elements were varied in accordance with the base saturation concept as follows: potassium 2.7%, 5.4% and 8.1%; magnesium 6.85% and 10.0%. The importance of nutrient balance was clearly shown in the yields, the best yield being obtained with 100 pounds nitrogen, 200 pounds phosphorus, 5.4% potassium and 6.85% magnesium. All treatments with the exception of three included trace elements. There was some indication of slightly larger yields with added trace elements.

#### BUSH GREEN BEANS

High yields of bush green beans were also obtained through balanced nutrition—with calcium and potassium levels constant at 70% and 5% of base saturation and the phosphate level at or above 300 lbs. per acre.

On sandy loam with relatively low nitrogen level (less than 1% of organic matter), 50 pounds of available nitrogen was found sufficient to promote good plant growth and high yields. However, the timing of nitrogen side dressing was very critical. Nitrogen applications during the blossoming period reduced the average daily blossom set to approximately 5% as compared to 35% for the controls. These results lend support to the contention that side-dressing applications of nitrogen on beans should follow blossoming and initial pod set. There was no significant difference in yields as a result of application of the trace elements.

**Nutrition of Fruit Plants** (A. E. Murneek and R. N. Goodman). In this investigation, two experiments were carried through the current year; one on the effects of mulching in apple orchards, and the other on fertilizing apple trees by means of urea sprays.

#### MULCHES IN APPLE ORCHARDS

Both the physical and chemical effects of hay and straw mulches were

studied, and their effects were contrasted with those of ordinary sod culture. Soil samples representing each type of mulch or culture were taken to a depth of 24 inches, first in June and again in November, and then analyzed for total nitrogen, nitrate nitrogen, total exchange capacity, and available phosphorus.

Findings were as follows: Total nitrogen was much greater under the hay mulch than under straw mulch or sod culture. Nitrate nitrogen varied little between the various plots, except that it was slightly greater under the hay mulch in the top 6 inches of the soil sample. Total exchange capacity was greater under either hay or straw than under sod—especially at the 18 to 24 inch level. Available phosphorus was much higher under hay or straw mulch than under sod. In pounds per acre the comparison showed 173 lbs under hay, 165 under straw, and 62 under sod.

#### FERTILIZING WITH UREA

Tests were completed on the use of a commercial urea fertilizer known as Uramon applied in the spring as a foliage spray. Three varieties of apples, in two experimental orchards, were sprayed three times each spring. The Uramon was used at a concentration of 5 lbs. in 100 gallon by adding it to the regular fungicidal and insecticidal sprays. For comparison, a check plot of trees of the same varieties received equivalent amounts of Uramon on the ground, or equivalent amounts of ordinary nitrogen fertilizer applied in the same manner.

The results, expressed in fruit yields (percentage of spurs setting fruit), showed the odds were 5 to 1 in favor of the Uramon spray. This was true regardless of whether the fruit set was very light, light, medium, or very heavy.

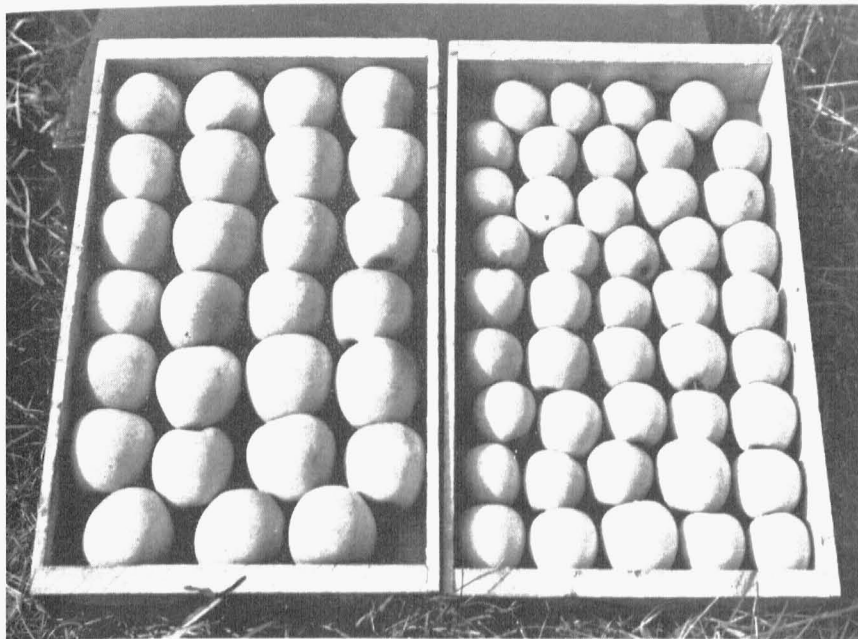
**Factors Affecting the Fruit Setting of Apples** (A. E. Murneek, Paul Rood and Aubrey D. Hibbard). This project included the experimental use of hormone sprays for thinning apples, as well as a search for a better preharvest spray.

#### APPLE THINNING SPRAYS

Biennially bearing Golden Delicious trees thinned heavily by one or two hormones (naphthaleneacetic acid) sprays in 1949 produced abundant flowers and set a heavy crop of fruit in 1950. Ten days after pollination one-half of these trees were left unthinned, and the other half were thinned by spraying with naphthaleneacetic acid at a concentration of either 20 or 30 parts per million with very satisfactory results.

Trials of chemical thinning by means of naphthaleneacetic acid sprays on Golden Delicious trees 4, 6 and 8 weeks after pollination were unsuccessful, though the concentrations of the sprays used were 40, 60, 80, 160, and 240 parts per million. Even two sprays of high concentration were ineffective so late in the season.





Golden Delicious apples. Left: Picked from hormone-thinned half of tree. Right: Picked from other half of same tree—not thinned.

#### PREHARVEST SPRAYS

The search for a more effective preharvest spray to prevent premature dropping of the fruit was continued through the year. Of the various materials tried, 2,4-D at a concentration of 10 parts per million (p.p.m.) was found very satisfactory for Winesap and Stayman varieties. It failed, however, to show any merit as a spray for the Jonathan apple. For that variety, fairly good results were obtained by spraying with Toloxy (2 methyl, 4 chlorophenoxyacetic acid) at 20 p.p.m.

Para-chlorophenoxyacetic acid also was tried at a concentration of 20 p.p.m., but it did not show any advantages over the other two (more potent) phenoxy compounds for this purpose.

**Physiology of Reproduction in Horticultural Plants** (A. E. Murneek, D. D. Hemphill, S. R. McLane, F. G. Teubner and Ruh Meo Li). One of the three experiments reported here involved the thinning of tomatoes by pruning as compared to attempts to get similar effects by use of hormone sprays. The second probed for a better understanding of the ways in which hormone growth regulators work, and the third was a study of syngamin, an indigenous hormone connected with seed and fruit development.

### PRUNING OR SPRAYING TOMATOES

Since the size of fruit is determined by the ration of leaf area to the number of fruits set, the leaf area must be increased when fruit set is increased by hormone sprays. At the Missouri Station this problem has been solved by the "Missouri method" of pruning staked tomatoes. This is done by leaving two axillary leafing shoots below each fruit cluster. This has resulted rather consistently in 10 to 20% increases in the fruit crop. Various chemicals were tested during the current year in an effort to find a material that would hold back leaf growth in undesirable locations, but none was found. Although some of the sprays increased the fruit set, they resulted in softer texture of the tomatoes making them undesirable for shipping and marketing.

### HOW DO HORMONES WORK?

Various synthetic plant hormones—chiefly naphthaleneacetic (NA) and para-chlorophenoxyacetic (CLPA) acids—were used as aqueous sprays or injections on the fruits of apple, peach, tomato and pepper. By this means it was found that unfertilized ovules and those just newly fertilized were usually stimulated in development by such sprays—provided the spray was not so concentrated that it was harmful to other parts of the plant. On the other hand, fertilized ovules (with seed set) proved extremely hard to stop in their development even by sprays covering the entire plant. This was true even when the naphthaleneacetic acid was used at concentrations as high as 240 p.p.m. on apples or 100 p.p.m. on grapes.

These findings left the investigators still without a clue as to how plant hormones are able to thin the fruit crop successfully.

### A STUDY OF SYNGAMIN

Methods were developed for extracting the hormone syngamin from immature corn kernels and for testing its concentration by means of corn embryo cultures. Comparative tests were made to determine the effects of heteroauxin (3-indoleacetic acid, a naturally occurring plant hormone) on the growth of corn embryos. On testing extracts of corn kernels harvested at various stages of maturity and determining the heteroauxin content in such extracts it was found that syngamin reaches its highest concentration about 5 days after pollination, while heteroauxin is at maximal concentration about 15 days after pollination.

Extracts of endosperm contained a greater quantity of syngamin than did the embryos. The best solvents for extracting it were water and 95% ethyl alcohol. Autoclaving destroyed it. It was stable under basic conditions and passed through a collodion membrane.

**Yield and Quality Response of Ranger Sweet Potatoes to Varying Fertility Levels.** (Victor N. Lambeth). A field experiment was conducted to test the response of a carbohydrate type plant to certain fertilizer

elements measured in terms of percentage base saturation. With calcium constant at 70% and phosphorus constant at 300 pounds ( $P_2O_5$ ) per acre, significant increases in yield were noted at the 7% potassium level as compared to the 2.7% level. This yield increase held irrespective of the magnesium level. No significant yield differences were noted with variations in the magnesium level at 2.3% and 4.6% of the total base saturation. Heavy nitrogen applications reduced yields markedly, the comparative values being 416 bushels per acre on plots fertilized with 50 lbs. of nitrogen per acre and 266 bushels on 150 pounds of nitrogen. This relationship held regardless of the cationic-element levels and furnished further support for an earlier observation that vegetative plant growth was stimulated at the expense of the carbohydrate reserves in the roots.

**Application of Phenological Principles to Lima Bean Production** (Victor N. Lambeth). Extensive field experiments were conducted at the Campbell Vegetable Field during the 1950 season to correlate initial pod set and yield of lima beans with specific factors of soil and climate.

Double-row plots of consecutive plantings of lima beans (variety Fordhook 242) were made in randomized blocks at four plant spacings 3, 6, 9, and 12 inches. The plantings were made on the following dates: April 22, May 5, May 13, May 23, May 27, June 5, June 14, June 19, June 26 and July 1. For this period, air temperature and relative humidity readings were recorded continuously by a recording hygrothermograph. Available soil moisture was measured with a soil moisture tensiometer and readings were recorded daily. Dates of bloom, initial pod set, date of harvest and pod yields were recorded. The initial pod set and pod yields were then correlated with the temperature and soils moisture readings.

In general, the results substantiate an earlier prediction based on a climatological study of the southeastern Missouri region that early seasonal planting would result in the highest yields, the conditions for pod set and development being more favorable during late June and July than later in the season.

The April 22 and May 5 plantings produced the greatest yields but did not show the greatest initial pod set. In fact, pod set 17 days after the initial bloom was twice as great for the May 13 planting as for either the April 22 or May 5 planting. Although the pod count was low for the May 5 planting, the critical pod stage (immediately following peak flower set) was favored by ideal weather, thus permitting a good yield. Pod set counts remained high through the other plantings up to the June 26 planting but the yields were, in general, progressively lower.

**Study of Flowering Plants** (James E. Smith, Jr., Zake G. Mekhaimer, John D. Schatz and Marlin N. Rogers). An effort was made to solve the problem of protecting delphinium plants from infection by crown rot. The organism causing this disease, *Schlerotium delphini*, is known to be wide-

ly distributed in Missouri. Consequently a great many delphinium species and hybrids were grown and tested for possible resistance to the crown rot organism. Repeated inoculations of these plants (under greenhouse conditions) were made. Individual plants were found to be resistant in each of four species: *D. bellamosum*, *D. paniculatum*, *D. grandiflorum* and *D. Clevedin Beauty*. These were saved for further breeding work.

At the suggestion of several commercial florists, a study was undertaken to test the effects of plant residues on the growth of the next planting of flowers in succession planting. For this study, the investigators tested the reciprocal effects of five greenhouse crops: snapdragons, chrysanthemums, sweet peas, stocks and calendulas. No toxic effects by one crop upon another were found, yet there were bacteria-carbohydrate-nitrogen relationships within the soil that caused some temporary retardation in growth of succeeding crops. This slight set-back was quickly overcome, however, by the growing plant.

In another investigation, the adaptation of soil testing to greenhouse soil management was studied. Results obtained during the year indicated that soil testing in commercial floriculture will be useful mainly in preventing excessive rather than insufficient use of fertilizers.

**New Sprays and Spraying Methods, Eradication Spraying, and Spray Injury** (H. G. Swartwout). These investigations included work with apples, strawberries and grapes.

#### WORK WITH APPLE SPRAYS

Four fungicides were tested for control of apple blight and their effect on fruit finish. The materials compared were:

1. Bordeaux 1½-4½-100
2. Copper 8-quinolinolate (Buiquin 1 at ½-100)
3. Ziram (Dithane Z-78 at 2-100, plus 1 oz. Triton B 1956 spreader)
4. 2, 3-dichloro-1, 4-naphthoquinone-sulfur combination (Kolofog 100 at 3½-100).

A spray was applied when ¼-½ of the flowers were open and a second one three days later at the end of the bloom period.

Bioquin 1 and Kolofog 100 failed to control blight. No information was obtained on the relative effectiveness of the bordeaux and Dithane Z-78 since only a trace of blight developed in these plots and in their adjoining unsprayed controls.

Effects of treatments on fruit finish were studied on three varieties, Jonathan, Winesap and Golden Delicious. The bordeaux caused considerable russeting on Golden Delicious, a moderate amount of damage on Jonathan and only a small amount on Winesap. None of the other spray materials caused any significant increase in russeting when compared to nearby trees not receiving these or any other bloom sprays.

Several synthetic organic insecticides, also, were tested for their ef-

fects on fruit finish. Used in combination with either sulfur or ferbam in the calyx as well as the first and second cover sprays, all these materials caused more russetting on Jonathan and Golden Delicious than did lead arsenate. The combinations used were DDT (2-100), parathion ( $\frac{3}{4}$  lb. of 15%-100), toxaphene (2 $\frac{1}{2}$ -100) and methoxychlor (2-100) with sulfur, and parathion and toxaphene with ferbam. The lead arsenate was used at 3-100 in combination with sulfur only. The methoxychlor-sulfur combination and the toxaphene-ferbam combination caused a very heavy russet development on Golden Delicious. A neutral zinc (Nu-Zinc) with lead arsenate as an arsenical corrective resulted in more russet on both Jonathan and Golden Delicious than lead arsenate without the safener. Tests were conducted with DN-111 in three locations, all favorable to sooty blotch development. At 1-100 it gave excellent control in two of the tests. It was moderately effective in the third test and probably would have given excellent control with one later application.

In a comparative test of several materials on Golden Delicious, ferbam at 1-100 gave the best control followed by ferbam,  $\frac{3}{4}$ -100, bordeaux 1-2-100 and DN-111 at 1-100 in that order. Dinitro capryl phenyl crotonate (Karathane 1-100), 2,3-dichloro-1, 4-naphthoquinone (Phygon XL,  $\frac{1}{4}$ -100), and copper 8-quinolinolate (Bioquin 1 at  $\frac{1}{4}$ -100), were effective during the period of application but had comparatively short residual action.

Tests for apple scab control were conducted to determine the comparative effectiveness of two phenyl mercury compounds, Tag and Puratized agricultural spray, alone and in combination with sulfur and with ferbam in preventing the spread of scab where the disease had become established. No sprays were applied to Rome Beauty trees until time for the second cover spray by which time considerable scab had developed on fruit and foilage. Rainy weather the remainder of the season provided the condition necessary for measuring the spread of the disease. Sprays were applied June 2, June 16, and June 30. No other fungicides were applied before or after these dates.

#### SPRAYS FOR STRAWBERRIES

Sprays were applied (1) as soon as the first leaves appeared, (2) when the first flowers had opened and (3) shortly after harvest. With slow plant development due to cold weather, at least three prebloom sprays should have been applied. Treatments were duplicated in randomized arrangement with five unsprayed controls. DDT at 1 $\frac{1}{2}$  lbs. and chlordane at 1 $\frac{1}{2}$  lbs.-100 gals. were included for insect control. Actidione gave much the best control which was rated excellent, followed by Dithane D-14 with fair control and Bioquin 1 with fair control. Bordeaux gave only slight control and ferbam none. There was no injury from any of the materials except possible slight damage from actidione.

## TESTS OF GRAPE SPRAYS

Several materials were tested for control of black rot and downy mildew on grapes. The treatments compared were the following:

- (1) Bordeaux 6-6-100
- (2) Ferbam 2-100,
- (3) Copper 8-quinolinolate (Bioquin 1 at  $\frac{1}{2}$ -100),
- (4) Nabam (Dithane D-14 at 2 qts.-100 gals.) plus 1 lb powdered zinc sulfate,
- (5) N-trichloromethylthio tetrahydrophthalimide (Orthocide-406 at 3-100, and
- (6) Fixed copper 26% metallic (Tenn. copper "26") to give 65 lbs. metallic copper-100.

Ferbam and Orthocide 406 were about equal with almost complete control of black rot; bordeaux and Tenn. Copper "26" were a little less effective; Bioquin 1 and Dithane D-14 gave fair control with Dithane D-14 the least effective. Injury was moderately light with bordeaux, light with Tenn. Copper "26", trace with Bioquin 1 and Dithane D-14 and none with ferbam and Orthocide 406.

Bordeaux was the only material to give effective control of downy mildew. It must be stated, however, that no mildew developed in the vineyard where Tenn. Copper "26" was used. There appeared to be some suppression of mildew by Bioquin 1 but its residual action was short.

**Controls of Weeds in Horticultural Crops** (D. D. Hemphill). Several chemicals were tested for safety and efficiency in weeding strawberries and vegetable crops.

For strawberries, 2,4-D, dichloral urea, and 2,4-dichlorophenyl "cellosolve" sulfate gave promising results when applied as preplanting and selective summer sprays. Among these, 3,6-disodium endoxohexahydrophthalate was found to be too toxic for the strawberries, even though very effective as a weed killer. Maleic hydrazide stunted strawberry plants and did not give satisfactory weed control, while 2,4-D gave a satisfactory kill of over-wintering weeds such as chickweed, sorrel, and wild beet without apparent injury to the strawberries. IPC (isopropyl N-phenyl carbamate) and 2, 4-dichlorophenyl "cellosolve" sulfate effectively controlled chickweeds without injury to strawberries.

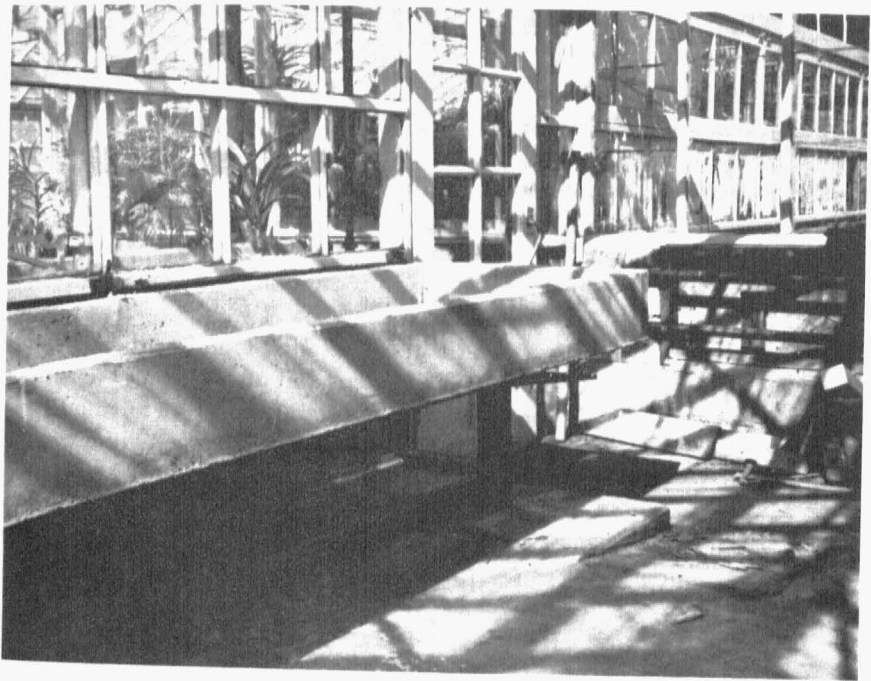
Summer mulches of sawdust and cotton hulls were applied along plant row in early June as runners began to form. Approximately  $1\frac{1}{2}$  inches of mulch eliminated most of the grass and weeds within the row. Geese were found to be very effective against crabgrass and certain broadleaved weeds. They do not control foxtail, lespedeza, ragweed, chickweed, oxalis, vetch, red sorrel and several other common broad leaved weeds.

Used for weed control in vegetable plantings, several chemicals were applied both before and after the newly planted crops emerged from the ground. Promising results were given by the following materials: (1) 2,4-D for pre-emergence use in sweet corn, onions, potatoes and post-

emergence use in sweet corn; (2) Dinitros for pre-emergence use in snap and lima beans, tomatoes, cucumbers, watermelons and post-emergence use in peas; (3) potassium cyanate for post-emergence use in onions; (4) NaPCP (sodium pentachlorophenate) for pre-emergence use in potatoes; (5) ethyl xanthogen disulfide (Sulfasan) for pre-emergence use in snap beans, cucumbers, cantaloupes, watermelons, sweet corn, direct-seeded tomatoes; (6) TCA for pre-emergence use in direct-seeded tomatoes; (7) Stoddard for pre-and post-emergence use in carrots.

**Sub-Irrigation Nutrient Culture for Commercial Greenhouse Crops** (James E. Smith, Jr., and J. B. McCully). More attention than in former years was given to sub-irrigation as a means of watering the soil in the greenhouse propagation and growing benches. Carnations were grown by ordinary top watering and by sub-irrigation. Results were about the same for the two methods, but sub-irrigation made a considerable saving of labor. It was found, however, that some species of plants are not adapted to sub-irrigation; for example, gardenias. Roses and chrysanthemums made good growth when water was added below the soil surface plus top watering once a month.

These investigators also made a modification of the Missouri concrete greenhouse bench. This is a V-bottom monolithic design poured on



The Missouri monolithic bench completed, and with the forms removed.



a single row of legs set 8 feet apart under the center line of the bench. This new design was found to be well suited to sub-irrigation of bench crops.

**Marketing of Fruits and Vegetables** (R. A. Schroeder, V. N. Lambeth, D. D. Hemphill and A. E. Gaus). Data collected in the 1950 marketing season showed that bruising at any stage of the harvesting and marketing program—from the orchard to the retail store—was the most serious factor in causing off-grade apples. The codling moth was no longer the major cause of cull fruit.

The study also revealed the fact that bruising can be eliminated by more careful handling in both the orchard and packing shed. Wholesaler and retailer also were found to be responsible for much of the bruising—in some instances for most of it.

## POULTRY HUSBANDRY

H. L. KEMPSTER, *Chairman*

**Systems of Breeding for Performance Characters in Poultry** (G. E. Dickerson, H. L. Kempster, Q. B. Kinder, W. F. Krueger, Natalee Thurmond, and Claude P. Howard). This work was done in cooperation with the Animal Husbandry department of the Missouri Station, and with the Regional Poultry Breeding project of the Bureau of Animal Industry, U. S. Department of Agriculture, and the experiment stations of the North Central States.

The breeding systems compared in this project were: (1) Intra-flock selection with minimum inbreeding, (2) recurrent selection for crosses between specific strains, and (3) outcrossing and cross breeding, using a new sample of males from representative purebred flocks each year. The performance characters in which improvement was sought included fertility, hatchability, viability of young stock through the first laying year, rate of growth, meat conformation, egg production, and egg quality.

### INTRA-FLOCK SELECTION

Intra-flock matings produced poorer hatch and viability than the line-cross matings for Leghorns and Hampshires but there was little difference for the White Rocks, and the linecross matings inferior for the Rhode Island Reds. In growth and fleshing, intra-flock progeny grew a little more rapidly up to 22 weeks and were fleshed as well as linecross progeny in all breeds. Intra-flock pullets were definitely inferior to intra-breed linecross pullets in both viability and egg production for Hampshires and White Rocks and slightly so for Leghorns. Intra-flock Reds were superior in viability.

### RECURRENT SELECTION

For these tests only those lines which had performed best in a given breed in the preceding year were retained for the retests here reported

Also six new lines of Leghorns, two of Reds and one each of White Rocks and Delawares were tested for comparison with the better lines among those previously tested.

Results of these comparisons showed noticeably lower hatchability for test crosses than for intra-flock matings—probably because of the increased inbreeding of dams for test crosses. On the other hand, viability of chicks on range was much better for crossbred than for intra-flock matings.

In growth rate and fleshing, weights at 8 weeks were about 7% greater for all three test crosses than for the mean of the two parental intra-flock progenies. This advantage was maintained up to 22 weeks, though the difference had dwindled by that time to only 3%.

#### CROSS BREEDING

Cross breeding consistently improved viability from hatching to 22 weeks of age compared with parent breeds. This advantage was 3 to 8% in Leghorn-New Hampshire Crosses, 8% in Leghorn-White Rocks, and 10 to 16% in Leghorn-Rhode Island Reds—regardless of the breed used as the male parent.

Cross breeding also increased the rate of growth over the parental records by 6 to 10% up to 8 weeks and by 3 to 6% up to 22 weeks. Cross-breeds also matured earlier in Leghorn-Rock and Leghorn-Hampshire crosses. Hen-day egg production was above parental mean by 4 to 5% for Leghorn-Red and Leghorn-Hampshire crosses, but 2% below parent breeds for Leghorn-Rock crosses.

**Feed Purchasing Power of Eggs (H. L. Kempster).** This study of the feed purchasing power of eggs was based on the relationship between the farm prices of eggs and feed with an assumed production of 122 eggs per hen in a year.

For 1950 the average farm price of feed (corn 5 parts, wheat 3 parts, and oats 3 parts) was \$2.58 a cwt., which was 11 cents higher than the preceding year. The price of eggs, on the other hand, was some 10 cents a dozen lower, or 28.13 cents a dozen. Due to this unfavorable relationship, the feed purchasing power of eggs per hen dropped to 110 pounds of feed, or 82% of normal.

The feed-egg ratio for 1950 was 9.17—an extremely high ratio of feed cost for the debit side of the poultryman's ledger. Only twice in the last 40 years had it been higher; 9.34 in 1934 and 9.77 in 1937. Usually when the feed-egg ratio is above 7 a decline occurs in poultry numbers. And on January 1, 1951, Missouri had 7.1% fewer chickens than on the same day one year earlier.

Table 16 shows the changes in these price relationships for each year from 1910 to 1950.

TABLE 16 --Income from Hens Averaging 122 Eggs per Year in Pounds of Feed, in Dollars, and Feed Egg Ratio by Years from 1920-1950 Inclusive.

Year	Price of Feed	Price of eggs per dozen	Pounds feed eggs from 122-egg hen would purchase	Income* over feed cost in terms feed lbs.	Income over** feed cost in terms of dollars	Feed Egg Ratio
1910	\$1.28	18.4¢	140	68	.87	6.996
1911	1.15	13.7	124	52	.60	8.4
1912	1.36	18.0	132	60	.82	7.5
1913	1.23	16.3	137	65	.80	7.5
1914	1.38	18.0	132	60	.83	7.7
1915	1.52	17.1	111	39	.59	8.9
1916	1.58	19.1	128	56	.89	8.3
1917	2.59	29.1	112	40	1.04	8.9
1918	2.75	32.7	119	47	1.29	8.4
1919	2.90	37.2	129	57	1.65	7.8
1920	2.82	39.3	142	70	1.97	7.2
1921	1.38	25.0	191	117	1.64	5.5
1922	1.31	20.7	163	91	1.19	6.3
1923	1.53	23.2	154	82	1.25	6.6
1924	1.71	23.0	133	61	1.04	7.4
1925	1.96	27.1	143	71	1.39	7.2
1926	1.50	25.0	169	97	1.47	6.0
1927	1.62	22.1	141	69	1.12	7.3
1928	1.81	25.2	139	67	1.21	7.2
1929	1.71	26.5	159	86	1.47	6.45
1930	1.50	21.2	138	66	.99	7.1
1931	.98	14.1	146	74	.73	7.81
1932	.58	10.8	196	124	.73	5.37
1933	.80	10.25	142	70	.56	7.81
1934	1.27	13.6	116	44	.56	9.34
1935	1.50	20.6	135	63	.945	7.28
1936	1.52	18.3	132	60	.91	8.28
1937	1.74	17.8	101	29	.51	9.77
1938	.91	16.1	179	107	.97	5.65
1939	.924	13.3	148	76	.70	6.94
1940	1.13	14.0	124	52	.59	8.09
1941	1.23	20.0	162	90	1.12	6.3
1942	1.61	26.7	167	95	1.53	6.03
1943	2.10	33.7	166	94	1.97	6.21
1944	2.25	29.3	131	59	1.34	7.67
1945	2.24	32.4	147	75	1.67	6.91
1946	2.65	30.66	123	51	1.35	8.64
1947	3.47	37.92	116	43	1.52	9.15
1948	3.43	38.36	112	40	1.39	8.94
1949	2.47	38.46	155.6	83.6	2.06	6.42
1950	2.58	28.13	110	38	.98	9.17

\* Assuming hen consumes 72 pounds of feed in one year.

\*\* Determined by multiplying income over feed cost in terms of feed by the price of feed.

**The Use of Synthetic and Natural Sources of "Animal Protein Factor" in Practical Chick Rations** (Q. B. Kinder). Ten rations using variable amounts of fish meal, B<sub>12</sub> and antibiotics were run in battery brooders. Chicks were weighed at two, four, six and eight weeks. Feed records were kept, and feed efficiency was figured at each interval. A total of 950 chicks were used. The mortality rate was very low in all lots.

Results indicated a good possibility that B<sub>12</sub> and antibiotic supplements may replace the animal proteins such as fish meal in chick rations. It will be necessary, however, reported these investigators, to run further tests in order to determine the best combinations for fast growth and feed efficiency.

B<sub>12</sub> alone gave a 6% increase in rate of growth and about 5% increase in feed efficiency over an all-vegetable protein (soybean oil meal) ration.

B<sub>12</sub> plus an antibiotic (aureomycin) fed at full recommended levels (10 mg. of B<sub>12</sub> a ton and 10 grams antibiotic per ton) increased growth rate an average of 17% over basal ration and a gain of 11% in feed efficiency.

Reducing the fish meal from 5% to 2½% and feeding B<sub>12</sub> and antibiotic at 50% of the recommended level raised the growth rate 11% and the feed efficiency 6.7%. The B<sub>12</sub> appeared ample but the antibiotic was apparently too low for best results.

Rations containing some bran and shorts appeared to be slightly superior to corn and soybean meal alone when supplemented only by B<sub>12</sub> plus antibiotic, riboflavin, vitamin A and D, and mineral.

#### TESTS UNDER FARM CONDITIONS

The battery brooder tests were followed in the fall by a comparison of three rations under farm floor-brooding conditions at University South Farm. The rations used were: (1) Basal control, an all soybean meal protein ration, (2) the same plus B<sub>12</sub> and aureomycin, and (3) the basal ration with 5% fish meal substituted for an equivalent of soybean meal.

TABLE 17--Results of Floor-Brooding Comparisons of Three Protein Supplements on Clean Litter and Built-up Litter.

No. Ration	Type litter	4-week data			8-week data		
		wt.--grams	Feed Eff.	Mort.	wt.--lb.	Feed. Eff.	Mort.
369	Clean	326	2.50	2.5%	1.32	3.95	10.6%
369	Built up	369	2.10	7.4%	1.66	3.42	10.6%
369L	Clean	382	2.20	.8%	1.74	3.33	5.7%
369L	Built up	383	2.14	2.5%	1.74	3.32	9.2%
10F	Clean	386	2.06	2.5%	1.88	2.93	3.3%
10F	Built up	390	2.00	3.3%	1.81	3.03	4.9%

Weights are average of all birds in group. However they ran almost 65% pullets in each lot.

Pens 10 by 12 feet in size were equipped with electric brooders, and each contained at the outset 122 straight-run White Rock chicks from a local hatchery. Results are shown in Table 17.

These data indicate that built-up litter improved the growth rate where the ration was deficient in B<sub>12</sub> and animal proteins. No additional value was credited to built-up litter when rations contained either fish meal, B<sub>12</sub> or antibiotic supplement.

Feed efficiency and growth rate were improved about 10% by the use of B<sub>12</sub> plus an antibiotic.

Mortality was much greater on the clean litter than on the built-up litter.

**Study of the Thyroxine Secretion Rate of Turkey Poults** (Harold V. Biellier and C. W. Turner). Experimental work was begun at this station during the spring of 1950 to determine the thyroxine secretion rate of growing turkey poults. Beltsville Small Whites were available as day-old poults and were used in this study. The ration fed was the regular poult starter ration feed in mash form. Poults, 220 in number, were brooded in electrically heated batteries and were transferred to commercial grower-type batteries with increasing age and size.

The thyroxine secretion rate was estimated by means of a technique used in earlier work with chicks consisting of determining the amount of DL-thyroxine injected daily required to correct the goitrogenicity of 0.1% thioracil administered in the complete ration.

By assays made at three, six and ten weeks, it was found that the daily rate of secretion by the thyroid gland expressed as micrograms of D, L-thyroxine per 100 gm body weight was 2.31, 1.93, and 1.52 for the male and 2.55, 2.30 and 1.67 for the female. These results substantiated previous reports that the female of several species studied has a greater thyroxine secretion rate than the male.

From the data presented it can be assumed that the thyroxine secretion rate of the growing Beltsville Small White turkey poult is slightly greater than that of the growing chick, as reported by earlier workers.

**Maintaining Quality in Shell Eggs by Thermostabilization** (E. M. Funk, James Forward, and Martha Lorah). The effect of oil processing of grade A and grade B eggs on the occurrence of stuck yolks was studied through a period of eight months. The eggs were purchased, treated and stored, during February, April and June. They were obtained from commercial egg packing plants, some were processed and others left in natural condition. Then in October of the same year, all were broken and studied for the occurrence of stuck yolks as affected by the following conditions: (1) grade of eggs, (2) time of storage, (3) cooling, (4) oil processing, and (5) movement of egg during the processing (thermostabilization).

The oil processing or thermostabilization increased the incidence of

stuck yolks. This had been shown also by former experiments, but the current study was undertaken to establish a definite measure of this effect under stated conditions. In the natural, grade A eggs no stuck yolks were found, while in the processed eggs, 9 were found. There were 1848 eggs in each lot. In the grade B eggs (1140 in each lot) there were no stuck yolks in the natural eggs and 10 in the processed eggs.

It was also found that stuck yolks occurred, under the conditions of this experiment, no oftener in grade B than in grade A eggs. It should be explained however, that storage was rather brief in duration and other conditions were not severe. For the same reason, no significant differences were found in relation to time of storage even though the June eggs were in storage two months less than the April eggs and four months less than the February eggs.

Even the holding of eggs at 100°F. for 12 hours before casing made no significant increase in the incidence of stuck yolks as compared to that in an equal number of eggs cooled immediately after the stabilizing process and then cased. Incidence of stuck yolks was less than 1% for all conditions, and the variations were within such narrow limits that even the apparent inconsistencies had no practical significance. For example: the grade A eggs cooled before casing had 0.89% stuck yolks, while eggs of the same grade held at 100°F. and cased immediately after processing had only 0.52% stuck yolks. For grade B eggs, the situation was reversed; the cooled eggs had 0.37% stuck yolks and those cased without cooling had 0.82%.

And finally, it was found that movement of the eggs during the stabilization process made no difference in the incidence of stuck yolks.

**The Effect of Humidity Prior to and During Incubation on the Hatchability of Chicken Eggs** (E. M. Funk and James Forward). Completed this year after three years of investigation, this study showed that high humidity gives the best hatch, and that humidity is more important during incubation than it is prior to incubation. The differences in hatchability of eggs incubated at three levels of humidity are reported in Table 18.

TABLE 18--The Effect of Incubation Humidity on the Hatchability of Eggs

Percentage Relative Humidity	No. Eggs	Percentage			
		Infertile	Dead 1-18 days	Dead in shell	Hatch all eggs
58	12,621	8.22	10.02	10.05	71.72
50	12,618	8.17	10.01	12.62	69.20
40	12,637	8.78	10.01	12.84	68.37

## RURAL SOCIOLOGY

C. E. LIVELY, *Chairman*

**The Relation of Background, Training and Other Factors to County Extension Agent Success** (C. E. Lively and Ivan F. Nye). The purpose of this study is to determine the characteristics most closely correlated with success in county extension work. As a beginning, early in 1951, all male county extension agents in Missouri were classified by various administrative devices so as to segregate the more successful from the less successful. At the same time a testing sheet was developed for scoring each agent on each of the following indices of character, capacity and performance: (1) Interest, (2) Personality, (3) Attitude, (4) Classroom record, (5) Extra-curricular activities, and (6) Background.

Similar classification and testing were applied to all new agents at the time they were hired, and this practice will be continued until about July 1, 1953. Furthermore a 50% random sample of senior students in the College of Agriculture was included in the studies made in 1951 and will be continued, year by year, until the investigation is closed.

In addition to the 50% random sample of seniors, all seniors preparing for extension agent work but not included in the random sample are subjected to the same selective and evaluation processes.

Tests used in these scoring procedures include: the AGCT general intelligence test, the Guilford-Martin personnel inventory, the Strong vocational interest test, the Minnesota teacher attitude inventory, and a specially constructed background-training biographical inventory.

**A Study of the Effectiveness of Teaching as Related to Background, Training, and Personality of the Teacher** (C. E. Lively, Fred McKinney, Robert Callis, Kenneth B. Brown, Thomas Burgess, Tolan Chappell, Wm. Engram, Arthur Krasner, Herbert Mizes and Fred Proff). This project is concerned with teaching as it occurs in public schools and in college. More specifically, it studies (1) personal relations in the classroom, including the teacher's attitudes toward teaching and students, (2) personality factors (hostile, anxious, fearful and constructive approaches to others), (3) a comparison of two methods of teaching—lecture vs. role-playing, and (4) formulation of criteria of effective teaching. The project is divided into various sub-projects, each of which is reported separately.

*Validation of the Minnesota teacher attitude inventory* (Robert Callis). This is a continuation of the work done by W. W. Cook, University of Minnesota; C. H. Leeds, Furman University; and Robert Callis of Missouri. Form A of the Minnesota inventory was used with ratings of the teacher's work by the school principal and by the students. During the year covered by this report, the ratings were secured on teachers in the schools of Jefferson City, Mexico, Boonville and Fulton.



*Study of hostility and anxiety in teachers as related to personal relations in the classroom* (Kenneth B. Brown and Wm. Engram). These investigators are using the Rorschach content test to measure teacher hostility and anxiety. The same criteria are used as in the preceding sub-project.

A closely related study was begun concerning the attitudes of college freshmen. This work is being done largely to determine the factors and influences that affect the student's choice of the college (Arts and Science, Education, Engineering or Agriculture) in which he plans to get a degree.

By the end of the current year a good start had been made on the gathering of the data, but at least another year will be required to complete the study.

**A Survey of Rural-Farm Morbidity and Related Factors** (C. E. Lively, Robert L. McNamara and John B. Mitchell). During the current year, the data collected in 20 Missouri counties were studied and classified. Along with the tabulation of data on morbidity in rural-farm areas, a count was made of physicians in the 20 counties surveyed. This count was applied to 18 of the years since 1906 when the first directory of physicians was published by the American Medical Association.

Work completed to date has shown as much illness among rural as among urban populations. The morbidity rates for farm people sampled in the 20 counties were as high or higher than those reported for urban places in nation-wide studies.

The gross amount of illness, measured in days lost over a certain period of time, was about the same for the two sample areas—north and south Missouri. Differences were marked, however, within age and sex categories.

Chronic illness, particularly, is a problem of very serious magnitude among farm people. Fully 30% of the farm people interviewed were suffering from chronic illness of some sort. It was evident also that chronic illness is a problem for farm people in the "productive" ages as well as for those in the old age classification.

**Movements of the Rural Population in Missouri** (C. E. Lively and Lawrence M. Hepple). The particular aspect of this problem studied was inter-area migration in Missouri, as related to schooling of the migrant. A migrant, as defined in this study, is a person who crossed a county line, or the boundry of a city of 100,000 or more, in changing domicile between 1935 and 1940. This includes both intra-regional and inter-regional migrations.

The study revealed that 174,428 persons aged 25 years or over moved across county lines or metropolitan city boundaries during the five years ending April 1, 1940. Of these, 92,508 persons moved from one region to another, and 81,920 moved only within their own respective regional areas.

In general, counties along the Missouri River gained in population. The same thing was true of counties along the Mississippi River from Lincoln County south to Cape Girardeau County and also of the western border counties south to Newton County. These were net gains.

All other counties in the state had a net loss in population. This was the pattern for persons with elementary or high school training.

But counting only migrants with a college education, the deep Ozark and Southeast Lowland areas gained in population. All other areas had a net loss.

**Social Area Refinement and Description** (C. E. Lively, C. L. Gregory and R. L. McNamara). During the current year this work was centered on establishing and adjusting core areas conforming to homogeneous cultural and social units. Tests of similarity and difference were applied to determine the unique character of each core. The cores established as sample areas were subjected to still further tests with respect to population characteristics by selecting a random sample from each core and comparing same with the known state average.

In the course of this preliminary work it was found that Missouri is naturally delineated into districts or unique regions, and that these regions are best represented in a few selected counties forming a homogeneous core near their center. These cores have been so selected that they can be shown to form a valid basis for sampling the state with a minimum of observations.

**Barriers to the Dissemination and Use of Scientific Information by Missouri Farmers** (C. E. Lively, Herbert F. Lionberger and Charles M. Coughenour). This study was undertaken as a continuation and revision of the earlier work reported in Missouri Research Bulletin 472 (April, 1951). The purpose is to study not only the factors that prevent scientific information from reaching a considerable fraction of the farms, but also report the benefits accruing to farm families that do receive and use such information.

Much of the data were gathered during the current year but not in time to be analyzed and included in this report.

## SOILS AND SOIL MANAGEMENT

W. A. ALBRECHT, *Chairman*

**Soil Erosion** (L. E. Barnes and C. M. Woodruff). The destructive force of soil erosion has been adequately measured over the last thirty years, but there remains the problem of restoring not only the soil's productivity but also its capacity for retention and utilization of rainfall. The experimental work of the current year included field plot studies of corn grown in different soil management systems and with different fertility practices on artificially eroded or desurfaced subsoil.

## CORN GROWN ON SUBSOIL

The field plots used for this investigation were the seven erosion plots established at the Missouri Experiment Station in 1917 by M. F. Miller. These plots were desurfaced in 1941 and divided into two soil management systems, one a pasture and meadow system, the other a grain system of cropping. Soil fertility treatments were varied on each system.

TABLE 19--Yields of Corn on Clay Subsoil of the Shelby Loam in Relation to Past Systems of Cropping and Soil Treatment.

System of Soil Management, 1941-1949	Fertilizer practices	Yield of corn bu/A-1950
Pasture system of grass and legumes with 8 years of growth returned to the soil unharvested.	Limed and phosphated pasture. Phosphate fertilizer on corn, 1950	32.8
	Untreated pasture and untreated corn	12.4
Meadow system of grass and legumes after 8 years with all crops harvested.	Limed and phosphated meadow. Phosphate fertilizer and 360 lbs. ammonium nitrate on corn, 1950	100.8
	Untreated meadow. Phosphate fertilizer and 360 lbs. ammonium nitrate on corn.	69.9

In this manner it was possible to test the validity of the idea that the soil is improved by years of so-called resting under a pasture or meadow. Four plots that had been cropped with a mixture of grass and legumes since 1941 were this year planted to corn. Two of these plots were treated with nitrogen, while the other two were left without nitrogen in order to determine the extent to which the lime and legumes of the preceding ten-year period had built up the nitrogen content of the soil. Corn yields of the four plots are shown in Table 19.

The results of the test justified the following conclusions:

- (1). Physical properties of the desurfaced soil were sufficiently good to support

high yields of grain crops when adequate plant nutrients were added to the soil.

- (2) Production of high yields of grain crops through the use of legumes and meadow crops as soil builders was impossible without addition of nitrogen through fertilizers.
- (3) Full benefits of fertilizer sources of nitrogen are not realized unless good systems of soil management are practiced as evidenced by the corn yield of 69.9 bushels per acre on land that had not been treated previously as contrasted to 100.8 bushels per acre of corn on land that had been fertilized during the previous 9-year period.
- (4) Subsoil that is seeded down without the use of soil treatments will not regain even a moderate level of productivity within a long period of years.

#### GREENHOUSE PLANTINGS

Earlier studies of soil rejuvenation revealed that the subsoil is very low in both lime and phosphorus. The deficiencies of lime were easily corrected but the shortage of phosphorus remained a serious fertility deficiency even after the considerable additions of superphosphate fertilizer. For further study of this problem, subsoil of Shelby silt loam was collected and potted for greenhouse experiments using treatments of lime, potash and nitrogen on all pots, but with phosphorus as a variable.

The treatments provided for comparisons of the following forms of phosphorus and methods of application:

- (1) Rock phosphate, superphosphate and colloidal phosphate.
- (2) Mixing the phosphate fertilizer through the soil as contrasted with layering it on the plow sole.
- (3) Rates of application in geometrical progression from 20 pounds up to 1280 pounds of  $P_2O_5$  per acre.

The oats did not respond to either rock phosphate or colloidal phosphate—regardless of the method of placement or of the amount used. Oats responded well to superphosphate even at application rates as low as 20 pounds of  $P_2O_5$  per acre. The most significant effect of increased amounts of phosphate was increased tillering of the oats. Small rates of application were insufficient to enable a plant to grow to maturity in a normal manner, but heavier rates of application caused tillering and the number of tillers increased as the amounts of phosphorus were increased up to 1280 pounds of  $P_2O_5$  per acre.

The lower rates of application of superphosphate were most effective when the phosphorus was placed on the plow sole. However, at the higher rates of application, method of placement was of little significance.

Following the harvest of oats all pots were planted to corn to determine if the corn might be better able to use the phosphorus supplied by rock phosphate. There was no evidence at harvest time that corn was able to utilize any of the phosphorus in either rock phosphate or in colloidal phosphate with rates of application varying from 20 pounds to 180 pounds of  $P_2O_5$  per acre.

The growth of corn increased with increasing amounts of superphosphate up to 1280 pounds of  $P_2O_5$  per acre which was the highest rate used. The young seedlings showed phosphorus deficiencies where 1280 pounds per acre had been mixed with the soil, but these deficiencies disappeared as growth progressed. The only seedlings which showed no deficiency symptoms were those grown with 640 pounds per acre or more of  $P_2O_5$  placed on the plow sole. These plants tasseled one week ahead of the plants grown on the soil receiving 1280 pounds of  $P_2O_5$  per acre mixed through the soil but did not make as much total growth.

The results of this investigation suggest that for crops of oats and corn, rock phosphate is of little value in supplying phosphorus direct to these crops when it is applied to the clay subsoil of the Shelby loam.

#### SUSPENDED CLAY IN RUNOFF WATER

A study was made in 1950 to determine the nature of material suspended in runoff from eroded land. It was readily observable that clay brought into suspension and carried from the soil in runoff water was responsible for the muddy condition of ponds on many Missouri farms.

And in all instances studied, the runoff water from land contributing to muddy ponds was very low in amounts of dissolved salts from the soil. In contrast, ponds free of suspended materials contained dissolved salts to the extent of 200 parts per million, while turbid pond water frequently contained less than 50 parts of dissolved salts per million parts of water.

Furthermore the low concentrations of salts were associated with badly eroded soils and with soils of low fertility.

**The Improvement of Pastures** (G. E. Smith and A. W. Klemme). New experiments were established during the year for testing the effects of time and amount of nitrogen applications on the yield of grass and on the survival of legumes in grass mixtures. This work was set up at Columbia on the University South Farms and Sanborn Field, and on outlying fields at Lathrop, Rosendale, Tipton and Weldon Spring.

One experiment at Columbia includes 42 seedings of different grasses and legumes, both singly and in mixtures, on plots receiving 12 different soil treatments. Several years of comparative results will be necessary to get the full meaning of these tests.

In experiments on permanent grasses, differences in yield and in composition of mixed stands were influenced by the levels of the different nutrients supplied. Where only the mineral deficiencies were corrected the stands were over 50% legumes, but when nitrogen was added the percentage of grass was increased.

Soil treatments in these permanent pasture plots were made with a machine that places the fertilizer beneath the sod with a minimum disturbance of the grass. This method will be compared with other appli-

cation methods including surface application and general renovation by reworking the seedbed.

**Outlying Experiment Fields** (L. E. Barnes, A. T. Fulkerson and G. E. Smith). Anhydrous ammonia as a source of nitrogen was compared with ammonium nitrate and other nitrogen carriers on outlying fields in some 25 locations in the state. No significant differences were found between the effects of anhydrous ammonia and ammonium nitrate in comparison where the two types of fertilizer carried the same amounts of nitrogen per acre. In most of the trials little or no further increases in yields resulted from raising the rate of nitrogen application above 80 pounds to the acre.

It was again revealed that an adequate supply of minerals must be present in the soil if maximum benefit is to be obtained from applications of nitrogen. Low levels of phosphorus, potash, magnesium or lime prevent the utilization of applied nitrogen. A good stand of corn also is essential for the higher yields. Few optimum yields were obtained with fewer than 12,000 corn plants per acre. On soils of good tilth and fertilized according to soil tests, highest yields were obtained from 14,000 to 16,000 plants per acre.

#### WHEN NITRATES ACCUMULATE IN CORN

An experiment designed to measure the amount of nitrogen needed in corn production, it was found that heavy nitrogen applications were effective in preventing nitrogen deficiency symptoms in the plants but resulted in dangerous accumulation of excess nitrogen in the corn stalks.

TABLE 20--Nitrate Nitrogen Content of Corn Stalks,  
December, 1950

Soil Type	Amount of N applied per acre	NO <sub>3</sub> -N
Sharpsburg	0	Trace
Sharpsburg	100 lbs.	.019%
Sharpsburg	300 lbs.	.316%
Wabash	0	.007%
Wabash	100 lbs.	.387%
Wabash	300 lbs.	.648%
Putnam	50 lbs.	.001%
Putnam	250 lbs.	.087%
Putnam	160 lbs.	.078%

Table 20 shows the nitrate nitrogen content of corn stalks produced under various soil treatments.

Earlier experiments with livestock have shown that nitrates in excess of .5% nitrate can be toxic to livestock.

### GOOD USE FOR CROP WASTE

Where ample fertilizer treatments were combined with deep tillage it was found that large quantities of carbonaceous organic matter could be plowed into the soil without adverse effects on the yield of following crops. Weights of corn stalks returned from thick stands provided from 6000 to 8000 pounds of dry material per acre. Other materials such as sawdust and cobs were plowed deep into claypan soils. Yields of corn and oats following these additions were high enough to indicate that the organic matter content of such soils may be safely increased by using waste materials grown on the land.

### DEEP TILLAGE TRIALS

On Gerald silt loam the yield of corn was increased 13 bushels an acre when the soil was plowed 12 inches deep and the furrow slice turned on edge, as compared to plowing 6 inches deep with an ordinary moldboard plow. With both methods of plowing the fertilizer treatments were equal and adequate.

On Putnam silt loam in Monroe County, deep placement of phosphate in the soil was studied for its effect on plant growth. Using a corn-small grain rotation, 1700 pounds of rock phosphate and 850 pounds of 20% superphosphate were placed on adjacent plots 6 inches deep, 12 inches deep, and on the surface (cut into plowed surface).

Greater root growth of the sweet clover was obtained when the phosphate was placed 12 inches than when 6 inches deep. There was less heaving where the phosphate was 12 inches deep—and also less lodging of corn.

**New Fertilizing Practices with Crop Rotations** (L. E. Barnes, A. T. Fulkerson, and E. R. Graham). Extensive revision was made during the current year in the Station's experiments with fertilizers on crop rotations. For many years it had been assumed that the legumes in the rotation would provide nitrogen for the non-legume crops—so long as phosphorus and potash were applied in mixed fertilizers to the row crops.

But the old system had failed to produce optimum yields. Regardless of the rotation, more nitrogen and minerals were removed by the row crops than were added through the legumes, crop residues and fertilizers. The soil's plant food reserves had dwindled steadily, and as a consequence the crops had declined in both yield and quality.

### MORE CHEMICAL NITROGEN IS USED

The revised plan is based on the increased availability of chemical nitrogen, which has lessened our dependence on legumes for renewal of nitrogen within the soil. In this plan maximum quantities of chemical nitrogen are used, and in addition enough mineral fertilizers to meet the soil's deficiencies of phosphorus, potash, calcium or magnesium.

Corn plots aggregating a total of 9 acres on Putnam silt loam receiving



these larger fertilizer treatments averaged 99.7 bushels an acre, as corrected to 15% moisture content and including all the no-treatment plots. The highest yield from the better treatment was 127.1 bushels. In contrast, the highest experimental yield recorded by the Missouri Station during the last 17 years from plots without chemical nitrogen was 110 bushels.

Although the season of 1950 was ideal for natural nitrification in the soil, very large increases in grain yields were maintained from applications of chemical nitrogen where adequate mineral levels were maintained. Corn yields in bushels per acre were obtained from varying quantities of nitrogen as follows: from 33 pounds nitrogen 82 bushels, from 60 pounds nitrogen 92 bushels, from 132 pounds nitrogen 113 bushels, and from 200 pounds nitrogen 115 bushels. The nitrogen treatments were preceded by a 150-pound starter of mixed fertilizer (3-12-12) in the row. Where only the starter was used the corn yield was 79 bushels.

#### NEED FOR POTASH IS INCREASING

Where sweet clover had been turned under as a green manure, soil tests indicated that the potash level in the surface soil was about 200 pounds an acre. But on soils where the legumes of the preceding ten years had included lespedeza, soybeans or red clover and these had been removed from the land, the available potassium was only slightly above 100 pounds an acre.

In the 1950 experiments, on soil where red clover had been grown and removed the preceding year, the addition of potassium fertilizer increased the corn yield 21 bushels an acre.

#### CORN YIELDS AFTER DIFFERENT LEGUMES

On fields where corn followed various legumes and grasses there was enough nitrogen in the soil to produce nearly 100 bushels of corn to the acre when adequate mineral fertilizers were added. See Table 21.

TABLE 21--Yield of Corn Following Different Legumes. All Plots Received 150 lbs. of 3-12-12 in row at Planting.

Legume or Grass	No nitrogen	66 lbs. Nitrogen
Red clover (hay)	118.4 bus. corn	125.7 bus. corn
Sweet clover (under)	124.2 bus. corn	127.1 bus. corn
Lespedeza (hay)	114.8 bus. corn	114.5 bus. corn
Lespedeza (under)	107.4 bus. corn	113.3 bus. corn
Soybeans (grain)	90.5 bus. corn	110.8 bus. corn
Timothy (hay)	79.3 bus. corn	113.0 bus. corn

Increased number of plants to the acre also gave significant increases in yield without applications of chemical nitrogen. These gains ceased to be significant, however, when the corn population reached about



These experimental plots show the effect of potash fertilizer in the establishment of a good stand of red clover. At left: Complete mineral treatment, lime and phosphate plus potash. At right: Lime and phosphorus without potash. University South Farms, 1951.

12,000 stalks per acre. The yields of one standard hybrid increased with increase of stalks in the following sequence: 7,000 stalks produced 76.9 bushels, 9,800 produced 98 bushels, 11,600 produced 102.6 bushels, and 14,000 stalks produced 103.6 bushels. With this range of increase in acre yields the ear weight of corn declined from .66 to .52 of a pound per ear. See Table 21.

#### NEW LIFE IN SANBORN FIELD

Addition of fertilizers according to soil tests in the revised plan of Sanborn Field produced yields of crops superior to any obtained in the previous 62 years of its cropping history. When the yield from the untreated contour corn plot (22.5 bushels) is omitted, the remainder of

the field produced an average yield of 100.6 bushels per acre. Plots 6-7, which had previously been abandoned because of nutrient exhaustion, produced 125.7 bushels of corn per acre.

**Processes by Which Plants Take Nutrients from the Soil** (E. R. Graham and Wm. Baker). Since earlier experiments established the fact that the acidity of the plant root is a dynamic factor in exchanging nutrients from the clay or humus to the root, it has become necessary to study the amount and condition of the hydrogen on plant roots.

This is doubly true because it is also true that acidity is a factor in the decomposition of reserve minerals in the sand, silt and clay.

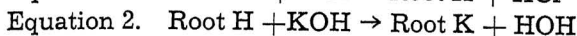
To go deeper into this problem, the investigators grew oats, barley, rye and wheat for about 6 weeks and then carefully removed the plants from the culture for analysis. The hydrogen saturation was determined by electro dialysis. After repeated hydrogen determinations, the roots in some instances were replanted in the nutrient culture to determine their vitality. And in other instances the roots were dried and weighed so that results could be expressed in milliequivalents per 100 grams of dry roots.



The legumes preceding corn in the crop rotation, demanding and using—as they do—more soil minerals than other crops, seriously depress corn yields unless complete treatments with mineral fertilizers are added. This picture, fall of 1950, shows corn yields following legumes with corn yields varying with current-year treatment as follows: (left) nitrogen, phosphorus, potash and lime—yield 118 bu. corn; (center) nitrogen, phosphorus and lime—48 bus.; (right) nitrogen and calcium—yield 67 bus.

## HYDROGEN REVEALED AS A SHUTTLE

This and earlier studies have revealed hydrogen at work in the soil as a busy shuttle between the nutrient-laden clay particle and the hungry plant root. The role of the hydrogen atom in this exchange is shown in the following equations:



When root hydrogen is measured with a neutral salt such as  $\text{K}_2\text{SO}_4$  or  $\text{KCl}$ , the results are erratic, and this would indicate that the high dissociation of the end product, namely  $\text{H}_2\text{SO}_4$  or  $\text{HCl}$ , as in Equation 1, is driving the reaction backward. On the other hand, when root hydrogen is measured with  $\text{Ca}(\text{OH})_2$  or  $\text{KOH}$ , the results are reproducible, indicating that the low dissociation of the end product, that is  $\text{H}_2\text{O}$ , as in Equation 2, would allow the reaction to go on to completion and permit reproducible measurements.

The percentage saturation of the root by hydrogen when at equilibrium with a particular nutrient solution for oats was found to be 11.5 to 29.2%, for barley 8.4 to 22%, for rye 42 to 64%, and for wheat 8 to 19%. This value was found to vary with duration of growth, a relationship which will require further investigation.

Electrodialysis increased the percentage hydrogen saturation to near 100% in 4 hours. The exchange capacity of the root hydrogen, expressed in milliequivalents per 100 grams of roots, was determined for the various small grain plants as follows: Oats 24 M.E., barley 24 M.E., rye 26 M.E. and wheat 21 M.E.

Analysis of the contents of the cathode chamber following electro-dialysis of the plants grown on nutrient substrates revealed widely varying amounts of cations per 100 grams of dry roots, ranging as high as 100% above the hydrogen exchange capacity.

The discovery that ions in excess of the exchange capacity of the root are removed during electro-dialysis clearly demonstrated that plants lose nutrient ions whenever the root atmosphere is completely saturated with hydrogen.

The demonstration of the absorbed hydrogen system on plant roots and the fact that it can be increased or decreased without killing the plant have opened the way to an entirely new concept in plant feeding. The root can now be regarded as one component of a chemical equation.

**Plant Root Penetration in Relation to Chemical and Physical Conditions of the Deeper Soil Layers** (C. M. Woodruff, D. D. Smith and D. M. Whitt). Started in 1941, this experiment was set up to learn more about the chemical and physical conditions in the subsoil that affect plant growth, root development and resistance to drouth.

During 1950, two phases of the investigation were in progress: (1) Continuation of the field plots at McCredie and (2) a greenhouse study of root development in metal containers.

#### SHATTERING AND FERTILIZING THE SUBSOIL

The work of earlier years—from 1941 to 1947—included shattering the subsoil to a depth of 18 inches, without observable benefits to plant growth or drouth resistance. It was only the somewhat later introduction of lime into the deeply shattered soil that proved beneficial—especially to sweet clover.

The subsoil was again treated in 1947, when rock phosphate and more lime were put down into the subsoil. But much more effective were the applications of fertilizer made to the topsoil since that time. The improved fertility program on the surface soil greatly increased the yields of grain crops, even though the subsoil treatments still failed to affect these crops favorably. Again, sweet clover alone responded to subsoil additions of lime and rock phosphate with improved stands and better quality of forage.

The yields of crops for two periods, 1942-1947 and 1948-1950 are compared in Table 22.

TABLE 22--Effects of Subsoil Shattering and Subsoil Fertilization on Crops Yields--McCredie Field

1942-1947 (6 years)			
<u>Soil Treatment</u>	<u>Corn</u>	<u>Oats</u>	<u>Barley</u>
Subsoil untreated	30.0	29.6	23.1
Subsoil shattered	31.8	30.8	19.0
Subsoil shattered and treated	34.8	31.4	22.0
1948-1950 (3 years)			
<u>Soil Treatment</u>	<u>Corn</u>	<u>Soybeans</u>	<u>Wheat</u>
Subsoil untreated	119	34.7	28.5
Subsoil shattered	101	35.0	24.5
Subsoil shattered and treated	112	37.4	29.3

From these experiments with the deeper layers of the soil several conclusions are warranted. For one thing, they proved that limestone or calcium is very useful in preparing a tight subsoil for normal development of sweet clover's deep-rooting system. On the other hand, there were no resulting benefits to small grains or corn.

Deep placement of phosphorus gave no advantage over shallow

treatments for root development of any of the crops used in the experiment.

And very clearly demonstrated was the fact that no benefit may be expected from deep tillage of claypan soils unless this practice is used to put lime down to these lower depths.

**Mineral Contents of the Silt Separates of Some Missouri Soils as a Measure of their Fertility and Degree of Weathering** (R. H. Hawkins and E. R. Graham). Representative samples of ten Missouri soils were analyzed for their fertility levels and the findings were reported in Experiment Station Circular 345. These samples were again studied in the current year. They were treated for dispersion and separated mechanically. The silt fraction of each was then analyzed both chemically and mineralogically. The determinations of quartz, potassium feldspar and plagioclase feldspar in five of these soils were found to be as follows:

	Wabash	Marshall	Knox	Lebanon	Clarksville
Quartz .....	67%	69%	67%	81%	84%
Potassium feldspar .....	13%	12%	13%	6%	9%
Plagioclase feldspar .....	20%	19%	20%	13%	7%

The other samples—Grundy, Putnam, Summit, Hagerstown and Waverly—were intermediate in all respects.

In all samples the percentages of quartz and the ratios of sodium to calcium in the silt were inversely proportional to the fertility levels and directly proportional to the considered degrees of weathering of the soils. The percentages of potassium feldspar and of plagioclase feldspar in the silt were directly proportional to the fertility levels and inversely proportional to the degrees of weathering.

**Relation of the Soil Fertility Level to Nitrogen Metabolism in Brome Grass** (T. R. Fisher and E. R. Graham). Samples from three Missouri soil types, Summit silt loam, Newtonia silt loam and Lintonia fine sandy loam, were placed in a sufficient number of pots for a wide variation of treatments. Each of the various treatments compared included an overall application of ammonium nitrate plus all but one of the other plant nutrients that soil tests indicated were deficient in the natural sample. Thus, in the entire study every nutrient under observation had been omitted from one pot, while all other nutrients in that pot had been brought up to optimum level.

The chemical analyses of the soil samples prior to treatment revealed the following fertility levels:

Soil	P <sub>2</sub> O <sub>5</sub>	K	Mg	Ca.	Cu	Mn.
Summit	Low	High	High	Medium	High	Medium
Newtonia	Medium	High	Low	High	High	Low
Lintonia	High	Very High	Low	Low	Medium	Medium

The no-phosphorus treatment on Summit silt loam, which had tested

low in phosphate, gave only 24% as much growth as did the same soil with complete treatment.

Treatments added to the original fertility of the sample of Newtonia silt loam failed to affect the growth and nitrogen metabolism of brome grass to any important extent, although the preliminary analysis had shown this soil low in both magnesium and manganese.

Calcium and magnesium were low in the Lintonia fine sandy loam. This was also reflected in the harvest of brome grass, which was found to be low in total nitrogen and nitrate nitrogen when no nitrogen was added.

In general, the results indicated that a soil content of near 12 pounds of  $P_2O_5$  represents the degree of phosphorus deficiency that seriously interferes with metabolism of nitrogen in brome grass. And at the other end of the scale,  $P_2O_5$  levels of 108 or above appear to be necessary for normal optimum nitrogen metabolism in this crop.

**The Role of Phosphate-Bearing Rocks in the Processes of Soil Development and Plant Nutrition** (E. R. Graham). Samples of 200-mesh Tennessee rock phosphate were placed in collodion sacks. These sacks were then immersed in flasks of various weathering substances: H-clay (pH 3.5), 20% saturated clay (pH 3.8), 40% saturated clay (pH 4.7), 60% saturated clay (pH 5.2), and 80% saturated clay (pH 6.2). Similar samples were enclosed in collodion sacks and immersed in distilled  $H_2O$ , HCl (1.36 M. E. H.), and H-Amberlite (8.4 M. E. H.).

After 6 months the sacks of rock phosphate were removed and analyzed for pH and available phosphorus. By this method it was found that rock phosphate acted on the acid clays as a liming material. This reaction changed the pH of 3.5 acid clay to 4.3 and that of 3.8 acid clay to 4.4 clay. The moderately acid clays were changed very little.

The percentages of weathering of the rock phosphate under the various immersions were:

Weathering Substrate	Percentage Weathered
1. Distilled $H_2O$	.036
2. HCl (1.36 M.E.H.)	3.420
3. H-clay (1.36 M.E.H.) (pH 3.5)	2.064
4. Clay (pH 3.8)	.596
5. Clay (pH 4.7)	.286
6. Clay (pH 5.2)	.173
7. Clay (pH 6.2)	.087
8. H-Amberlite (8.4 M.E.H.)	14.860

The method used in this investigation proved to be particularly well adapted to the study of phosphate-bearing rocks. It is likely to develop into a highly efficient technique for studying particle size and its relationship to differences in mineralogical stability. Since clay acids were used for the weathering, the results were directly related to soil conditions.



**Chemical Studies and Bio-Assays of Forage Feeds Grown on Soils Treated with Trace Elements** (G. E. Smith, Wm. A. Albrecht and A. W. Klemme). Sudan grass grown on soil from an abandoned field of Lindley silt loam fertilized with the major elements was found to contain twice as much boron, cobalt and copper; four times as much manganese and zinc; seven times as much molybdenum; and ten times as much iron as was found in a similar harvest from "well managed" fields.

In other words, spectrographic analyses of soils and plants grown on these soils indicate that trace elements are lowest where soils have had heavy applications of calcite limestone and annual treatments with synthetic fertilizers. The copper-cobalt ratio in Sudan grass from the low fertility soil was 3 to 1, while a 1 to 1 ratio was found in Sudan grass grown on soil from an adjoining field that had been well treated.

A mixture of trace elements broadcast and disked into Putnam silt loam produced differences in plant appearance. Corn receiving the trace element mixture was darker green throughout the growing season. There was, however, no significant effect on yield. Sweet clover on the same soil was more vigorous and contained less of other plant species where the trace elements were applied.

Trace elements have given significant increases in the yield of cotton where the major plant nutrients have been added in adequate amounts. With corn, on the same soils, however, the trace elements have had a depressing effect on yield.

Alfalfa hay grown on Newtonia silt loam has been assayed with rabbits. Animal gains were increased where the soil received both magnesium and a mixture of trace elements.

These data suggest that on this soil the trace elements or magnesium alone failed to increase animal gains, but when both were applied the rate of animal growth was increased.

It was observed that mice cut the sacks containing corn from soil receiving trace elements. These grains were given to rabbits permitting free choice and these animals ate 80% more of the grain that had received the trace element applications.

**The Cationic Activities in Soil Colloids** (C. E. Marshall and E. O. McLean). The mutual effects of calcium and potassium have now been rather fully investigated for the following clay minerals: two montmorillonites, beidellite (Putnam clay), attapulgite, two illites, halloysite and kaolinite. Similarly calcium-magnesium interactions have been studied in a bentonite, beidellite (Putnam clay), illite and halloysite. In all these cases, without exception, the calcium or magnesium has caused an increase in the potassium activity as compared with the acid clay.

The effect of the potassium upon the calcium or magnesium varied with changes in the percentage of base saturation. Where this was be-

low 50% the potassium decreased the activity of the calcium or magnesium to values too low for measurement. Above 50% saturation, there was generally a slight increase in activity.

In a closely related study, sodium and potassium were tested for their mutual effects and their influence on calcium. As expected, sodium depressed calcium activities more strongly than did potassium. Sodium also exerted a strong effect on potassium activity. These and other effects observed were summed up by McLean as follows.

"When both sodium and potassium ions are present they compete for positions of high-bonding energy on the clay surface. Potassium itself has a higher bonding energy than sodium, consequently it preempts the higher energy positions, leaving those of lower energy for sodium. Thus the initial difference in the two cations becomes much accentuated and the sodium ions show very much higher activities than potassium when both are present in equal total amounts. Sodium and potassium are commonly present in soils in roughly equal amounts but it has not previously been realized how much sodium would predominate in the ionic environment of the plant roots under these circumstances."

**Soil Survey and Land Classification** (H. H. Krusekopf, J. A. Frieze, C. L. Scrivener and M. E. Springer). During the year, the soil surveys of Boone and Livingston counties were completed and that of Moniteau County was nearly finished.

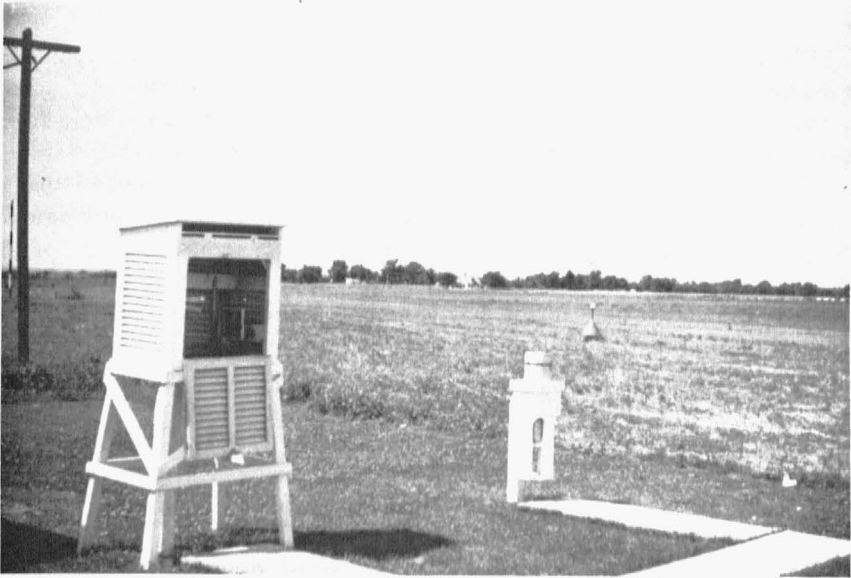
Additional information was assembled on the thickness of loess soil material in the central part of the state. The demand for soil survey reports has been greater than ever before, and only a very small percentage of the requests can be met, because reports are not available or surveys have not yet been made. Soil maps are available for only 30 counties.

**Trace Elements in the Limestones of Missouri** (Wm. A. Albrecht, W. D. Keller and E. E. Pickett). Since limestone has been the parent material of the major areas of the soils of Missouri, the question as to whether or not this material originally contributes some of the trace elements to the soils developed from it can be answered by analyses of the remaining limestones. Then since crushed limestone is serving as soil treatment at the rate of more than 2 million tons per year in Missouri, it is essential to know whether it may be carrying some of the trace elements, such as manganese, copper, zinc, cobalt, molybdenum and others for possible soil improvement.

Limestone quarries in use and in prospect have been sampled to give more than nine hundred samples to date. These samples were collected by the Missouri State Geological Survey under the direction of Dr. Edward Clark, cooperating in this project. The locations and geological details in question have been under observation and study by Dr. W. D.

Keller, Department of Geology, who has followed through also the preparation of the samples, and served as correlator of many of the activities of the project.

**Compilation and Study of Weather Data** (Wayne L. Decker, M. F. Miller and Aubrey D. Hibbard). Throughout the year, weather information was accumulated from 34 Missouri weather stations. These data were summarized and placed on punch cards for statistical study. Two sub-projects received special attention; the determination of freeze hazards to tender crops and the collection of data on soil temperature.



Instrumental exposures of the U. S. Weather Bureau's station at Chillicothe, Mo., one of the 34 stations in this state supplying records for studies now in progress at the Missouri Agricultural Experiment Station.

### Freeze Hazards to Tender Crops

Freeze hazards to tender crops have been determined for ten Missouri weather stations. All of these are located within regions where tender crops are grown. The stations used were: St. Joseph, Kansas City, Columbia, St. Louis, Rolla, Lebanon, Mountain Grove, Birch Tree, Springfield and Neosho.

On the basis of earlier work, critical temperatures injurious to tender crops have been postulated. These temperature limits are shown in Table 23. They give an estimate of the amount of expected damage and are expressed in terms of *light*, *moderate* or *severe* freezes.

TABLE 23--Temperature Limits for Killing Freezes

Light Freeze	28 <sup>o</sup> -32 <sup>o</sup>	Little or no damage to most plants. Heavy damage to tender plants, and to semi-hardy plants in lowlands.
Moderate Freeze	24 <sup>o</sup> -28 <sup>o</sup>	Some damage to all plants. Heavy damage to fruit trees, tender and semi-hardy plants.
Severe Freeze	Less than 24 <sup>o</sup>	Heavy damage to all plants.

The last occurrence of a particular type of freeze in the spring marks the earliest possible date of beginning growth for plants normally killed by that type of freeze. The date on which this occurs varies widely from year to year. For example, the last date in the spring for a light freeze may be as early as March 15 or as late as May 1. It is believed that a simple expression of the probability of a freeze occurring after any date in the spring should greatly aid the growers of tender crops.

The investigators constructed probability charts based on the assumption that the coded date of the last freeze in the spring follows an independent normal distribution. This assumption is upheld by rigorous statistical tests. Estimates of the sample mean and standard deviations give the factors necessary for estimating the probability of a freeze occurring after a given date. It can also be shown that the standard deviations for the coded dates of the last light, moderate and severe freezes in spring must be equal. The best estimate of the standard deviation is, therefore, the pooled standard deviation of the three types of freezes.

Table 24 gives the coded means, standard deviations and pooled standard deviation of the last date in spring of each type of freeze at Columbia, Missouri. Similar estimates were computed for the nine other locations from which weather records were obtained for this study.

Just as the last occurrence of a killing temperature in spring marks the earliest possible date of spring growth, so also the first occurrence of freezing in the fall marks the end of the growing season. The probability or likelihood of a freeze occurring before any date in the fall can be computed by estimating the mean and standard deviations of each type of freeze by the method just described.

TABLE 24--Means and Standard Deviations for Last Freeze in Spring at Columbia, Missouri

Freeze	Average date coded from March 1	Average date uncoded	Standard deviation	Pooled standard deviation
Light	50	April 19	11.87	
Moderate	38	April 7	11.71	
Severe	25	March 25	11.71	
				11.76

The computed likelihoods are then expressed in percentages. In case of the spring freeze, a likelihood of 10% indicates that a freeze will occur *after* that date in one out of ten years. A likelihood of 10% in the fall indicates the freeze will occur *before* the indicated date in one out of ten years.

Accompanying graphs show the likelihood lines for each type of freeze in spring and fall at Columbia. Similar likelihood curves have been constructed for the other nine regions where this study was conducted.

#### COLLECTION OF SOIL TEMPERATURE DATA

Two soil temperature stations were installed during the year. At each of these stations, daily soil temperature readings at the 1, 3, 6, 12, 24, 48, and 72-inch levels have been taken. It is not the purpose of these observations to obtain a detailed study of the soil temperature conditions. It is more a matter of defining the general picture of changes in soil temperature with season and geographic area.

The two soil temperature stations have been set up in widely separated areas of the state. One is located at the Speas Horticulture Farm at Faucett in Northwest Missouri. This set of thermometers is placed in a typical river-hill type of soil. The other set of soil thermometers has been placed at the Field Crops and Horticulture Farm at Sikeston. This set was placed in a sandy soil typical of the area.

An attempt has been made to install both sets of thermometers under a uniform sod cover. In this way, some of the difficulties of cover variations have been overcome. In both cases, one observation a day is taken at about 5:00 in the afternoon.

Tables 25 and 26 list the mean, the highest and the lowest temperatures observed for each month at each of the seven depths below the surface of the soil. From these data it is seen that at both stations during August and September the mean temperature decreased with depth; while in November and December there was a general increase of temperature with depth. For the month of October the mean temperatures were nearly isothermal, indicating a transition from summer to

TABLE 25--Monthly Summary of Soil Temperature Observations at the Speas Horticulture Farm at Faucett, Missouri

Period	Depth in Inches																					
	1			3			6			12			24			48			72			
	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	
August																						
24-31	74	79	70	72	75	70	71	72	69	70	70	69	68	69	67	66	67	65	63	63	62	
September	71	76	65	70	73	65	69	72	64	68	71	63	66	69	63	64	66	63	63	63	62	
October	63	71	56	62	70	56	61	69	57	61	67	58	61	65	59	61	63	60	61	63	60	
November	44	61	35	44	60	36	46	60	37	48	60	42	52	60	45	57	60	54	57	60	55	
December	35	40	30	35	38	31	36	38	33	38	43	35	43	46	40	49	55	45	52	55	48	

TABLE 26--Monthly Summary of Soil Temperature Observations at the Field Crops Experimental Farm at Sikeston, Missouri.

Period	Depth in Inches																				
	1			3			6			12			24			48			72		
	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest
Sept. 19-30	70	80	64	71	79	66	71	77	66	70	74	66	70	72	68	70	70	69	69	69	68
October	66	75	59	67	75	61	66	73	62	65	70	63	66	69	64	66	68	65	66	68	65
November	46	68	31	47	69	33	48	68	35	50	67	39	54	66	44	59	65	53	61	65	56
December	36	60	31	37	58	32	37	54	33	39	50	36	43	49	40	49	52	45	52	56	48

winter condition. The time of this transition should be very important in any study of heat balance in the soil.

It is of interest, also, to note that the lowest soil temperature observed at the Speas Horticulture Farm in Northwest Missouri was 30°F. Yet the 3½-month period during which the observations were made included some very cold weather. There were eight days in November and December when the air temperature went no higher than 15 to 20°. And despite this very cold weather, the soil temperatures, even at the coldest levels—1 and 3 inches below the surface—were essentially near or above freezing.

An explanation may be found for this condition in the fact that there had been little or no precipitation in the area after October 1, so that the soil surface layers must have been very dry. It is believed that this condition resulted in higher temperatures than would have been found if the soil had been moist.

It would seem, on the basis of these observations, that water is necessary for rapid conduction of heat within the soil.

**Water Utilization of Crops in Relation to Solar Radiation** (C. M. Woodruff). This investigation sought to measure the average daily con-

sumption of water required by a crop in order to provide a complete canopy of green through the growing season. The study was made on a renovated bluegrass pasture for which runoff measurements were available. The average daily consumption of water was determined for each of four periods, as follows:

Period	Average daily consumption of water, in inches.
April 20 to June 1 (42 days)	0.17
June 2 to June 30 (29 days)	0.15
July 1 to August 1 (32 days)	0.11
August 2 to September 14 (44 days)	0.14

The foregoing records include the combined losses of water by transpiration and evaporation. The moisture content of the soil was at field capacity when the measurements were started April 20, so that some of the moisture lost April 20 to June 1 was probably lost by percolation into deeper layers of the soil.

It should be added also that moisture supply of the soil became deficient in July so that the grass ceased growth and became partially dormant and ceased to provide complete transpiration. This is reflected in a decreased rate of water transpiration.

The measured rates of water consumption for June and for August through September 14 were for periods when moisture was adequate and the grass was in growing condition. Moisture tension measurements also showed that the moisture content of the soil was not great enough for the occurrence of moisture losses by percolation. The measurements obtained for these two fairly normal periods were used to establish the consumption rates at 0.15 to 0.14 inches a day, or 1.05 to 0.98 inches a week. These rates are in close agreement with that of 1 inch a week for corn, a rate established at this Station in 1947.

## VETERINARY MEDICINE

A. H. GROTH, DEAN

**Blood Studies in Bang's Disease** (Cecil Elder and Donald E. Rodabaugh). This investigation was set up to learn more about the differences between blood titres that occur as the result of infection and those produced by vaccines. For this purpose the investigators selected nine naturally infected and four vaccinated cows for comparison in trial tests. Maximum blood titres were determined for all the cows. Each animal was then given a 6 cc dose of *Brucella abortus* strain 19 vaccine administered subcutaneously.

After two weeks the animals were retested and a comparison made between the pre-injection and post-injection titres. Two of the nine naturally infected cattle show no appreciable rise in blood titre, whereas all four vaccinates showed a marked increase in titre following injection.



tion of *Brucella abortus* strain 19. Apparently there are some factors which prevent naturally infected cattle from increasing in agglutination titre following injection of vaccine, but such factors do not seem to operate in all cases. This plan of differentiation between vaccinal and natural infection titres needs more study.

Further study was carried out on the possible effects of trace minerals on vaccinal blood titres of cows. Ten cattle were used on this experiment. Four of the animals were adults that had been used in previous trials and six were unbred heifers. In order to produce a blood titre for testing purposes the cattle were given two injections each of *Brucella abortus* strain 19 vaccine, 18 days apart. In establishing a titre for each animal which would be fairly uniform, weekly blood samples were drawn and tested. When the blood titre curve leveled off, all the cattle were treated with a mixture of trace minerals. The minerals given consisted of 200 parts manganese sulfate, 20 parts copper sulfate and one part cobalt sulfate. This mixture was sprinkled on the hay and fed at the rate of one ounce per 1,000 pounds of body weight per day. The cattle were kept on this mixture constantly for 30 days. Weekly blood tests were made throughout the feeding period and for 30 days following discontinuance of the minerals.

No appreciable change was noticed in blood titre in any of the blood tests during the first fifteen days following discontinuance of the minerals. Some variations in titre were noted during the last fifteen days but further tests must be made before correct interpretations of data can be made.

**Bang's Disease Vaccination** (Cecil Elder, Donald E. Rodabaugh and James E. Comfort). Using the beef cattle on the University Farms, an attempt was made to determine how quickly a Bang's disease infected herd could be freed of infection by a combination of calftlood vaccination and blood testing. Table 27 is a report of the work done in the first year of this experiment.

This record shows that some improvement of breeding efficiency was made in the reactor herd during the year. This was probably due to the fact that several of the animals with breeding difficulties were eliminated from the herd.

**Parasites of Sheep** (Cecil Elder and Donald E. Rodabaugh). Many sheep owners keep a mixture of phenothiazine and salt before their sheep to prevent parasite infestation, or at least to hold such infestation at a minimum. There still remains, however, a need for more information, especially to determine the value of individual treatment of the animals supplementing the standard mixture during the summer when parasite loads are unusually high.

For this purpose the Station workers selected six lambs which had

TABLE 27--Summary Bang's Disease Vaccination, March 1, 1950 to February 28, 1951

<u>Total Herd</u>	
Cattle on experiment . . . . .	167
Bang's agglutination tests made . . . . .	355
Heifers vaccinated with Strain 19 virus . . . . .	45
Cows vaccinated with Strain 19 virus . . . . .	17
<u>Negative Herd</u>	
Non-vaccinated cows in negative herd . . . . .	25
Cows that delivered normal calves . . . . .	17
Average number breedings per normal calf . . . . .	1.75*
Breedings per cow not delivering normal calf . . . . .	1.75
Cows becoming reactors during experiment . . . . .	0
Aborting during period (negative on three later tests) . . . . .	1
Sold because of breeding difficulties . . . . .	0
Sold for other reasons. . . . .	2
Died (during anaplasmosis outbreak) . . . . .	9
Cows not calving during experimental period. . . . .	7
Calfhood-vaccinated cows and bred heifers . . . . .	57
Cows that delivered normal calves . . . . .	21
Gestation period not completed . . . . .	36
Breedings per normal calf . . . . .	1.09*
Breedings per cow not delivering normal calf . . . . .	2.76
Animals that became reactors . . . . .	1
Sold because of breeding difficulties . . . . .	0
Aborting during period . . . . .	0
Sold for other reasons. . . . .	1
Died (during anaplasmosis outbreak) . . . . .	2
Total number vaccinated under breeding age. . . . .	44
<u>Reactor Herd</u>	
Total number in reactor herd. . . . .	41
Number of calfhood-vaccinated cows . . . . .	2
Cows that delivered normal calves . . . . .	26
Breedings per normal calf . . . . .	1.52*
Breedings per cow not delivering normal calf . . . . .	1.66
Cows that delivered premature calves . . . . .	2
Aborting during period . . . . .	1
Sold because of breeding difficulties . . . . .	1
Sold for other reasons. . . . .	3
Have not delivered calves during period . . . . .	12

\* Exclusive of Herefords which were pasture bred.

been on a phenothiazine-salt mixture. Two were treated with a mixture containing 1½% copper sulfate and 1½% nicotine sulfate. Two were treated with liquid phenothiazine (commercial product) and two were left untreated as controls.

Considerable benefit was observed in the lambs which received the copper sulfate-nicotine sulfate treatment when compared with the controls. The liquid phenothiazine treatment showed very little if any benefit when compared with the controls. More important was the effect on parasite egg counts when sheep were changed from pasture to hay feed regardless of treatment given. The experiment definitely indicated the necessity of controlling this factor when trying to evaluate experimental results.

#### WINTER SURVIVAL OF LARVAE

To study the question of winter survival of parasitic ova and larvae on contaminated pastures a specially constructed rabbit-tight plot at the Veterinary Research farm was used. Four lambs born in the Spring of 1950 had been removed from their mothers shortly after birth and raised parasite-free in wire-bottom cages. These parasite-free lambs were placed in a special plot which had been heavily contaminated the previous fall but kept free of sheep during the winter months. By this method it was found that although many parasitic larvae and ova did not survive the winter temperatures of Central Missouri, a sufficient number did survive to infest the sheep. Among the larvae that survived were several species including: *Haemonchus contortus*, *Ostertagia*, *Nematodirus*, *Strongyloides*, Tapeworms, *Trichostrongyles* and *Trichuris*. Further work on pasture survival of parasites should be done.

In an attempt to study parasitic infestation that takes place during the winter months, four parasite-free lambs which had been maintained parasite-free during the entire 1949 season were placed with other sheep on one of our contaminated pastures on January 13, 1950. These lambs were left on this pasture through the 1950 grazing season. Fecal counts were made on them every two weeks. A mild infestation occurred in the early spring and extended throughout the grazing season. At no time did these yearling sheep show egg counts approaching in numbers those of the 1950 spring lambs on the same pasture. Indications are that the increased age of these lambs played a very important role in their resistance to parasites picked up on the pasture. In this connection it should be pointed out that all experimental sheep had adequate feed and that good feed is very important in the control of parasites. Sheep that are improperly fed are much more susceptible to the ravages of parasites.

#### HOW RESISTANCE IS DEVELOPED

We have been quite successful in raising lambs parasite-free by keeping them in wire cages with wire bottoms. Some of these parasite-free lambs were used to study results obtained when they were artificially dosed with pure cultures of parasitic larvae. One lamb, No. 738, was dosed with a pure culture of *Haemonchus contortus* receiving only 610

infective larvae which were administered by means of a stomach tube. This dosing extended over a 30 day period. Approximately 30 days following the initial dose, *H. contortus* ova began appearing in the feces. Large quantities of these feces were then collected and cultured in a large Baermann apparatus. The infective larvae thus cultured were given to a second parasite-free lamb, No. 739. During a 14-day period approximately 117,588 infective larvae were given to this lamb by means of a stomach tube. The initial dose was 38,000 larvae. Within 20 days after receiving the initial dose, the lamb showed severe symptoms of parasitism. Even though parasitic ova had not appeared in the feces this lamb was autopsied and material was collected for histological study.

The original lamb, No. 738, was subsequently redosed with a total of 86,510 infective larvae. This lamb showed no ill effects from such treatment, nor did it have any increase in fecal egg counts over those produced by the initial dosing, for the three months thereafter. It appeared that the relatively small number of larvae administered early in the season had caused this lamb to produce an increased resistance to *Haemonchus contortus* larvae.

**Efficacy of Choline Chloride in Treating Pregnancy Disease in Sheep** (Cecil Elder and Harry H. Berrier). Seven ewes showing typical symptoms were treated with choline chloride and 50% dextrose. In addition to this treatment some of the seven received concentrated vitamins and A.P.F. (animal protein factor). Tablet ketone tests were made on all seven of the ewes and each showed a 4+ reaction. Within two to four days after treatment the ketone test showed results varying from negative to a 1+ reaction. Three of the seven ewes made complete recoveries and were sent home. Four of the ewes died. Results following the use of choline chloride are encouraging enough to warrant further trials with this medicine.

In addition to being very thin, all fifteen cases with pregnancy disease were heavily infested with internal parasites. All had been on deficient diets, an observation which we have previously reported in connection with pregnancy disease of sheep.

The ewes were all field cases handled for farmers in connection with the clinic of the School of Veterinary Medicine. In fact, 15 such cases were available for the study but eight of the ewes were down and unable to stand at the time they were received. None of these lived long enough to respond to treatment.

**Blood Studies Related to Leukemia in Fowls** (A. J. Durant). This investigation of Leukemia (visceral lymphomatosis) in fowls were carried on in connection with work on other types of fowl paralysis, because of the close relationship between these diseases.

Of 82 chicks inoculated with whole blood from birds visibly affected

by fowl paralysis, 10 received blood from a donor with a typical case of visceral leukemia. None of the 82 chicks developed leukemia, even including the 10 chicks inoculated with blood from a leukemia-affected fowl. This was interpreted as indicating that this was not a transmissible form of leukemia and, furthermore, that the other donors were likewise incapable of transmitting the visceral form of leukemia.

**Blood Studies on Transmission of Fowl Paralysis** (A. J. Durant). An experiment was undertaken to test the transmissibility of fowl paralysis by blood from visibly infected hens to day-old chicks. In groups of 10 chicks for each hen, 72 chicks were injected intravenously with 1 to 2 cc. each of blood from hens having the ocular form of fowl paralysis. Controls in equal number were held for observation.

In compartments accomodating 10 chicks each, the experimental birds were held under observation for 90 days, after which the inoculated birds and the control birds were confined in separate pens and observed for another period of about four months. In addition, 10 other day-old chicks were inoculated from a fowl affected by leukemia or visceral lymphomatosis.

Of the total of 82 birds inoculated, 28 died during the periods of observation, 9 developed fowl paralysis, and 7 were held as suspects for periods varying from 37 to 127 days. Of the 9 cases of fowl paralysis—definitely diagnosed as such—5 occurred in one group of 10 chicks inoculated from the same blood donor. In none of the 82 birds in the inoculated group was there any evidence of leukemia.

Of the 80 control birds held under the same conditions, 16 died during the periods of observation, 9 developed fowl paralysis, and four were held as suspects but not diagnosed as affected by paralysis. Cases among the control birds were scattered throughout the 8 groups.

#### INOCULATION OF EGG EMBYROS

Sixty-five embryonated eggs (9 days) received from .3 to .5 cc of fresh whole blood into the veins or allantoic sac from 7 New Hampshire hens—donors showing visible evidence of ocular lymphomatosis. Only four of the 65 eggs hatched and one of the chicks died immediately after hatching. The 3 surviving chicks all developed some form of fowl paralysis. One, No. 7292, died with a typical case (blood picture and the lesions) of visceral lymphomatosis in 90 days after hatching. This bird as an embryo received .5 cc of blood intravenously. Chick No. 7296 received 1 cc of blood into the allantoic sac and 21 days after hatching showed symptoms of neurolymphomatosis.

**Studies on Cecal Abligation for the Prevention of Blackhead in Turkeys** (A. J. Durant). This work was continued from the preceding year, primarily to make further trials of sodium morrhuate used as an escharotic—to dry up the ceca following abligation.

For this experiment during the current year, 45 fowls were used: 28 chickens and 17 young turkeys. The chickens were White Leghorn hens, while the turkeys ranged in age from 1 to 4 months. In all these fowls the ceca were abligated or tied-off. Then 13 of the chickens received 2½ cc of sodium morrhuate into each cecum at the time of abligation. And 7 of the turkeys were similarly treated, receiving into each cecum silver nitrate as an alternative treatment instead of sodium morrhuate.

In 7 of the 13 chickens receiving cecal injections of sodium morrhuate the treatment was successful; that is, the ceca were either dried up or prevented from developing the enlargement typical of the blackhead disease.

Among the 7 turkey poults treated with silver nitrate, only one was saved from cecal enlargement, indicating that sodium morrhuate may be considered the best preventive so far tested in connection with cecal abligation.

## SERVICE PROJECTS

### BY THE DEPARTMENTS

**Fertilizer Inspection and Analysis** (Director's Office and Agricultural Chemistry Department). For the 58th consecutive year the Experiment Station collected samples and made chemical analyses required for administration of the Missouri Fertilizer Control Law. The total numbers of samples collected and determinations made are reported below:

Total Fertilizer Samples Collected .....	2,007
Potash (K <sub>2</sub> O) Determinations, Total Analyses .....	1,863
Total Phosphorus (P <sub>2</sub> O <sub>5</sub> ), Total Analyses .....	2,896
Insoluble Phosphorus (P <sub>2</sub> O <sub>5</sub> ), Total Analyses .....	2,600
Total Nitrogen (N <sub>2</sub> ), Total Analyses .....	2,135
Water Soluble Nitrogen (N <sub>2</sub> ), Total Analyses .....	1,366
Total Fertilizer Analyses .....	10,860

The results of this analytical work were published by the Experiment Station in Bulletin 557—Fertilizer Inspection in Fall of 1950 and Bulletin 564—Fertilizer Inspection in Spring of 1951. In these publications, 35 manufacturers were reported to have violated some provision of the control law in their fall sales, and 27 were reported similarly negligent in the spring of 1951. These violations included failure to attach registration tags to bags of fertilizer offered for sale, improper labeling of fertilizer, and failure to register their products in Missouri despite the fact that dealers had been supplied with stocks of their fertilizers.

**Chemical Analytical Service** (Department of Agricultural Chemistry). Chemical analyses were made during the year for research workers in animal nutrition, agricultural engineering, animal husbandry, dairy

husbandry, horticulture, field crops, home economics, soils, and extension projects of the College of Agriculture. Similar services were rendered for the Production and Marketing Administration and for the Missouri Geological Survey.

**Farm Building Plans, a Blueprint Service** (Agricultural Engineering Department). Eight new plans were added to the blueprint service during the year, bringing the total number of available plans up to 350. All plans are available at very low cost—a few cents or merely enough to pay cost of paper and the duplicating process after the master plans have been drawn.

**Identification of Plant Diseases** (Botany Department, Plant Pathology Section). More than 500 requests for information on plant diseases were received by this department and answered by personal correspondence. Due to the unusually wet spring, a great many of these inquiries were related to molds and blights on garden vegetables, especially potatoes and tomatoes. Others were concerned with cotton wilts and nematode injury, crown rust of oats, smut and leaf rust on corn, and fungous diseases of wheat and oats.

**Official Testing of Dairy Cows** (Dairy Husbandry Department). Through Herd Improvement Registry and Advanced Registry testing, many records on proved sires and brood cows were completed and made available to Missouri breeders. Such information is highly useful in selection and breeding for more efficient production. The service this year included the testing of 2,997 cows a month in 160 Missouri dairy herds, the highest number of animals handled up to this time.

**Investigation of Diseases Affecting Forest, Fruit and Shade Trees** (Departments of Botany, Forestry and Horticulture). Due to wide interest in the rumored spread of Dutch elm disease, oak wilt and similar threats, a considerable amount of work was done this year on surveys, especially on oak wilt. For more details on this see report on page 29, under Botany.

**Weekly Information Service to Fruit Growers** (Entomology and Horticulture). During the seasons of pre-bloom, pollination, fruit setting and fruit development a weekly letter was sent out to fruit growers. These gave the latest current information on insect threats and other hazards as reported from the field by fruit growers, county extension agents and weather observers. Similar service, but on irregular schedule, was supplied to county agents on state and federal surveys indicating invasions by grasshoppers, chinch bugs, army worms and similar insects.

**Seed Testing Laboratory** (Field Crops Department). The identification of weed seeds and other foreign matter in samples of field crops seeds was continued through the year as a service to farmers, seedsmen and professional workers in field crops research and teaching. This work



was also an essential part of the longtime program of field crops improvement carried on by the College of Agriculture in cooperation with the Missouri Seed Improvement Association. During the year, 4,879 seed samples were examined by the laboratory staff. The total number of tests applied, including tests for purity and germination, was 7,967.

**Soil Testing Service (Departments of Soils and Agricultural Chemistry).** The soil testing service, long operated through the laboratories of the soils department at Columbia, is now performed largely through county soil testing laboratories under the joint supervision of the Experiment Station and the Extension Service. The number of such laboratories had grown during the current year to a total of 70. These are so well distributed over the state that any Missouri farm operator or land owner can have soil samples tested and the analyses interpreted by skilled technicians in his own or an adjoining county. The number of samples tested this year was 69,939.

**Soil Survey and Classification (Department of Soils).** Soil surveys of two additional counties, Boone and Livingston, were completed during the current year. Soil maps are now available for 30 Missouri counties.

**Diagnosis of Animal Diseases (Veterinary Medicine).** Examination of sick or dead animals for diagnosis of diseases—including rabies—has long been a part of service freely rendered by the Experiment Station to the people of the state. With the recent establishment of the School of Veterinary Medicine at the University, this service has been greatly enlarged. A veterinary hospital and clinic are now maintained at Columbia.

**Field Days and Producer Conferences at the Experiment Station (Departments of Soils, Crops and Animal Husbandry, with Agricultural Extension Service cooperating).** Field days and producer conferences were held at the Experiment Station fields and feedlots during the year, enabling farmers to receive first-hand reports on current investigations. Some 7000 farmers and vocational agriculture students attended summer field days conducted by the departments of crops and soils, and at least 4000 attended the spring and fall livestock feeder days sponsored by the Animal Husbandry Department.

**Personal Service on Farm and Home Problems (All Departments).** Staff members of the Experiment Station during the year answered more than 130,000 individual requests for information and advice. Farmers and homemakers brought their inquiries to the college in person or sought help through the mail. In many cases bulletins and circulars were used in supplying basic information, while supplementary advice was added by interview or personal letter in keeping with specific conditions described by the inquirer. This service was of value to both questioner and consultant.

## PUBLICATIONS

A. A. JEFFREY, EDITOR

The Experiment Station in the year ending June 30, 1951, printed 78 publications. These included 24 technical bulletins, 29 popular bulletins, 21 circulars and 4 progress reports. The total number of copies printed was 494,600. A complete file including only one copy of each of these publications would contain 2452 pages. Members of the Station staff also prepared 49 articles for publication in scientific journals.

The Station also published throughout the year, in cooperation with the Extension Service, two periodicals; a weekly newspaper copy service known as the *Missouri Farm News Service*, and a monthly mailing piece, the *Announcer*, going out regularly to some 26,000 farm families and carrying announcements of new publications and events of interest to farmers and homemakers.

Following is a list of the publications and scientific articles issued by the Station during the year.

## RESEARCH BULLETINS

- 457 Some Factors Affecting the Carotenoid and Vitamin A Levels in the Blood and Milk of Dairy Cattle, by O. T. Stalcup and H. A. Herman, July, 1950, 56 pages, 2500 copies.
- 458 Rural Social Organization in Dent County, Missouri, by R. B. Almack and L. M. Hepple, August, 1950, 72 pages, 2500 copies.
- 459 Genetic Factors in Milk Production, by R. C. Laben and H. A. Herman, August, 1950, 96 pages, 2500 copies.
- 460 Environmental Physiology IX, by A. C. Ragsdale, H. J. Thompson, D. M. Worstell and Samuel Brody, September, 1950, 36 pages, 2500 copies.
- 461 Environmental Physiology X, by H. H. Kibler and Samuel Brody, September, 1950, 20 pages, 2500 copies.
- 462 Factors Affecting the Interval Between Parturition and First Estrus in Dairy Cattle, by H. A. Herman and J. E. Edmondson, September, 1950, 8 pages, 2500 copies.
- 463 Influence of Nesting Material on Production of Clean Eggs, by E. M. Funk, H. L. Kempster and M. Y. Dendy, September, 1950, 24 pages, 2500 copies.
- 464 Environmental Physiology XI. Effects of Temperature, 50° to 9° F., on Heat Production and Cardiorespiratory Activities in Brahman, Jersey and Holstein Cows, by H. H. Kibler and Samuel Brody, September, 1950, 20 pages, 2500 copies.
- 465 Productivity of Farm Land in Missouri, by Buel Franklin Lanpher, Jr., February, 1951, 52 pages, 2500 copies.
- 466 Some Factors Influencing Pod Set and Yield of the Lima Bean, by V. N. Lambeth, November, 1950, 80 pages, 2500 copies.
- 467 Quality in Shell Eggs, by E. M. Funk, January, 1951, 64 pages, 2500 copies.
- 468 Loose Housing of Dairy Cattle in Missouri, by R. E. Stewart, December, 1950, 36 pages, 2500 copies.
- 469 The Quantitative Determination of Chromic Oxide in Feeds and Feces, by Charles W. Gehrke, Dennis T. Mayer, Edward E. Pickett and Charles V. Runyon, January, 1951, 20 pages, 2500 copies.
- 470 Effect of Packaging and Storing on the Acceptability of Frozen Beef, by Carl Emerson, D. E. Brady and L. N. Tucker, January, 1951, 32 pages, 2500 copies.

- 471 Environmental Physiology XII, by A. C. Ragsdale, H. J. Thompson, D. M. Worstell and Samuel Brody, February, 1951, 28 pages, 2500 copies.
- 472 Sources and Use of Farm and Home Information by Low-Income Farmers in Missouri, by Herbert F. Lionberger, April, 1951, 36 pages, 1500 copies.
- 473 Environmental Physiology With Special Reference to Domestic Animals—XIII Influence of Increasing Temperature, 40° to 105°F, on Heat Production and Cardiorespiratory Activities in Brown Swiss and Braham Cows and Heifers, by H. H. Kibler and Samuel Brody, April, 1951, 16 pages, 1500 copies.
- 474 The Determination of Methemoglobin in Beef Muscle Extracts, by Margaret Mangel, May, 1951, 24 pages, 1500 copies.
- 475 Strip-Mined Lands of the Western Interior Coal Province, by Nelson F. Rogers, 56 pages, 3600 copies, May, 1951.
- 476 The Nutritive Value of Black Walnuts, by Dorothy Poertner Tyrrell, Mary Holke Jenkins, and Adelia E. Weis, May, 1951, 12 pages, 1500 copies.
- 477 Plant Nutrition and the Hydrogen Ion, by D. A. Brown and Wm. A. Albrecht, May, 1951, 24 pages, 1500 copies.

#### Reprints

- 425 Environmental Physiology II Influence of Temperature 50° to 150°F, on Milk Production and Feed Consumption in Dairy Cattle, by Ragsdale, Brody, Thompson, Worstell, October, 1950, 28 pages, 1,000 copies.
- 452 Forest Resources and Industries of Missouri, by King, Roberts, Winters, of the Forest Survey Staff, February, 1951, 92 pages, 4,000 copies.
- 423 Environmental Physiology With Special Reference to Domestic Animals—I. Physiological Backgrounds, by S. Brody, 44 pages, 1,000 copies, April, 1951.

#### BULLETINS

- 540 Artificial Insemination of Dairy Cows, by H. A. Herman and A. C. Ragsdale, July, 1950, 32 pages, 12,000 copies.
- 541 Hog Cholera, by Cecil Elder and O. S. Crisler, July, 1950, 12 pages, 10,000 copies.
- 542 Success with Strawberries, by A. D. Hibbard and D. D. Hemphill, November, 1950, 32 pages, 10,000 copies.
- 543 Fertilizer Inspection and Analysis; Fall 1949, by J. H. Longwell, R. C. Prewitt, C. W. Gehrke, E. W. Cowan, November, 1950, 60 pages, 7,000 copies.
- 544 1950 Yield Trials with Corn Hybrids in Missouri, by M. S. Zuber, C. O. Grogan and W. E. Aslin, December, 1950, 28 pages, 6,000 copies.
- 545 Missouri Cotton Insects and Their Control, by W. R. Enns, January, 1951, 20 pages, 8,000 copies.
- 546 Corn Hybrids Adapted for Missouri, by M. S. Zuber and C. O. Grogan, February, 1951, 32 pages, 10,000 copies.
- 547 Good Pastures Pay, by E. Marion Brown, January, 1951, 24 pages, 10,000 copies.
- 548 Potato Growing in Missouri, by V. N. Lambeth, March, 1951, 24 pages, 10,000 copies.
- 549 Chemical Weed Control in Horticultural Crops, by D. D. Hemphill, A. E. Murneek, J. E. Smith, Jr., April, 1951, 28 pages, 10,000 copies.
- 550 Fruit Tree Fertilization with Nitrogen, by A. E. Murneek, April, 1951, 24 pages, 3,500 copies.
- 551 Fertilizer Inspection and Analysis; Spring, 1950, by R. C. Prewitt, C. W. Gehrke, E. W. Cowan, March, 1951, 60 pages, 7,000 copies.
- 552 Pop Corn Production in Missouri, by M. S. Zuber, April, 1951, 12 pages, 6,000 copies.
- 553 Chemical Thinning of Apples, by A. E. Murneek, May, 1951, 16 pages, 10,000 copies.

- 554 Effect of Humidity and Turning of Eggs Before Incubation on Hatching Results, by E. M. Funk and James Forward, May, 1951, 24 pages, 8,500 copies.
- 555 Probability of Killing Freezes in Missouri, by Wayne L. Decker, June, 1951, 28 pages, 3,500 copies.
- 556 Serving Missouri Agriculture (Station Annual Report), 152 pages, 2,000 copies.

#### Reprints

- 430 Controlling Bot and Warble Flies of Livestock in Missouri (Rpt.), by Haseman and Roland, July, 1950, 32 pages, 8,000 copies.
- 503 Preparing Frying Chickens for Locker Storage, (Rpt.), by Miss Bowman and Mr. Funk, July, 1950, 8 pages, 10,000 copies.
- 373 Controlling Borers of Fruit, Forest and Shade Trees, (Rpt.), by L. Haseman, July, 1950, 24 pages, 8,000 copies.
- 305 Beekeeping in Missouri, by L. Haseman, August, 1950, 52 pages, 8,000 copies.
- 531 More Efficient Use of Fertilizer, (Rpt.), by A. W. Klemme and W. A. Albrecht, September, 1950, 20 pages, 20,000 copies.
- 423 The Normal Growth of Chickens, (Rpt.), by H. L. Kempster, September, 1950, 20 pages, 6,000 copies.
- 492 Alfalfa in Missouri, (Rpt.), by W. C. Etheridge and C. A. Helm, November, 1950, 16 pages, 10,000 copies.
- 433 Representative Missouri Weeds and Their Control (Revised), by W. B. Drew and C. A. Helm, December, 1950, 216 pages, 2,000 copies.
- 501 Growing Good Crops of Oats in Missouri, (Rpt.), by J. M. Poehlman, January, 1951, 20 pages, 15,000 copies.
- 377 Raising the Dairy Calf, by H. A. Herman, June, 1951, 28 pages, 5,000 copies.
- 466 Good Pasture and Roughage in Fattening Cattle, E. A. Trowbridge and A. J. Dyer, June, 1951, 12 pages, 3,500 copies.
- 443 Measuring the Productive Value of Pastures, by Homer J. L'Hote, June, 1951, 36 pages, 3,500 copies.

#### CIRCULARS

- 349 Value of Farm Woodlot Management in Missouri, by Paul Y. Burns, July, 1950, 8 pages, 10,000 copies.
- 350 Flea Beetle Damage to Garden Crops, by L. H. Haseman, July, 1950, 4 pages, 10,000 copies.
- 351 Prevent Cabbage Worm Injury, by L. Haseman, July, 1950, 4 pages, 10,000 copies.
- 352 Home Floriculture, by J. E. Smith, Jr., October, 1950, 16 pages, 12,000 copies.
- 353 The Care of Light Horses, by John M. Kays, October, 1950, 48 pages, 10,000 copies.
- 354 Weed Control in Corn Through Use of Chemicals, by C. A. Helm, November, 1950, 8 pages, 12,000 copies.
- 355 New Weed Control Practices in Strawberries, by D. D. Hemphill, January, 1951, 4 pages, 5,000 copies.
- 356 Formulating Rations for Swine, by John F. Lasley, and G. C. Anderson, February, 1951, 12 pages, 15,000 copies.
- 357 Soil Improvement and Soil Conservation in Missouri, by M. F. Miller, February, 1951, 48 pages, 15,000 copies.
- 358 Grass Silage, by A. C. Ragsdale and H. A. Herman, April, 1951, 12 pages, 10,000 copies.
- 359 Some Social Aspects of Forest Conservation, C. E. Lively, 3,000 copies, 8 pages, April, 1951.
- 360 Farming as an Occupation, by M. F. Miller, 36 pages, 20,000 copies, May, 1951.

#### Reprints

- 331 Plant Late for Fall Vegetables, by July, 1950, 12 pages, 8,000 copies.

- 336 Keeping Up Soil Organic Matter, by M. F. Miller, August, 1950, 28 pages, 10,000 copies.
- 303 The Missouri Program of Land Improvement, by W. C. Etheridge and committee, September, 1950, 24 pages, 6,000 copies.
- 248 The Value of Farm Manure, (Rpt.), by G. E. Smith, September, 1950, 12 pages, 10,000 copies.
- 325 Saving Gasoline on the Farm, by M. M. Jones, October, 1950, 4 pages, 5,000 copies.
- 326 Spraying Home Fruit Plantings, by Swartwout, April, 1951, 8 pages, 5,000 copies.
- 322 Lawn Culture in Missouri, by Talbert and Brown, April, 1951, 8 pages, 10,000 copies.
- 355 New Weed Control Practices in Strawberries, by D. D. Hemphill, June, 1951, 4 pages, 3,000 copies.
- 335 An All-Year Pasture System for Missouri, by W. C. Etheridge, C. A. Helm, E. Marion Brown, June, 1951, 12 pages, 3,500 copies.

#### PROGRESS REPORTS

- 11 Feeding Investigations, by Animal Husbandry staff members, September, 1950, 8 pages, 2,500 copies.
- 12 Key for Identifying Soils of Missouri, by J. A. Frieze, October, 1950, 24 pages, 2,500 copies.
- 13 Feeding Investigations, by Animal Husbandry staff members, April, 1951, 8 pages, 5,000 copies.
- 14 Soils of Boone County, by C. L. Scrivner and J. A. Frieze, May, 1951, 12 pages, 5,000 copies.

## CONTRIBUTIONS TO SCIENTIFIC JOURNALS

- 1221 Sedimentation of Spermatozoa and Settling of Dilute Solids and Their Effects Upon Survival of Spermatozoa During Storage, by Ralph F. Kampschmidt, Dennis T. Mayer, Harry A. Herman and Gordon E. Dickerson, Animal Husbandry, Agricultural Chemistry, and Dairy Husbandry Depts. Submitted for publication in the Journal of Dairy Science, July, 1950.
- 1222 The Release of Mineral Magnesium and Its Effect on the Growth and Composition of Soybeans, by Wm. H. Longstaff and E. R. Graham. Submitted for publication in *Soil Science*, July, 1950.
- 1223 Observation of a Spreading Factor Present in Mammary Gland Extracts by J. R. Elliott and C. W. Turner. Submitted for publication to the Proceedings of the Society of Experimental Biology and Medicine, August 4, 1950.
- 1224 Comparative Efficiency of Intracervical and Intrauterine Methods of Insemination in Dairy Cattle, by H. J. Weeth and H. A. Herman. Submitted for publication in the Journal of Dairy Science, August 15, 1950.
- 1225 Mineral Contents of the Silt Separates of Some Missouri Soils as These Indicate the Fertility Level and Degree of Weathering, by Richard H. Hawkins and E. R. Graham. Submitted for publication in Proceedings Soil Science of America, August 31, 1950.
- 1226 The Cataphoresis of Clay Minerals and Factors Affecting Their Separation, by Alvin H. Beavers and C. E. Marshall. Submitted for publication in Proceedings Soil Science of America, September 1, 1950.
- 1227 Complementary Ion Effects as Measured by Cation Exchange Between Electrolyzed Hydrogen Clay and Soils, by D. A. Brown and Wm. A. Albrecht. Submitted for publication in Proceedings, Soil Science Society of America, September 2, 1950.
- 1228 Interrelationships of Potassium, Sodium, and Calcium Activities in a Beidelite Clay, by E. O. McLean. Submitted for publication in Proceedings Soil Science Society of America, September 11, 1950.
- 1229 Spermatozoan Motility as a Measure of Semen Quality, by John F. Lasley for publication in Journal of Animal Science, September 11, 1950.
- 1230 Water Retention by Clays, by C. M. Woodruff, for publication in Proceedings Soil Science Society of America, September, 13, 1950.
- 1231 Oak Wilt Fungus Isolated from Chinese Chestnut, by T. W. Bretz, for publication in The Plant Disease Reporter, submitted September 19, 1950.
- 1232 The Extraction and Hydrolysis of the Androgens of Cow Manure, by W. R. Miller and C. W. Turner, for publication in the Journal of Dairy Science. Submitted October 27, 1950.
- 1233 Adequacy of Synthetic Diets for Reproduction of Swine by Gerald C. Anderson and Albert C. Hogan, for publication in the Proceedings of the Society for Experimental Biology and Medicine. Submitted November 1, 1950.
- 1234 A Comparison of Certain Chemicals with 2, 4-D for Weed Control in Strawberries by D. D. Hemphill. Submitted for publication in the North Central Weed Control Conference, November 8, 1950.
- 1235 Stem and Root Rot of *Daphne Odora* caused by *Phytophthora Parasitica*, by C. M. Tompkins and C. M. Tucker. Submitted for publication in Phytopathology, November 28, 1950.
- 1236 Oak Wilt Fungus Pathogenic to Chinese Chestnut, by T. W. Bretz. Submitted for publication in Plant Disease Reporter, November 28, 1950.
- 1237 Odor, Flavor and Peroxide Value as Measures of Rancidity, by H. D. Naumann, D. E. Brady, A. Z. Palmer and L. N. Tucker. Submitted for publication to the Journal of Food Technology, December 27, 1950.
- 1238 Nitrogen Fertilization of Watermelons by Ray L. Christian, A. D. Hibbard.

- Submitted for publication to the Proceedings of the American Society for Horticultural Science. December 28, 1950.
- 1239 Maintenance of Quality in Shell Eggs by Thermostabilization, by Ernest M. Funk. Submitted for publication in the Ninth World Poultry Congress, January 2, 1951.
- 1240 The Variations in Concentration of Several Essential Amino Acids and of Nicotinic Acid Associated with Increase in Crude Protein in Corn, by Laura M. Flynn, Marcus S. Zuber, Delbert H. Leweke, Robert B. Grainger, and Albert G. Hogan. Submitted for publication in the American Chemical Society, January 9, 1951.
- 1241 Studies in the Ionization of Soils and Soil Colloids Part I. Methods for the Simultaneous Determination of Two Cationic Activities, by E. O. McLean, S. A. Barber, and C. E. Marshall. For publication in Soil Science, January 11, 1951.
- 1242 Studies in the Ionization of Soils and Soil Colloids Part II. Potassium-calcium Relationships in Montmorillonite Clays and in Attapulgite. Submitted for publication in Soil Science, January 11, 1951.
- 1243 Vitamin B<sub>12</sub>, A Factor in the Prevention of Hydrocephalus in Infant Rats, by Boyd L. O'Dell, James R. Whitley, and Albert G. Hogan. Submitted for publication in the Proceedings of the Society for Experimental Biology and Medicine. January 11, 1951.
- 1244 Reactions of European and Indian Cattle to Wide Temperature Changes by S. Brody, A. C. Ragsdale, H. H. Kibler, C. R. Blincoe of Dairy Department, and H. J. Thompson and D. M. Worstell, BBISAE, U. S. D. A. To be presented at Meeting of Federation of American Society Exp. Biology, Cleveland (April 28 to May 4).
- 1245 Gamete Selection, by L. J. Stadler. Volume of papers from Heterosis Conference held at Ames, Iowa, during first week in July. Submitted for publication, December, 1950.
- 1246 Growth Regulators During Fertilization and Postfertilization Periods, by A. E. Murneek. Submitted for publication in the Journal of Horticultural Science, January, 1951.
- 1247 Established Grasses and Legumes With Soybeans, by E. M. Brown in cooperation with J. J. Pierce of Soil Conservation Service. Submitted for publication in the Agronomy Journal, February, 1951.
- 1248 The Effects of Vitamin B<sub>12</sub> and Thyroprotein on Egg Production, Egg Weight, Shell Quality and Hatchability. By J. E. Savage, C. W. Turner, H. L. Kempster and A. G. Hogan, Departments of Poultry Husbandry, Dairy Husbandry and Agricultural Chemistry. For publication in Poultry Science.
- 1249 The Effect of Environmental Temperature on the Composition of Milk. By J. W. Cobble, H. A. Herman and A. C. Ragsdale. Submitted for the Proceedings of the American Dairy Science Association, June 5-8, 1951.
- 1250 Progesterone and the Corpus Luteum in Maintenance of Pregnancy in Dairy Heifers, by James I. Raeside and C. W. Turner. Submitted for publication in Proceedings of the American Dairy Science Association, June 5-8, 1951.
- 1251 Effects of Environmental Temperature on Hunger and Thirst in Cows, by Samuel Brody, A. C. Ragsdale, H. H. Kibler, C. R. Blincoe, H. J. Thompson and D. M. Worstell. Submitted for Proceedings of the American Dairy Science Association, June 5-8, 1951.
- 1252 Our Present Knowledge Concerning Oak Wilt, by T. W. Bretz, Pathologist, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture, in cooperation with the Missouri Agricultural Experiment Station. Submitted and approved March 22, 1951, for publication in Trees Magazine.



- 1253 The Mammary Spreading Factor and Relaxin, by J. R. Elliott and C. W. Turner, Submitted for Proceedings of the Society for Experimental Biology and Medicine, March 23, 1951.
- 1254 Effect of Diet on Maze Learning in Second Generation Rats. Folic Acid Deficiency, by J. R. Whitley, B. L. O'Dell and A. G. Hogan, Department of Agricultural Chemistry, University of Missouri. Submitted to the editors of the Journal of Nutrition.
- 1255 Ionization of Soils and Soil Colloids III Potassium-Calcium Relations in Illite, Kaolinite and Halloysite, by S. A. Barber and C. E. Marshall, Department of Soils. Submitted to Soil Science, April, 1951.
- 1256 A Transmissible Dicentric Chromosome, by E. R. Sears, Senior Geneticist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture; and Research Associate, Field Crops Department, University of Missouri; and A. Camara, Director, National Agronomy Station, Sacavem, Portugal. Submitted to Genetics, April, 1951.
- 1257 Some Hormones Involved in Elaboration or Activation of the Mammary Spreading Factor, by J. R. Elliott and C. W. Turner, from the Department of Dairy Husbandry, for publication in the Proceedings of the Society of Experimental Biology and Medicine, May 7, 1951.
- 1258 Subsoil Conditioning on Claypans for Water Conservation, by D. D. Smith, Soil Conservation, for publication in Agricultural Engineering, May, 1951.
- 1259 Ionic Saturation of Plant Roots—With Special Reference to Hydrogen, by E. R. Graham and W. L. Baker, Department of Soils, to be published in Soil Science, May, 1951.
- 1260 Breeding Winter Barley for Hardiness and Disease Resistance, by J. M. Poehlman, Department of Field Crops, for publication in *Economic Botany*, May, 1951.
- 1261 Lymph Flow From the Mammary Gland of the Dairy Goat, by D. C. Blendon, T. E. Patrick and C. W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted for publication in the Journal Dairy Science, June, 1951.
- 1262 A Preliminary Report of The Perithecial Stage of *Chalara Quercina* Henry, by T. W. Bretz, Department of Botany. Submitted for publication in Plant Disease Reporter, June, 1951.
- 1263 Effect of Heat and Cold on European and Indian Cattle, by Samuel Brody, Department of Dairy Husbandry, University of Missouri. Submitted at the American Meteorological Society meetings in Minneapolis, Minnesota, and to be published in the 32nd annual business meeting publication, June, 1951.
- 1264 Essential Amino Acids in Self-Selected Diets of Older Women, by E. T. Mertz, J. Baxter, L. E. Jackson, C. E. Roderuck and A. Weis, July, 1951.
- 1265 Thiolutin as a Possible Inhibitor of Fire Blight, by A. E. Murneek, Department of Horticulture, University of Missouri. To be published in "Phytopathology," July, 1951.
- 1266 Characterization of an Androgen in Cow Manure, by W. R. Miller and C. W. Turner, Department of Dairy Husbandry, University of Missouri, August, 1951.
- 1267 Spontaneous Mutation in Maize, by L. J. Stadler, Department of Field Crops, University of Missouri. To be published in Symposium of Quantitative Biology, Carnegie Institute of Washington, August, 1951.
- 1268 Misdivision of Univalents in Common Wheat, by E. R. Sears, Senior Geneticist, U. S. Department of Agriculture and Field Crops Department, University of Missouri. Submitted for publication in *Chromosoma*, August, 1951.
- 1269 The Behavior of Isochromosomes and Telocentrics in Wheat, by E. R. Sears, U. S. Department of Agriculture and Field Crops Department, University of Missouri. For publication in *Chromosoma*, August, 1951.

## RESEARCH GRANTS

### U. S. Public Health Service

For study of the project "Relation of Nutrition to Hydrocephalus in Infant Rats."

### Parks, Davis and Company

For research in the field of vitamins.

### Merck and Company, Incorporated

In support of research work on the nutritional requirements of swine.

### Office of Naval Research

For a research project on "The Relation of Nutrition to the Occurrence of Arthritis in Experimental Animals."

### Parke, Davis and Company

For a study of the effects of certain antibiotics upon chickens and pigs.

### National Mineral Wool Association

For the conduct of research in connection with the project on "Psycho-energetic Laboratory Studies," to establish certain fundamental data relating to the housing and production of dairy animals.

### American Dairy Association

For continued support of the investigations concerning "The Use of Whey Solids in Ice Cream and Sherbets."

### American Dairy Association

For a comprehensive study of the Four-Day Grading Plan of Buying Cream in Missouri.

### Cerophyl Laboratories

For continuation of the support of endocrine studies.

### Ortho Research Foundation

#### Midwest Breeding Farms, Trenton, Missouri

For use in connection with the project "The Inheritance and Transmission of the Characters of Capacity for Fat Production and Dealing with the Artificial Insemination and Fertility of Dairy Cattle."

### Kraft Cheese Company

For the study of composition of milk, cheese and whey from Missouri cheese factories.

### Office of Naval Research

For research on "The Effects of Radiations, Infrared to Ultraviolet, on Animals, Beginning with Rats."

### Office of Naval Research

For continued support of a project on the investigation of the in-

fluence of climatic factors and muscular work in large animals (sweating species).

**Atomic Energy Commission**

For a research project pertaining to "The Determination of Thyroid Activity in Farm Animals by the Use of Radioactive Tracers."

**American Dairy Association**

To support an investigation entitled "Study of Methods of Manufacturing a Cultured Cream Salad Dressing."

**American Cancer Society**

For support of research on the genetic nature of X-ray induced mutations.

**Quaker Oats Company**

For research in the breeding of white hybrid corn.

**Midwest Regional Turf Foundation and the Green  
Section of the U. S. Golf Association**

For research on the improvement of fairway turf in the vicinity of St. Louis.

**Atomic Energy Commission**

Research on a cytogenetic study of the effects of radiation on the differentiated chromosomes of the tomato plant.

**Missouri Conservation Commission**

For farm forestry research.

**Dow Chemical Company**

For support of studies on the use of plant hormones in orchard practice.

**Camp Detrick Chemical Corps**

To support a research project, "Seed or Fruit Development as Affected by Certain Plant Growth Regulators."

**International Baby Chick Association**

For research in connection with hatchability studies.

**Institute of American Poultry Industries**

For research in the use of various nesting materials in the prevention of soiled shell eggs.

**College of Agriculture Foundation**

For use on a project entitled "Unrecognized Nutrients Required by Laying Hens."

**American Potash Institute**

For research dealing with the relationship of potash to soil fertility.

**Coronet Phosphate Company**

For research on the influence of plant food including "trace min-

erals" applied to the soil in the improvement of feed quality and animal health.

#### **International Minerals and Chemical Corporation**

For support of magnesium studies carried on in the Department of Soils.

#### **Shrock Fertilizer Service**

For research on the influence of plant food including "trace minerals" applied to the soil in the improvement of feed and animal health.

#### **Spencer Chemical Company**

For research in connection with pasture studies.

#### **Middle West Soil Improvement Committee**

To further extension projects in soils improvement.

#### **Missouri Portland Cement Company**

For use in the study of the application of precipitator dust from cement plants as a fertilizing material.

#### **Missouri Farmers Association**

For summarizing data on the fertility of soils in Missouri.

#### **Ruhm Phosphate Company**

For research in connection with phosphate absorption from the soil.

#### **Soil and Health Foundation**

For a study of minerals in rocks from various sources of possible value as a fertilizer.

#### **Swift and Company**

For research on the project dealing with "The Influence of Soil Composition and Treatment on the Composition of Forages and the Resulting Development of Animals."

#### **Missouri Turkey Federation**

To support research on Salmonellosis (primarily pullorum disease) in Missouri turkeys.

#### **Agricultural Institute of St. Louis**

For a special study of agricultural activities in St. Louis and adjacent area in Missouri, concerning the relationships of business groups and farm people.

#### **Soil and Health Foundation**

To support research on the relationship of soil fertility and insect infestation of crops.

#### **U.S.D.A. Extension Service**

For a research project on the relation of background, training, and other personal factors of county agent and teacher success.

#### **Griffith Laboratories**

Portable electric smokehouse for use in meats research and teaching.

**CHANGES IN STATION STAFF FOR THE YEAR ENDING  
JUNE 30, 1951**

**Appointments**

- George F. Aker, Assistant Instructor in Animal Husbandry  
Fred B. Anderson, Research Assistant in Agricultural Economics  
J. M. Baker, Analyst, Department of Agricultural Chemistry  
Tracy H. Barrett, Assistant Analyst, Department of Agricultural  
Chemistry  
Donald W. Barton, Assistant Professor of Field Crops (Genetics)  
Denver O. Baxter, Research Assistant in Agricultural Engineering  
Paul E. Blesi, Research Assistant in Agricultural Economics  
John M. Buckalew, Assistant Instructor in Dairy Husbandry  
Henry S. Bull, Research Assistant in Agricultural Chemistry  
Marvin C. Burnett, Analyst, Department of Agricultural Chemistry  
Marialice Cunningham, Research Assistant in Home Economics  
Ethel R. Cutler, Assistant Professor of Home Economics  
Richard D. Darley, Research Assistant in Agricultural Economics  
Edward Paul DeVido, Research Assistant in Entomology  
James E. Dillion, Assistant Instructor in Agricultural Economics  
Thaleta J. Dye, Analyst, Department of Agricultural Chemistry  
Carlos C. Erwin, Assistant Professor of Agricultural Economics  
Sina F. Fowler, Assistant Professor of Home Economics  
John W. Fronabarger, Assistant Analyst, Department of Agricultural  
Chemistry  
Betty Ruth Glasgow, Research Assistant, Department of Agricultural  
Chemistry  
Robert N. Goodman, Research Assistant in Horticulture  
Jesse C. Grady, Junior Instructor in Agricultural Economics  
Orrine Gregory, Assistant Professor of Home Economics  
Paul Q. Guyer, Instructor in Animal Husbandry  
Nicholas R. Gyles, Assistant Instructor in Animal Husbandry  
Herman M. Haag, Professor of Agricultural Economics (part-time)  
Isaac F. Harder, Assistant Analyst, Department of Agricultural  
Chemistry  
Bryce C. Hendricks, Assistant Instructor in Dairy Husbandry  
Robert G. Jensen, Assistant Instructor in Dairy Husbandry  
W. F. Krueger, Instructor in Poultry Husbandry  
R. K. Leavitt, Assistant Instructor in Animal Husbandry  
Ruh-Meo Li, Research Assistant in Horticulture  
R. Dale Moore, Research Assistant in Agricultural Economics  
Harold E. Mosher, Instructor in Horticulture  
Arthur J. Muehling, Research Assistant in Agricultural Engineering

Ivan F. Nye, Assistant Professor of Rural Sociology  
 James I. Raeside, Assistant Instructor in Dairy Husbandry  
 Lester W. Reed, Research Assistant in Soils  
 Martha Richardson, Research Assistant in Home Economics  
 Paul Rood, Research Assistant in Horticulture  
 Charles V. Runyon, Assistant Analyst, Department of Agricultural  
 Chemistry  
 Doris G. Saxon, Instructor in Home Economics  
 Victor L. Sheldon, Instructor in Soils  
 Frieda A. Sloop, Assistant Professor of Home Economics  
 Robert C. Suter, Assistant Professor of Agricultural Economics  
 Fred G. Teubner, Research Assistant in Horticulture  
 Rosemary Louise Tink, Research Assistant in Home Economics  
 Shirley F. Titus, Assistant Instructor in Home Economics  
 Leland F. Tribble, Assistant Instructor in Animal Husbandry  
 Shirley C. Weiner, Research Assistant in Home Economics  
 Dorothy M. Worstell, Research Associate in Dairy Husbandry  
 Helen E. Wright, Instructor in Home Economics

#### Withdrawals and Resignations

George F. Aker, Assistant Instructor in Animal Husbandry  
 Gerald C. Anderson, Instructor in Animal Husbandry  
 Tracy H. Barrett, Assistant Analyst, Department of Agricultural  
 Chemistry  
 Donald W. Barton, Assistant Professor of Field Crops (Genetics)  
 Stanley C. Benbrook, Instructor in Veterinary Bacteriology  
 Gloria U. Burge, Research Assistant in Dairy Husbandry  
 Beverly Jack Butler, Instructor in Agricultural Engineering  
 W. Leon Cameron, Research Assistant in Agricultural Engineering  
 Robert C. Combs, Assistant Instructor in Dairy Husbandry  
 A. R. Conley, Assistant Professor of Agricultural Economics  
 C. Milton Coughenour, Instructor in Rural Sociology  
 Thaleta J. Dye, Analyst, Department of Agricultural Chemistry  
 Joyce F. Elwell, Assistant Professor of Home Economics  
 Carl Emerson, Instructor in Animal Husbandry  
 Merna D. Fisher, Instructor in Home Economics  
 George B. Garner, Fertilizer Inspector  
 George W. Graham, Assistant Instructor in Dairy Husbandry  
 Jacquelyn W. Hearne, Analyst, Department of Agricultural Chemistry  
 Bryce C. Hendricks, Assistant Instructor in Dairy Husbandry  
 H. A. Henley, Assistant Instructor in Soils  
 Ross Hortin, Instructor in Forestry

Mary H. Jenkins, Research Assistant in Home Economics  
 Robert C. Laben, Assistant Instructor in Dairy Husbandry  
 John H. Landers, Jr., Assistant Instructor in Animal Husbandry  
 Ruh-Meo Li, Research Assistant in Horticulture  
 Louise Nunnolley Meadows, Instructor in Home Economics  
 Marian Midforth, Instructor in Home Economics  
 Joseph Milligan, Research Assistant in Poultry Husbandry  
 Eugene O. McLean, Assistant Professor of Soils  
 Wade R. McMillan, Assistant Professor of Agricultural Economics  
 Sarah Neblett, Assistant Professor of Home Economics  
 Joseph G. O'Mara, Research Associate in Field Crops  
 Zane Palmer, Research Assistant in Animal Husbandry  
 Lee K. Paulsell, Instructor in Forestry  
 David H. Pinson, Instructor in Agricultural Economics  
 Paul Rood, Research Assistant in Horticulture  
 J. E. Savage, Research Assistant in Poultry Husbandry  
 John D. Schatz, Assistant Instructor in Floriculture  
 C. D. Squiers, Instructor in Animal Husbandry  
 Rosemary L. Tink, Research Assistant in Home Economics  
 Jeanne C. Vinyard, Research Assistant in Home Economics  
 Helen E. Wright, Instructor in Home Economics  
 Deloris Young, Instructor in Home Economics

### FINANCIAL STATEMENT

UNIVERSITY OF MISSOURI  
 AGRICULTURAL EXPERIMENT STATION  
 in account with  
 THE UNITED STATES APPROPRIATION, 1950

Dr.	Hatch Fund	Adams Fund	Purnell Fund	Bankhead- Jones Fund	Research and Marketing Fund
To Balance from 1950-1951. . . . .	-----	-----	-----	-----	\$ 3,652.63
Receipts from the United States Treasury, appro- priation for fiscal year ended June 30, 1951. . . . .	\$15,000.00	\$15,000.00	\$60,000.00	\$89,383.63	\$106,039.24
Total. . . . .	15,000.00	15,000.00	60,000.00	89,383.63	109,691.87
Cr.					
Personal Service . . . . .	12,732.89	11,844.30	46,277.46	65,130.82	83,057.86
Travel . . . . .	105.96	-----	1,900.43	1,378.54	3,608.48
Transportation of Things . . . . .	14.40	20.00	178.37	170.70	132.80
Communication Service . . . . .	-----	-----	18.43	360.00	183.29
Rents and Utility Services . . . . .	-----	19.70	103.00	520.96	560.48
Printing and Binding . . . . .	-----	-----	17.91	143.92	26.95
Other Contractual Services . . . . .	28.65	697.80	891.45	3,151.58	6,433.88
Supplies and Materials . . . . .	1,120.54	1,653.34	8,633.23	14,016.28	9,721.65
Equipment . . . . .	292.99	558.51	1,103.49	2,993.66	4,443.82
Land and Structures . . . . .	473.00	-----	-----	141.51	175.80
Contributions to Retirement . . . . .	231.57	206.35	876.23	1,375.66	1,346.86
TOTAL EXPENDITURES . . . . .	15,000.00	15,000.00	60,000.00	89,383.63	109,691.87
Unexpended Bal. June 30, 1951	none	none	none	none	none