

PRODUCTION, MARKETING

Advance Through

RESEARCH

ANNUAL REPORT OF MISSOURI
AGRICULTURAL EXPERIMENT STATION
1951-1952



UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

J. H. LONGWELL, *Director*
COLUMBIA, MISSOURI

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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, 1952. 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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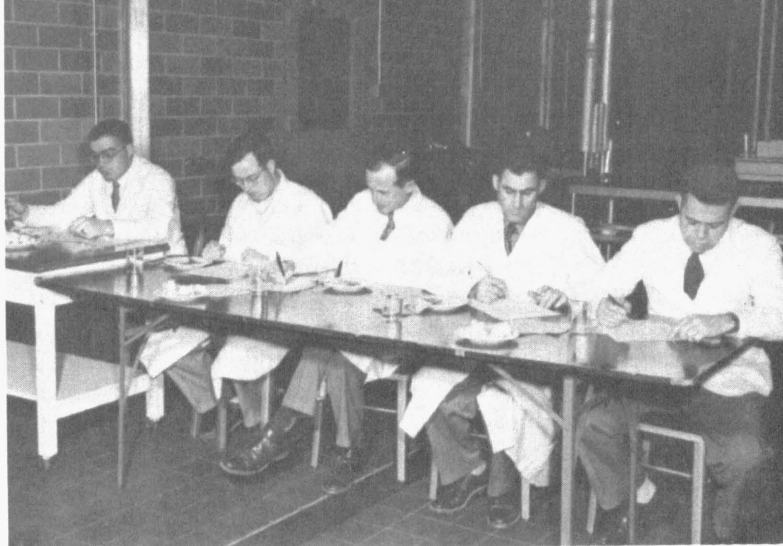
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Annual Report of

Missouri Agricultural Experiment Station

J. H. Longwell, *Director*

S. B. Shirkey, *Associate Director*



No phase in the production and marketing of livestock products escapes the study of Missouri Experiment Station workers in their search for ways to make farming more profitable. This panel of experts is giving the final taste test to cooked meat from animals that were raised and fed under different experimental conditions.

Production, Marketing Advance...Through Research

This is a report on the research program of the Missouri Agricultural Experiment Station. The creative power of research has made possible the State's great agricultural production-industry team. Modern farm technology primarily is a product of research. The animal, the plant, the soil, the machine, all have been improved and made more efficient by study. To date, a great part of our research effort has been directed toward increasing productivity. Of great importance in our net production, are the components of loss. The causes of enormous loss are drought, insects, diseases, waste in harvest and storage, rodents, weeds, winter-kill, frost damage, floods, damage in transport and damage by consumer handling. Attention is being directed in part to the development of procedures for eliminating some of these factors of waste.

Marketing Research Under Way

Problems involved in the storage, distribution, processing and marketing of farm products are recognized and becoming increasingly important. Research in these fields is being conducted, but progress must wait on the development of adequate research methods and procedures.

All cases of increased farm efficiency, as measured by increased yield, result from earlier advancements in technology. The cumulative effect has been 150 bushels of corn per acre; 70 bushels of oats per acre; 60 bushels of barley per acre; 50 bushels of wheat per acre; and 3 bales of cotton per acre—resulting from the use of better seed of improved varieties, studies

on dates and rates of seeding, seed bed preparation, correct use of fertilizers, use of supplemental water and machine farming. Breeding, feeding, management, and sanitation studies in livestock production also have contributed to higher and more efficient production of animal products. Advances in technology have been great in recent years, but great as they are, have been unable to meet demand. Solving problems of importance to all agricultural interests of the state has been an objective of the Missouri Agricultural Experiment Station since 1888. Within the limits of means available, constant effort has been maintained to find answers to the increasingly complex problems arising in the "business of farming."

A Never Ending Search

Increased yields depend upon the use of improved varieties and strains of plants and animals, increased use of soil plant foods, better control of insects, diseases, and weeds, and better land management. Only a fraction of the potential in breeding plants and animals for increased production has been realized. Antibiotics and vitamins have greatly increased the efficiency of hog and poultry feeding, and have proved of great value in the control of plant diseases, especially fireblight in pears and apples. Tremendous advances have been made in the development of organic fungicides, insecticides, and herbicides (weed killers). Through these efforts in research, both the quality and quantity of agricultural products have improved greatly. During the years, the Missouri Station has

established itself as a leader in vitamin research and in the study of hog cholera and Texas fever; as a source of information on soil-plant food-plant relationship; as a top dairy research station; as the introducer of new crops, such as lespedeza and varieties of soybeans and new cropping systems; as the virtual savior of the beekeeping industry with the introduction of sulfathiazole for the control of American foul brood in honey bees; as a leader in the animal industry, animal nutrition, and horticulture fields; as the originator of the open-front Missouri poultry house, in a vast improvement in the feed using efficiency of poultry, especially broilers; as a pioneer in the use of X-ray and ultra-violet radiation to induce mutation in plants; as one of the first reliable sources of information about soil erosion and water run-off; as a pioneer in the utilization of "marker" elements in plant and animal nutrition; and as a research center in the Home Economics field since 1909.

Missouri a Leader in Research

The Missouri Station was the first institution in America to produce and make available to cattle raisers a preventive vaccine against black leg in calves. The Missouri Station produced and distributed to the medical profession the first Smallpox vaccine made west of Boston and was the first state experiment station to establish a laboratory to put hog cholera serum to extensive scientific and practical tests and to demonstrate its effectiveness in the field of protecting swine against hog cholera.

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 finish them. Missouri corn yields have risen in recent years from an average of 28 bushels to 43 bushels per acre. This basic change was due largely to the introduction of corn hybrids specifically adapted to Missouri conditions. Of equal or greater significance are the gains made in corn yields by more liberal and intelligent use of fertilizers. The Missouri Station is able to recommend fertilizer treatments to meet many plant requirements and to compensate for such soil deficiencies as are revealed by soil tests. Guided by this research, Missouri corn growers are producing yields up to 150 bushels per acre. Yields of 100 bushels or more are commonplace. Missouri farmers used $\frac{1}{4}$ million tons of fertilizer in the period covered by this report.

Food to Share

These instances are but a few of the contributions made by the Experiment Station over the years. Countless smaller gains have been made in the efficiency of farming and homemaking. Each of them has made some additional saving in cost of production; some reduction of loss of waste; some saving of time and human energy; some addition to comfort or safety; some enlargement of the opportunity to full family living. 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. The present stage of development of agriculture in America is the partial fulfillment of a deliberate plan made possible by the United States Congress in 1862, when it provided for the establishment of the Land Grant Colleges of Agriculture and Mechanic Arts.

Pictured here are a few of the 3,500 farmers who attended soils and crops days at the Experiment Station this year. Latest discoveries of the Station are made available to farmers of Missouri through county extension offices, an

agricultural news service to newspapers and magazines, University publications, radio and television programs, short courses at the University, and field days like the one shown here.



AGRICULTURAL CHEMISTRY

A. G. Hogan, Chairman

Chemical Analytical Service. (*Charles W. Gebrke, E. W. Cowan, Marvin Burnett, Edward Martin, Joe Vandepopuliere, Roscoe Pearce, Tracy H. Barrett, Jr., Jack Brown, Lewis Ferguson, George Leuthage, Charles Runyon, Harry Sawyer.*) The Department of Agricultural Chemistry is responsible for the chemical analytical work of the Agricultural Experiment Station, including analyses necessary under the Missouri Fertilizer Law. The following list gives a classification of the samples analyzed.

Fertilizer samples tested	2,161
Limestone samples tested	1,841
Samples from College departments	868
Miscellaneous samples	54
Total	4,924
Single fertilizer analyses	11,462
Single analyses of limestone	3,682
Analyses for College departments	2,737
Single miscellaneous analyses	120
Total	18,001

Four separate analyses usually are made to test samples of commercial fertilizer; one to determine nitrogen percent, another the potash percent, a third the phosphorus percent and a fourth to find what portion of the phosphorus is soluble. Thus the total number of single analyses is usually three or four times the number of samples tested.

An analysis is made of each sample of limestone for its calcium carbonate equivalent. (Project 132).

Nutritional Requirements of Poultry. (*A. G. Hogan, J. J. Cole.*) The objective of this investigation is the discovery of unrecognized nutrients required by poultry.

Purified soybean protein was investigated as a source of amino acids for poultry feeds. Commercially prepared "Alpha" protein (a purified soybean protein) was found to contain sulfite, which destroys thiamine. When the sulfite was removed from "Alpha" protein by leaching with warm water, the "Alpha" protein supplemented with methionine served as a good source of protein for the growing chick. "Alpha" protein was found to be seriously deficient in sulfur-containing amino acids; a deficiency that can be corrected partially by the addition of cystine and cysteine, but can be completely corrected only by methionine.

A mixture of glycine and arginine supported a slightly lower growth rate than gelatin when added to a casein supplement in chick rations.

The water insoluble fraction of liver was found to contain a factor, or factors, accelerating growth rate in chicks. This activity was lost upon hydrolysis with acid.

The addition of penicillin, chloromycetin and streptomycin to chick rations resulted in slightly better gains.

Gelatin contains vitamin B₁₂, but a B₁₂ concentrate proved superior to a 5 percent gelatin supplement in rations. Methionine added at levels of 0.3 percent to a casein-gelatin ration and at a level of 0.6 percent to a soybean meal ration supported the optimum growth rate in chicks. (Project 10).

Herbivora Vitamin Requirements. (*A. G. Hogan, W. B. House, H. S. Bull.*) Nutrients required for growth, gestation, and reproduction of the guinea pig were investigated. The guinea pig has more complex nutritional requirements than other commonly used experimental animals, and therefore is well adapted to studies of unrecognized vitamins. Prior to the discovery of folic acid, guinea pigs did not survive on a wholly synthetic diet. Addition of folic acid to the ration enabled animals to survive and grow reasonably well, but growth was still sub-maximum. Vitamin B₁₂ failed to improve the rate of growth.

In earlier work it had been found that gum arabic, supplemented with the ash of alfalfa, would accelerate growth. Potassium acetate and magnesium oxide in the alfalfa ash were found responsible for its favorable effect on growth.

The question arose whether or not gum arabic and the potassium and magnesium of alfalfa ash were essential nutrients. Experimental results indicated that gum arabic combined with magnesium oxide and potassium acetate in alfalfa ash, must be in a ration to obtain maximum rate of growth. There was some evidence that these elements, when included in the ration, permitted normal reproduction in the guinea pig.

The mode of action of the magnesium oxide and potassium acetate is still difficult to explain. It seems improbable that they have any important function in the metabolic processes; rather, with gum arabic they appear to bring about an important change in the flora of the intestinal tract of the guinea pig. This

change may cause a more rapid synthesis of an unrecognized vitamin(s); or, possibly, the destruction of a toxic substance.

When the three constituents were contained in a ration there was a lowered pH of the cecal content (see Table 1).

TABLE 1 -- PH OF CECAL CONTENTS

No. of animals	Description of Ration	Avg. PH Values
2	Cellu Flour alone	6.87
3	Cellu Flour + MgO +KAc	6.63
2	Gum Arabic + KAc	6.67
2	Gum Arabic + MgO + KAc	5.77

These substances should result in increased alkalinity. This suggests the pH in this case was determined by bacteria in the cecum, rather than by food eaten by the animal. Other workers have observed coliform and anaerobic bacteria in significantly larger numbers in the cecum of guinea pigs consuming rations containing gum arabic, magnesium oxide, and potassium acetate.

In a comparison of white and whole wheat bread as a source of unknown factors for guinea pigs, white bread diets were a failure while whole wheat breads supported excellent growth. Further research revealed that wheat germ was a potent source of some of the unrecognized factors responsible for enhanced growth.

Ashing of the wheat germ gave evidence that this growth stimulation was not due to minerals contained in the wheat germ after ashing. These results do not rule out the possibility that the minerals of wheat germ may be important in combination with some organic factor present in the wheat germ. (Project 11).

Abnormal Increases in the Mineral Content of Body Tissues in Relation to Age and Nutrition. (*A. G. Hogan, W. B. House*). Fresh spinach was the only vegetable tried which successfully prevented stiffness of wrists, in testing the relation of nutrition to appearance of arthritic-like syndrome in experimental animals. This condition can be produced in guinea pigs by elevating phosphorus content of their diet, or by lowering the calcium-phosphorus ratio.

Soreness and stiffness of joints, followed by deposition of calcium in soft tissues, are typical symptoms. Various fresh vegetables were tried with a basic synthetic ration in efforts to locate an organic factor which would prevent this condition.

The factor contained in fresh spinach proved to be unstable in nature, thus explaining former failures with dehydrated natural foodstuffs. Not a single case of stiffness developed among animals on fresh spinach during forty weeks of study, while those on the basic

ration developed stiffness in four weeks. Spinach in dehydrated form failed to prevent stiffness.

Animals receiving 250 micrograms of stigmaterol orally each day for 10 to 17 days showed no improvement in degree of stiffness or deposits.

From the data it appeared that the symptoms were much less severe if the calcium and phosphorus were both limited to 0.65 percent or less of the total ration.

The rate of growth was materially increased by the addition of gum arabic, potassium, and magnesium to the diet (See Table 2). Since fresh green spin-

TABLE 2 -- STIFFNESS RETARDING EFFECTS OF GUM ARABIC FED IN CONJUNCTION WITH K AND Mg

Type of Roughage	Gum Arabic	Cellu Flour
Estimated Amounts %		
K	1.41	0.41
Mg	0.34	0.04
Ca	1.0	0.9
P	1.5	1.6
No. of animals	5	23
Avg. wt. at 12 weeks (gm)	481	355
No. of weeks to lapse before stiffness occurred	8	5 ¹
No. of weeks to lapse before 50% of the animals became stiff	22	8 ¹
No. of weeks to lapse before deposits appeared	33	7 ¹
Avg. inorganic blood phosphorus mg/100	7.5	8.9

¹ Average week for appearance of stiffness and deposits

ach and gum arabic, plus potassium and magnesium, were the only feedstuffs examined which gave protection from the syndrome, the possibility arises that the problem may be one of intestinal synthesis. (Project 53).

Nutrients Required During Reproduction. (*A. G. Hogan, B. L. O'Dell, J. R. Whitley, R. B. Grainger, J. H. Bruemmer*). Rations used with rats can be classed into (a) rations used primarily to study hydrocephalus (pressure condition from fluid in the skull) and its relation to Vitamin B₁₂ and folic acid, and (b) rations used primarily to study skeletal malformations and their relation to Vitamin B₁₂ and riboflavin.

Approximately 15 percent of the offspring born of rats receiving soybean meal rations which lacked Vitamin B₁₂ were hydrocephalic, and 6 percent had eye defects. Less than 2 percent of the young animals survived. When adequate Vitamin B₁₂ was added there was no hydrocephalus in offspring; eye defects were reduced to less than 2 percent; and approximately 75 percent reached weaning age. In another case hydrocephalus resulted from the inclusion of a folic acid antagonist (methylfolic acid) in the ration. This

caused symptoms of folic acid deficiency even though an adequate quantity of Vitamin B₁₂ was supplied. The occurrence of hydrocephalus due to the folic acid antagonist was about 19 percent compared to 15 to 20 percent from Vitamin B₁₂ deficiency. Additional folic acid in the diet counteracted the antagonist.

By using purified soybean protein ration and adding Vitamin B₁₂ hydrocephalus again was eliminated. The soybean protein contained sufficient folic acid to prevent hydrocephalus provided Vitamin B₁₂ was added. Injecting one-tenth microgram of Vitamin B₁₂ into the parent on the first day of gestation, or adding one-tenth microgram of Vitamin B₁₂ per 100 grams of ration fed during gestation, also prevented hydrocephalus (See Table 3).

Vegetables commonly used in human diets failed to protect against congenital abnormalities in rats. However, when a Vitamin B₁₂ deficient diet was supplemented with 5 percent dried milk, 5 percent dried pork, or 2 percent dried egg yolk, hydrocephalus was prevented in all subsequent litters from dams receiving the supplement.

Pencillin and aureomycin added at optimum levels to a Vitamin B₁₂ deficient diet also prevented hydrocephalus.

When a yellow corn-wheat gluten ration was fed to dams which had received a Vitamin B₁₂ deficient ration, they produced offspring with a high incidence of hydrocephalus and skeletal defects. Inclusion of Vitamin B₁₂ in the ration prevented hydrocephalus and decreased skeletal defects. Addition of riboflavin had little or no effect. It appears that neither riboflavin, Vitamin B₁₂, nor a combination of the two will completely prevent skeletal defects in newborn rats when the dams receive a wheat-gluten type ration. However, Vitamin B₁₂ played a more important role than riboflavin, and a low calcium-phosphorus ratio may decrease the incidence of malformations.

A deficiency of either folic acid or Vitamin B₁₂ in the maternal diet resulted in hydrocephalus in infant rats. Maternal deficiency of folic acid resulted in a decrease in maze learning ability of the offspring. A large percentage of "normal appearing" litter mates of hydrocephalic animals showed defects of the brain ventricular system. (Project 32).

TABLE 3 -- EFFECT OF FOLIC ACID, VITAMIN B₁₂ AND ANTIBIOTICS ON THE INCIDENCE OF HYDROCEPHALUS IN NEWBORN RATS

Ration No.	Supplements Per 100 Gm	Litters No.	Offspring		Weight at 4 wks. Gm.	Hydrocephalic		Eye Defects o/o
			born No.	Weaned ¹ o/o		Litters No.	Offspring ² o/o	
1. Soybean Meal Rations								
2087	Basal	72	421	1.8	30	30	14.7	6.2
2530	0.5 mg folic acid	148	857	8.7	22	52	15.5	10.1
2699	R2530 + B ₁₂ conc. (2.2 mcg)	23	90	71.0	57	0	0	2.2
2884	R2530 + 3 mcg cryst. B ₁₂	29	285	75.0	43	0	0	0.7
2692	50 mg methyl-folic acid + B ₁₂ conc. (4.4 mcg)	24	88	39.7	43	11	19.3	-6.0
2743	50 mg methyl-folic acid + B ₁₂ conc. (4.4 mcg) + 1 mg folic acid	26	160	88.5	52	1	0.6	1.3
2728	R2530 + 10 mg pro- caine penicillin	30	193	44.4	41	1	0.5	1.6
2920	R2530 + 5 mg. pro- caine penicillin	9	53	22.4	40	2	5.7	5.7
2768	R2530 + 10 mg aureomycin HCl	2	10	0	--	2	60.0	----
2919	R2530 + 5 mg aureomycin HCl	8	54	50.0	54	0	0	1.9
2921	R2530 + 5 mg chloromycetin	6	23	24.0	38	1	8.7	8.7
2. Purified Soybean Protein Rations								
2647	Basal	15	71	0	--	7	17.0	11.3
2689	0.5 mg folic acid	14	95	6.6	35	5	18.0	10.5
2690	B ₁₂ conc. (2.2 mcg B ₁₂)	23	127	57.3	54	0	0	3.9
2676	0.5 mg folic acid + B ₁₂ conc. (2.2 mg)	12	70	65.0	57	0	0	0

Conservation of Nutritive Value of Foods.

(A. G. Hogan, Laura M. Flynn, R. B. Grainger, Osman Kocturk, George Gillespie). Studies under this project consisted of:

- (1) The determination of nutrients in sweet potatoes and in Bibb lettuce grown under varied fertilizer treatments.
- (2) The determination of ascorbic acid content of tomatoes of different genetic backgrounds.
- (3) Assays of folic acid and B₁₂ activity in fermented foods and in animal tissues.
- (4) Introductory assays of the nutrients in several forages.
- (5) Further statistical studies of data on essential amino acids in high protein and low protein corn.
- (6) Animal feeding tests of the comparative nutritive value of high protein and low protein corn.
- (7) Vitamin assays made for other departments of the University.

Sweet potatoes were found to be an excellent source of carotene but only a fair source of ascorbic acid. Bibb lettuce proved to be an excellent source of carotene and a good source of ascorbic acid. Increasing the application of nitrogen fertilizer to sweet potatoes resulted in an increase of as much as 75 to 85 percent in protein content.

While tomatoes generally are a good source of ascorbic acid (Vitamin C), an assay of 197 different lots of varied genetic constitution showed a wide range in the content of this vitamin.

Sodium bisulfite acts as a reducing agent in the medium for Vitamin B₁₂ activity and decreases the destruction of Vitamin B₁₂. A modification of extraction procedures by the addition of sodium bisulfite, using 25 percent neutral ethyl alcohol and 0.1 percent sodium bisulfite, gave the highest assay and the most consistent results in B₁₂ activity. The concentrations of folic acid and of B₁₂ activity in typical animal tissues and in foods were determined.

In the study of essential amino acids in high protein and low protein corn, rats receiving high protein corn grew more efficiently than those receiving

Fig. 1—A simple test tube "artificial rumen" saves much time and money in studying the action on feeds of microflora from an animal rumen. Final checks are made in live animals.

low protein corn. Both high and low protein corn were seriously deficient in both lysine and tryptophane and supported a very slow rate of growth. Lysine appeared to be the first limiting amino acid. However, tryptophane became a seriously limiting factor when lysine was supplied. A deficiency of niacin limited growth in rations of high protein corn supplemented with lysine. Even when supplemented with tryptophane and lysine, corn protein was markedly inferior to the protein of casein for the growth of rats.

When the protein content of corn was increased, the zein fraction increased more rapidly than the non-zein fraction. The zein fraction is deficient in tryptophane and lysine, which are essential amino acids normally present in ordinary corn. (Project 33).

Hemorrhagic Conditions in Swine and Other Farm Animals. (M. E. Mubrer). Clotting defects in human, canine, and swine hemophilia were compared. Plasma anti-hemophilic factor tests were made on normals and bleeders of each species. Human plasma contained roughly one-fifth as much anti-hemophilic factor as dog plasma while swine plasma contained one and one-half to two times as much as dog plasma. In canine and human hemophilia the prolonged clotting time and impaired prothrombin utilization are corrected by small amounts of normal plasma injection. The abnormality in the swine disease appeared less severe than that in the other two species.

Artificial Rumen Studies. (M. E. Mubrer). An artificial rumen was constructed in which synthesis of Vitamin B₁₂ was studied. In the artificial rumen, following treatment with the microflora from the rumen of a healthy cow, a ration that was void of Vitamin B₁₂ was changed to a feed which contained adequate Vitamin B₁₂ concentration for chick and swine rations.

Urea was added to a ration low in protein nitrogen and fermented in an artificial rumen. The contents were analyzed before and after fermentation. The non-protein nitrogen (urea) was converted in the artificial rumen into protein nitrogen. The protein content in the ration was raised from 10 to approximately 15 percent. In addition to the increase in protein, there also was a marked increase in fat content in the ration. The protein increased at the expense of urea and the fat increased at the expense of carbohydrate.

The use of the artificial rumen technique has revealed:

1. That the vitamin concentration of a ration is increased by rumen microflora.
2. Non-protein nitrogen such as that present in urea is converted into protein nitrogen.

3. Fats were synthesized to an extent greatly beyond our expectation. As much as 100 percent increase was found. (Project 152).

Gains in Swine Receiving Thiouracil. (*M. E. Mubrer*). Animals receiving Vitamin A supplement made faster and more economical gains the first three

weeks of the trial. After the fourth week, the rate and economy of gain decreased rapidly. Data indicate addition of Vitamin A to the ration containing thiouracil for swine increases both rate and economy of gain for a short period of time. However, Vitamin A is not the only factor in the gross return effect of thiouracil. (Project 76).

AGRICULTURAL ECONOMICS

O. R. Johnson, Chairman

Land Use Investigations. (*Frank Miller, Buel F. Lampher, Jr.*) Land in Missouri was divided into 15 areas and sub-areas for which separate determinations of productivity were made. Productivity varied greatly in these areas. Range when calculated in terms of gross product per acre was from 49.60 units on the most productive soils down to 5.96 units on the poorest soils. Pemiscot county was the most productive county in the State. Relationships were found between the following factors:

- (1) Productivity per acre and the value of land and buildings per acre.
- (2) Productivity and value of machinery per acre.
- (3) Productivity per farm and the number of farms rented.
- (4) Productivity per acre and the amount of gross product per person on the farms.

The proportion of farms equipped with telephones, running water, and electricity, also showed some tendency to vary with productivity of the land.

Data assembled in a study of wildlife populations in various soil areas and demand for outdoor recreation in the form of hunting and fishing will furnish the basis for recommendations on wildlife development.

Corn acreage in Missouri has gone through a cycle starting with 6,650,000 acres in 1920, declining to a low of 3,900,000 acres in 1941 and climbing back to 4,500,000 acres at present. An overall decline also was shown in wheat with 3,250,000 acres in 1921, dropping to 1,350,000 in 1933, rising to 3,240,000 in 1937, and declining again to the present level of 1,744,000 acres. Tame hay production fluctuated between a high of 3,650,000 acres in 1922 and a low of 2,300,000 in 1937. Present production stands at 3,250,000 acres of tame hay. Oat acreages hit a low of 1,950,000 acres in 1934, a high of 2,250,000 in 1949 and the state now has 2,000,000 acres planted to oats. (Project 14).

Marketing Livestock by Carcass, Grade and Weight. (*Elmer R. Kiehl, Paul E. Blesi*). Carcasses of 592 hogs were studied in an effort to establish objective carcass grade standards. Measurement of back fat thickness appeared to be the best indicator of carcass merit. It was determined that 70 percent of the variation in proportion of lean in cuts could be explained by the variation in back fat thickness.

On the basis of a study of the meat supply sources of Missouri consumers there appeared to be duplication in some instances of wholesale delivery routes. In addition there were more deliveries to retail stores by individual wholesalers within a given week than appeared necessary from the standpoint of maintaining condition of the product. The excessive services were thought to be due to expressed consumer preferences for several brands of meat and to sales policies of wholesalers competing for a larger share of the market. Detailed cost analysis of meat wholesaling must be completed before drawing conclusions on the efficiency of these methods and their effect on overall prices. (Project 59).

Marketing Missouri Poultry and Poultry Products. (*John D. Miller, Johnny B. Kimmons*). Influences of farm handling and marketing processes on egg quality were studied. Eggs purchased from 75 retail outlets in six cities in Missouri were candle graded or broken out and scored. Analysis of the data showed that it was possible to bring the consumer AA quality eggs if the air cell was not used as a criterion of quality. Of the broken out eggs, 13.2 percent scored AA while none scored AA from the candling process. (Project 60).

Farm Real Estate Price Problem and Assessment Situation. (*Frank Miller*). There were four basic forms of inequity in tax procedures in Missouri, according to a study of property tax assessment methods:

- (1) Inequality of assessment of property within a county.
- (2) Inequality of assessment of property in one county compared to property in another.
- (3) Inequality of assessment of farm property compared to urban property.
- (4) Inequality of assessment of property of different grades.

These data indicated that equality in property tax structure does not exist. (Project 61).

Cotton Marketing. (*J. W. McKinsey, Eugene Simpson, Fred Anderson*). Arrangements were made to obtain data on prices, dates of sale, ginning dates, and bale weights from buyers at two markets and from 50 farmers in different market areas. Arrangements were made with PMA and the cotton classing office in Haiti, Missouri, to obtain quality information on each bale for which historical data were obtained. This is primarily a pilot study of pricing mechanisms in local markets. (Project 65).

Marketing Grain at Country Elevators in Missouri. (*J. W. McKinsey, Dale Moore*). Study of facilities revealed an average investment of \$44,108 per elevator. Total storage capacity per elevator averaged 50,520 bushels. The typical country elevator received grain from a radius of 50 miles.

Many of the elevators handled feed, seed, fertilizer, and farm machinery as part of the business. On the average, 46 percent of the net income of elevators came from other services. Eighteen percent of the elevators were found to lack hoists for quick unloading of trucks, an essential in peak seasons.

From the survey, investigators concluded grain grading was not entirely satisfactory at country elevators. Much of the grading was by sight and feel of the kernel. Many patrons were not paid according to quality of grain delivered.

Elevators experienced shortage of boxcars at the peak run and lacked sufficient capacity to overcome this handicap. Approximately 20 percent of the grain received at the country elevators sampled was resold locally for feed or seed. Southeast Missouri soybeans frequently were sold for export. Buying margins varied and there was considerable overlapping of trade territory. (Project 104).

Agricultural Raw Materials—Sources and Markets. (*H. M. Haag, Elmer Kiehl*). An appraisal of various organizations in St. Louis with reference to rural-urban relations was made. Shows, fairs, and expositions in 15 major cities were studied and newspaper and radio activities analyzed for influence on

rural-urban relations. Thirty metropolitan newspapers and 22 radio programs were included. (Project 111).

Power and Machinery Problems and Costs. (*Robert C. Suter, R. D. Darley*). A total of 214 farm machinery records in four different types of farming regions were obtained to determine farm machinery requirements on various sizes of farms.

Fifteen percent of the total farm capital on these farms was found to be invested in machinery and equipment. In general, the investment in machinery and equipment increased as the size of the farm increased. Wide differences were found in this relationship between non-livestock and livestock areas, also between large and small farms.

The average number of tractors used on 214 farms was 1.7 per farm. Average cost per tractor was \$1,696; the average age was 4.5 years; and the present value was \$1,118. The farm tractor made up 28.3 percent of the capital invested in machinery and equipment.

Average amount of capital invested in Missouri farms surveyed was \$45,000 each, and the average size was 239 acres. A table was evolved from this survey, listing annual hours of use to make a machine pay for itself (See Table 4).

TABLE 4 -- RECOMMENDED MINIMUM LEVELS OF USAGE FOR FARM MACHINERY AND EQUIPMENT (212 FARMS, ATCHISON, LINN, GREENE, AND PEMISCOT COUNTIES, MISSOURI, 1951)

Type of Equipment	Average Usage for All Four Areas	Recommended Minimum Levels of Usage
Tractors:		
one	902 hours	750 hours
two	1,390	1,500
three	1,878	2,500
four or more	3,401	4,000
Moldboard plows:		
2-12 "	51 acres	50 acres
2-14 "	67	75
2-16 "	85	100
3-14 "	111	125
Disc plows:		
2-disc	48	50
3-disc	67	75
Middlebusters:		
2-row	118	125
3-row	250	250
Disc harrows:		
straight	234	300
tandem	174	225
Stalkcutters:	217	225
Grain drills:	55	100
Listers:	100	125
Planters:		
2-row corn	89	110
2-row general purpose	136	150
4-row general purpose	267	300
"Go-devils":	116	125
2-row tractor cultivators:	280	300
7-foot tractor mowers:	137	150
Side delivery rakes:	98	125
Hay balers:	10,254 bales	11,000 bales

Combines:		
5-foot tractor-drawn	119 acres	125 acres
6-foot tractor-drawn	108	150
2-row tractor-drawn	91	125
3-row self-propelled	193	400
Corn pickers:		
one row	69	100
two row	157	200
Corn binders:		
	15	30
Stationary ensilage cutters:	203 tons	225 tons
Field choppers:	130	400
Manure spreaders:	162 loads	175 loads

A young man starting in farming today as a tenant should have capital for approximately \$9,000 investment in some areas. For the State as a whole, where the livestock-pasture system of farming is practiced he should have at least \$15,000. The average investment that a part-owner had in his business was about \$35,000 and a full-owner usually had more than \$40,000. (Project 88).

TABLE 5 -- THE CAPITAL INVESTMENT PER FARM (FARMER AND LANDLORD) 212 FARMS, FOUR TYPE-OF-FARMING AREAS IN MISSOURI, 1951

	Atchison Area	Linn Area	Greene Area	Pemiscot Area	Average Four Areas
Predominant type of farming.....	cash-grain livestock	General livestock	dairy	cotton	-----
Number of farms.....	53	52	53	54	212
Size of farm (acres)..	325	240	205	187	239
Capital investments*					
Real estate.....	\$41,285	\$17,214	\$21,172	\$27,668	\$26,884
Livestock.....	14,203	10,570	10,786	979	9,089
Machinery.....	7,822	5,189	5,892	7,932	6,722
Feed and supplies...	5,461	2,761	1,590	953	2,683
Total.....	\$68,771	\$35,734	\$39,440	\$37,532	\$45,378

*Simple averages

Marketing Dairy Products. (C. C. Erwin, S. F. Whitted). In a study of the economic position of the dairy industry in Missouri, it was found that in 1949 dairy products accounted for 34 percent of the total cash farm income in southwest Missouri. Sales of whole milk have increased materially in the past several years, amounting to 74 percent of the total sales in 1949.

As a result of emphasis on sanitation, rejections of milk due to poor quality were only 1 percent of total farm deliveries. Southwest Missouri produces and manufactures about 1/4 of the State's creamery butter, 2/3 of the cheese, and more than 9/10 of the total production of evaporated and condensed milk. Much of the fluid milk is for consumption outside the Southwest Missouri milkshed. However, it appears that the manufacture of high grade dairy products for sale in a national market will continue for a considerable time as the backbone of the dairy industry in this area.

A survey of cream handling by local cooperative exchanges in Missouri showed that cream producers were making more frequent deliveries of cream to

local cooperative exchanges than formerly. Under the four-day grading plan local cooperative cream buying stations were doing a more effective job in paying differential prices for quality cream than they were before the plan was initiated. Cream buying stations did not appear to have been careful in protecting cream from high temperatures while in storage. Analysis of data indicate that cream buying stations of the cooperative exchanges were being highly subsidized by sale of other farm supplies. Competition in prices paid producers appeared stronger in north Missouri than in south Missouri. (Project 93).

Marketing Fluid Milk in Federal Order Markets. (C. C. Erwin, S. F. Whitted). The number of farmers regularly supplying fluid milk to Federal Order markets has decreased. At the same time, the volume of milk supplied by Missouri farmers has increased. Although wholesale prices of fluid milk do not usually go up as rapidly or as high as many other farm prices during inflationary periods, milk prices have been maintained in these two markets at a reasonable balance with other farm commodity prices. Both markets have been in short supply for brief periods during winter months in spite of an increased percentage of St. Louis and Kansas City milk requirements having been filled by Missouri producers. (Project 93).

Community Improvement in Use of Economic Resources. (Frank Miller). Improving production and marketing methods of farm products in the Joplin, Missouri, trade area has been the objective of this work. Most of the land around Joplin is divided into small farms. A majority of the rural residents depend on supplementary income from off-farm work.

A slow-down in business activity of the community consequently hurts many family incomes. Few of the industries in which these part-time farmers work are engaged in processing agricultural products.

Stabilized income from part-time farming and off-farm work is a vital problem in the Joplin rural community. One of the best answers would be to develop interest in intensive farm enterprises, such as small fruits, broilers, or vegetable production on small acreages. At the same time operators, or members of their families, could work in processing plants. Successful broiler enterprises have been started by several farmers in the region. A few have combined dairy farming and broiler production. Strawberries and vegetables are well adapted to this area. (Project 111).

Marketing Missouri Poultry and Poultry Products. (John D. Miller, Johnny B. Kimmons).

A merchandising school was held in connection with the study of poultry merchandising methods. More than 100 retail stores sent trainees to the school.

The pre-cut method of retailing chicken captured interest of trainees and was the most widely adopted of the practices taught.

Training had little influence on egg merchandising. Analysis of classes revealed that much of the other material offered was already in use at progressive establishments. (Project 135).

Economics of Soil Conservation. (*Frank Miller*). The reasons farmers gave for not establishing Balanced Farming programs on their farms were gathered to determine obstacles to expansion of conservation in Missouri. The following were the chief obstacles uncovered:

(1) Reluctance of farm operators to change old methods.

(2) Insufficient skill to lay out the work.

(3) Lack of accurate information on costs and benefits.

(4) Frequent changes in recommended conservation practices.

(5) Community traditions and attitude of neighbors.

(6) Reluctance to invest.

Work should be undertaken on a community basis in some instances. In other cases, establishment of conservation plans on individual farms, to make known the benefits and cost, would influence others to follow.

Farmer interest in conservation has been found to be closely related to the number of years he expects to control the land. In the case of rental land, short leases, lack of cooperation, and lack of provision in leases to compensate for conservation were big problems retarding conservation. (Project 14).

AGRICULTURAL ENGINEERING

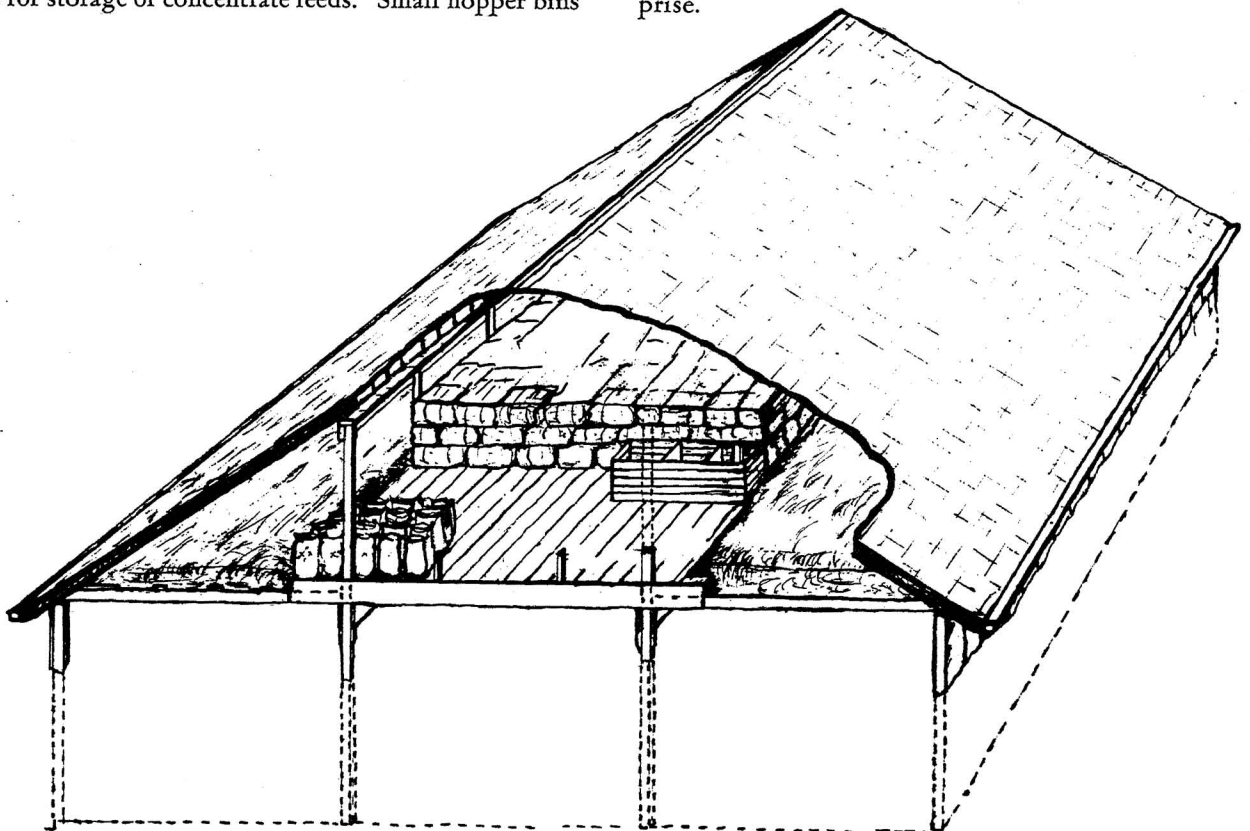
M. M. Jones, Chairman

Design of Farm Buildings and Equipment. (*J. C. Wooley*). Efforts were directed toward designing two types of barns for young stock on average sized Missouri dairy farms. Consideration was given to en-

vironment for young dairy animals and to arrangement of stalls, pens, and alleys to enable the operator to work efficiently. Cost adjustment within economic limits of the enterprise was included in the plan. A

Fig. 2—This drawing of a barn designed by the engineering department shows the straw loft areas on each side of a central storage section. The south end provides space for storage of concentrate feeds. Small hopper bins

provide for the delivery of different kinds of feed to the feeding alley below. The remainder of the central area is for storage of hay and bedding for the livestock enterprise.



30-foot by 30-foot building to furnish facilities required by a 20 to 30-cow enterprise has been planned. Under ordinary conditions it has been found necessary to raise 2 to 3 heifers yearly for each 10 herd cows. Plans provide for 3 maternity pens, a pen for 8 yearlings, and space for 10 to 12 young calves. Two straw covered spaces in the ceiling permit gradual movement of air from stable to attic where it is removed by louvers or a roof ventilator. Fresh air entry is regulated by adjusting windows.

Calf pens are tightly partitioned to prevent drafts and located to obtain winter sunshine. The center section of the loft is floored for storage (see Fig. 2). (Project 71).

Economic Use of Power, Labor and Machinery in Crop Production. (*C. L. Day, M. M. Jones, J. S. McKibben, D. B. Brooker.*) Results of a survey to determine hay and ensilage harvesting cost indicated tractors were being used more and more hours per year, thus lowering average cost per hour in spite of rising total cost. Increased use of the machine adds to repair cost but depreciation, interest, housing, taxes and insurance costs remain about the same whether or not the machine is used. Thus steady use of the tractor reduced its cost per job.

Equipment on 45 farms was studied to compare costs on farms having home repair shops with those not having shops. (See Table 6). Tractor repairs on farms with shops averaged 5 cents per hour, compared with 6 cents on farms without shops. The comparison in combine repair cost was 25 cents to 35 cents per hour of use, a 10-cent margin in favor of the shop. Corn picker repair costs were 7 cents per hour where the farm shop was available and 12 cents per hour on other farms.

The survey discovered that 58 percent of the farm shops were provided with heat and 89 percent with electricity.

Tests have been made with liquified petroleum (L. P.) gas. A two-plow tractor would have to use more than the average amount to justify conversion to liquified petroleum gas. If the farm already has storage facilities for this type of fuel (home heating supply tanks may be available) conversion may be economical.

Another study concerned practical methods for use in rotations of small grain following corn. This system of management will prove of great practical value. In order to seed wheat in the fall after corn, the corn must be harvested as early as possible. Early corn harvesting reduced corn picker losses but moisture content became a problem. Corn was picked between September 28 and October 3. The moisture content was 27 percent. The corn was placed in a crib fitted with an "A" frame air tunnel. A 36-inch propeller type fan, driven by a 7 h. p. gasoline engine was used to force air through the crib. The fan, operated intermittently for 109 hours, used 64 gallons of fuel. Fuel cost per bushel was 2.4 cents. Moisture content was reduced from 27 percent to below 20 percent. Corn kept well without further forced ventilation and tested 15 percent moisture by March 1. Without the benefit of forced ventilation, other locally cribbed corn tested 18 to 20 percent on March 1.

Corn stalks in the early harvested field were shredded and disked and the ground prepared for wheat, which was seeded October 15. Ammonium nitrate was applied to the shredded stalks at a rate of 200 pounds per acre and different methods of preparing seedbeds were used. (Project 15).

Influence of Climate on Farm Animals. (*M. L. Esmay, R. E. Stewart, W. C. Chandler, H. J. Thompson, R. E. Yeck, M. M. Jones.*) The influence of climatic factors, such as temperature, humidity, rate of air movement, and light on the production and physical condition of dairy cows was studied.

TABLE 6 -- ANNUAL COSTS AND REPAIR PRACTICES ON FARMS WITH AND WITHOUT SHOPS

Item	Tractors		Combines		Corn Pickers	
	With shops	Without shops	With shops	Without shops	With shops	Without shops
Number of machines	34	27	13	15	12	8
Average cost of parts for home repairs	\$23	\$10	\$66	\$55	\$12	\$11
Average hours of owner's time for repairs	8	2	18	19	6	4
Average cost of hired repair service and parts	\$24	\$57	0	\$12	0	\$20
Average total repair cost per hour of use	\$.05	\$.06	\$.25	\$.35	\$.07	\$.12
Percent spending \$10 or more for parts	50	40	83	93	33	25
Percent spending \$10 or more for repair service	30	50	0	13	0	12
Percent spending 10 hours or more repair time	40	11	60	70	33	12

Preliminary analysis has shown that varying air velocities have a definite effect on the surface temperature of animals. Moisture load in the ventilating system showed a sizable increase with faster movement of air. In some cases this moisture load was twice that accounted for in direct loss from the animals through respiration and skin evaporation.

Considerable experimentation on instruments to measure heat loss from animals and the chamber was required. Heat losses through radiation and convection are very difficult to determine. Detailed reports on the various investigations are covered in the following Missouri Experiment Station bulletins:

Bulletin 371, "The Effect of Rising Temperatures on Feed and Water Consumption, Body Weight and Milk Production;" Research Bulletin 473, "The Effect of Rising Environmental Temperatures on Heat Production, Rectal Temperature, Pulse and Respiration Rates of Dairy Cattle;" Research Bulletin 479, "The Effect of Temperature on Insensible Loss and Moisture Vaporization under Varied Heat Conditions;" and Research Bulletin 481, "The Effect of Temperature on Skin and Hair Temperatures." (Project 66).

Effect of Infrared to Ultraviolet Radiations on Animals with Different Hair and Skin Colors. (*R. E. Stewart*). Marked change in cattle hair occurred with changes from 65 to 95 degrees F. University of Missouri Research Bulletin 484 reports on the reflecting ability of cow hair when cattle were kept under varied environmental temperatures. Small laboratory animals have been used for more thorough study. A set of air-conditioned chambers has been constructed for this purpose. (Project 66).

Low Cost Home Construction and Improvement. (*M. L. Esmay, J. C. Wooley, L. H. Temple*). Small space heaters were used to study heat efficiency of farm buildings. Use of fans decreased fuel consumption. As expected, insulation had a great influence on loss of heat. Good circulation was important for even distribution, as well as lowered cost. It had been thought that removing a decorative jacket from an oil stove would increase its circulation efficiency. Aside from increasing the difference in temperature between ceiling and floor in the room where it was located, removal of the jacket had little effect on heating results. (Project 67).

Farm Water Supply. (*M. L. Esmay, L. H. Temple, J. C. Wooley*). Slow sand water filters were tested for farm use in a study of problems of utilizing pond water for home purposes. If carefully operated they produced water that would pass drinking water requirements. Treatment of the pond to prevent grow-

th of algae helped to prevent clogging of the filter and to eliminate undesirable tastes and odors. In some cases it was still necessary to chlorinate to remove bacteria completely for drinking purposes. (Project 67).

Design of Dairy Barns and Related Structures. (*M. L. Esmay, J. C. Wooley, R. E. Stewart, H. F. Williams, M. M. Jones, R. E. Yeck*). A study was made of the design of dairy barns to increase efficiency of space, labor, and milk production. Missouri Agricultural Experiment Station Bulletin 559 sets forth plans for preparation of the loose housing system of management, discussing its possibilities and limitations.

A pilot study of fly population and dust concentration in milk houses and barns was made to determine the value of the double door vestibule entrance from milking room to cooling room. The investigation also included a study of the effects on dust, odor intensity, and fly population when concentrates were fed in the milking room.

A wide variation in fly population occurred between milking barn and cooling house, depending upon the method of handling the vestibule doors. Weather conditions affected the number and movement of flies. As much variation in dust concentration occurred as a result of wind as from method of operating vestibule doors.

An index to ideal temperature, moisture, and ventilation conditions was sought for use in designing dairy structures. Data were gathered on such things as room temperatures, animal skin temperatures, heat given off by animals, and room moisture content, which will be useful in scientific planning of healthy, efficient, livestock housing. A cow activity meter was developed that records, automatically, the periods of time the cow is lying down. Much thought and planning has been given to the possibility of devising an instrument that will automatically measure the moisture given off by a cow through surface evaporation and respiration. (Project 81).

Farm Water Management. (*R. P. Beasley*). A graphic method of determining suitability of pond sites and adaptation to the location has been developed. By this method, it is possible to determine in advance of construction the amount of earth required in the dam, pond capacity, surface area, maximum depth area, depth of water at any point, and distance earth must be moved.

Effects of terrace systems on yield and income have been under study. Records have been kept of yield and net income from areas that were handled the same, with the exception that half were terraced and the other half farmed on the contour. Improve

ment of design of terraces and related structures is another object of this investigation.

An evaluation of water management practices was undertaken to obtain information on over-fall structures. Data also were obtained on terraces, terrace outlets, and diversion channels to show weaknesses in design of these structures. Data revealed that serious rill erosion occurred when terrace over-topping resulted from rainfall in excess of that for which the terrace was designed. (Figure 3). Where recommended spacings were used, this happened only in cases of hard rains falling on soil that was not protected by vegetation, or hard rains on ground already completely saturated with water.

A major problem in outlet control was the discharging of terrace water, heavily loaded with silt, into grass outlets. This problem can be avoided in most cases by constructing the terraces at a grade that will not result in excessive amounts of silt. Other chief causes of damage to outlets were: water from diversion channels being improperly spread over the outlet; grazing outlets when wet; over-grazing outlets; using outlets for roadways; and rodent damage. Di-



Fig. 3 Serious erosion resulted between terraces in this field where terrace spacing was 160 feet instead of the 100 feet recommended for this slope.

version channels were causing serious damage to many grass outlets. Use of silting basins, and reducing the grade in the diversion channel seemed the most effective means of avoiding this damage. (Project 98).

ANIMAL HUSBANDRY

L. A. Weaver, Chairman

Effects of Antibiotics and Vitamins on Swine. (*A. G. Hogan, J. F. Lasley, L. F. Tribble*). The antibiotics aureomycin and procaine penicillin increased rate of gain 13 to 18 percent and saved an average of 11 percent of the feed required per pound of gain when added to corn-soybean meal rations for pigs in drylot.

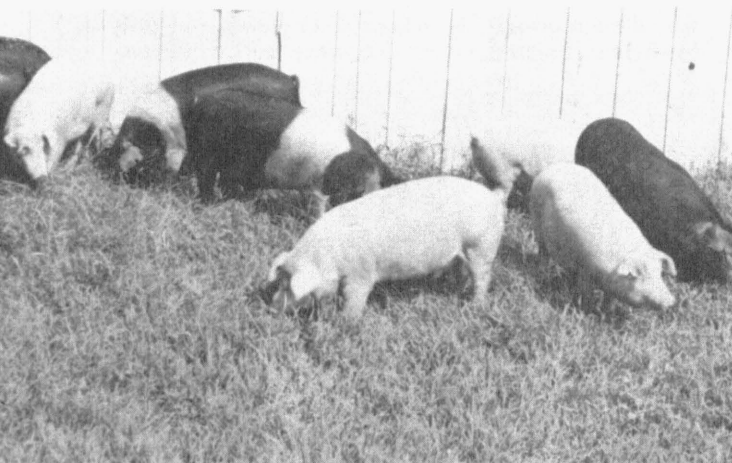
These two antibiotics were less effective with a corn-tankage ration and no increase in rate of gain was obtained from their use when pigs were on good, clean pasture.

Fig 4 These two lots of pigs received the same ration with the exception that those at right received 5 milligrams of an antibiotic per pound of ration. The pigs that received the antibiotic (right) gained 0.2 pound faster and

Streptomycin and Chloromycetin showed some improvement in production efficiency with the same corn-soybean meal ration but were much less effective. Streptomycin increased the rate of gain 7 percent and saved an average of 8 percent of the feed required per unit of gain. Chloromycetin decreased gains 6 percent but saved 3 percent of the feed required per unit of gain.

Data indicated the amount of antibiotic fed was important. Streptomycin included at a level of 15 milligrams per pound of ration was more effective

required 3 percent less feed per 100 pounds of gain than the other pigs (left). In other feeding tests with swine, the antibiotics proved even more effective in stimulating fast and efficient gains.



than 2.5 milligrams per pound. Procaine penicillin was more effective at 7.5-milligram rate than at 1 milligram per pound of ration.

In vitamin tests, practical type rations of corn-soybean meal and corn-tankage appeared deficient in the B-Vitamins, niacin, riboflavin and pantothenic acid, as shown by an increased rate and efficiency of gain when they were added to dry lot swine rations. The addition of Vitamin B₁₂ to these rations did not increase the rate or economy of gains. Inclusion of rye pasture in the ration was found to be a satisfactory substitute for the B-Vitamins.

Results indicated that rations of corn-soybean meal could not be improved materially by the addition of trace minerals for weaning pigs and brood sows. A corn-tankage ration was improved slightly for weanling pigs when trace minerals were added but this difference was not considered significant.

A corn-soybean meal ration fortified with B-Vitamins, Vitamin B₁₂ and trace minerals was slightly superior to a corn-tankage ration fortified with the same products and fed to brood sows in drylot. The main difference was in a greater survival of pigs from sows fed the fortified soybean meal. (Project 1).

Beef Production with Pasture and Roughage.

(A. J. Dyer, J. E. Comfort, R. K. Leavitt, Paul Q. Guyer, Donald Naumann, D. E. Brady). Forty head of choice feeder yearling steers averaging 605 pounds were used in the test, started in December, 1950. The steers were divided into 4 uniform lots of 10 each. Three phases were included in the test: (A) Wintering (B) Grazing (C) Full Feeding.

The winter phase extended from December 6, 1950, to April 20, 1951, for a total of 135 days. Three lots were wintered on corn silage and red clover hay. One lot was wintered on bluegrass pasture and supplemented with 1 pound of red clover hay per 100 pounds liveweight daily. The grazing phase extended from April 20 to September 29. At the start of the grazing phase all steers foraged together on bluegrass pasture for 10 days. Starting May 1, 3 lots of the cattle

Fig. 5—These two lots of steers weighed the same when started on experiment but the one at left was wintered to gain only 16 pounds per head while the other lot was wintered to gain 207 pounds per animal. The lot at left was pastured on ladino clover and fescue during the

were placed on fescue-ladino clover pasture and one lot on wheat lespedeza pasture. The full feeding phase was initiated on September 29 and completed for each lot of cattle when they reached choice market finish.

From this study, investigators concluded the best system of management for Missouri was to winter yearling cattle on good roughage that would produce 1¼ to 1½ pounds gain per day, then pasture them on succulent, nutritious pasture and finish with a short period of full feeding.

Steers that were wintered to gain only 0.1 pound a day with red clover hay on bluegrass pasture showed faster gains from pasture in the spring but lacked 80 pounds equalling the overall gain of those that made 1.5 pounds gain in winter on a ration of good corn silage and red clover hay. It required 37.7 bushels of corn and 145 days drylot feeding for the poorly wintered cattle that grazed Alta fescue-ladino clover compared with 10.7 bushels corn and 51 days feeding for the lot that was wintered well and grazed wheat-Korean lespedeza pasture in summer. Well wintered cattle that grazed fescue-ladino required 25.4 bushels corn and 98 days. The cattle that grazed fescue-ladino clover were in feeder condition at the close of the grazing season; those that grazed wheat-Korean lespedeza were fleshy enough to grade good as slaughter cattle.

In comparing wheat-lespedeza pasture and fescue-ladino clover pasture, it was estimated the fescue-ladino had almost 3 times the carrying capacity, though it did not produce as much finish. Gains were 42 percent faster on wheat-lespedeza. Average daily gain was 1.74 pounds for wheat-lespedeza and 1.22 pounds for fescue ladino clover.

A comparison of total gain coming from roughage and pasture showed 80 percent for the group wintered well and pastured on wheat-lespedeza; 60 percent for the group wintered the same and pastured on fescue-ladino clover; and 50 percent for those wintered on bluegrass pasture supplemented with red clover hay.

summer and weighed 849 pounds August 29. The other lot ran on lespedeza and wheat and weighed 1,000 pounds August 29. It took an average of 37.7 bushels of corn to finish each poorly wintered steer (left) and only 10.7 bushels to finish the ones that were well wintered.



Paired wholesale rib cuts were obtained from experimental cattle. Detailed measurements and scores were made on these carcasses and an additional 15 carcasses of market cattle. Chemical and physical determinations were made on rib sections. Other rib sections were separated into sub-cutaneous fat, other fat, ribeye lean, and other lean and stored to await tests for ether extract, total nitrogen, and moisture content. (Project 16).

Physiology of Reproduction of Farm Animals. (*G. E. Dickerson, D. T. Mayer, J. F. Lasley, C. D. Squiers, E. H. Lerner, Wells Farnsworth, Betty Glasgow, John Alleva, Marta Cancio, Frank J. Rice, H. A. Herman, Robert Lipe, Wayne Ryan, Edward Wojciekowski*). Data obtained from this study with swine have indicated that approximately two-thirds of all fetal mortality occurred prior to the seventeenth day of gestation.

A second group of data showed the total number of corpora lutea on the left and right ovaries, the total number of normal and degenerating embryos in each horn of the uterus, and the number of normal embryos in each horn of the uterus. It was found that the total number of embryos of all types observed in the right uterine horn was 309 (50.57 percent) and in the left horn 302 (49.43 percent), representing an approximately equal distribution of embryos between the two horns. However, fetal mortality enhanced equality of embryonic distribution in the two uterine horns, rather than detracting from it. Thus normal embryos were more equally distributed between the two uterine horns than the total of normal and abnormal embryos. This suggested that fertilized ova migrated within the uterus and that intra-uterine migration between the two horns occurred.

Investigations on other animals have indicated that the blood supply was greater at implantation sites and that near these sites lipids and glycogen were in greater abundance. If a similar situation exists in the sow's uterus, then each sow may have a limited number of implantation sites capable of carrying an embryo through the gestation period. Thus, in the free migration of ova, some may attach at less favored sites and degenerate, resulting in fetal death. (Project 38).

Natural and Artificial Breeding. (*D. T. Mayer, H. A. Herman*). It was found that minor changes in procedure of preparing and mixing egg yolk media for semen have a marked effect upon settling of egg yolk and semen plasma solids. At storage temperatures the minute spermatozoa behaved as inert particles because sedimentation rates of live and dead cells

were identical. Evidence presented indicated that rapid sedimentation of spermatozoa during storage did not affect spermatozoon survival.

A staining technique was devised which separated live and dead spermatozoa cells into color groups, thus assisting study of cell survival. In addition to shock and storage, four other requirements were found necessary in a dilution media for spermatozoa: A buffer against increased acidity resulting from sugar metabolism during storage; a metabolizable sugar to meet energy requirements of spermatozoa; a low concentration of sodium ions and possibly other ions; and a non-electrolyte in amount to exactly balance osmotic conditions.

Reduction in quantity of the sodium-containing buffer salts diluting medium promoted increased survival of bull spermatozoa during storage. Sugar solutions, especially solutions of metabolizable sugars, were most satisfactory for replacing buffer salt solutions. However, enough buffer solution must be maintained to hold optimum pH level.

A diluting medium composed of 1 part egg yolk and 5 parts isosmotic mixture of 1 part NaHCO_3 solution (1.3 percent) plus 4 parts glucose solution (5 percent) gave better results than any other diluter studied as a storage medium for bull spermatozoa.

One of the main advantages of egg yolk as a diluting medium was its ability to protect spermatozoa from temperature shock. The lipid portion of the lipid-protein complex of egg yolk was found to supply this protection. Lecithin or cephalin, either from egg yolk or from soybeans, in the presence of an ironizable buffer, protected spermatozoa from rapid drop in temperature. However, these substances were not adequate for low temperature storage. The lipid-protein complex from egg yolk proved very effective for prolonged storage of spermatozoa.

A detailed investigation of the chemistry of spermatozoa of farm animals has been started. This study was undertaken for three important reasons: (A) The head of the spermatozoon constitutes a major part of the cell mass and carries the hereditary genes and chromosomes. The investigation may contribute to understanding of the nature of genes and chromosomes. (B) Chemistry of the sperm cells and the ova must be understood before it will be possible to describe adequately the process of fertilization prior to formation of the zygote. Possibly, the chemistry of the two is complementary. (C) More knowledge of the chemistry of spermatozoa is needed to aid in understanding the metabolism of these cells to formulate ideal media for storage of spermatozoa and to build up knowledge necessary for a more complete understanding of reproduction. (Project 38).

Factors Influencing Litter Size. (*Wells Farnsworth, Dennis Mayer, Marta Cancio, John Alleva*). Pilot experiments were made on small laboratory animals. Uterine tissues of rats were subjected to thorough histological and bio-chemical study. Ovaries were removed from adult female rats two days following mating. The rats were then treated by the administration of 1.0, 1.5 or 2.0 micrograms of progesterone daily, either alone or in combination with doses of estrogen. Normal control rats were kept for comparison.

On the twelfth day following mating the rats were killed and examined. Results indicated that: (1) In the absence of ovaries, both progesterone and estrogen were necessary for maintenance of viable embryos in rats; (2) the ratio of progesterone to estrogen was as important as the amount of each, the most favorable ratio being 1,000 parts progesterone to 1 part estrogen; (3) in the ovariectomized rats receiving insufficient dosage of the two hormones, a hypertrophy of the adrenal glands occurred. Adrenal cortex compounds, which are similar to progesterone in the chemical structure, may be able to replace progesterone. (4) In no case did the number of viable embryos in the operated hormone-treated rats equal the number in normal rats on the twelfth day.

An investigation has been started to study the effect of varying doses of progesterone and estrogen on uterine glycogen and alkaline phosphates. The purpose of this is to help evaluate the importance of the ratio of these two hormones in maintaining optimum uterine conditions. It also should indicate whether factors other than the two hormones are required to maintain the uterus during normal gestation periods. (Project 38).

Growth and Feeding Effects on Carcass. (*J. F. Lasley, D. E. Brady, L. A. Weaver, A. G. Hogan, G. E. Dickerson, L. F. Tribble*.) In these investigations two feeding trials were made on swine.

In the first trial, one lot of Duroc pigs was full fed throughout the trials; a second lot full fed to 125 pounds, then limited fed; and a third lot limited fed throughout the experiment. The limited fed pigs received approximately 77 percent as much feed as the full fed pigs. Limiting the amount of feed during the growing-fattening period increased the percentage of lean meat at market time, but production costs were higher for limited feeding. The limited fed pigs made less efficient gains and required 33 days longer to reach market weight. They sold on a declining market and brought a lower price per pound than the other two groups.

Pigs on full feed until they reached 125 pounds and then limited fed to market weight gave the best

all around results. They required only 9 days longer to reach market weight than those full fed throughout, had almost as efficient gains, and produced a carcass of comparable quality to hogs that were limited fed for the entire feeding period.

In the second trial, four different levels of feeding were employed: Lot 1, full fed throughout the experiment; lot 2, full fed to 155 pounds, then limited fed to market weight; lot 3, limited fed to 155 pounds, then full fed; and lot 4, limited fed throughout the experiment. The amount of feed supplied limited-fed pigs in the second trial was changed to 85 percent of that supplied full fed pigs (per unit of body weight).

Limited fed pigs at this 85 percent level of feeding made the most efficient gains, requiring 9 percent less per unit of gain than full feds. If the cost of the ration was considered this would mean \$1.43 less per 100 pounds gain.

Results obtained in the second feeding trial differed from those obtained in the first in that limited fed pigs made the most efficient gains and brought the greatest return per pig above feed cost. They required an average of 19 days more to reach market weight than full fed pigs, but brought approximately the same price per pound. (See Table 7) (Project 36).

TABLE 7 -- RATES AND EFFICIENCY OF GAINS OF GROWING-FATTENING PIGS ON DIFFERENT FEEDING LEVELS FROM BEGINNING OF EXPERIMENT TO FINAL MARKET WEIGHT

	Full-Fed	Full-Limited-Fed	Limited-Full-Fed	Limited-Fed
No. of Pigs/Lot	12.0	12.0	12.0	12.0
Avg. Initial Wt.	39.6	38.6	38.4	38.3
Avg. Final Wt.	215.0	214.7	219.9	216.7
Avg. Days to reach Mkt.	117.8	122.9	133.1	136.7
Avg. Daily Gain	1.49	1.43	1.37	1.30
Feed/100 lbs. Gain	413.9	403.5	392.7	368.6
Cost of feed/100 lbs. Gain	\$16.60	\$16.18	\$15.75	\$14.78
Return/Pig for Expr. Period	\$36.70	\$37.70	\$37.53	\$36.68
Net Return Per Pig (Mkt. value minus feed cost)	\$7.45	\$9.21	\$8.93	\$10.43

Deterioration in Fresh and Frozen Meats. (*D. E. Brady, C. W. Gehrke, E. E. Pickett, L. N. Tucker, E. E. Martin*). An attempt was made to determine a relationship among flavor, odor, and peroxide values in rancid frozen pork. The three factors do not appear to be closely associated. Free amino acid content of fresh meat, meat stored six months, and meat stored 12 months was little different. The amino acids found in the stored meat included cysteine, aspartic acid, glutamic, glycine, serine, threonine, alanine, tyrosine,

valine, and (or) tryptophane, leucine, iso-leucine, and (or) phenylalanine.

Twenty pigs were divided into 4 equal lots and fed rations designed to produce different degrees of firmness of fat deposit. Keeping quality of the ground pork from these lots decreased with reduction in the amount of pork fat. The effect was not apparent on pork chops and pork loin roasts. These cuts were acceptable in flavor and aroma after 12 months of storage regardless of the degree of fat saturation.

No significant differences were found in odor or flavor of pork chops and roasts stored for 12 months with or without boning. (Project 101).

Quality of Beef. (*D. E. Brady, E. E. Pickett, H. D. Naumann, L. N. Tucker*). Paired wholesale rib cuts were obtained from experimental cattle. Detailed measurements and scores were made on these carcasses and an additional 15 carcasses of market cattle. Chemical and physical determinations were made on rib sections. Other rib sections were separated into subcutaneous fat, other fat, ribeye lean, and other lean and stored to await tests for ether extract, total nitrogen and moisture content. (Project 101).

Improvement of Swine Through Breeding. (*G. E. Dickerson, J. F. Lasley, L. A. Weaver, R. L. Artbaud, N. R. Gyles, H. F. Tucker, W. M. Warren, C. F. Craig, W. E. Smith*.) On the basis of performance of 1950 test crosses, one Duroc, two Landrace, and the Hampshire stocks were retained and reproduced. Fall litters in 1951 included test crosses of Landrace with the Poland China, Duroc, and Hampshire strains and a Poland with a Duroc to determine the best combination of these strains for continued selection for maximum strain-cross performance. This plan of selection was designed to create heterosis that can be obtained by two methods: (1) Using a rotation of boars from boar lines (example, Duroc to Landrace to Poland China to Hampshire to Duroc, etc.); (2) by special crosses, mating sows of the line-cross selected for sow performance and carcass desirability with boars of a line selected mainly for its transmitted effect on livability, rate of growth, and carcass (example, Poland or Duroc Boars on Landrace-Hampshire sows).

In comparing performance of strains themselves, the level of in-breeding must be considered. Poland China line 2 is about twice as highly inbred as line 6; therefore, line 2 inbreds were poorer than line 6 inbreds in prolificacy, livability, and growth. Line 2 inbreds, however, were superior to line 6 in conformation. In contrast, the transmitted influences of line 2 in test crossing showed line 2 superior to line 6 in livability and carcass desirability and only slightly behind in growth rate and prolificacy.

Because of their performance in test crosses, two lines were combined into a single Poland China line. Landrace test crosses were particularly superior in carcass type and prolificacy.

In full-feeding tests of line-crosses and top-crosses hybrid vigor was expressed in greater feed consumption and more rapid and economical gain. Line-crosses between breeds resulted in much more rapid gain than line-crosses within a breed. Little difference was found between full-fed line-crosses and inbreds in net carcass value. Top-crosses, however, yielded carcasses that were definitely superior to the average carcass of their parent groups.

Apparently hybrid vigor appeared in the form of true growth of muscle and bone, accompanied by increased appetite and more efficient utilization of food energy. Even when restricted to the same amount of feed as inbred lines were able to take, line-cross and top-cross pigs gained more economically by 9 and 19 percent, with no difference in ability to digest the ration and a negligible difference in carcass composition.

Compared with the average of the two parental lines at the same level of feed, top-cross pigs gained 10 percent more rapidly, required 10 percent less feed and showed superiority in net carcass value per unit of liveweight. Their carcasses contained less fat and more muscle tissue.

A new technique was tried for measuring potential prolificacy without farrowing and raising litters. Ovulation rate and litter size were determined on the twenty-fifth day of pregnancy on a sample of gilts from each cross. (Project 39).

Lamb Production. (*Melvin Bradley, Sam Rowe, A. J. Dyer*). Sixty-four immature yearling ewes, averaging 90 pounds were used in a pasture and roughage study of lamb production. Bluegrass pasture proved fairly satisfactory as the only feed for the young ewes during gestation. No cases of pregnancy diseases occurred and the lambs were strong.

Birth weight of lambs was boosted 13 percent by feeding ewes concentrates during the last 6 weeks of pregnancy. However, the advantage from grain feeding was not sufficient to offset the cost.

Results from the immature ewes were less satisfactory than in previous tests when mature ewes were handled in the same manner.

Comparing *early* versus *late* lamb production, another phase of the test indicated that more concentrates were required for early lamb production than for late lambs. The reason for this was largely the necessity of feeding concentrates to early lambing ewes from the time lambs were born until adequate grass was available. Late lambs averaged 15 pounds heavier



Fig. 6—Feeding concentrates during the last two months of pregnancy had a big effect on udder size in this test. Both groups of ewes were handled the same with the exception that those on the right received the con-

centrates during final stages of pregnancy. Even though the ewes were fed alike again after lambing, the ewes on the right produced approximately 10 percent more milk during the first 9 weeks of lactation.

at marketing time. Late lambs were more uniform in size and 95 percent were dropped within a 3-week period. Early lambs were dropped irregularly over a 75 day lambing period. (Project 77).

Effect of Sire on Lamb Production. (*P. Q. Guyer, V. Payne, A. J. Dyer*). Two rams differing widely in type and size were used to breed 60 ewes to study the influence of ram size and type on birth weight and growth rate of lambs and lambing difficulties of ewes. Half the ewes bred by each ram were fed liberal amounts of concentrates during the last six weeks of pregnancy.

Size of sire definitely influenced birth weight of single lambs but had little effect on birth weight of twin lambs. Single lambs by the large sire were 16 percent heavier than those by the small sire. By the time the lambs were 20 weeks of age singles by the larger ram were only 9 percent heavier and twins were slight-smaller than those by the small ram. Difficulties of parturition were so few in number that they could not be correlated with size of sire. (Project 77).

Nutrition of Ewes During Late Pregnancy. (*P. Q. Guyer, V. Payne, A. J. Dyer, Merle Muhrer, A. A. Case*). This study was made to determine the effects of grain-feeding of ewes on birth weight and growth rate of lambs, milk yield of ewes, and dystocias (difficulty in parturition or labor). Data revealed that liberal grain concentrate feeding resulted in 12 percent larger single lambs, 22 percent larger twins at birth, and 10 percent more milk produced by ewes during the first nine weeks of lactation than when grain was not fed. Only one dystocia occurred and that in the case of a ewe that had been liberally fed. (Project 77).

Acceptability of Prepackaged Meats. (*D. E. Brady, Starley Hunter, Elmer Kiehl, Freida Sloop, R. F. Brooks, R. L. Henrickson*). Nearly half of 1,385 household consumers interviewed in St. Louis stated a pre-

ference for pre-packaged meat service. The chief reason given was that it speeded up shopping. Other reasons given were opportunity to examine the meat, convenient selection of size and quantity, large selection available, and sanitation. With the exception of roasts and hamburger which they bought by the pound, most of those interviewed said they purchased cuts on the basis of number of servings needed for their family.

Bologna, souse, and spiced luncheon meat were selected at random from three stores for a test of bacteria in prepackaged ready-to-eat meats. Plates inoculated from the meat were incubated at 15 and 37 degrees C. The bacteria counts obtained at 15 degrees were consistently higher than those found at 37 degrees. This was expected as low refrigeration temperatures at the stores had killed most of the bacteria that needed warmth for survival, but the cold loving bacteria remained and continued to multiply.

The best method tried for keeping meat cutting blocks sanitary was to clean with detergent, rinse with hot water, and salt down. A Sanitizer was substituted for the salt with equal success. These two methods were far superior to others studied. (Project 165).

Factors Influencing Efficiency of Beef Production. (*J. E. Comfort, G. E. Dickerson, A. J. Dyer, L. A. Weaver*). This project is part of a regional study and is concerned primarily with the development and demonstration of more effective breeding methods for improving performance in beef cattle. (North Central Region Project, NC-1).

The first calves from the foundation cattle were the result of half-sib matings to compare the seven foundation groups of Herefords under uniform management conditions. Growth and feed utilization records on six young sires were reported in 1951.

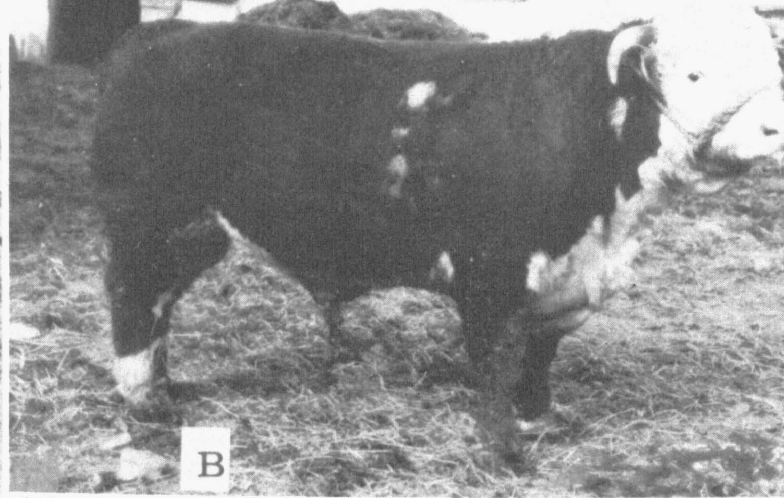
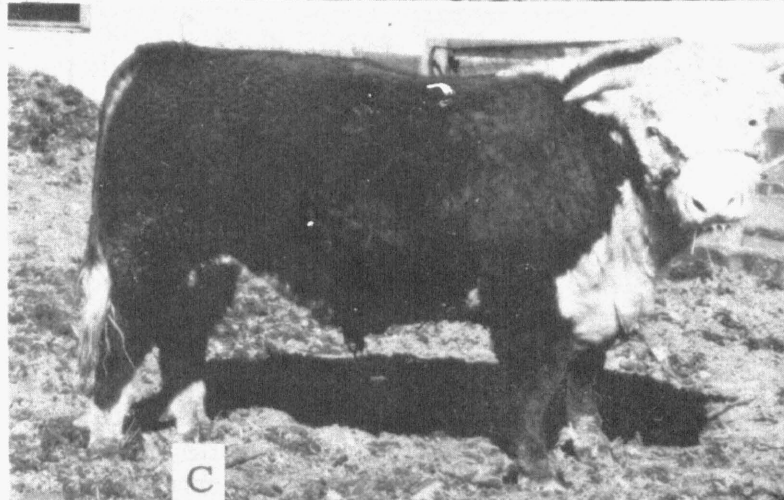


Fig. 7—This is the group of bulls used in the first year of a beef cattle breeding experiment in which the Station will strive to develop more effective breeding methods. The experiment is part of a North Central Region project. The bulls are: A—CK Cadet 19; B—WHR Navigator; C—Husker Mischief 1488; D—LVF Onward Plus 10; E—Windsor B Royal; and F—Triumph Domino 23rd.

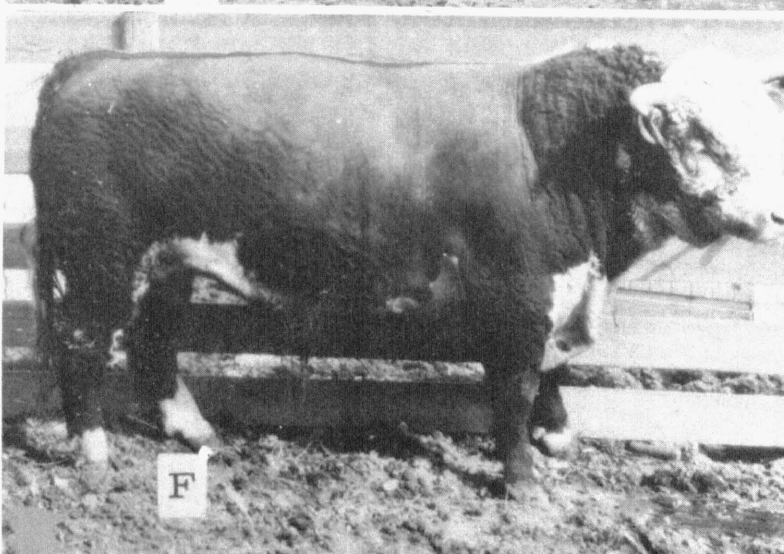
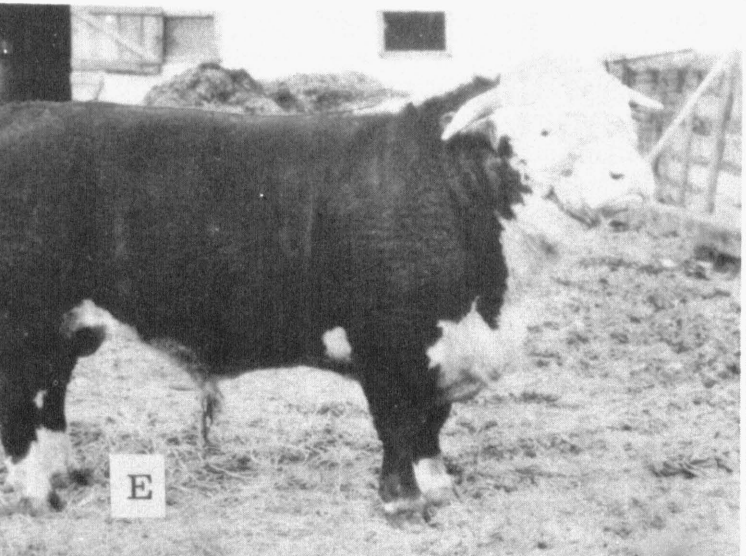
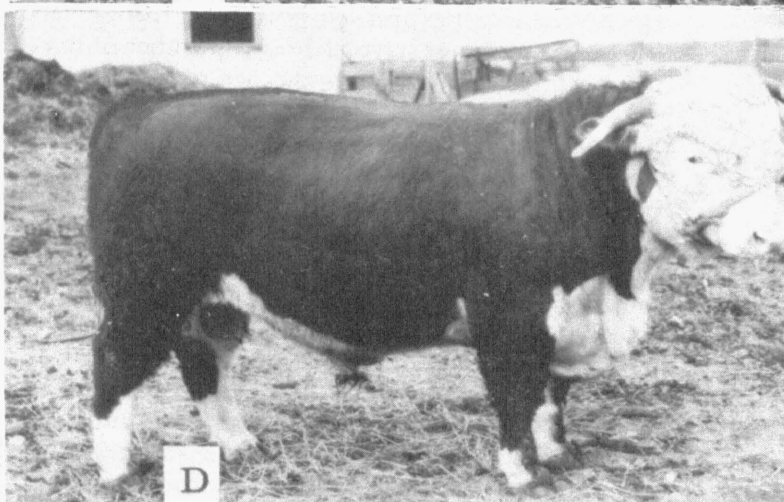


The weaning weights on 51 calves from two-year-old Hereford cows ranged from 338 to 402 pounds at 182 days of age. Nine bull calves from three sires were grainfed following weaning and after a six weeks' preliminary feeding were fed individually for 150 days.

A limited number of performance-tested yearling bulls with average or above average records were supplied to Missouri beef cattle producers from this herd. The producers obtaining the bulls agreed to furnish the following records on calves sired by these bulls:

- (a) Birth date and birth weight of each calf.
- (b) Weaning weights or sale weights and prices if calves were sold at or near weaning time.
- (c) Weights on cattle as yearlings if carried over as yearlings.
- (d) Cooperate in grading of the calves at weaning time.

Some of the yearling bulls will be sold at prevailing commercial beef prices to cooperating cattlemen. Others that may be used later on the project will be loaned on an annual basis. (Project 82).



BOTANY

C. M. Tucker, Chairman

Resistance to Tomato Wilt Fungus. (C. M. Tucker, J. P. Baumgardt). While searching for sources of resistance to Race II of tomato wilt fungus, a large number of *Lycopersicon pimpinellifolium* plants were grown in the presence of Race II of the tomato wilt fungus. About 60% of the first year's crop showed vascular discoloration, indicating the presence of Race II of the fungus. After two years, 108 descendants of the original tomato plants were free of vascular discoloration caused by the fungus. This indicated that the original *Lycopersicon pimpinellifolium* plants were heterozygous to Race II, and that the 108 plants derived from them, but showing no discoloration, were practically homozygous to Race II of the fungus. These 108 plants should be ready for crossing with commercial varieties to incorporate resistance to Race II of the wilt fungus in varieties of tomatoes with acceptable horticultural characters. (Project 41).

Developing Disease Resistance in Tomato Varieties. (C. M. Tucker, R. A. Schroeder). Tomato hybrids produced by commercial varieties and *Lycopersicon pimpinellifolium*, backcrossed several times to commercial varieties and self-pollinated through six or more generations have yielded a number of lines of tomatoes that combine resistance to tomato wilt and acceptable horticultural characters. A number of these lines were compared in yield tests with several commercial varieties. Even under wilt-free conditions, the yields of fruit from the commercial varieties were smaller than those from the wilt resistant lines. The comparisons were made under the following conditions; (1) in the field with the plants staked and pruned to two stems, (2) in the field without staking or pruning, and (3) in the greenhouse.

The field test in which the plants were staked and pruned compared 20 wilt resistant lines and commercial varieties, including Stokesdale, Break-O-Day, and Holman. One strain, S-46, which has supplanted the Holman variety in southwest Missouri ranked

second high in the test. The highest yield was obtained from a selection from a cross involving the Holman variety. The quality of fruit on this high yielding hybrid also was superior to that of S-46.

The field test in which the plants were not staked or pruned included 51 strains and varieties. The ten highest yielding lines were wilt resistant selections. The quality of the fruit of the highest yielders, however, was inferior in color and shape to that of the better commercial varieties. In addition to these comparative test plants, 210 strains were grown in replication for observation; about 400 individual plants were selected from these for seed collection and individual yield records.

The greenhouse test included 24 wilt resistant strains and commercial varieties adapted to greenhouse culture. The highest yielding commercial variety, Break-O-Day, was exceeded in yield by three of the wilt resistant line. (Project 41).

Diseases of Forest and Shade Trees. (C. M. Tucker, T. W. Bretz). A perfect (sexual) stage of oak wilt fungus *Chalara quercina*, Henry, was discovered in cultures by the investigators. The relationship between sexual and asexual stages in the life history of the fungus was demonstrated by various laboratory techniques. Sexual spores (ascospores) were demonstrated to be capable of causing infection and typical oak wilt symptoms. Heterothallic condition of the fungus was demonstrated. An airplane was used effectively in scouting for oak wilt outbreaks. (Project 52).

Identification of Plant Diseases. (C. M. Tucker, D. D. Lutes). The cool, wet season of 1951 was particularly favorable to development of certain types of plant diseases. Late blight of tomatoes was prevalent in July and with other defoliation diseases resulted in early death of tomato plants. Bacterial spot of peppers caused unusual damage. Fire blight of pears and apples was exceedingly common. Virus diseases in peppers occurred frequently. (Project 57).

DAIRY HUSBANDRY

A. C. Ragsdale, Chairman

Studies in Milk Secretion: (C. W. Turner, J. I. Raeside, M. H. Magrabi, W. R. Miller, A. J. Olsan). Studies on hormonal and nutritional methods for maintaining milk secretion were continued. A pilot study was conducted using White Plymouth Rock chicks to investigate effects of thyro-protein feeding

on growth. The possibility of meeting nutritional requirements of the hyperthyroid animal with additional vitamins and growth stimulating substances also was considered.

Animal Protein Factor was more effective than Vitamin B₁₂ in stimulating growth in hyperthyroid

chicks. Extracted liver residue, used at 5 percent of the ration, had a growth promoting effect on both normal and hyperthyroid chicks. Addition of A. P. F. in the diet revealed that A. P. F. contained additional growth promoting factors not present in the liver residues.

Thyro-protein and diethylstilbestrol were included in feed for dairy goats to determine their value toward boosting milk production. (Project 43).

Bacterial Effects on Milk. (*J. E. Edmondson, K. L. Tallman, J. H. Gholson, R. G. Jensen, A. R. Brazis, T. D. Peck, E. W. Kirk, R. W. Leftwich*). A study was made of the utilization of water soluble vitamins by microorganisms in dairy products. Growth factors required by microorganisms causing mastitis also were studied.

Effects of six microorganisms found in dairy products upon biotin and folic acid were studied. Nicotinic acid, pantothenic acid, pyridoxine, riboflavin and thiamine were studied in 1951. Amounts of biotin or folic acid utilized or synthesized by these microorganisms were determined. The *Escherichia coli* microorganisms were able to synthesize considerable amounts of each vitamin. Additional work proved that most of the vitamins removed by the organisms were not utilized but were stored within the cell. These stored vitamins were bound and not available for further metabolism.

Studies on the growth factors required by *Streptococcus agalactiae* indicated that the nutrient medium exerted a marked influence upon the morphology of the microorganisms. Glutamine and thioglycolic acid appeared necessary for the mucoid (or smooth growth) phase which includes the hemolytic qualities (break-up of red blood corpuscles with the liberation of hemoglobin). (Project 37).

Dairy Cattle Improvements. (*H. S. Peet, A. C. Ragsdale*). Improvement of dairy cattle by breeding continues as the primary objective. Line-breeding seems to be developing a more uniform herd of improved type. The Herd Improvement Registry testing program has provided a background for constructive breeding by making possible the elimination of undesirable animals. Animals of low production and low type conformation have been removed from the herd. Average production for the herd was 7,191 pounds of milk and 404 pounds of butterfat during 1951. Artificial insemination has been used to supplement studies on this method of herd improvement. (Project 64).

Wood Sugar Molasses vs. Cane Molasses as Alfalfa Silage Preservative. (*H. S. Peet, A. C. Rags-*

dale, H. A. Herman). Results indicate there is no difference between the use of wood molasses and cane, or blackstrap, molasses as a silage preservative in terms of preserving ability, milk production, live-weight, silage palatability, and consumption. (Project 17).

Pasture Investigations. (*A. C. Ragsdale, H. S. Peet*). Fifty-seven acres of improved bluegrass pasture and a 28-acre alfalfa-brome supplemental pasture furnished adequate forage for 33 Jersey cows and 22 Jersey heifers. Management practices included fertilizing the bluegrass with manure annually, clipping twice during the year and dividing the area into three parts for rotation grazing. Alfalfa-brome pasture was used as supplemental pasture for cows in milk. The pasture season ran from April 24 to November 5 in 1951, or a total of 10,780 animal pasture days. The alfalfa-brome provided silage and 367 bales of hay, in addition to pasture. (Project 64).

Official Testing of Dairy Cows. (*P. R. Cornelison*). A total of 3,211 cows per month were officially tested in herds of 165 Missouri breeders. The highest milk and butterfat producing cow for the year in the Herd Improvement Registry program produced 26,073 pounds of milk and 1,389 pounds of butterfat in a 365-day record. The highest milk and butterfat producer in the Advanced Registry program produced 15,240 pounds of milk and 988 pounds of butterfat. (Project 5).

Nutritional Studies on Growth and Milk Production. (*H. A. Herman, W. H. Cloninger, A. C. Ragsdale, K. W. Bower*). Typical silage samples were used in an attempt to evaluate factors affecting the nutritive value of Missouri grown roughages. The samples were obtained from farms where soil analyses had been made and complete information on cutting and harvesting methods was available. A total of 127 hay and 17 silage samples were taken. Samples of hay were graded according to U. S. D. A. standards and the percentage of leaf, stem, and foreign matter determined.

Chemical analyses are being made for vitamin, mineral, and other nutrient content. (Project 17).

Effect of Environmental Temperatures on Milk. (*H. A. Herman, Paul Cornelison, A. C. Ragsdale, S. Body, K. W. Bower*). A total of 212 samples of milk subjected to temperature changes (ranging from 50°F. to 105°F.) were analyzed for total solids, solids-not-fat, butterfat, total nitrogen, lactose, and ash. Some of the analyses were on milk from cows maintained under humidity conditions varying from 30 to 95 percent.

At temperatures between 90 and 105 degrees F. all constituents of milk, except lactose, increased. Solids-non-fat and specific gravity decreased. (Project 17).

Influence of Diet on Growth, Lactation, and Reproduction. (*H. A. Herman, A. C. Ragsdale, K. W. Bower*). Heavily fed heifers developed into cows that were 5 to 30 percent heavier than normal, and 5 to 10 percent above normal in skeletal conformation. However, they were one-third more expensive to raise than check animals handled normally. Heifers on a low plane of nutrition failed to attain normal size until 5 to 7 years old. Production of milk from this group was under that of the control group at first but after the third and fourth lactation equalled normal production. Fat heifers were also poor producers.

Reproduction was lowest in the heavily fed heifers, apparently due to deposition of fat around reproductive organs. The accumulation of fatty tissue in udders of these heifers prior to freshening may partly explain their poor milk production during the first lactation.

It was concluded that normal growth using pasture and roughage with a minimum concentrate feeding was the most economical and practical plan for raising heifers. (Project 17).

Mechanism Causing Bovine Mastitis. (*H. A. Herman, C. P. Merilan, J. E. Edmondson, K. E. Tallman, J. E. Gholson, O. S. Crisler*). A form of bacteria (beta-hemolytic, Lancefield group B, Streptococci) isolated from a few cases of bovine mastitis *Streptococcus agalactiae* was cultured in a casein-acetate-lactose broth medium. Samples of the medium were set aside for a check. After 18 hours in the culture, the bacteria was filtered out, leaving a sterile filtrate.

Addition of this filtrate to a reaction flask containing metabolizing mammary tissue caused a marked decrease in the rate of sugar decomposition (anaerobic glycolysis), compared to an only slight effect when the uninoculated check medium was added.

Injections of the filtrate into a cow's mammary system produced hardness and swelling of the injected quarters within 1 to 2 hours, followed by rectal temperature increase of 3 to 5 degrees F. The temperatures reached a peak in 6 to 9 hours and returned to normal in approximately 12 hours. The animal produced abnormal milk for 2 to 3 days.

Uninoculated check media produced only minor symptoms of irritation in the infused quarter. Milk obtained from this quarter was abnormal the first milking after infusion. The substance in the filtrate responsible for producing hardness and swelling was not determined. (Project 17).

Influence of Milk Procurement and Processing Methods. (*W. H. E. Reid, J. H. Gholson, R. L. Rolens, V. D. Grace*). Manufacturing methods were perfected for a cultured cream spread and salad dressing. The term "cultured cream" is being encouraged for this produce in an effort to overcome public prejudice against the words "sour cream."

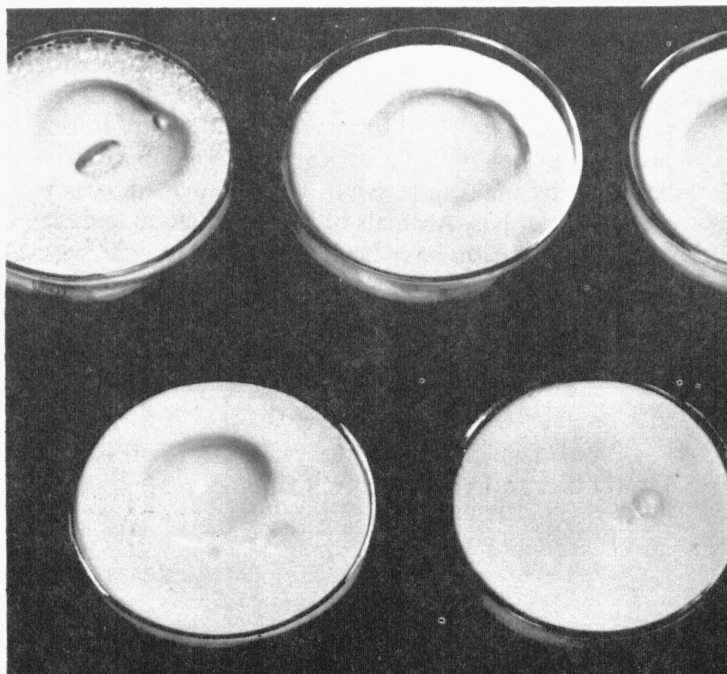
Taste panel groups representing all economic levels have been organized to acquaint the public with this new product.

In developing the spread and salad dressing, whey separation was overcome by using 0.1, 0.2, and 0.3 percent gelatin as a stabilizer. Amounts of 0.1 and 0.2 percent cornstarch resulted in a firmer cultured cream product. Stabilizers improved only the spreading properties. Whey separation was very slight when high quality starter culture was used. (Project 37).

Factors Influencing Melting Qualities of Ice Cream. (*W. H. E. Reid, J. H. Gholson*). The following were major factors in melt-down qualities in different flavored ice creams:

- (1) Composition of the mix in relation to fat, solids-non-fat, sugars, etc.
- (2) Methods of processing mix in relation to homogenization.
- (3) Methods of freezing the mix in relation to firmness of the ice cream.
- (4) Kind and amount of stabilizers used.
- (5) Kind and amount of emulsifying agent used. (Project 37).

Fig. 8—Variation of the fat content in these ice creams caused the striking difference in their melt-down quality.



A Study of Quality of Milk Received at Missouri Cheese, Evaporated Milk, and Dry Milk Factories. (*W. H. E. Reid, J. H. Gholson*). Improvement in the quality of milk received will result in improvement in the finished products. The sediment test was found to be one of the most accurate practical tests in use. It revealed conditions under which the milk was produced and furnished a good index to quality for plant managers, milk haulers, field men, county agents, and dairy farmers. (Project 37).

Hormone and Energy Factors in Milk Secretion. (*C. W. Turner, C. R. Hoover, Mei H. Wang, M. H. Magrabi, W. F. Williams, A. J. Olsan*). Radioactive phosphorus was used in an attempt to establish a more simple assay method for thyrotrophin. Chicks were injected with thyrotrophin, then given a dose of P^{32} . The time of maximal effect for a single intraperitoneal (abdominal membrane) injection of one unit of thyrotrophin was 6 hours after administration, when measured by specific activity (the ratio of uptake of P^{32} to the total orthophosphate content). Pituitary preparations have been assayed in comparison with the U. S. P. Thyrotrophin reference substance. It was estimated that 1.8 mg. (0.09 units) of the reference substance produced about a fourfold increase in the specific activity when compared with normal controls.

The radio-active phosphorus taken up by the thyroid gland, the content of orthophosphate, and weight of the thyroid gland varied with the season. Largest thyroids and the greatest uptake of F^{32} occurred during winter, whereas the orthophosphate content was low during this period.

Pituitaries of 14-week old chicks fed six days on a 0.1 percent thiouracil ration showed the highest concentration of thyrotrophin. However, the concentration of thyrotrophin in thiouracil-fed females was higher than in males. Pituitaries of chicks fed 3 days on this ration showed slightly less thyrotrophin concentration.

A study was made to reveal hormonal control of calcium metabolism. These results and the results from previous work suggested that control of bone alkaline phosphatase may be the primary action of parathyroid hormone. Through control of bone alkaline phosphatase, the parathyroid hormone also may control calcium metabolism in relation to body demand and supply. Experiments with rats showed that the alkaline phosphatase level in bone was increased above normal in a partial hypoparathyroid condition, while low serum calcium and high serum inorganic phosphorus levels were maintained. (Project 43).

Improvement of Dairy Cattle Through Breeding. (*H. A. Herman, A. C. Ragsdale, P. R. Cornelison, C. F. Foreman, H. J. Weeth, W. H. Cloninger, R. C. Laben, Chase Wilson*). Data showed upward trends in milk and butterfat production and butterfat percentage in the University of Missouri Experiment Station herd, where effects of inbreeding and outcrossing on production were being studied.

Variation of daughter and dam records was found to be essentially the same; thus intra-sire daughter-dam correlations in regression estimates of daughter on dam were of equal magnitude. The effect of inbreeding was analyzed by intra-sire regression of production on inbreeding. A significant decline of 66 pounds of milk and 2 pounds of butterfat for each percent increase in inbreeding was observed.

Increasing attention has been given to reproductive problems. An investigation of histological and histochemical changes taking place in normal genitalia during the estrous cycle and gestation period of the reproductive process was completed. These data should be of value in recognition and interpretation of experimentally and pathologically induced deviation from reproductively normal genitalia. For example, an accumulation of glycogen, plus a low alkaline phosphatase content in the placentome, might indicate the inability of carbohydrates to pass the placental barrier. (Project 84).

Transmitting Ability of Sires. (*H. A. Herman, A. C. Ragsdale, Chase Wilson*). In a study of transmitting ability of sires proved in Missouri Dairy Herd Improvement Associations from 1937 to 1949, it was found there had been an average annual increase in butterfat production of 4.06 pounds per cow for daughters of sires proved since 1937. These studies were made in the hope of formulating more accurate prediction indexes for sire influence on production. (Project 84).

Improving Artificial Insemination. (*H. A. Herman, A. C. Ragsdale, H. J. Weeth, John Buckalew, K. W. Bower, W. H. Cloninger, P. R. Cornelison*). In an attempt to study semen characteristics in relation to conception rate under field conditions, 4,424 samples of semen from 200 sires were examined. Observations were made on number of spermatozoa, viability under storage conditions, and morphology of spermatozoa.

Conception rates were calculated on the basis of all cows that failed to return for second service after a 60-day period. More than 85,000 cows were artificially inseminated with an average rate of about 65 percent first service non-returns. The relationship between

survival time of spermatozoa under storage conditions and the sire's actual breeding record was still the best index of semen evaluation. (Project 89).

Factors in Conception Rate. (*H. A. Herman, A. C. Ragsdale, W. H. Cloninger, P. R. Cornelison, K. W. Bower*). Diseased herds, particularly those with brucellosis infections, continued to have low first service settling rates. Poor feeding, especially in the case of low quality roughage, reduced breeding efficiency.

Seasonal distribution of services by artificial insemination revealed 54.3 percent of the cows were bred April 1 to September 1, clearly demonstrating the tendency of too many dairymen to have spring freshening cows with a resulting period of low milk supply from November to March. (Project 89).

Semen Preservation Techniques. (*H. A. Herman, A. C. Ragsdale, H. J. Weeth, E. Weiciehowski, K. W. Bower, R. Campschmidt*). The influence of the sodium ion on spermatozoa and sedimentation rates of spermatozoa was studied. An improved diluter was perfected. It is now undergoing field test. Skim milk and whole milk have been tested as semen diluents, but to date, results do not exceed the efficiency of sodium citrate-egg yolk diluent.

Hemolytic bacteria have been found to be detrimental to survival of semen when present in large numbers in storage. Non-hemolytic bacteria seem to exert a favorable influence. (Project 89).

Influence of Climate on Cattle. (*Samuel Brody, C. R. Blincoe, H. E. Dale, H. H. Kibler, O. J. Miller, A. C. Ragsdale, R. E. Stewart, and D. M. Worstell*). Reports on this research project published this year are given in Missouri Agricultural Experiment Station

Fig. 9—A technician is in the process of measuring heat production by the closed circuit method in the University's climatic laboratory. Animals can be subjected to almost any set of temperature, light, humidity and wind conditions in this building's two chambers.



Research Bulletins 471, 473, 479, 481, 484, 488, 489 and 515. Experiments with climatic conditions at the Missouri Station tend to disprove a popular belief that tropical breeds of cattle, such as the Brahman, have superior "sweating" ability. No difference in this characteristic was found between breeds evolved in tropical and temperate climates. The maximal outer surface evaporative rate attained was 150 grams per square meter per hour.

The maximum evaporation rate was reached between 75 and 85 degrees F. in European cattle and between 90 and 100 degrees in Indian cattle. The slower rise of evaporation rate in Indian cattle presumably resulted from their 12 percent greater surface area per unit weight and their lower rate of heat production. Their greater surface area, found in large dewlaps, long ears, naval flaps, hump, folds in the skin, and particularly in the very large vulva, gave them an advantage in surface cooling by evaporation and convection.

Reduced feed consumption was another factor found to be associated with greater heat tolerance in tropical breeds. From the opposite standpoint, cold tolerance was associated with such conditions as high feed consumption, high milk production, and small surface area for heat dissipation in relation to body weight—all characteristics of the European dairy breeds.

Cattle have been tested under the following climatic conditions; temperature range 5 to 105 degrees F; relative humidity range from 35 to 85 percent; and wind velocity range from .5 to 10 mph. Observations were made on the cows for effect on milk production, feed and water consumption, body weight, pulse rate, respiration, pulmonary ventilation rate, rectal temperature, skin and hair temperatures, heat production, total evaporative moisture loss, respiratory moisture loss, blood and urine composition, and thyroid activity.

While Indian cows were found to be more heat tolerant than European cows, no difference was found in yearling Brown Swiss and Brahman heifers. The critical temperature for Brown Swiss cows for milk production, feed, and water consumption appeared to be 85 degrees F. Higher temperatures reduced feed consumption more than milk production in the Brown Swiss cows. This resulted in loss of body weight. In comparison to lactating Brown Swiss cows, non-milking Brahman cows showed higher critical temperatures for feed consumption and body weight.

The skin and hair temperatures differ greatly from the air temperatures at 0 degrees F. (around 75 degrees F. difference between skin and air temperature and about 45 degrees between hair and surrounding

air). The surface temperature increased linearly with environmental temperature from 0 degrees to about 65 degrees F., then continued this linear increase, but at a reduced rate, until 105 degrees F. was reached, at which temperature the hair, skin, and air coincide.

Non-evaporative cooling was virtually constant for hair-to-air cooling and was increased with increasing environmental temperature for skin-to-hair cooling. This indicated that both peripheral vasomotor control of the skin and change in hair coating were important factors in making cattle tolerant to low temperature. Lack of tolerance to heat was due to a low threshold and narrow range of sweating.

Feed consumption, milk production, and heat production declined during the period of rise in environmental temperature. Since the decline in heat increments associated with milk production and feed consumption was not sufficient to explain the amount of decline in total heat production, it was assumed

that increasing environmental temperatures reduced thyroid activity. Attempts to measure thyroid activity by the concentration of radioactive iodine in the blood plasma 24 to 72 hours following injection appeared to confirm this statement. However, the data are too inadequate to give conclusive evidence.

Light reflectance, between wave lengths of 400 to 700 millimicrons, was measured periodically with a recording spectrophotometer from the hair of one gray Brahman and three Brown Swiss cows. The amount of light reflected by the hair of all cows increased with the rise in environmental temperature from 65 degrees F. and was associated with the increase in length of time kept in the chamber.

The rise of reflecting ability with rising temperature was more rapid and began at a lower temperature in the Brahman than in the Brown Swiss, indicating a more sensitive adaptation of Brahmans to rising temperatures. (Project 100).

ENTOMOLOGY

Leonard Haseman, Chairman

Insect Information Service. (*Leonard Haseman, P. C. Stone, H. E. Brown, Lee Jenkins, C. W. Wingo, W. R. Enns, G. W. Thomas, E. R. Oatman*). Several thousand personal letters to farmers and others with detailed answers to specific questions on insect problems were among services rendered in this project. Several hundred farm site visits were made to help with control of termites, household pests, moles, rats, and other insects and rodents. Leaflets, circulars, and bulletins were usually included with letters answering specific questions for farmers. Hundreds of telephone inquiries also were answered.

Regular annual grasshopper, chinch bug, hessian fly, screw worm, and European corn borer surveys were made to provide forewarning for farmers and provide rush service on chemicals. While no major pest swept the state in 1951, some uneasy days were encountered in threats from greenbugs in grain, garden web worms in a number of crops, cutworms, and orchard insects; and flies, mosquitoes, rats, and fleas as carriers of disease in flooded areas. (Project 30).

Control of Fruit and Vegetable Insects. (*Lee Jenkins, G. W. Thomas, E. R. Oatman*). The continued search for chemicals to control fruit insects uncovered several useful materials and eliminated others as helpful controls.

Dieldrin at 1 pound of 25 percent wettable material per 100 gallons of water gave excellent control of plum curculio without causing noticeable russet on golden delicious apples when applied in the calyx and first cover sprays.

Dieldrin failed to give satisfactory control of the codling moth. One pound of 15 percent wettable parathion per 100 gallons of water killed a high percentage of the codling moth larvae that had already entered apples.

Use of 2 pounds Stauffer's sulphenone per 100 gallons in the calyx and first cover sprays resulted in severe russetting of golden delicious apples.

EPN-300, at the rate of 1 ½ pounds per 100 gallons, gave excellent control of plum curculio on apples. Methoxychlor at 2 pounds of 50 percent wettable powder in 10 gallons of spray, used in the calyx and first two cover sprays, gave excellent control of plum curculio in apples but caused some russet on golden delicious.

Dieldrin, aldrin, EPN-300, parathion, and methoxychlor each gave excellent control of plum curculio on peaches. Dilan emulsion did not control curculio and caused injury to peach leaves.

EPN-300, parathion, and methoxychlor each gave satisfactory control of oriental fruit moth. Dieldrin and aldrin failed to control oriental fruit moth.

Parathion applied at 10-day intervals controlled grape scale satisfactorily. This insecticide also showed promise for control of grapeberry moth. The tests failed to bring to light any material that would effectively repel or kill rose chafer beetle and green June beetle.

Spraying or dusting with a combination of equal parts DDT and chlordane afforded good control to strawberry growers who encountered heavy damage from sucking insect pests. EPN-300 and parathion each gave good results. **CAUTION:** As a precaution against poisonous residues at harvest time, these materials should not be applied after the peak of bloom. (Project 31).

Controlling American Foulbrood of Bees. (*Leonard Haseman*). Sulfathiazole treatment continued to give complete protection from American foulbrood in the experimental apiary in 1951. Reports from beekeepers throughout the country bear out these results when they used the control as recommended. Sulfa drugs, by protecting bees, have saved tons of valuable honey and thousands of badly needed colonies of bees, in addition to adding much legume seed and fruits to our country's production. (Project 45).

Malarial Mosquitoes in Missouri. (*Philip C. Stone*). Many additions to the list of Missouri mosquitoes and their distribution over the state were made. The main effort was directed toward collecting and identifying mosquitoes in the flooded Missouri River Valley. Pest mosquitoes were reared, pinned, and identified from various sources of water in and around Columbia. (Project 34).

Control of Livestock Insects. (*C. W. Wingo, P. C. Stone*). Studies of field strains of house flies indicated little or no correlation between the past spraying history of the environment and degree of insecticide resistance developed by the flies. Spraying tests of these environments indicated that fly control is still possible in some cases with chlorinated hydrocarbons, even where resistance to DDT has developed, provided adequate sanitary measures have been taken to prevent excessive fly breeding.

Lindane-methoxychlor barn sprays, which have been effective in controlling some strains of house flies, were found to be ineffective in stable fly control. Preliminary studies of field strains of stable flies indicated that no resistance to DDT has been developed among stable flies.

A new species of horse fly, not previously reported in Missouri, was found in southeast Missouri

during a heavy outbreak of anthrax in that section. Observations indicated that this species may have acted as a vector of the disease. Piperonyl butoxide-pyrethrum sprays gave absolute protection from horse flies for periods up to 48 hours but lost effectiveness rapidly afterward.

Studies on field control of horn flies resulted in control periods up to 30 days in length when animals were sprayed with 8 pounds DDT per 100 gallons of water. (Project 46).

Influence of Soil Minerals on Insects. (*Leonard Haseman, P. C. Stone, H. E. Brown*). The influence of different chemical fertilizer mixtures on insect pests was studied in this project. European house crickets were reared through two generations in a laboratory under controlled conditions. Plant materials tested were grown in the field and greenhouse on different soils with known amounts and combinations of soil minerals. Such plant materials as ground dried sweet potato tops, ground alfalfa, and ground field corn were used as diets for the crickets. Two control diets were included for comparison.

The type of food had a direct influence on the length of nymphal stage, weight at maturity, and fecundity of the crickets. Nymphs matured much slower when fed ground sweet potato tops.

The rate of maturing and weight at maturity varied with the fertilizer treatment of soil on which the food had been grown. The smallest crickets frequently had wings which were reduced in size and deformed.

In greenbug studies, three levels of nitrogen were added to a prepared soil-sand mixture and a single wheat plant grown in each plot, which contained 5 pounds of soil. Apparently the lowest level of nitrogen used in the test was adequate, as none of the plants showed nitrogen deficiency on chemical analysis. No significant difference in aphid fecundity was noted where nitrogen was supplied in the form of compost, though there was a tendency toward higher fecundity. Nitrogen showed little effect on reproduction. The highest number of reproductions in aphids occurred on high magnesium and high phosphorus bearing plants. (Project 74).

Biology in Control of Field Crop Insects. (*H. E. Brown, P. C. Stone, Leonard Haseman*). Observations indicated that the low European corn borer populations during 1949 and 1950 were due to climatic conditions.

The regular abundance survey of overwintering European corn borer larvae showed the continued trend toward lower fall populations, which started

in 1950. The average number of borers per 100 plants was 37 which was much below the high average of 122 reached in 1949. The corn borer was found in 16 additional Missouri counties. While the borer has not been specifically recorded from a few Ozark counties, where little corn is grown, the whole state of Missouri may now be considered infested by this pest.

Studies were continued on parasitic control of the European corn borer. Most of the parasites tested in Missouri have failed to establish themselves, but one, the *Lydella* fly, continued to show good promise of biological control.

Field corn hybrids (single and double crosses) were studied for possible resistance to corn earworm attack. Little evidence of resistance was found but valuable experience in technique for future investigation was obtained. (Project 102).

Mites and Ticks of Missouri. (Philip C. Stone).

Appearance of a fungus disease of bluegrass in Northwest Missouri which completely destroyed seed production on infested plants led to a study of silver top mite, the vector of the disease.

Miticides proved effective in selective killing of mites of the drosophila fly, which are used by geneticists working out basic problems in genetics. These mites have been shown to destroy important mutant lines of the drosophila fly. The discovery of a selective miticide made possible preservation of these cultures.

A technique was developed for collecting eggs from two species of overwintering Trombididae adult mites, and for rearing the mites. These mites are closely related to the chigger and have much the same life cycle, with the exception that they attack only insects. (Project 131).

FIELD CROPS

W. C. Etheridge, Chairman

Cotton. (W. R. Langford, W. C. Etheridge, Lloyd Cavanah). Fox was the most productive of 25 varieties of cotton tested at Sikeston, Mo. It yielded 2,013 pounds of seed cotton per acre, including 725 pounds of lint.

In date of planting trials, cotton planted April 16 produced 1,771 pounds of seed cotton per acre, compared with 1,434 pounds from May 1 plantings, and 1,020 pounds from May 14 plantings. Seventy-three percent of the cotton from the April plantings had been picked by October 10, compared with 39 percent for May 14 plantings.

Dinitro, applied at 2 quarts per acre as a pre-emergent spray, was fairly effective in controlling weeds without reducing cotton yields.

Burr clover, vetch, and vetch rye, seeded in cotton rows and plowed under the following spring, increased yields of seed cotton by 33, 32, and 26%, respectively. Nitrogen fertilizers applied at the rate of 50 pounds of nitrogen per acre increased yield of seed cotton 40 percent; 100 pounds per acre brought a 71 percent increase. Further addition of nitrogen failed to increase yield. (See Table 8).

TABLE 8 -- RESPONSE OF COTTON TO NITROGEN
SIKESTON, 1951

Pounds N ₂ per acre	Pounds seed cotton per acre		
	1950	1951	2-year Average
0	1348	650	999
50	1247	910	934
100	1095	1110	1103
200	1037	1050	1044
300	940	1000	970

Phosphorus applied at 40, 80, and 120 pounds P₂O₅ per acre more than doubled the yield of seed cotton per acre. Application above 40 pounds did not bring enough increase in yield to pay. (See Table 9).

TABLE 9 -- RESPONSE OF COTTON TO PHOSPHORUS
SIKESTON, 1951

Pounds P ₂ O ₅ per acre	Pounds seed cotton per acre
0	
20	420
40	730
80	720
120	750
1000# rock phosphate	320

Cotton variety performance tests at Sikeston are reported in Table 10. (Project 160).

TABLE 10 -- PERFORMANCE OF COTTON VARIETIES
AT SIKESTON, 1951

Variety	Pounds per Acre		Gin Turn- out %	Staple length 1/32"	Bolls per lb.	Lbs. lint at first picking
	Seed cot.	Lint				
Fox	2013	725	36.0	35	74	337
Empire	1890	695	36.8	35	57	292
Deltapine 15	1690	684	40.5	35	71	273
Stoneville 62	1800	682	37.9	34	66	313
Tennessee 241	1777	640	36.0	35	59	224
Deltapine 33	1773	640	36.1	34	73	280
Early Fluff	1808	636	35.2	35	62	327
Delfos 9169	1782	629	35.3	38	65	285
Stoneville 2B-6221	1720	617	35.9	34	62	222
Paula C	1746	602	34.5	35	63	201
Paula 95-47-U	1670	601	36.0	34	64	223

Pandora	1686	597	35.4	34	63	195
Tennessee 818	1619	588	36.3	34	62	212
Stoneville 2B	1663	572	34.4	34	64	230
Coker 100W	1594	569	35.7	35	66	235
Bobshaw 1A	1570	560	35.7	34	67	234
Plains	1514	556	36.7	35	65	249
Arkot 2-1	1555	544	35.0	35	63	240
Coker 100 Staple	1546	535	34.6	39	67	201
Stoneville 2B-2492	1502	526	35.0	35	66	190
Hybrid 56	1419	518	36.5	36	61	151
Stonewilt	1403	498	35.5	35	65	194
Rowden	1261	442	35.1	32	56	163
Deltapride	1225	440	35.9	36	65	196
Wilds	1258	421	33.5	40	68	163

Rice. (*W. R. Langford, W. C. Etheridge, Lloyd Cavanah*). Rice variety yield tests were grown at Elsberry and Palmyra. At least five of the varieties matured early enough and brought high enough yields to be of economic importance to Missouri rice growers. (Project 173).

Seed Testing Laboratory. (*C. A. Helm, Lloyd Cavanah, Viola Stanway*). More than 8,600 individual tests were made on approximately 4,200 samples of seed during the fiscal year 1952. The seed testing laboratory is a necessary part of the process of producing new varieties and strains of plants. Testing must be carried on at all stages from the plant breeding field to the final multiplication of seed for distribution.

A large part of the laboratory's annual job is testing seed from inspected fields of farmers who specialize in growing high quality certified seed. An additional assignment is testing for farmers who do not specialize in seed production but are interested in quality for their own crop needs. Samples are frequently tested for commercial seed dealers. Table 11 shows the sources of seed samples, the number of tests, and the kinds of tests made.

TABLE 11 -- SEED SAMPLES TESTED FROM JULY 1, 1951 TO JUNE 30, 1952

I. Source of Samples:	
1. Seed Growers	1604
2. Other Farmers	2294
3. Seed Dealers	296
Total	4194
II. Number of Tests	
1. Germination	4195
2. Purity	1636
3. Examination for quality	860
4. Examination for weeds	1838
5. Identification	142
Total	8671

Breeding Better Oats for Missouri. (*J. M. Poehlman, W. P. Sappenfield, C. L. Koehler*). Breeding and testing of new oats for Missouri continued to re-

ceive much attention. Two new varieties, Missouri 0-200 and Missouri 0-205, have been developed as a result of this project. Both are early maturing, Columbia type oats.

Missouri 0-200, from the cross of Columbia and Bond-Iogold, was distributed in 1949. It was high yielding and resistant to smut, stem rust, and races of crown rust that were common in Missouri at the time of its release. New races of crown rust now have developed in the State that attack Missouri 0-200, and place it in the crown rust susceptible class.

Missouri 0-205, from the cross of Columbia and Victoria-Richland, was distributed in the spring of 1951. It appears to be a very valuable variety in the southern spring oats region. Missouri plant breeders believe it may be the most promising variety developed since Columbia was distributed in 1930. Exceptionally vigorous and high yielding, it has averaged 59.7 bushels per acre as compared with 57.0 bushels for Andrew, 54.3 for Missouri 0-200, 52.0 for Columbia, and 48.9 for Clinton. Missouri 0-205 has a strong straw and is resistant to smut, Victoria blight, stem rust, and crown rust. Approximately 12,000 bushels of Missouri 0-205 seed were planted in the State in 1952.

An initial increase in foundation seed of Columbia x Marion cross was made in 1950. This strain has a source of resistance to smut, stem rust, and crown rust differing from that of Missouri 0-205, making it useful as a possible substitute should new races of rust develop that attack Missouri 0-205. No plans have been made for immediate release of this new strain. (Project 21).

Improvement of Soft Red Wheat. (*J. M. Poehlman, B. H. Beard, Leta Maharg*). Efforts have been made toward breeding and evaluating new strains of soft red winter wheat with resistance to leaf rust, loose smut, and Hessian fly. Vigo, Clarkan, and Royal lead standard varieties in yield. Pawnee, a hard wheat popular among farmers, has been less productive under experimental testing.

Outstanding among experimental strains are selections from the Vigo x Clarkan cross. These selections are being considered for increase and distribution. Wheat quality studies were continued in the hope of finding a new variety high in yield and possessing good baking quality. (Project 20).

Testing and Improvement of Pasture Species. (*E. Marion Brown, Joe Baldrige, O. H. Fletchall, W. R. Langford*). Orchard grass plants were selected by progeny test and grouped into 8 isolation blocks for in-

tercrossing. A progeny test consisting of 52 selected plants from tall fescue was established.

Lespedeza variety tests were grown at Columbia and Sikeston, Mo. An early strain of Korean Lespedeza, Iowa 6, proved equal to Korean in forage yield and was 7 to 10 days earlier in maturity. At Columbia, two medium maturing strains of Korean lespedeza, Rowan and FC 31757-43, yielded 33 percent more hay and 49 percent more seed than Korean. A late maturing Korean strain, Climax, produced 188 percent more hay and 207 percent more seed than Korean at Sikeston. Kobe, a late maturing strain of common lespeleza, produced 102 percent more hay and 117 percent more seed than Korean at Sikeston.

Efforts to build up seed stocks of Climax have yielded 140 pounds of breeders' seed and 1,900 pounds of registered seed during the past two seasons.

Because of its rank as the most destructive lespepeza disease in Missouri, bacterial wilt has been the object of experiments to develop suitable control methods. A search has been made for suitable methods of inoculation and for resistant lines. More than 12,000 plants have been inoculated with bacterial wilt to test their resistance. Several interstrain crosses have been made in attempts to locate wilt resistant lines in the segregating generations of hybrids. (Project 47).

Interaction Between Pasture Species in Mixtures. (*E. M. Brown, O. H. Fletchall*). At the Sikeston field, steers gained 229 pounds per acre on tall fescue and a sparse stand of birdsfoot trefoil; 249 pounds on brome grass and ladino clover; and 204 pounds on wheat and lespepeza (undergrazed in the spring). Orchard grass provided a better balanced mixture with ladino clover in small plots than did tall fescue, brome grass, or bluegrass. Better stands of tall fescue and ladino clover resulted from seedings made in late August and early September than from seedings made in late September and early October. (Project 47).

Improvement of Permanent Pastures with Legumes. (*E. M. Brown*). At Columbia, steers gained 256 pounds per acre (2.03 pounds per day) on bluegrass and Kobe lespepeza; 335 pounds (1.99 pounds per day) on tall fescue and ladino; and 224 pounds per acre (1.93 pounds per day) on tall fescue and Korean lespepeza. Rotation grazing preserved a stand of Kobe lespepeza in bluegrass. Alternate grazing partially protected ladino clover and tall fescue from injury due to selective grazing.

At Lathrop, steers gained 355 pounds per acre (2.47 pounds per day) on wheat and lespepeza pas-

ture; 350 pounds per acre (1.62 pounds per day) on tall fescue and ladino clover; 347 pounds per acre (1.72 pounds per day) on bluegrass fertilized annually with ammonium nitrate; 313 pounds per acre (2.18 pounds per day) bluegrass with sparse stands of ladino and birdsfoot trefoil; 270 pounds per acre (1.8 pounds per day) on brome grass, bluegrass, and ladino clover; and 229 pounds per acre (2.01 pounds per day) on unfertilized bluegrass, redtop, and Korean lespepeza mixture. Rotation grazing protected ladino clover in brome grass from injury by spot grazing. (Project 47).

Breeding and Developing Superior Strains of Birdsfoot Trefoil. (*J. D. Baldrige*). Broadleaf birdsfoot trefoil is a promising legume for use in permanent meadows and pastures in Missouri. For the past two years broadleaf trefoil varieties and timothy have produced from 6,650 to 7,260 pounds of hay and aftermath and from 17 to 157 pounds of trefoil seed per acre. (Kenland red clover and timothy yielded 6,050 pounds and Korean lespepeza and timothy 5,480 pounds per acre of hay and aftermath.

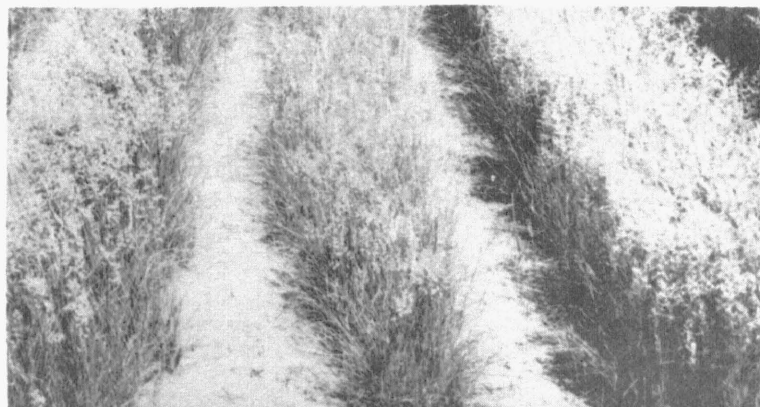
Approximately 1,000 selected birdsfoot trefoil plants were moved to an isolated location for intercrossing of selected plants. Seed was saved from approximately one-half of the plants. This seed is intended for planting in progeny rows, for future evaluation. (Project 47).

Breeding Hybrid Corn for Missouri. (*M. S. Zuber, W. A. Crane*). Objectives of corn investigation at the Missouri Station are:

- (1) Development and selection of new, inbred lines from open pollinated varieties; single, double, and multiple crosses.
- (2) Testing of new inbred lines through top-cross progeny.
- (3) Testing of single crosses.
- (4) Testing of double crosses.

A new mid-season yellow hybrid, Missouri No. 843 (WF 9 x Oh 7 A) x (C 103 x B 10), proved superior in yield to U. S. 13 by 14.1 bushels per acre. Mis-

Fig. 10—The bluegrass nursery at Lathrop, Mo., shows progress that is being made in improving this native grass. Row in center is the common check and the other rows are advanced generation hybrids.



souri 843 also had a superior record of resistance to lodging. It has been recommended for release for commercial production as soon as seed stocks can be produced.

Four new medium-maturing white hybrids are ready to be released for commercial production. They are especially adapted to northern Missouri. (Project 85).

Breeding Winter Barley. (*J. M. Poehlman, D. D. Terhune*). From one bushel of seed planted at Sikeston in the fall of 1947, more than 25,000 bushels of certified seed of the new Missouri B-400 variety were produced in 1951. This winter barley variety has a high yield, stiff straw, and early maturity, and resistance to diseases, especially field resistance to loose smut (*Ustilago nuda*). It possesses excellent winter hardiness and has been well received by Missouri winter barley growers.

A total of 116 varieties and strains of winter barley were grown in five yield tests at Columbia, Bethany, Pierce City, and Sikeston to test adaptation to different climatic and soil conditions of the State. Outstanding performers were selections from the crosses Admire x Early Beardless; Kentucky No. 2 x Early Beardless; and Ward x Early Beardless. In addition to seedings in the yield tests, approximately 1,500 new experimental strains originating from new crosses have been tested. Several of these were advanced to the variety yield test.

Selected winter barley varieties and strains were artificially inoculated in 1951 with one of the three smut diseases infecting barley. Results showed excellent resistance to all three of the barley smuts, with some varieties having resistance to more than one smut. Crosses have been made in attempts to combine resistance to all three smut diseases in one barley strain which will have good production qualities. (Project 90).

Mechanism of Heredity in Corn. (*L. J. Stadler, M. G. Nauffer*). Mechanism of heredity studies were concerned primarily with two problems; (1) problems of gene structure, and (2) the nature of radiation-induced mutations.

Evidence accumulating from inheritance studies suggested that the gene may not be the ultimate unit but rather a complex of gene elements of related action. Detailed study of spontaneous mutations with *R* and *A* genes indicated existence of separately mutating elements within the entity regarded as a single gene.

Previous studies on the nature of radiation-induced mutations have shown that those induced by X-ray treatment were largely or wholly the result of chromosomal derangement, rather than the evolution of new genes. However, mutations induced by ultra-violet radiations were indistinguishable from mutations which occurred spontaneously. These appeared to be true intra-genic changes.

Distinction between true gene mutations and various pseudo-mutations is possible only by critical examination, using specific genes that are unusually favorable for analysis. Studies on comparisons must be made under conditions where frequency of induced mutations is extremely low, since only mutations at a single gene locus are of significance.

A comprehensive study of effects of X-ray and ultra-violet treatment of pollen upon the alleles *A* and *A* is now in progress. (Project 48).

Special Genetics of Polypoidy in Wheat. (*E. R. Sears*). Using X-ray treatment on wheat plants with an added chromosome from *Aegiolops umbellulata*, four different translocations have been obtained which, in effect, consist of the replacement of a piece of wheat chromosome with a segment of the *Aegiolops umbellulata* chromosome carrying resistance to leaf rust. These substituted chromosomes apparently included most or all of one arm of the *Aegiolops* chromosome, suggesting the gene for expression is located near the centromere.

Behavior of resistance-carrying telocentric chromosomes gives additional evidence for this hypothesis since resistance supposedly is obtained from substituted chromosomes. These telocentrics usually join with a wheat pair to form a trivalent, indicating that only a small piece of the telocentric can be from *Aegiolops*. This piece can scarcely be at the end opposite the centromere, for then the centromere and the other arms of the chromosome from which the telocentric was derived would have to be derived from the wheat. In that case, this two-armed chromosome should pair more readily with the popular wheat chromosome than does the telocentric. It does not. Thus, it seems likely the small segment carrying the resistant gene or genes lies near the centromere of the *Aegiolops* chromosome.

Hope wheat has been shown to carry a gene for resistance to stem rust on chromosome III. This is the sixth chromosome in four varieties of wheat shown to carry stem rust resistance.

Nullisomic XIV had been identified, completing the series of 21 nullisomics and monosomics. Tetrasomic XXI also had been attained, leaving only XV

TABLE 12 -- SOYBEAN VARIETY TESTS IN SOUTH MISSOURI

	Bushels per acre			(1) Matur- ity	Lodg- ing score	Height in.	% oil
	Ladonia	Norborne	Columbia				
Hawkeye	28.3	29.4	25.6	-16.1	1.5	35	21.6
Adams	28.3	29.6	20.6	-12.5	2.0	37	21.9
Lincoln	32.5	30.9	25.5	- 9.6	2.0	39	21.6
Chief	33.0	32.5	27.5	- 1.8	2.6	48	20.6
Wabash	31.5	30.7	29.1	0	2.1	42	21.4
Patoka	32.1	33.6	28.0	+ 0.3	2.2	36	20.2
Perry (C 612)	37.3	36.2	31.0	+ 2.9	1.9	38	21.5

(1) Days earlier or later than Wabash

needed to complete the tri- and tetrasomic series.

Most of the genetic relationships among the 21 chromosomes of wheat apparently may be confined to seven groups of three. This is in line with the fact that wheat originated as an addition product of three related species each with seven pairs of chromosomes. (Project 48).

Improvement of the Missouri Soybean Crop. (*L. F. Williams, W. C. Etheridge*). Emphasis in the soybean project was shifted toward breeding for disease resistance and study of breeding methods. Tests were planted at Sikeston, Columbia, Ladonia, and Norborne for most of this work. Variety tests were grown at Elsberry and Pierce City.

Excessive rainfall in June and early July, followed by drought in August, severely reduced yields at Sikeston.

Perry and the new strain, L 6-2132, were in close competition for high yield. The two varieties alternated as high-yielder as location for the test changed.

In general, Perry will excel south of the Missouri river, where it should replace much of the Wabash, Chief, and S-100 seedings. Tests indicated that Perry increased production several bushels per acre in this region. (See Table 12).

While Perry offers higher yields than common varieties north of the Missouri river, tests indicated L 6-2132 will be still better for this portion of the State when enough seed is available. See Table 13. (Project 49).

TABLE 13 -- SOYBEAN VARIETY TESTS IN NORTH MISSOURI

	Bushels per acre		(1) Matur- ity	Lodg- ing score	Height (in.)
	Sikeston	Pierce City			
Lincoln	22.6	22.1	-12	2.6	45
Chief	21.3	22.4	- 5	2.8	57
Wabash	22.6	15.8	0	2.3	51
Perry	31.7	14.4	+ 3	2.1	48
S-100	19.3	13.7	+17	2.4	54
Ogden	27.3	11.2	+35	1.8	44

(1) Days earlier or later than Wabash

FORESTRY

R. H. Westveld, Chairman

Christmas Tree Culture. (*R. H. Westveld, R. Brooks Polk*). Experimental Christmas tree culture was conducted on the Ashland wildlife area and arboretum under four separate investigations.

- (1) Production and marketing of Scotch pine Christmas trees.
- (2) Development of Christmas trees through stump culture.
- (3) Factors causing winter discoloration of winter evergreens.
- (4) Adaptability of Christmas tree species to Missouri lands.

Planting method, spacing, and vegetable-competition control treatments were made throughout the work. Cultivation following planting of a 1951 specie adaptability plot proved harmful rather than beneficial.

Discoloration in Christmas trees was thought to be physiological, rather than nutritional in nature, according to comparative studies.

Only the Danish and Rigi forms of Scotch pine showed satisfactory vigor after the first season's growth in adaptability tests. The other varieties tested were Norway spruce, White fir, and Douglas fir. (Project 9).

Forest Management and Utilization. (*P. W. Fletcher, Julian Ochrymowych, W. E. Stiles, E. E. Pickett, C. W. Gehrke*). Studies were made on the following problems: The relation between season and mineral composition of foliage and twigs; effect of soil on mineral composition and growth rate of seedlings; growth and yield in both artificial and natural stands and pruning in an artificial stand; and the place of

Eastern Red cedar in the ecological succession of abandoned fields.

When seed-bearing trees were in the locality, the cedar rapidly invaded abandoned fields, regardless of parental type of material, if fire was eliminated and grazing continued. Cedar made the most rapid growth on alkaline soils derived from dolomitic limestone.

Ash content of foliage was considerably greater than that of twigs. Calcium and silica content of foliage and twigs was found to be inversely related to ash content, but the potassium and magnesium relation was not clearly defined.

Phosphorus content of foliage and twigs appeared to be directly and more clearly related to the regularly available phosphorus content of the soil. Phosphorus content of the foliage and twigs was directly related to the size of root system. Mineral constituents were observed to vary according to seasonal fluctuations. (Project 55).

Inferior Species Control. (*R. H. Westveld, J. M. Nichols*). This study covered the percentage of stems killed by 2,4,5-T in persimmon, sassafras, hickory, white oak, and black oak stumps $\frac{1}{2}$ to 4 inches in diameter. (See Tables 14 and 15) (Project 75).

TABLE 14 -- PERCENTAGE KILL OF SPROUT CLUMPS TREATED BY FOLIAGE SPRAY

	2,4,5-T ($\frac{1}{2}$ % by vol. in water)	2,4,5-T (1% by vol. in water)	Ammate ($\frac{1}{2}$ lb. 1 gal. water)	Ammate (1 lb. gal. water)
Scarlet oak	18	41	0	6
Hickory	26	50	11	10
Black oak	20	30	5	30
Post oak	15	20	0	5
Average	20	35	4	13

(Note: The original stems were satisfactorily killed. The above figures indicate the percentage of the original stems sprayed in July, 1950 which had failed to re-sprout by September 1951.)

TABLE 15 -- PERCENT EFFECTIVENESS OF TREATMENTS ON FRESHLY-CUT STUMPS OF PERSIMMON, SASSAFRAS, AND HICKORY; TREATMENTS MARCH 1949; RESULTS, RECORDED SEPTEMBER 1951

	Persimmon	Sassafras	Hickory
2,4,5-T - 5% by vol. in kerosene	80	70	20
2,4,5-T - 1% by vol. in kerosene	70	50	20
2,4,5-T - 5% by vol. in water	30	10	30
Ammate - 4# 1 gal. water	40	50	30
Ammate - 1# 1 gal. water	20	10	10
Ammate sale - 1 tablespoon applied directly to stump	10	10	20

(Note: Some stems apparently dead at the end of two growing seasons re-sprouted during the third year.)

Pruning of Oaks. (*R. H. Westveld, Paul Burns, J. M. Nichols*). A study of the effect of pruning and its financial benefit was conducted on an oak stand in the Missouri Ozarks. Pruning wounds healed quickly; water sprouts developed on trees in the lower crown classes. Profit from pruning dominant and co-dominant scarlet oak and black oak was estimated at \$1.49 per tree, evaluated 15 years after pruning. (Project 75).

Decay and Defect in Missouri Trees. (*Paul Burns, Dale Shaw*). One hundred trees, including black, scarlet, and white oaks growing in three localities in the Missouri Ozarks, were dissected to determine loss in wood volume associated with each external indicator of a defect. Large losses came from conks, fire wounds, butt bulge, and insect holes. Considerable damage was hidden, with no external indication of loss.

External fire wounds were found to have an average linear spread from 25 inches in black oak to 66 inches in white oak. Average loss of wood from insect holes in black oak was approximately three times as much as in scarlet oak or white oak.

Fire wounds caused the most loss of all the hidden defect causes. White oak was more seriously affected than either black oak or scarlet oak.

Sodium arsenite, 4 pounds per gallon of water, applied in partial axe-frilled 4- to 8-inch trees resulted in quick kill of tops of all species treated. A few weak sprouts developed below the frill on trees treated in August. (Project 75).

Missouri Forest Plantations. (*R. M. Dingle, R. H. Westveld*). Apparently survival of forest plantations in Missouri is affected most by man-controlled factors involved in establishment of the plantation and its treatment, although climate and soil fertility factors also have an important bearing on survival.

Growth of forest plantings was dependent upon species aspect (direction slope faces), erosion conditions at time of planting, and grazing. The most important factors were those affecting quality of the planting site. A measure of planting site quality may be obtained from analysis of soil and climatic data that have been collected. However, the importance of growth of a forest plantation will remain secondary until planting practices are capable of producing higher survival. (Project 103).

Utilization and Marketing of Farm Woodland Products, Gasconade, Osage, and Franklin Counties. (*R. H. Westveld, R. C. Smith, Ross Hortin*,

Julian Ochrymowych, Donald Grate, Richard Taylor). Tree volume was determined by species on 242 one-fifth acre plots in three counties. Growth measurements were taken. Tree quality was estimated. Farm operators were interviewed to determine the amount of wood products required for use on the farm, the amount sold and purchased, size and condition of farm woodlots, and the farm owner's interest in and knowledge of woodlot management.

Forty percent of the forest land in these three counties was in Franklin, 28 percent in Gasconade, and 32 percent in Osage. Stand sizes of the 656,000 acres of forest were broken down into 11.4 percent large saw-timber, 18.6 percent small saw-timber, 50.5 percent pole-size timber, 17.6 percent seedlings and saplings, and 1.9 percent poorly stocked area. Although there was an excess of pole-size timber stand, the poorly stocked area was small. Indications were that sustained annual yield of timber products was possible under proper management. (See Table 16) (Project 107).

TABLE 16 -- AN ANALYSIS OF TIMBER HARVESTING ON A COMMERCIAL BASIS DURING 1951

County	Actual Harvest			Total equivalent board feet, thousands*
	Volume Cut			
	Cordwood	Staves	Sawlogs	
	Cords	M. chord ft.	M. bd. ft.	
Franklin		85	4,547	6,247
Gasconade		203	859	4,919
Osage	6,200	45	1,532	2,442
Total	6,200	333	6,038	13,608
*Not incl. cordwood				
County	Potential Harvest			
	Cordwood		Sawtimber	
	Cull	Sound	Cull	Sound
	Cords		M Board Ft.	
Franklin	22,355	87,068	21,294	20,812
Gasconade	21,288	86,339	12,428	15,084
Osage	15,977	48,051	5,559	10,697
Total	59,620	221,458	39,281	46,593

HOME ECONOMICS

Starley Hunter, Chairman

The Quality of New Varieties of Soft Winter Wheat for Baking. (*Leta G. Maharg, J. M. Poehlman*). Baking performance tests were run on 33 varieties and experimental strains of soft wheat grown in experimental fields at Columbia, Lathrop, Sikeston, and Elsberry.

Scores and baking volumes of cakes and cookies were determined and mixogram areas and viscosity values tabulated on these varieties. A white cake formula was used for the 70 percent patent flours. Gluten properties of straight flours were measured with cookie baking tests. Cookies with large spread indicated weak gluten and cookies with narrow spread indicated a strong gluten. A strong gluten is undesirable for baked products made from soft wheat flour.

Flour from soft wheat gave smaller mixogram areas and lower viscosity value than flour from hard wheat. Quality in this experiment was determined by suitability for cake and cookie flour, rather than for general milling purposes where other traits may be desired. Nutritive value also was left out of consideration.

Early Premium wheat has continuously produced the best cake volume since the start of this experiment. Its flour was rated as the best all around cake flour tested thus far. It ranked first in the current year's test, with Clarkan second. Kawvale produced flour with poor baking qualities.

The two commercial classes of wheat grown in Missouri are hard red winter and soft red winter wheat. Of the two, soft red winter wheat has been the leader in the past, comprising more than 90 percent of the State's crop. Recently, Pawnee, a hard wheat, has gained popularity and has shown a sharp increase in acreage.

A complete report of the Missouri flour experiments has been published in Research Bulletin 480, "Testing Missouri Soft Wheat Flours for Quality," by Fern Bowman, Leta Maharg, and J. M. Poehlman. (Project 97).

Comparison of Quality and Bacterial Growth in Cooked Egg Products From Heat Treated and Non-heat Treated Dried Eggs. (*Margaret Mangel, Treva Kintner*). Various bacteria were used to study salad dressings made from dried eggs. Dressings were inoculated with 5 species of Salmonella and 1 species of Staphylococcus.

Heating to 86 degrees F. for ½ minute was found sufficient to destroy all bacteria in inoculated samples of reconstituted eggs. When cooked salad dressings of varying pH were inoculated with the organisms, the acidity in all the dressings tested hindered bacterial growth. A pH of 3.4 was necessary to kill all bacteria. Dressings of this type were considered too acid for most people's tastes. (Project 130).



Fig. 11 — These tasty appearing cookies were made with dry milk solids. Tested recipes and suggestions for use of dry milk solids were published in Missouri Experiment Station Bulletin 571.

Development of Recipes Using Non-fat Dry Milk Solids. (*Margaret Mangel, Leta G. Maharg*). Recipes for quick bread and other products have been developed that make maximum use of non-fat dry milk solids. Advantages, methods, and suggestions for using dry milk solids have been published with tested recipes for cookies and quick breads in Station Bulletin number 571. Laboratory work has been done on enriching other products, such as cream sauces, custards, casseroles, meat substitutes, and soups with non-fat dry milk solids.

Milk clotting and proteolytic methods of testing enzyme activity are being standardized with pure papain. A testing method for effectiveness of commercial meat tenderizers is being developed. (Project 130).

Thiamin, Riboflavin, and Niacin Content of Diets. (*Margaret Mangel, Jean Houston, Inez Harrill, Martha Richardson, Marialice Cunningham, Frances Hoxworth*). Thiamin and riboflavin intake and urinary excretion and niacin intake have been determined during two consecutive five-day periods for 13 women between the ages of 50 and 70. Vitamins were administered as additions to a self-selected diet. There was evidence that intake of thiamin, riboflavin, and niacin tended to be lower than recommended dietary allowances of the Food and Nutrition Board of the National Research Council. (Project 95).

Rate of Change of Hemoglobin to Methemoglobin in Ground Beef in Different Storage Conditions. (*Margaret Mangel*). A standardized method for estimating methemoglobin in beef muscle extracts was developed from the Austin and Drabkin method for blood hemoglobin. This consisted of a weighted mean of estimates made of observed readings at four critical wave lengths of the spectro-photometer.

Analysis of the methemoglobin estimates was made at individual wave lengths. This indicated a systematic rather than random variation. Use of muscle hemoglobin or myoglobin, instead of blood hemoglobin constants, and wave lengths critical for myoglobin resulted in decreased variations in estimates of individual wave lengths, but the systematic variation persisted. The possibility that this variation was caused by the presence of a third pigment confronted in the mixture is suggested. While estimates of methemoglobin made by adaptation of the Austin and Drabkin methods were high as shown by a study of the methods, they were comparable to those in the literature and were no more variable than those made with better constants and wave lengths.

First year experiments indicated that methemoglobin did not increase in storage, when stored up to 32 weeks. Methemoglobin formation was slower when samples were stored at minus 12°C. than when stored at minus 18°C, minus 24°C, or when the temperature was allowed to fluctuate from minus 12°C to minus 18°C. However, samples stored at minus 12°C were considered the least palatable. When samples were permitted to thaw 1 to 5 times, methemoglobin formation did not increase. Repeated thawing did result in undesirable flavor and odor.

Methemoglobin formation tended to be slower when tissues were stored under oxygen than when stored under nitrogen, carbon dioxide, or air. Apparently, methemoglobin estimates did not reflect flavor changes consistently.

Samples containing more than 15 percent fat showed higher methemoglobin content than those containing less but this tendency was not related to storage time. During this study no difference in methemoglobin formation could be observed between ground and unground tissue samples.

Due to the large and unexplained variations in results, even with trained workers and strict adherence to schedule, the possibility of the presence of a third form of pigment in the extracts is being investigated. (Project 87).

Serviceability of Marquisettes. (*Bernice Blue, Adella Ginter*). Curtain marquisettes offer a problem to the homemaker in excessive shrinkage and loss of their crisp, new, appearance. To overcome these difficulties the homemaker resorts to starching and stretching.

The stretching process may work satisfactorily on cotton fabrics as cotton fibers are stronger wet than dry. Rayons and other synthetics may encounter serious breaks as a result of stretching. Wet strength of rayon is about one-half that of its dry strength.

Cotton marquisettes offer greater serviceability when the fiber has good balance in warp and filling count and strength. Cotton marquisettes with special finishes prove more stable dimensionally than those with ordinary finishes. With the possible exception of nylon, all marquisettes studied displayed enough shrinkage to necessitate changes in dimensions during their period of usefulness.

Original crispness of curtain marquisette with special finish proved very little indication of how well crispness was retained. Rayon marquisettes displayed low wet breaking strength and decided dimensional changes. (Project 13).

Home Applied Finishes Giving Starch-like Qualities. (*Yolande Bennet. Adella Ginter*). Effects

on physical properties such as weight, crispness, strength, and resistance to stains were measured on cotton percale and sail cloth, which had been treated with two different starch-like finishes.

One of the finishes was a plastic type starch advertised as being durable through several launderings after one application. A wax type was tried that had to be applied after each laundering. Both finishes were easy to apply. Both added weight to fabrics but not an undesirable amount. The plastic type finish displayed a more dependable amount of crispness. Statistical treatment showed the finishes to be nonsignificant in effect on tensile strength. Wax type finish tended to resist stains. (Project 13).

HORTICULTURE

R. A. Schroeder, Chairman

Factors Affecting Apple Fruit Setting. (*A. E. Murneek*). A study of the use of hormone sprays for thinning apples, advantages of the procedure, and factors determining efficiency and economy of the spray thinning process was made as was a search for a better pre-harvest spray.

Blocks of heavily bearing biennial Golden Delicious were sprayed with 40 percent dinitro-orthocyclohexylphenol, 1 pound per 100 gallons of water, at full boom. This was followed 12 days later with an application of Naphthaleneacetic acid (NA) at 30 parts per million. Results were compared with the use of NA as the only spray, applied 12 days after full bloom. In both cases NA at 30 parts per million indicated ability to thin Golden Delicious apples considerably.

DN No. 1 (40 percent dinitro-ortho-cyclohexylphenol) has a greater effect in reducing clusters of apples to single fruit, a factor of value in obtaining better spray coverage and larger fruit size.

Chemical thinning apparently did not exert its effect by causing abscission of fruit in lower average seed number.

In a study where half of the trees in a heavily blooming Golden Delicious orchard were sprayed twice with NA at 25 parts per million, 7 days and 13 days after full bloom, and the other half left for comparison, the following observations were made:

(A) The NA sprays increased fruit drop from shaded branches 21.9 percent, compared with 11.9 from exposed branches.

(B) More fruit dropped from weak spurs than from strong ones.

(C) Greater fruit drop, after spraying, was noted in year-old twigs than in older wood.

(D) Most thinning of fruit and increase in drops occurred 3 to 4 days after the NA spray.

(E) When applied at the described time, NA spray primarily affected the second natural drop.

(F) There was a negative correlation between size of dormant flower buds and the natural drop and the increase in drop due to use of a hormone spray.

Relative value of Trichlorophenoxypropionic acid (C₁₃PP) as a pre-harvest spray for apples was studied. Extensive comparative spraying tests of NA and C₁₃PP were conducted in two experimental orchards on several summer and fall varieties of apples. Results indicate Trichlorophenoxypropionic acid delayed pre-harvest drop two to four times as long as the period previously obtained by standard NA spray at 10 parts per million.

Color was increased when C₁₃PP was used on red varieties. Fruit maturity apparently was speeded up as

Fig. 12—Wealthy apples showing relative amount of red color development at harvest time. (1) Not sprayed; (2) sprayed with naphthalene acetic acid, 10 parts per million (p.p.m.); and (3) sprayed with trichlorophenoxypropionic acid, 20 p.p.m.

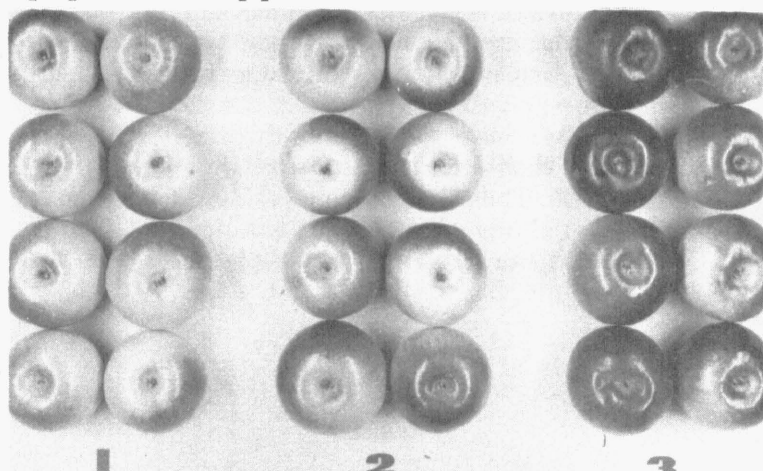




Fig. 13—Fire blight is a serious virus disease in pear (illustrated above) and apple orchards of the state. Two in bloom sprayings of Bordeaux gave fair control in tests conducted this year but caused moderate russet on Jonathan apples and heavy russet on Golden Delicious.

a result of Trichlorophenoxypropionic acid spray, especially in summer varieties such as Duchess and Golden Delicious where the fruit is well exposed. Maleic Hydrazide, at 250 and 500 parts per million, did not counteract effects of Trichlorophenoxypropionic acid of fruit maturity. (Project 23).

Fire Blight and Sooty Blotch on Apples. (*H. G. Swartwout*). Suggested spray material and schedules based on the most recent information have been published as a guide to commercial apple growers in formulating their spray programs in Experiment Station Circular 611, "Spraying Suggestions for Commercial Apple Orchards, 1952."

Two *in bloom* sprayings of three materials were tested for their value against fire blight and effects on fruit finish. The materials were (a) Zineb at 2 pounds per 100 gallons of water plus 1 ounce of Triton B 1956; (b) Bordeaux 1½ 3-100; (c) Nabam at 2½

quarts per 100 gallons of water, plus 1 pound powdered zinc sulphate with 1 ounce Triton B 1956. Bordeaux gave by far the best control and was rated good. However, Bordeaux caused moderate amounts of russet on Jonathan and heavy russeting on Golden Delicious.

Ferbam was more effective in checking sooty blotch than wettable sulphur, when applied early in the season (first four cover sprays). Lead Arsenate in the calyx, first, and second cover sprays, delayed onset of sooty blotch but did not provide full season protection in a year favorable to heavy late infection. The following 10 materials were applied in five sprays as a protective schedule:

1. Ferbam 1-100.
2. Lead Arsenate with zinc-lime 3 and 1-100.
3. Lead Arsenate with Ferbam 1-¼-100.
4. Dicyclohexylamine salt of dinitro-o-cyclohexylphenol (DN-111, 1-100).
5. N-Trichloromethylthio tetrahydrothalamide (ortho 406, 1-100).
6. Two-3 dichloro 1, 4 naphthoquinone (phygon XL), 6 ounces-100.
7. Nabam-zinc sulfate, 3 pints, and ⅔ pound-100.
8. Zinc-lime 1-1-100.
9. Ferbam-yellow cuprous oxide, ¼-¼-100.
10. Split schedule Ferbam 1-100 and yellow cuprous oxide 2 ounces-100.

All gave control for approximately one month after the last spray application. The zinc-lime mixture gave poorest protection. The two lead arsenate combinations (2 and 3) gave much the longest residual protection, 2½ months. Ferbam (1) was third. There was little difference among other treatments.

In a study on control of sooty blotch after the disease had appeared, 3 materials were applied in 3 and 4 spray schedules at 10-day intervals. They were (a) DN-111 at 1¼-100, plus 1 ounce of B 1956; (b) Orthocide 406 at 1½-100, plus 1 ounce of B 1956; (c) lead arsenate 1½ with ¼ pound Ferbam, plus 1 ounce of B 1956. All effectively checked further development of sooty blotch but none was effective in removing the established film. (Project 69).

Effect of Synthetic Organic Pesticides on Fruit Finish of Apples. (*H. G. Swartwout*). Synthetic organic pesticides were tested for effects on fruit finish. Prior studies had demonstrated that synthetic organic insecticides, such as chlorodane, BHC, Methoxychlor, Toxaphene, TDE, and DDT, when applied with sulphur to the calyx in first or second cover sprays caused more russet on apples than lead arsenate with sulphur.

Generally they also caused more russet than a combination of lead arsenate with sulfate-Ferbam, especially on Golden Delicious apples.

Organic insecticide comparisons included (a) parathion wettable powder, (b) parathion emulsion, (c) EPN wettable powder, and (d) Dieldrin in combination with sulphur in the calyx, first and second cover sprays.

Parathion in both wettable powder and emulsion forms failed to noticeably affect finish of Jonathan apples, compared to the lead arsenate-sulphur-Ferbam combination. But both parathion combinations greatly increased russet on Golden Delicious. (Project 69).

Leaf Spot and Scorch Control of Strawberries. (*H. G. Swartwout*). Two pre-harvest sprays were applied to Armore strawberries for control of leaf spot and leaf scorch on foliage and berry caps. Following materials were compared:

1. Nabam (Dithane D-14) at 2 quarts per 100 gallons of water plus 1 pound of powdered zinc sulphate.
2. Bordeaux 6-6-100.
3. Phygon SL (2-3 Dichloro 1, 4 Naphthoquinone) $\frac{3}{4}$ -100.
4. Orthocide 406 (N-trichloromethylthio tetrahydrophthalimide) 2-100.
5. Actidione at 5 parts per million, 10 parts per million and 20 parts per million.

Actidione and Nabam-zinc sulphate were generally most effective. There was little difference in the three concentrations of Actidione. Bordeaux and Phygon XL gave least desirable results. They caused moderate to severe fruit injury. (Project 69).

Persistence of Dithiocarbamate Fungicides. (*H. G. Swartwout*). Field evaluations for control of black rot of grapes were conducted using two Dithiocarbamates.

1. Sodium dimethyldithiocarbamate solution, 30 percent active (Nabamate).
 2. Nabam (Disodium Ethelyne Bisdithiocarbamate solution, 19 percent active) plus Dithane D-14.
- Nabamate was tank-mixed with Ferrous sulphate, manganese sulphate, and lead nitrate in quantities calculated to give a thiocarbamate content approximately equivalent to that in $1\frac{1}{2}$ pounds of 76 percent commercial Ferbam. This was about $3\frac{3}{4}$ pints of 30 percent material per 100 gallons.

Nabam was used at the rate of $2\frac{1}{2}$ quarts of Dithane D-14 per 100 gallons of water. A sufficient quantity of manganese sulphate and lead nitrate were added to react with the Nabam. Nabamate with manganese sulphate and lead nitrate combinations proved

less effective than Ferbam. The lead nitrate-Nabam combination was least effective. The manganese-Nabam combination caused severe injury to the host. (Project 69).

Downy Mildew on Grapes, Apple Scab Eradication, Peach Scab and Brown Rot of Peaches, and Cherry Leaf Spot. (*H. G. Swartwout*). The following materials were used in studying control of downy mildew on grapes:

1. Ferbam at $1\frac{1}{2}$ -100 plus $\frac{3}{4}$ pound of copper ammonium silicate.
2. Ferbam $1\frac{1}{2}$ -100 plus 4 ounces of yellow cuprous oxide.
3. Ferbam $1\frac{1}{2}$ -100 plus 6 ounces of yellow cuprous oxide.
4. Orthocide 406 at 2-100.

Orthocide 406 gave good control of mildew during the spraying period but appeared to afford shorter residual protection than Bordeaux. Both combinations of Ferbam and inorganic copper compounds gave good protection against downy mildew.

To check spread of downy mildew after it had become established, two applications were made in July of (a) Orthocide 400 at 2-100; (b) Bordeaux 3-3-100; (c) Ferbam at $1\frac{1}{2}$ -100, plus 2 ounces of yellow cuprous oxide; (d) Ferbam at $1\frac{1}{2}$ -100 with 4 ounces of yellow cuprous oxide; (e) Ferbam at $1\frac{1}{2}$ -100 with 8 ounces of copper ammonium silicate; (f) Ferbam at $1\frac{1}{2}$ -100 with 4 ounces powdered copper sulfate; and (g) Ferbam at $1\frac{1}{2}$ -100 with 6 ounces powdered sulfate.

The orthocide effectively checked development of downy mildew and permitted fruit to reach acceptable maturity compared to a total crop loss on untreated vines. There was no visible injury. Bordeaux was effective but caused some injury.

Puratized agricultural spray (Phenyl mercuri triethanol ammonium lactate) when used alone proved most effective in checking spread of apple scab.

Lead arsenate $1\frac{1}{4}$ -100 with zinc-lime arsenical safener gave almost complete control for peach scab under conditions highly favorable for scab infection.

Two *in bloom* sprays of wettable sulfur followed by sulfur-parathion spray until within six weeks of harvest was as effective against brown rot as a like program plus two pre-harvest sprays of sulfur at four weeks and two weeks prior to harvest.

The following materials were tested for relative residual protection against cherry leaf spot: (a) Ferbam $1\frac{1}{2}$ -100; (b) Ferbam $1\frac{1}{2}$ -100 plus 4 ounces of yellow cuprous oxide; (c) Ferbam $1\frac{1}{2}$ -100 plus $\frac{3}{4}$ pound copper ammonium silicate; (d) Bordeaux

2-3-100 in first spray and 3-3-100 in second spray; (e) and actidione 5 parts per million.

Bordeaux gave longest protection. It lasted 3½ months after the last spray. Actidione gave best control for the first 2 months following spray application but after that time leaf spot developed rapidly. Within a few weeks the trees were largely defoliated. The Ferbam-yellow cuprous oxide was third in residual protection, followed by Ferbam-copper ammonium silicate and Ferbam. Ferbam gave adequate protection but lasted the shortest time. (Project 69).

Effect of Soil Mulches on Physical and Chemical Changes of Soil. (A. E. Murneek, R. N. Goodman). Hay and straw mulches were contrasted with the sod system of orchard culture. An evaluation was made of the efficiency with which mulches utilized precipitation. Experimental data revealed that following early fall and winter droughts soils under mulch reached field moisture capacity to a depth of 24 inches 8 weeks sooner than unmulched sod. Soil moisture under sod was depleted to a depth of 12 inches twice during the growing season, but remained near field capacity under the mulches. **Moisture intake through the soil surface under mulch was five times greater than under sod.** Root excavations and counts showed that 85 to 90 percent of the root distribution was in the upper 24 inches of the soil profile. The upper 12 inches of soil contain roots as follows: if hay, 63 percent of total; if straw, 58 percent; and if sod, 51 percent.

As a result of mulching, small feeder roots were extremely abundant on the surface of the soil and in the mulch material itself. (Project 4).

Effects of Synthetic Plant Growth Regulators. (A. E. Murneek, F. G. Teubner). A detailed study of carbohydrate metabolism in ovaries as affected by auxins (P-chlorophenoxyacetic acid, C1 PA, and ethyl ester of indolacetic acid Et IA), by pollination, and by fertilization was made. C1 PA was used in the concen-

Fig. 14—Remarkable increases in tomato yields are being obtained by using hormone sprays to cause the fruit to set. The row at left is the yield from an untreated plant.

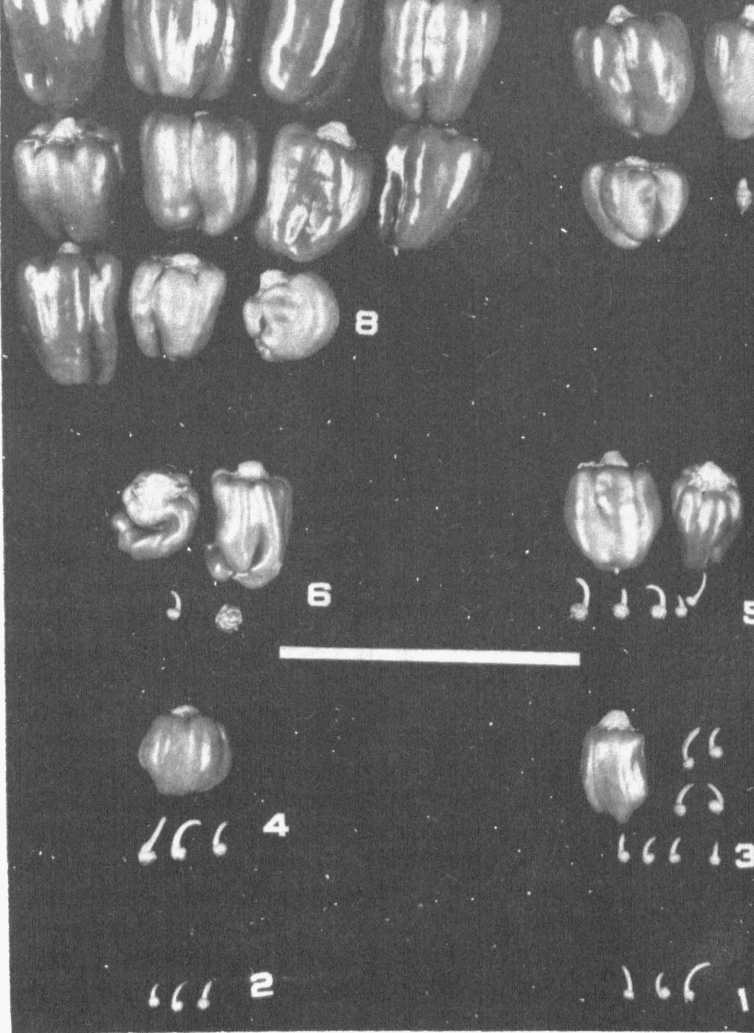
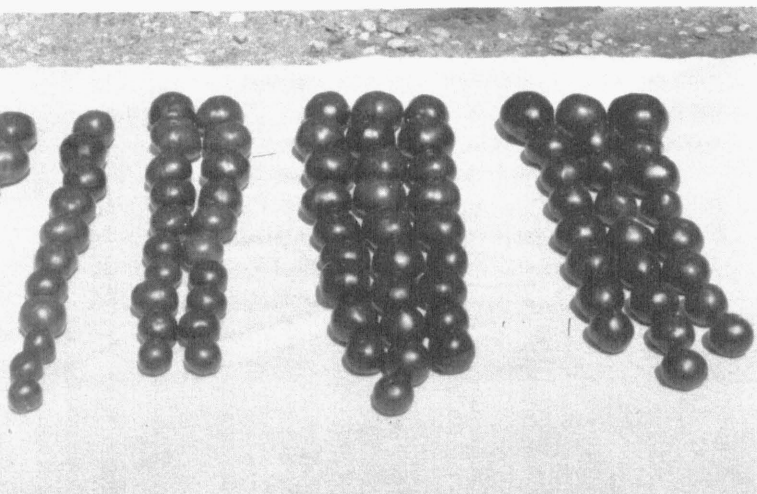


Fig. 15—Time of treatment proved very important in applying the hormone naphthalene acetic acid to pepper fruit. Here is the relative development of fruit treated 1 to 8 days after pollination.

tration of 10 to the -3 M and the Et IA at concentrations of 10 to the -3 to 10 to the -5 M applied in lanolin .01 milliliter on the cut surface of the style. This resulted in a rapid increase of starch and reducing sugars in the ovaries with a simultaneous decrease in sucrose. This pattern in carbohydrate metabolism was strikingly similar, but of varying intensity whether the fruit was pollinated, fertilized, or treated with an auxin. In this manner a parallel metabolic effect between natural and artificial induction of fruit set was made. These data were derived from histological and microchemical examination of tomato fruit.

Histological and microchemical examinations were made of pepper fruit treated with a naphthaleneacetic acid NA, 200 parts per million spray. As a result of the hormone's action when applied 3 to 4 days following pollination, the embryo was held in a resting zygote (4 to 6-cell) stage for as long as 3 months.

A technique was developed for injection of the hormone solutions directly into the placenta of pepper

fruit, which seems to be a more accurate method than spraying.

In beans, spraying the entire plant with NA, 5 to 10 parts per million, increased pod status; especially when the treatment was applied soon after fertilization. However, higher concentrations of NA (up to 50 parts per million) decreased set roughly in proportion to increased concentration. (Project 50).

Pruning of Peaches. (*A. D. Hibbard*). A study was started in the greenhouse to determine the effect of different types of ground cover on branch angle of young trees. Branch angles of the first limbs largely determine final shape of the tree. It had been noted that peach trees growing on soil with a vegetative cover frequently assumed an undesirable upright position while those under cultivation had a horizontal habit of growth. During 1950 and 1951 nursery stock trees were grown in plots with different types of covers surrounding the plants. The cover was maintained with different materials in order to obtain varying degrees of light reflection. No difference in branch angle was observed with this lot. In a second test in which seedlings were used instead of nursery stock, the seedlings showed a definite response in branch angle to reflection of the ground cover. (Project MS-126).

Thinning Peaches with Hormone Sprays. (*A. D. Hibbard*). A new hormone type material known as "Color-Set" was used as a pre-harvest spray on peaches. This material is known chemically as trichlorophenoxypropionic acid. It has been used to prevent premature dropping of apples. Since it is chemically similar to other hormone-like materials which have been used to thin peaches, it was thought advisable to spray this material on peaches in order to determine the reaction. Several varieties at the Midway Orchard were sprayed at a concentration of 20 parts per million. The growth regulator brought 3 to 5 days earlier ripening. It also stimulated development of red color. On Elberta peaches the color was increased from 25 to 46 percent of the fruit surface. Quality of color was improved from a pale tint to a good medium red. As a word of caution, very early application (one month before harvesting) resulted in spotty color and rough fruit on certain varieties. (Project 126).

Breeding Watermelons. (*A. D. Hibbard*). The development of improved watermelon varieties adapted to production under southeastern Missouri conditions would be highly desirable. An attempt was

made to introduce new characters for disease resistance, improved flesh color, sugar content, early ripening, and increased size.

Evaluations of varieties supplied through cooperative field variety trials were made. Hybrids were developed between the best of these varieties and the best Missouri lines. Selected lines were selfed and further selections made. Three of these lines were promising for Missouri's commercial watermelon industry. The new varieties appeared superior to any now available. (Project 128).

University Orchard. (*A. D. Hibbard*). Experimental farm orchards located at Midway Horticulture Farm have been carried nine years. Good crops were obtained from all fruits planted in 1943, except pears. Pears were killed by a fire blight disease in 1948 and had to be replanted. Fruit harvests were made from strawberries, cherries, blackberries, gooseberries, currants, peaches, plums, grapes and apples. A total of 3,780 pounds of fruit was harvested from each one-half acre orchard. This had an estimated farm value of \$215. To produce this fruit, 28 man hours of hand labor and 10 man hours with a team or tractor were required. The only additional expense was \$15.00 for spray materials.

The Missouri general purpose spray mixture was used. It gave satisfactory control of major orchard pests. It was apparent that a single schedule can be used satisfactorily in small farm orchards. (Project 129).

Variety Trials of Strawberries. (*D. D. Hempbill*). Variety trials, including eleven newly introduced, recommended, varieties of strawberries were established. Yield records in crates per acre were as follows:

Armore	257
Blakemore	240
Temple	185
Premier	138
Aroma	128
Tennessee Beauty	91
Suwanee	87
Maytime	75
Midland	75
Tennessee Shipper	71
Fairpeake	19

Armore, introduced by the Missouri Agricultural Experiment Station in 1950, appeared worthy of recommendation as a shipping, local market, or home garden berry for all sections of Missouri. Temple, introduced by the U. S. D. A. appeared to be an excellent



Fig. 16—Caution must be used when spraying weeds in strawberries. These deformed strawberries resulted when 2,4-D was applied during fruit bud differentiation.

variety for production on Red Stele infested soils. Blakemore appeared to be best for commercial freezing purposes. (Project 119).

Comparison of Clean Cultivation and Permanent Mulch Systems. (*D. D. Hemphill*). Permanent mulch and clean cultivation systems of culture of boysenberries, raspberries, strawberries, and blueberries have been compared. In the case of blueberries, no difference in growth could be observed between clean cultivated and mulched plots after one season. However, 3 to 4 inches of sawdust eliminated all cultivation and hand weeding, a large saving during the 1951 season. No yield data were collected. Boysenberries and raspberries under permanent sawdust mulch made better cane growth than under clean cultivation. It was estimated that the value of mulch for weed control alone was approximately \$75.00 per acre. All but a few large seeded weeds were controlled by the 3- to 4-inch sawdust mulch.

Yields of marketable strawberries in varieties studied were approximately 50 percent higher under the permanent mulch system. This was due primarily to reduction of fruit rots. The berries decayed as they began to ripen under clean cultivation, but matured normally under mulch. Mulching more than paid for itself by eliminating weeding expense. (Project 119).

Elimination of Hormone Softening Effects of Tomatoes. (*D. D. Hemphill, A. E. Murneek*). The effectiveness of plant growth regulators C1PA (p-chlorophenoxyacetic acid), C1PP (alpha-chlorophenoxypropionic acid), NOP (beta-Naphthoxypropionic acid), C1₃PP (2,4-5 trichlorophenoxypropionic acid), NOA (beta-Naphthoxyacetic acid) in improving fruit set, size, and total yield, and their effect on fruit softness were determined. C1PA was the most effective material in increasing yields of greenhouse

tomatoes but caused a greater amount of softness in fruit than the other materials. CaCl₂ applied at 0.1 molar spray to the flower clusters or on the whole plant eliminated the softening effects of hormone treatment. (Project 121).

Weed Control in Horticulture Crops. (*D. D. Hemphill, W. W. Roberts, Daniel D. Meador*). In this project, chemicals designed for weed control were tested on strawberries, grapes, and various vegetable crops. Materials were tested in greenhouse, in experimental field plots, and in commercial planting. The most promising were 2, 4-D, and sodium 2, 4-dichlorophenyl "cellosolve" sulfate (EH-1 Craig herbicide-2). These herbicides gave good control for broad leaf weeds and grassy weeds. However, when used for control of small germinating, over-wintering weeds 2, 4-D caused a deformity in berries, leaves, and runners when applied during fruit-bud differentiation (August 15 to October 15).

The sprays used on grapes were not effective long enough to warrant expense of application. This study was made, however, during a season of high rainfall.

A number of chemicals were evaluated for pre-emergence and post-emergence use in vegetable crops. For use in pea and sweet corn production, 2, 4-D proved promising. Pre-emerge (dinitro-o-secbutyl phenol, alkinolamine salt) proved effective for snap beans, lima beans, cantaloupes, cucumbers, and watermelons. Sodium pentachlorophenate proved best for pre-emergence use on triumph potatoes. N-1 naphthyl phthalamic acid (NPA) proved best for pre-emergence and post-emergence use on cantaloupes, cucumbers, squash, and watermelons. Sodium 2, 4-Dichlorophenyl "cellosolve" sulfate (EH1) was best for post-planting use in sweet potatoes. Sodium Cyanate appears promising for post-emergence use in sweet corn and seeded onions. (Project 146).

Nutrition of Vegetables. (*V. N. Lambeth, E. R. Graham*). The effect of nitrogen, phosphorus, and potassium balance on growth of onions has been studied. Data indicated the level recommended for one nutrient must depend upon the levels of the others. Data on interaction were significant, the balance as well as the levels, of all three elements must be considered in planning fertilizer treatments.

Within limits of this experiment, the best balance, measured by weight of bulbs, or bulbs and tops, was obtained with 100 pounds nitrogen per acre, 300 pounds P₂O₅ per acre, and potassium at a level of 8.1 percent of the soil base saturation. The effect of increasing phosphorus (P₂O₅) from 100 to 300 pounds per acre was pronounced. Yields increased in a linear trend for bulbs alone, also for bulbs and tops. This

suggested that further increase in rate of application of phosphorus would raise yields even higher. (See Table 17). (Project 96).

TABLE 17 -- NUTRIENT ELEMENT BALANCE (NPK) AND GROWTH OF ONIONS

	Percent K Saturation		100 lb./A	200 lb./A	300 lb./A
			P ₂ O ₅	P ₂ O ₅	P ₂ O ₅
N 100 lb./A	2.7	Bulbs & tops	94.9	103.1	109.9
		Bulbs	62.8	66.4	71.6
	5.4	Bulbs & tops	102.5	114.0	120.9
		Bulbs	56.1	74.8	75.4
	8.1	Bulbs & tops	113.9	108.4	134.0
		Bulbs	75.4	67.0	81.9
N 200 lb./A	2.7	Bulbs & tops	80.5	103.8	102.0
		Bulbs	39.8	64.9	72.4
	5.4	Bulbs & tops	62.6	110.5	123.5
		Bulbs	25.0	66.9	80.8
	8.1	Bulbs & tops	47.3	87.8	120.3
		Bulbs	24.2	50.3	78.5

Food Preservation and Utilization. (*H. W. Ballou*). A field study was made of the effect of soil fertility levels upon the yield, soluble mineral content, and freezing quality of green beans. In growing the beans, two levels each of magnesium, phosphorus, nitrogen, and trace mineral elements were used in all possible combinations, making a total of 16 treatments. Five replications were used with treatments randomized within blocks.

Differences in flavor, texture, and color of the frozen beans were determined by a six-member taste panel, using a score card.

Increasing the phosphorus supply resulted in increased yield, increase in soluble phosphorus content, variable effect on flavor, and no effect on texture or color. Magnesium, nitrogen, and trace minerals had no direct effect upon yield, but their interaction was of importance.

Increasing the magnesium level reduced the amount of nitrate nitrogen in the beans, resulted in significantly reduced eating quality (as measured by impaired flavor and texture, and impaired color after six months storage), decreased texture, and impaired color at nine months of storage.

An increase in nitrogen supply caused an increase in nitrate nitrogen present in beans, decreased soluble phosphorus, and enhanced eating quality of frozen beans. These effects were noted in flavor, texture, and color after six months storage and in texture and color after nine months storage.

Application of a trace element mixture was found to be of little value in this study. Of particular importance was the interaction of nutrients studied. (Project 135).

Commercial Flower Studies. (*J. E. Smith, Jr., M. M. Rogers, Joe L. Bennet, R. E. Entzeroth*). Produc-

tion of systemic disease-free carnation cuttings was studied. Approximately 400 cuttings of two carnation varieties were cultured. Twenty plants have been isolated as free from the disease organism *Fusarium dianthi*. Isolations of *Fusaria* from carnation plants from four different sources in Missouri have been made and cultured to identify possible fungus race differences. Colonies of these four isolations have been increased for inoculation studies. Carnation varieties have been planted in soil infected with the four kinds of *Fusaria* to test for resistance. Antibiotic materials have been used for possible control of this organism. Several crosses were made of reportedly resistant varieties but no seed was harvested.

Studies on nutrition of snapdragons revealed that the plants were exceptionally efficient users of low nutrient supplies. They grew well at relatively low nutrient levels. For commercial purposes, nitrogen, phosphorus, and potassium should be maintained at fairly low levels to obtain a commercially acceptable type of growth. Levels recommended are: Nitrate, 10 to 15 parts per million; phosphorus 2 to 5 parts per million; potash, 15 to 20 parts per million. (Project 114).

Commercial Cucumber Production. (*V. N. Lambeth*). The latest recommendations based on this project concerning varieties, fertilization, cultivation, insect and disease control, and harvesting of the commercial cucumber crop for pickling have been published in Missouri Extension Service circular number 608.

In fertility studies there were indications of a need for additional nitrogen above the 75- to 100-pound level established at planting time. This implied that several small side-dressing applications of nitrogenous fertilizers after production starts would be beneficial.

There was no evidence of potassium need above 3 percent of total exchange capacity, or phosphorus requirement in excess of 300 pounds per acre. Five fungicide applications proved ineffective against the bacterial disease, which destroyed the cucumber crop where it was present. (Project 121).

Tomato Culture in Southwest Missouri. (*V. N. Lambeth*). The objectives of this project were: (1) to determine fertility requirements for tomatoes grown on Clarksville stony loam and Lebanon silt loam soil types; (2) to study effects of nitrogen side dressing on yield and quality of fruit; and (3) to establish by actual experiment an adequate spray program for the control of insects and fungus diseases of tomatoes.

A depleted Clarksville stony loam soil testing 25 pounds per acre of P₂O₅ and 80 pounds per acre of

TABLE 18 -- NATIONAL LIMA BEAN COOPERATIVE NURSERY YIELD TRIALS FOR 1951

Variety	Harv. Date	Shriv. pods Approx. %	Yield in grams of usable pods				Total	Av.
			Replicate Number					
			1	2	3	4		
Ey. Thorogreen	9/14	10	2142	2349	2096	2771	9,358	2339
Clarks Bush	9/14	12	2771	3253	2699	2832	11,555	2888
Evergreen	9/14	3	747	783	241	988	2,759	690
Emerald	9/14	3	730	843	361	723	2,657	664
Greencoat	9/14	7	2096	2506	2229	3036	9,867	2466
Allgreen	9/14	5	1988	2108	1807	2289	8,192	2048
Okla. 8-2	9/14	8	2530	3253	3217	2892	11,892	2973
Okla. 10	9/14	10	2048	2952	2554	1928	9,482	2370
Okla. 13-1	9/14	16	2109	2169	1301	1843	7,422	1855
Okla. 19	9/14	12	2735	2591	3228	2651	11,205	2801
Henderson	9/14	14	2108	2337	1868	2313	8,626	2156
Date seeded:	May 28	Date Thinned	July 11	Circle kind of stand:	Poor	Fair	Good	Excellent
Temperatures during first blooming period Av. night temp. (July 21-Aug. 14) (9-12-3) 76°F.								
Av. daytime temp. (July 21-Aug. 14) (9-12-3) 90°F.								

TABLE 19 -- 1951 SWEET POTATO VARIETY TESTS USDA CO-OPERATIVE TRIALS - JERSEY TYPE YIELD OF MARKETABLE (U. S. NO. 1 AND U. S. NO. 2) BUSHEL (55 LB.) PER ACRE

Variety	Replicate I	Replicate II	Replicate III	Replicate IV	Total	Mean Acre Yield
Rols	243.7	198.5	294.0	257.8	994.0	248.5
Yellow Jersey	161.7	112.7	147.8	105.2	527.4	131.8
Orange Little Stem (K 44 strain)	226.6	181.2	221.1	198.4	827.3	206.8
Okla. 46	170.3	220.3	254.8	222.7	868.1	217.0
Maryland Golden	295.2	345.4	324.4	253.6	1218.6	304.6
Big Stem Jersey	202.3	199.8	158.8	194.2	755.1	188.7
Vineland Bush	129.2	123.5	206.3	146.0	605.0	151.2
Orlis 3511	286.1	241.5	231.1	225.4	984.1	246.0
Jersey Orange *Estimated	243.1	268.0	209.3	224.9*	720.4	240.1
Analysis of Variance						
Source	df	ss	ms			
Total S. S.	35-1	115,602.24				
Blocks	3	2,945.68	981.89			
Treatments	8	89,247.05	11,155.88**			
Experimental Error	23	23,409.51	1,017.80			
Difference Required for Significance (5% level) 33.29 Bu./Acre						
Difference Required for Significance (1% level) 45.16 Bu./Acre						

exchangeable potassium with no fertilizer applied yielded 1.4 tons of fruit per acre.

When sufficient fertilizers were added to bring the total nitrogen to 100 pounds per acre and the P₂O₅ to 300 pounds the yield was increased to 5.8 tons per acre. When potassium fertilizers were added to increase potassium saturation from 3.8 percent to 6 percent of the total base exchange capacity the yield was increased to 9.1 tons per acre. Increasing the P₂O₅ from 300 pounds to 400 pounds per acre with the other nutrient levels comparable, increased the yield approximately 1 ton per acre.

Response to a nitrogen side dressing applied after the set of the first fruit cluster was highly significant. Where 50 pounds of nitrogen was applied in one side dressing application the average yield was increased from 7 to 14.7 tons per acre while two nitrogen side dressing applications supplying 6 pounds of nitrogen per acre produced 16.1 tons of fruit per acre. Softening and cracking of fruit was not observed following any of the treatments.

Six spray applications gave effective disease control but two sprays proved relatively ineffective. (Project 121).

Lima Bean Variety and Strain Test. (V. N. Lambeth, R. E. Wester). This project is in cooperation with the United States Department of Agriculture. Varietal testing program results are presented in Table 18. (Project MS-122).

Sweet Potato Variety Testing. (V. N. Lambeth). The performance of approximately 24 of the more promising new varieties and lines representing both the dry Jersey type and the moist-fleshed or "yam" type sweet potato was tested in the U. S. D. A. Cooperative testing program. The sweet potato lines were grown in a randomized block field experiment, using regular cultural practices. At harvest, the roots from each plot were graded and weights recorded to the nearest 1/2 pound for marketables "U. S. No. 1 and No. 2," jumbos, and culls. A comparison of the marketable yield (per acre basis) of both types is given in Table 19.

Results indicated a marked difference in varietal response which, in some cases differ from that observed in the other cooperating states. In the case of the B5941 variety, for example, a temporary physiological wilting was noticed which apparently had not been reported before. A very promising line (B4570) which has been carried for a number of years, but which was not included in the cooperative tests, continued to out-perform all other varieties tested. Much variation in root shape was observed with soil type. A heavy claypan soil contributed to roughness and stringiness of the roots, a characteristic which was reflected by a much lower percentage marketable yield. Sandy soils favored uniformity and well-shaped roots and a higher percentage marketable yield. (Project 121).

Vegetable Irrigation. (*V. N. Lambeth, I. Wabba, A. D. Hibbard*). Vegetable irrigation work started at Campbell has as its ultimate goal the development of a working formula for efficient irrigation of several important vegetable crops in Missouri. A better index for judging the time, amount, and frequency of water application to supplement natural rainfall and to measure that required for maximum crop benefits must be found. Since the need for supplemental irrigation varies with the amount and distribution of natural rainfall and with hydrologic topo-

graphic, and soil characteristics of an area, the supplemental irrigation treatments must be integrated with these factors.

The climatic survey of six recording stations in the Southeast Missouri lowland area indicated that the total rainfall was usually sufficient for good crop growth; but the distribution was generally such that a serious drought may be expected frequently (one year out of four). The precipitation was found to be greatest and most frequent in the spring and early summer, and lightest and least frequent in September and October. The incidence of weekly rainfalls below one inch was lower in the period March to June than July to September.

Results clearly indicated the value of timely irrigation applications. Even during seasons of average or above average rainfall, as during the 1951 season, yields were markedly increased by irrigation. In these studies, one timely application of one inch of water increased the marketable yield of snap beans by more than 70 percent, while two timely applications increased that of seed corn by more than 150 percent and the yield of cucumbers by more than 400 percent. Germination experiments indicated the necessity of keeping the soil moisture well above the permanent wilting percentage for proper germination. (Project 121).

POULTRY HUSBANDRY

H. L. Kempster, Chairman

Rations for Growing Chicks. (*Q. B. Kinder*). Two series of feed tests were conducted. A spring series of 10 rations compared the use of crude vitamin B₁₂ and antibiotics in general types of rations under experiment. These feedstuffs were crude by-products and the exact analysis of B₁₂ and antibiotic activity was not determined.

The first test of series A was conducted, using straight run crossbred chicks of semi-broiler and broiler types, to permit a breeding comparison as well as growth rate evaluation for each ration. The second test was conducted using sexed male chicks of half leghorn heritage. Each test ran eight weeks and the growth rate and feed efficiency were determined at four and eight weeks of age.

It was found that addition of vitamin B₁₂ plus antibiotic (either aureomycin or terramycin) at a level of 10 grams per ton resulted in a 10 percent increase in growth rate and a 7 to 8 percent improved feed efficiency of 3 to 4 percent.

The all soybean meal protein ration (No. 8) gave good growth rate and feed efficiency when supplemented by B₁₂ and antibiotics. Data indicated that the

use of these materials in the ration largely (not entirely), eliminated the need for animal protein in starter and broiler rations. Satisfactory rations can be devised using natural feedstuffs. However, these rations were more expensive and lacked the increased response provided by the antibiotic.

Average final weight of the non-broiler crosses was 15 to 16 percent less than that for the best broiler strains.

Upon completion of the spring series, a series of fall tests was designed to compare rations of corn and soybean meal composition. The series included rations with and without additional "B" vitamins (choline chloride, pantothenic acid, and niacin); rations from all vegetable origins compared were supplemented with vitamin B₁₂ and antibiotic from crude supplement; and Missouri Agricultural Experiment Station rations compared with a standard commercial broiler mash. Procaine penicillin at 2 grams per ton was compared with aureomycin at 10 grams per ton.

These studies revealed that rations containing up to 18.5 percent of wheat mill by-products were almost as good as rations composed of corn and soybeans.

There was very little difference in growth rate or in feed efficiency. Additional "B" vitamins above B₂ and B₁₂ were of little or no value in improving the rations. The addition of meat scrap or fish meal to an all vegetable protein ration containing B₁₂ and antibiotic appeared to be of less value where part of the ration was made up of mill by-products. Some increase resulted where the ration was a corn-soybean derivative.

Station rations were as good as, and in eight of nine cases slightly superior to, the commercial rations with which they were compared on growth rate and in all cases proved superior in feed efficiency. The improved feed efficiency varied from 2 percent to 10 percent, depending on the ration considered. The procaine penicillin ration at 2 grams per ton gave equally good results when compared with like rations containing 10 grams per ton of aureomycin.

After 8 weeks of age the chicks used in these experiments were divided into two groups. Each of these two lots had had similar previous treatment and were thoroughly uniform in sex and weight. A higher energy, lower protein ration was then fed. The all soybean meal protein rations were adjusted to 16 percent and 18 percent protein levels by adjusting the percentage of corn in the ration. Vitamin B₁₂ and antibiotics were omitted from the ration. Birds were fed an additional 10 days and weights and feed efficiencies computed.

Both the 16 percent and 18 percent protein levels gave satisfactory growth and feed efficiency for this weight and age group. There was no apparent advantage in the 18 percent over the 16 percent.

Reducing protein level of 20 percent chick mashes after eight weeks of age and weights of 2 to 2.2 pounds by supplementing 10 percent more yellow corn meal in place of 10 percent soybean meal proved a sound and economical practice.

A study was designed to test three Station rations and one commercial ration under farm brooding conditions. Each ration was tested on clean and on built-up litter using 100 straight run broiler chicks for each lot. Feed costs per pound of broiler gain were analyzed. The results are presented in Tables 20 and 21.

TABLE 20 -- RESULTS OF BROILER CHICK RATION

No. Ration	Type Litter	TESTS		
		4 Week Data		8 Week Data Feed eff.
		Wt.-gms.	Wt.-lbs.	
13	Clean	381	2.57	2.80
13	Built-up	385	2.65	2.84
17	Clean	392	2.54	2.78
17	Built-up	384	2.48	2.86
18	Clean	414	2.55	2.86
18	Built-up	408	2.55	2.82
Com. xx	Clean	331	2.35	3.04
Com. xx	Built-up	359	2.48	2.85

TABLE 21 -- FEED COST PER POUND OF BROILER

Ration No.	Feed Cost		Feed Cost Per lb. Gain
	100 lb.	Feed eff.	
13	4.23	2.82	.1193
17	4.50	2.82	.1269
18	4.40	2.84	.1250
Com. xx	5.10	2.94	.1500

The all-vegetable protein ration when supplemented with vitamin B₁₂ and antibiotic (aureomycin) showed substantially cheaper per pound gain than other rations containing fish meal and meat scrap. (Project 24).

Cleaning and Preserving Eggs. (*E. M. Funk, James Forward, Martha Lorah*). In this project various means for cleaning and preserving shell eggs in storage were studied. It was found that eggs washed in tap water containing Kleneg, at 50 to 60 degrees F, suffered heavy losses of 9.1 to 54.4 percent, compared to losses of 0 to 1.6 percent in a similar lot of eggs washed for 15 minutes in water held at 130 degrees F. Losses also were very low (0 to 2.4 percent) in eggs washed in cold water and later submerged in water for three minutes at 145 degrees F. or five minutes at 140 degrees F. Eggs washed within six hours after soiling suffered as much or more spoilage than eggs washed 48 hours and 96 hours after soiling. On eggs washed 6, 48, and 96 hours after soiling the thermostabilization process reduced the storage spoilage to less than 1 percent. (Project 62).

Poultry Breeding Systems. (*G. E. Dickerson, H. L. Kempster, Q. B. Kinder, W. F. Krueger*). Results from this project indicated that older females were consistently lower in fertility (by 4 to 12 percent) and had poorer hatch of fertile eggs than pullet breeders in three of the four breeds studied. Pullet and older breeders differed little in viability of progeny up to 12 weeks of age or in body weight or scores at 12 and 22 weeks of age. Progeny from pullet breeders were equal or superior to progeny from older hens and sexual maturity in hen-day egg production and in viability. The advantage for pullet breeders was largest in the Leghorn flock where older females were used most extensively. Apparently the selection of pullet breeders based on part-year family performance improves or maintains total performance as well as or better than selection of yearling or older hens on the basis of full-year family and part-year or full-year progeny test.

In the study on recurrent selection for maximum performance in strain crosses, the three crosses of Leghorn x Rhode Island Red, Leghorn x White Rock, and Leghorn x New Hampshire progeny laid their first eggs approximately 10 days earlier than the mean for

the intra-flock Leghorns. The hen-day egg production up to 300 days of age averaged 10 to 16 percent higher for test crosses than for the mean of parental purebreds and from 4 to 6 percent higher than for Leghorns. Sex-linked superiority of Leghorn male for sexual maturity in crosses with Rhode Island Reds and White Rocks was again indicated, although it had little effect on net rate of production to 300 days of age.

In general, fertility was poorer in the test crosses than in the intra-flock matings, but the test crosses had appreciable advantage in hatchability and viability up to 22 weeks of age. Test crosses have averaged approximately 5 percent additional weight when compared to parental stocks. Fleshing score averaged 3 to 4 percent higher for test crosses. Shank length averaged 0 to 2 percent longer for test crosses than for intra-flock parental means. Hen-housed egg production averaged 8 to 14 percent over parental mean for test crosses but only 1 to 3 percent above the Leghorns. Length of life (mortality) from 154 to 456 days averaged 0 to 4 percent shorter for test crosses but total viability ranged from 4 percent higher to 10 percent lower among the three breed crossings. (Project 83).

Feed Purchasing Power of Eggs. (*H. L. Kempster*). Relationship between feed costs and egg prices was more favorable in 1951 than in 1950. Average price of feed (corn 5 parts, oats 3, and wheat 3) was \$3.08 for 1951, compared to \$2.58 for 1950. In 1951 the farm price of eggs was 39.1 cents per dozen, compared with 28.13 cents per dozen in 1950.

In 1951 the average hen with a lay of 122 eggs would have purchased 130 pounds of feed; this is 20 pounds more than in 1950. The feed purchasing power

of eggs was 97 percent of normal. This left a comfortable margin over feed costs. The feed-egg ratio was 1:7.88, compared to 1:9.77 for 1951 and 1:6.42 in 1949. Feed prices rose perceptibly in November and December while producers experienced a sharp decline in egg prices in December. The feed purchasing power of eggs declined from 119 percent of normal in September to 63 percent in December. Thus, an unfavorable relationship between feed and egg prices resulted in a decline in poultry numbers on January 1, as measured by hatchery output. (Project 73).

Care of Hatching Eggs Prior to Incubation. (*E. M. Funk, James F. Forward*). Though the percentage of hatch of all eggs set is not greatly increased by high humidity (80 to 90 percent) during the holding period, high humidity generally does give best hatching results, as measured by the percentage of hatch, the time of hatch, and the quality of the chicks hatched. Data obtained in this experiment justify the use of high humidity for holding hatching eggs. The hatchability of eggs which showed a high rate of evaporation (poor shell quality) was maintained best by high humidity.

Eggs incubated where the relative humidity was approximately 58 percent hatched significantly better than eggs incubated with 40 percent relative humidity.

The hatchability of eggs held at proper temperature for 10 days or less was not increased by turning. However, the hatchability of eggs held longer than 10 days (11 to 14 days) was increased appreciably by turning and more significantly, by turning daily from the day they were laid. (Project 40).

RURAL SOCIOLOGY

C. E. Lively, Chairman

Rural Population Trends: (*L. M. Hepple, C. E. Lively*). The method of studying migration of rural people involved collection of birth and death rate data by years from 1940 to 1950 on a resident basis by counties and economic areas. By compiling the data on a rural farm, non-farm, and urban basis by years for comparison with 1940 and 1950 census reports, it was possible to show the amount of natural increase and estimate the net migration.

These patterns of net migration then were studied with respect to their relation to other measures of the socio-economic position of the population; such as levels of living, extent of mechanization; changing number and size of farms, farm income, and the use of farm labor. These measures were available for com-

parison from both the beginning and end of the decade under study.

First results revealed that the rural population of Missouri would have gained by at least 200,000 persons if there had been no migration. Actually, there were approximately 150,000 fewer rural people counted in 1950 than in 1940. This means that the rural areas of the State lost more than one-third of a million people by net migration from rural communities.

The volume and rate of decline in rural population was not uniform throughout the State. Relatively heavy losses have occurred in areas where mechanization and farm consolidation tend to reduce the number of people required to carry on farming operations. In other parts of the State, where human fertility is re-

lately high, a different set of factors have been the chief contributor to population loss (Project 27).

Current Extension Personnel and Prospective Personnel. (*I. F. Nye, C. E. Lively*). The purpose of this project was to determine characteristics correlated with success in county extension personnel. In 1951, all male county extension agents in Missouri were classified by various administrative devices intended to segregate the more successful from the less successful. Agents were given the army general intelligence test, the Strong vocational interest test, the Guilford-Martin personality inventory, the Minnesota teacher attitude inventory, and a specially constructed extra-curricular background inventory.

The tests were given to all male county extension agents in Missouri who had been in the field eighteen months or longer and to a random sample of College of Agriculture seniors.

There were 148 county agents and 128 college seniors included in the sample. The specially constructed professional training inventory included a testing sheet developed for scoring each agent on character, capacity, and performance. These items were measured by interest, personality, attitude, performance record, extra-curricular activities, and background training.

Data differentiated county agents from College of Agriculture seniors. It also differentiated between high and low performance county agents. The criterion to measure success of a county agent was developed by using the following ratings: Rating by two administrators, by two subject matter specialists, by three farm leaders in the agent's county, by two non-farm leaders in the same county, and by his salary with service constant. The 10 ratings were given equal weight and pooled.

In these determinations personality items contributed 44 percent to success; background and training contributed 24 percent; vocational interest, 18 percent; and attitude, 14 percent. (Project 47).

A Study of Teaching Effectiveness. (*Robert Callis, T. C. Burgess*). Assuming that good teacher-pupil relations are related to teaching effectiveness and the quality of teacher-pupil relations can be rated successfully by qualified observers and other techniques, the Minnesota teacher attitude inventory test was useful as an instrument for predicting teacher effectiveness.

The coefficient for determination of effectiveness was 21 percent. A study of the effectiveness in personality characteristics revealed by the Minnesota multi-

phasic personality inventory suggested that successful teachers more often were characterized by (1) freedom from tension and anxiety, (2) ability to get along well with family and friends, and (3) realistic attitudes. (Project 48).

Rural Health Facilities in Missouri. (*C. E. Lively, R. L. McNamara, J. B. Mitchell, Carl Jehlik*). Although physicians were concentrated in urban areas in Missouri, the number in cities as well as in rural areas failed to keep pace with increase in population. A survey of sickness in two socially different areas of Missouri was made. Generally persons who lived a greater distance from medical facilities tended to experience fewer calls from doctors and more days in bed for an illness than those who lived relatively near good medical facilities. This was especially true among persons in the low socio-economic levels. Illness experience records were made for more than 100,000 adults living on Missouri farms. Data revealed that at least 5 percent of the people were unable to work on a given day because of some form of disabling illness. Chronic or prolonged illness is a problem of serious proportion among farm people. At least one-half of the disabling illnesses on a given day and more than three-fourths of the disabling illnesses reported over a period of time were due to illness of a prolonged nature.

It was established that morbidity of a large farm population involving 50,000 or more people can be studied by interviewing as few as 200 families. The average farm person loses about 15 to 20 days of work annually because of sickness. (Project 25).

Barriers to Use of Scientific Information. (*C. E. Lively, H. F. Lionberger, C. M. Coughenour*). The purpose of this study was to determine the factors which hinder dissemination of scientific information.

Interviews with 459 farm operators and wives in the better farming areas of the State indicated that they were bound to the soil by tradition and sentiment. They have little inclination to leave the farm and were not prepared to follow any other type of employment. Economically, they generally were included in the lower economic third of the population and had an average gross income of \$763.00 in 1946. The possibility for change and improvement seemed good. They lived on some of the better farm land in the State. They were favorable to farm education. A high percentage of them desired more practical farm and home information. A great number recognized important farm problems of the day.

Of the personal interviews, 70 percent of the households depended largely on friends and neighbors for an indirect means of obtaining new information, 32 percent got help directly from county agents, 32 percent from AAA offices, and 9 percent from FHA offices. Extensive use of mass communicative media was made.

Newspapers supplied information to 78 percent of the households, farm journals to 73 percent, and radio broadcast to 62 percent. The mass communication agencies not only were more extensively used than the direct sources but they were less affected by education, income, and locality factors. Timely information to newspapers and radio stations will show good results in any agricultural education program.

The survey indicated a greater need for multiple approach to farm people to insure that scientific information reaches the user. Amount of schooling interviewees had received was closely associated with use of all information, particularly the impersonal.

Final analysis of data relating to 459 low-income farm operators and wives in north and west central Missouri disclosed that they like to farm and have little inclination to do any other type of work. Since natural resources and general conditions prevailing in the area were favorable for farming, their situation evidently was a product of limiting human factors.

Farm operators reported that they found both solicited and unsolicited farm bulletins useful. Timely and selective distribution of simply written publications may be of considerable usefulness as a means of getting farm and home information to low income farmers. Efforts of the agricultural extension service in getting timely bits of information to newspapers and radio broadcasting stations have been well received.

The study revealed that low-income farmers were highly favorable to high school and college education for better farming and improved farm living. (Project 29).

SOILS

W. A. Albrecht, Chairman

Corn. (*G. E. Smith, A. W. Klemme, Ted Fiber, R. I. Steffens*). A study was made of the practices necessary to obtain optimum corn yields under varied soil fertility conditions in Missouri. Outlying fields were operated under lease agreements at nine locations. Locations were selected for variety in soil types. Due to past management of soil and the effect of this management on soil requirements, a great deal of variation in response has been encountered on different fields of the same soil type.

Extensive comparisons were made of different rates of nitrogen application on corn and other crops on a large number of soil types. A summary of the 208

trials conducted during the 5 year period showed that where soil treatments were applied according to soil tests, the average yield of corn was 92.3 bushels per acre. Where there was no fertilizer treatment, or the fertilizer was applied by guess, the yield was 56.9 bushels per acre. This was an increase of about 35 bushels of corn from an application of approximately 80 pounds of nitrogen per acre.

Experimental evidence indicated that under good farming conditions an application of 2 pounds of nitrogen will result in an increase in corn yield of approximately 1 bushel, after this element becomes the limiting factor.

Fig. 17—Soil treatments made the difference on these two plots that were of similar fertility originally. Application of manure only (left), gave a yield of 34.7 bushels

of corn per acre. Manure plus fertilizers according to soil tests (right) resulted in a yield of 120 bushels of corn per acre.



Applications of nitrogen to small grain resulted in greatly increased yield. Sixteen comparisons in 1951 gave an average increase from 13.4 bushels of wheat where no treatment was applied to 30.8 bushels where soil received fertilizer according to soil test and starter fertilizers were applied, followed by a top dressing with nitrogen.

TABLE 22 -- RESPONSE OF CORN TO SUPERPHOSPHATE AND ROCK PHOSPHATE WHEN PLACED 6 AND 12 INCHES DEEP

	4-year average-yield-bushels per acre	
	Plowed 6" deep	Plowed 12" deep*
No soil treatment	75.8	86.7
Starter fertilizer only**	80.1	82.3
880# 0-20-0**	83.4	92.0
1750# rock phosphate**	82.8	94.6

* TNT plow.

** Starter fertilizer applied to all plots except the no treatment plot.

Putnam silt loam - Limestone @ 4 tons per acre. 2-year rotation: Corn, oats, sweet clover.

Use of excessive amounts of calcium limestone and increased use of other plant nutrients have reduced available magnesium on some soils to levels where shortage of this element is limiting crop growth. In one experiment on a field showing only 150 pounds of exchangeable magnesium the following responses to magnesium supplementation were obtained: No fertilizer, 52 bushels; soil treatment according to test excepting magnesium, 102.7 bushels; soil treatment according to test including magnesium, 111.8 bushels. (Project 78).

Continuous Cropping Versus Rotations of Different Length. (*G. E. Smith, T. R. Fisher, R. I. Steffens*). For the first 50 years of operation, rotations without soil treatment produced a considerably higher yield than continuous cropping plots. However, in the last 15 years the yield from rotation plots has dropped rapidly. At the present time, the yield and quality of crops produced in rotation plots without treatment are little better than where the same crops are grown continuously without treatment. A six year rotation has been followed. The last year that the rotation plot was in corn and wheat it produced only three and one-half bushels more of each grain than where these crops had been grown continuously for 60 years.

Legumes and rotations add nitrogen to the soil and furnish surface protection to reduce soil erosion. However, when these legumes are removed from the land they take more nutrients from the soil than do grain crops. Average loss in fertility removed by the crops is about the same under continuous cropping or

rotation. In these studies, the yields of grain crops were lowest following an increase in proportion of grass and legumes in the rotation when the forage was removed for hay. (Project 78).

Effect of Soil Treatments in Rotations and Continuous Cropping Systems. (*G. E. Smith, Ted Fisher, R. I. Steffens*). The highest yield of corn ever produced on Sanborn field was obtained this year. This record growth of 134.2 bushels per acre was produced (plot 3) where red clover was turned under with 150 pounds of nitrogen, and 200 pounds of starter fertilizer applied at the time of planting.

This high yield was in contrast to 8.6 bushels per acre on a plot that had been in continuous corn with no soil treatment. Where manure has been applied during the last 63 years, the corn yielded 40 bushels per acre. Two previously abandoned plots were fertilized according to soil tests and returned to continuous corn production. These plots produced more than 125 bushels per acre in 1950 and 112 bushels in 1951. This showed what could be done to return "worn out land" to high production through proper use of soil amendments. It is both practical and profitable to

Fig. 18—Plots at Sanborn Field which received no fertilizer treatment for 63 years (top) while in a six-year rotation of corn, oats, wheat, clover and timothy (2 years) had a final plant population of broom sedge, tickle grass, and timothy. Plots receiving test guided soil fertilizer treatments remained pure stands of timothy (bottom).



produce corn on land once thought unsuited for corn production.

A comparison of yield data from three fertility plots gave ample evidence of the necessity of adequate fertilizing or high fertility levels. Treated plots were managed in a 6 year rotation, with 2 years of timothy. On the plot which received no soil treatment, a yield of less than 500 pounds of weeds per acre was produced in 1951. In the plot where manure was applied as the only treatment, the yield was 1,960 pounds per acre which was about one-half weed species. On the plot that was fertilized according to soil tests, 12,250 pounds of hay was harvested per acre (three cuttings). When land was plowed in December, untreated plots contained 2,700 pounds of dry materials, of which 44 percent was broomsedge, 50 percent lespedeza, 2 percent tickle grass, and 4 percent timothy. On the plot receiving manure treatment only, growth was 80 percent tickle grass, 15 percent broomsedge, and 5 percent lespedeza and timothy. The total weight was 4,000 pounds harvested from this plot. From the plot receiving adequate soil treatment 3,540 pounds of dry material was harvested. This material was 99 percent timothy. Residues turned under on treated plots analyzed 17.9 percent protein or contained a total of 627 pounds of protein per acre turned under in plant residues. This material would have made excellent winter pasture. (Project 78).

The Effect of Heavy Applications of High Analysis Fertilizers on Soils With Average Clay Content. (*G. E. Smith, T. R. Fisher, R. I. Steffens*). There appeared to be no detrimental effect unless soluble fertilizer materials were placed adjacent to seed. However, excessive amounts of nitrogen caused lodging and changed chemical composition of grain and forage in a manner that may not be desirable. Data in Table 23 show nitrogen content, percentage lodging, and nitrate content of corn fodder following different rates of nitrogen application.

Excessive nitrogen application (250 pounds per acre) delayed maturity and resulted in a higher moisture content. High concentration of nitrogen in the stalks may have been toxic to animals if this fodder had been used as the only feed for livestock. Lodging increased as more nitrogen was used. It was evident



Fig. 19—Plant nutrient balances may be disturbed when a heavy rate of fertilizer is added for maximum yields. This corn produced 125 to 150 bushels per acre. Where nitrogen addition was high (top) lodging was almost 100 percent. Where only a small amount was added in starter fertilizers, plants stood much better (bottom). Both areas received adequate phosphorus and potash.

that factors other than phosphorus and potassium must be given attention when sufficient nitrogen and increased corn population were provided in yields in excess of 100 bushels per acre.

Influence of Fertilizer Additions. (*G. E. Smith, T. R. Fisher, R. I. Steffens*). Repeated applications of a high degree of purity CaCO_3 have produced soil reactions with a pH above 7.0. The magnesium content of the surface soil in these studies has been reduced to a ratio of one part magnesium to 15 to 20

TABLE 23 -- EFFECT OF RATE OF NITROGEN ON CORN PRODUCTION (ADEQUATE MINERAL TREATMENTS APPLIED TO ALL AREAS)

	Moisture in fodder	NO ₃ N in stalks	% stalks lodging	Protein in grain	Yield per acre	Weight of ears
No nitrogen	29.7%	.002%	42.1%	7.78%	84.2 bu.	.47 lbs.
50# nitrogen	21.2	.001	35.1	7.26	81.7	.47
120# nitrogen	38.7	.008	47.3	7.78	112.0	.58
250# nitrogen	39.1	.076	64.3	9.43	114.9	.62

parts calcium. The exchangeable magnesium is less than 100 pounds per acre. When plants are young, indications of magnesium deficiency are observed on the leaves. Crop yields have not been influenced by the application of soluble magnesium salts or dolomitic limestone in the plots studied. However, the subsoil still contains a high level of magnesium and apparently when the roots reach this soil region they are able to utilize a sufficient quantity.

Little or no difference was observed in response to rock phosphates from different deposits, from widely separated areas, and from ground phosphate rock of different degrees of fineness. Colloidal phosphate has been compared with super phosphate and rock phosphate in experiments with small grains. Both rock and colloidal phosphate have proved inferior sources of phosphorus for barley. When applied to a low phosphorus content Putnam silt loam there was little difference in response from colloidal or rock phosphate when applied at the same rate of P_2O_5 per acre.

Studies on the value of different sources of potassium (including muriate of potash, potassium sulfate, sulfate of potash), magnesium, and glauconite have been continued on small grains and alfalfa. There was little difference in their response to the different sources of soluble potassium. (Project 78).

Comparisons of Fertilizer Materials Containing Nitrogen, Phosphorus, Potassium, Calcium, and Magnesium. (*G. E. Smith, T. R. Fisher, R. I. Steffens*). This study showed that where plant nutrients were applied according to soil tests there was little difference in response, regardless of placement of phosphorus, potassium, calcium, or magnesium. Where magnesium was deficient, the use of soluble magnesium salts gave a more rapid response than dolomitic limestone. This was particularly true where the soil's pH was high. Unless exchangeable hydrogen was present in the soil, dolomitic material went into solution very slowly. (Project 78).

Use of Heavy Nitrogen Application for Conversion of Carbonaceous Organic Matter into Humus. (*G. E. Smith, T. R. Fisher, R. I. Steffens*). This project was designed to study the effect on yield of plowing under sawdust, corn cobs, corn stalks, and other carbonaceous material. Adequate nitrogen, phosphorus, and sulfur were added to insure that soil microorganisms could break down the material without competing with growing crops for these elements. Corn yields in excess of 100 bushels per acre were obtained on plots treated with these organic materials. The application of 15 to 18 pounds of nitrogen per

ton of organic material was sufficient to accomplish the necessary breakdown. When larger nitrogen quantities were applied the crop of oats following corn lodged severely. Application of these materials offers possibility for improving the deficit in organic matter of eroded soils. (Project 78).

Relationship of Plant Stand and Spacing to Fertilizer Application. (*G. E. Smith, E. R. Graham, T. R. Fisher*). When adequate plant foods are used, plant population must be increased to utilize fully the increases in the soil fertility level (Table 24). It

TABLE 24 -- RELATIONSHIP OF PLANT POPULATION AND SPACING TO FERTILIZER APPLICATION (SOIL TREATMENTS APPLIED ACCORDING TO SOIL TEST FOR 125 BUSHELS PER ACRE CROP)

Experiment Field	Plant Population			
	5000-6000	7000-8000	10000-12000	16000-18000
Columbia	87.5 bu.	94.5 bu.	113.0 bu.	104.5 bu.
Norborne	----	65.7	87.8	90.2
Lathrop*	----	31.1	37.8	54.1
Savannah*	----	52.6	58.9	63.1

*Excessively wet season - corn cultivated only one time.

appears possible to eliminate natural soil fertility as a factor in production, when climatic conditions are favorable. This makes better and higher yielding varieties important if higher yields are to be obtained through use of additional plant nutrients. (Project 78).

Soil Building Values of Legumes. (*G. E. Smith, T. R. Fisher, R. I. Steffens*). In this project, corn and small grain yields were used to measure soil-building value of grasses and legumes in a corn-small grain-forage rotation. When 66 pounds of nitrogen per acre were added to rotations growing timothy, sweet and red clover, lespedeza, and soybeans corn yields were increased substantially. The yield of corn was increased 13 bushels following sweet clover, 16½ bushels following red clover, 4 bushels following lespedeza, and 22 bushels following soybeans.

TABLE 25 -- CROP YIELDS AS MODIFIED BY LEGUMES AND CHEMICAL NITROGEN IN THE ROTATION

Cropping System	Average Yield			
	Corn	1936-1949		1950-1951*
		Small grain	No Nitrogen	
Corn, small grain, timothy	53.5	30.7	86.2	102.5
Corn, small grain, sweet clover (seed)	64.5	39.1	100.8	113.4
Corn, small grain, red clover (hay)	56.4	34.6	90.3	106.9
Corn, small grain, lespedeza (hay)	56.3	34.8	93.8	97.6
Corn, small grain, soybeans (seed)	56.3	35.5	90.3	112.6

*Corn

The residual effect of nitrogen applied to corn grown in rotation with grass and legumes was sufficient to influence greatly the yield of the following crop. In one case the residual effect of 200 pounds of nitrogen applied to corn resulted in an increase of 12.3 bushels in the following wheat crop. This was sufficient to pay for the entire cost of the nitrogen with none being charged against the corn crop. When expenditures are planned for rebuilding fertility reserves by the addition of commercial fertilizers, the charge should be pro-rated over a period of years. It should not be charged entirely against the immediate crop. Later crops derive much of the benefit.

The following table demonstrates residual effect of nitrogen applied to corn on wheat yields. (Project 78).

TABLE 26 -- RESIDUAL EFFECT ON WHEAT YIELDS OF NITROGEN APPLIED TO THE CORN CROP

	Corn yield 2-year average	Wheat after corn 1-year
No nitrogen	86.2 bu.	15.7 bu.
33 pounds nitrogen	95.7	18.0
66 pounds nitrogen	102.5	19.0
132 pounds nitrogen	114.5	22.7
200 pounds nitrogen	116.7	28.0

Fertilization Programs for Rotation Systems.

(G. E. Smith, T. R. Fisher, R. I. Steffens). The type of crop grown and method of handling influenced nutrient requirements of different rotations. Corn has a high nitrogen requirement, but legumes removed much larger quantities of phosphorus, potassium, and calcium.

In a rotation system where sweet clover was turned under as a green manure crop for 15 years, the potassium test showed an excess of 200 pounds of exchangeable potassium per acre. In another test where red clover had been removed for hay, the exchangeable potassium was only slightly over 100 pounds per acre. In plots where lespedeza and soybeans were grown, the potassium level was not as low as for red clover but lower than where sweet clover was turned under. These soil and nutrient levels were reflected in response of different crops to various fertilizer formulas.

Corn following sweet clover responded well to applications of available phosphate. Little benefit was obtained from addition of potassium. Where legume crops have been removed for hay, addition of phosphorus showed little response unless potassium also was added. These results pointed to the absolute necessity for an accurate soil testing program to guide and determine fertilizer needs. Individual soil man-

agement systems have a pronounced effect on fertilizer and soil management responses and results obtained on a single field may be applicable only to that particular area. Therefore, detailed fertilizer experiments on a given field are limited in application. (Project 78).

Methods of Improving Fertility of Subsoils.

(G. E. Smith, T. R. Fisher, R. I. Steffens). The purpose of this work was to measure the effect of soil depth on crop yields. Much of the land in Missouri has undergone serious sheet erosion and is making a low yield return. In these studies lime and starter fertilizer on corn and wheat were the only soil treatments. Influence of soil depth on yields is shown in Table 27.

TABLE 27 -- EFFECT OF SOIL DEPTH AND ADEQUATE TREATMENT OF ERODED SOIL ON YIELD OF GRAIN (PUTNAM SILT LOAM)

Soil	Soil Treatment	12 year avg.		2 year avg.	
		Corn bu.	Wheat bu.	Corn bu.	Wheat bu.
Double depth	Starter fertilizer				
	Lime	71.6	31.0	100.5	12.6
Normal depth	Starter fertilizer				
	Lime	56.1	29.2	77.5	12.6
Subsoil	Starter fertilizer				
	Lime	35.8	13.0	67.0	11.0
Subsoil	Treatments according to soil tests	----	----	91.5	15.3

Rotation: Corn, wheat, meadow.

In 1950, an adjacent area of subsoil was given soil treatments according to soil tests. The yield of corn on subsoil treated according to soil test has been 14 bushels greater than the yield on soil of a normal depth with starter fertilizer application. It was only 9 bushels less than where the soil had been increased to double depth. Wheat yields, though only 15.3 bushels per acre, were greater than yields obtained from any of the other areas. Satisfactory crops can be produced on eroded soil provided the necessary plant food nutrients are added. (Project 78).

TABLE 28 -- EFFECT OF SOIL TREATMENTS ON WHEAT YIELD WHEN ADEQUATE MINERALS ARE PROVIDED IN BOTH SURFACE AND SUBSOIL

Variable Soil treatment	Yield per Acre
Starter fertilizer	43.6 bu.
Starter + 66# N	47.6
Starter + 66# N + Trace elements	47.6

EFFECT OF SOIL TREATMENTS ON BARLEY YIELDS WHEN ADEQUATE SOIL MINERALS ARE PROVIDED IN BOTH SURFACE AND SUBSOIL (AVERAGE FOUR VARIETIES)

Variable soil treatment	Yield per acre
Starter fertilizer	58.5
Starter + 33# N	66.4
Starter + 66# N	61.1

TABLE 29 -- EFFECT OF SUBSOIL TREATMENTS ON CROP YIELDS, 1951

Crop	None	Shattered to a depth of 18"	Shattered to depth of 18" with lime and rock phosphate mixed in the subsoil
Corn	108 bu/A	93 bu/A	112 bu/A
Wheat	30.5 bu/A	27.3 bu/A	31.5 bu/A
Soybeans	32.8 bu/A	33.3 bu/A	32.6 bu/A

Soil Treatments for Improving Yield of Small Grains. (*G. E. Smith, T. R. Fisher, R. I. Steffens*). Experiments have been conducted using different varieties of small grains on soils where heavy applications of minerals have been made, both in the subsoil and in the surface soil. Also, increasing amounts of nitrogen were top dressed on the small grains. Yields given in Table 28 were obtained during 1951 on Putnam silt loam; these yields are far above those commonly obtained on most farms. (Project 78).

Soil Survey and Land Classification. (*H. H. Krusekopf, J. A. Frieze, C. L. Scrivner, M. E. Springer*). A soil survey of Moniteau County has been concluded. Classification of the soils in this county revealed that the loess was not as thick south of the Missouri River as north of this river. Deep loess, as a soil forming material, usually is much more productive than shallow material. Loess less than 10 feet in depth usually forms less productive soils. (Project 78).

Mechanism of Nutrient Uptake by Plants from Soil. (*E. R. Graham, C. E. Marshall, W. L. Baker, A. Haselhorst*). Exchangeable hydrogen ions from root surfaces of different crop plants were measured. Determinations were made of the degree of saturation by hydrogen ions in relation to exchange capacity of roots; and factors modifying this ionic activity were studied.

The amount of hydrogen exchangeable from the surface of roots may be measured directly on roots immersed in water by titration of the standard solution of calcium hydroxide. This exchangeable hydrogen may be expressed as a percentage of the total surface ions after the total exchange capacity of the root has been measured, subsequent to electro-dialysing, hydrogen saturating, and titrating the total with calcium hydroxide.

The amount of hydrogen was found to vary according to: (a) nutrient treatment during plant growth, (b) age of the plants, (c) plant species, and (d) temperature at which plants were grown. The per-

centage of saturation by hydrogen ions was low when nutrient solutions had been added shortly before the determinations were made. The percentage of hydrogen concentration was high when addition of the nutrient had been withheld for considerable time in advance of the determination. (Project 51).

Relation of Primary Mineral Reserve to Available Nutrients and Plant Uptake. (*E. R. Graham, Earl Watts, M. C. Carter*). Various potash minerals and rocks containing potassium have been compared with potassium containing soils in their effect on growth and composition of Ladino clover for four successive crops. All mineral rock applications were at the rate of 220 pounds of K_2O per acre corresponding to 2,000 pounds of potash feldspar. Glauconite, Rhyolite, granite, feldspar, alunite, illite, basalt, Wyomingite, orendite, and orendite pumice, in the form of ground minerals and rocks were employed. Glauconite, illite and alunite also were used after calcination at 400° and at 700°C. A feldspar-dolomite mixture was calcinated at 700°C. prior to use. The base soil medium used was one of low available potassium. All other nutrient requirements, including trace elements, were added as basal treatment. The study revealed that calcining the minerals made potassium more available. Also that there were pronounced differences in the way the minerals released potassium to the crop. Orendite pumice released the most potassium and Phylolite released the smallest amount. (Project 51).

Plant Root Penetration. (*C. M. Woodruff, D. D. Smith, D. M. Whitt*). Work on this project was to determine the effect of deep placement of fertilizer materials in clay pan soils. All plots received equal fertilizer treatments on the surface. The variable in the study was the treatment of subsoil. Table 29 indicates conditions and yields obtained from the various crops:

There was a definite decrease in yields where the subsoil was shattered without fertilizer treatment and a slight increase in yield where lime and phosphate were added to the subsoil. Fertilizing surface soil and the practice of fairly deep plowing (9 inches) gave yields almost as great as where the subsoil was fertilized. (Project 51).

Characteristics of Heavy Clays. (*C. E. Marshall, W. J. Upchurch, N. Patnaik*). The potassium-calcium relationship in Wyoming Benonite and the general electro-chemistry of montmorillonite clays were studied. The calcium-potassium relationship for

Putnam clay (a beidellite), Arizona Bentonite (intermediate in character between a typical montmorillonite and a typical saponite), and an attapulgite (fibrous clay) was examined in detail. Appropriate membrane electrodes were used to determine potassium and calcium activity. Fractions active in the mean freebonding energies of the cations were calculated. Results showed that calcium and potassium neutrally affected each other through the bonding energy relationship of ionizing surfaces.

In general features, the potassium-calcium relationships of two illites (grundite and Magaoketa) were found to be closely similar to those of Putnam clay (bidellite). Increase in calcium saturation greatly increased potassium activity. Potassium lowered calcium activity up to about 60 percent saturation. Beyond this point it increased it slightly. Compared with montmorillonite clay groups, illites tend to hold potassium more tenaciously but calcium less tenaciously. Calcium increased the potassium of kaolinite.

By the use of suitable membrane electrodes, sodium and potassium activities were measured in the presence of each other and in the presence of calcium. Potassium raised sodium activity greatly while sodium lowered potassium activity. Sodium caused a greater lowering of calcium activity than did potassium on the Putnam clay studied.

Cationic activity measurements were made on soil organic matter and its fractions. Measurements consisted of sodium, potassium, magnesium, and calcium activity for the humic, hmatomelanin, and erode humic acid fractions, and the whole soil for a Wisconsin peat and a Kansas Chernozem soil. Bonding energies of the cations at different degrees of saturation were calculated. Soil organic fractions held these cations less tenaciously than clay minerals. In this project, work has been continued on natural soil clays and artificial clay mixtures. Conditions in natural soil clays have been found more complex than those for artificial clay mixtures.

Cataphoretic studies were made of hydrogen in sodium clays in the presence of different amounts of polyvalent cations. Two Bentonites, Putnam clay, illite, hallopate, kaolinite, and quartz were used for study. Data showed that the different clays varied greatly in stability in the presence of lanthanum chloride, thoriochloride, and hexol chloride. Separations were affected in artificial mixtures based on these differences. Starch was used as a flocculating agent to differentiate montmorillonite from the other clays. (Project 6).

Soil Weathering and Development. (*E. R. Graham, C. E. Marshall*). Mineral content of silt sep-

arates of Missouri soils was studied in regard to fertility level and degrees of weathering. Silt fractions of Wabash, Marshall, Knox, Lebanon, and Clarksville soils contain 67, 69, 67, 81 and 84 percent quartz, respectively; and 13, 12, 13, 6, and 9 percent potassium feldspar, respectively. The percentage of plagioclase feldspar were 20, 19, 20, 12, and 7 respectively; and ratios of sodium to calcium were 1.6 to 1, 1.9 to 1, 1.2 to 1, 2.8 to 1, and 3.0 to 1, respectively.

When properly considered the ratio of sodium to calcium was found to be a sensitive indicator of the fertility level and degree of soil weathering. The potential in the use of differentially stained slides of such separate is a technique deserving further development and wider use in the study of soil weathering. (Project 6).

Chemical Studies of Feed Grown on Soils Treated with Trace Elements. (*W. A. Albrecht, G. E. Smith, A. W. Klemme, Ted Fisher, Lester Reed*). Grains and forages produced on soils receiving different trace elements were analyzed by spectrographic methods. Determinations for amino acids were made. Addition of magnesium and a trace element mixture increased the concentration of tryptophane 35 percent and methionine 19 percent in alfalfa.

An increasing number of boron deficiencies in alfalfa have been observed on Missouri soils. Alfalfa has the highest requirement of crops for boron. Missouri Agricultural Extension Circular No. 599 discusses boron deficiency in alfalfa. (Project 92).

Animal Assays of Trace Elements in Soils. (*W. A. Albrecht, G. E. Smith, T. R. Fisher*). In this work spectrographic, chemical, biological, and greenhouse studies have been conducted in an effort to develop laboratory techniques for establishing trace element levels in Missouri soils. To date workers have been unable to locate a soil type that was thought to be sufficiently low in one or more trace elements to make it satisfactory to produce feed for experimental farm animals. Missouri soils derived from different parent materials showed a wide difference in total trace element content. It is evident that where the major elements have been applied in liberal amounts, the resulting increased crop yields have a lower trace element content than where the yields per acre were low.

Efforts to determine available, rather than total, quantities of trace elements have not been satisfactory. Considerable time has been spent on improving methods for determining available minor elements. Heavy applications of synthetic nitrogen and high analysis mineral fertilizer will be applied as a technique for in-

ducing low nutrient balances of trace elements. (Project 92).

Weather Data. (*W. L. Decker, M. F. Miller, J. H. Poehlman, A. D. Hibbard*) Monthly precipitation patterns were determined for Missouri from past records. January presented a typical pattern for winter months. Heaviest rainfall occurs in the southeast corner and the amount decreases diagonally across the State to the northwest corner. April's pattern differs slightly, with the heaviest rainfall all across the south and decreasing straight north. July presents a highly irregular pattern due to the scattered showers typical of that month. By October the pattern was found to return to one similar to that described for January.

Appreciable snowfall seldom occurred before October or after May 1 in Missouri. Heaviest snowfalls occurred in the northern part of the State. (Project 92).

Soil Temperature Data. (*W. L. Decker*). Soil temperature data were collected at two locations in Missouri. At each location, daily soil temperature readings were taken in the evening, usually between 4 and 6 p. m. In these temperature recordings a five day mean temperature was computed in order to remove minor variations and to facilitate plotting. The annual variations represented all the major temperature changes throughout the year.

The depth of soil freezing is not great in Missouri. At Sikeston and Faucett, temperatures below freezing extended only a short distance into the soil and persisted for only short periods of time. Below freezing temperatures occurred at the three inch level at both locations during the last few days of January and the early part of February. At neither location did the temperature dip below freezing at the soil 12 inch level. Temperature at the three-inch level dropped below freezing for a few days in late December.

As spring approached, soil temperature rose at all depths. By measuring temperatures at the 3 inch level, it was possible to gain information on when the soil reached a temperature high enough for seed germination. The following table shows the dates after which the soil temperatures were above 50°, 60°, and 70°F at the two Missouri locations.

	Faucett	Sikeston
Above 50° F.	April 20	April 12
Above 60° F.	May 12	April 18
Above 70° F.	June 5	April 28

From the above data it is obvious that during 1951 the soil became warm enough for rapid growth

of crops about one month earlier at Sikeston than at Faucett. Normally these differences would not be so great. During 1951, dry conditions in Southeast Missouri caused soil temperatures to rise rapidly in the spring.

Relatively high soil temperatures occurred for an extended period during the summer at the three and 12-inch depths at Sikeston. The highest temperature at these depths at Faucett occurred for only a short period of time during early August. It is very likely that this difference in temperature reflected the difference in soil moisture conditions at the two locations. Soil temperature dropped sharply at the 3-inch depth in the fall.

	Faucett	Sikeston
Below 70° F.	September 10	October 8
Below 60° F.	October 1	October 28
Below 50° F.	October 21	November 5

In general, the range of soil temperature was greater in the winter season than for the summer season. The temperature range decreased with increased soil depth. At one and six-inch levels, winter temperatures varied as much as 20 to 25 degrees each month. During summer months the temperatures varied 10 to 15 degrees at these depths. At 48 and 72-inch depths, the range of soil temperature was seldom greater than 2 to 4 degrees. (Project 94).

Permanence of Grass-Legume Sod. (*G. E. Smith, A. W. Klemme, T. R. Fisher, Ray Steffen*). Increasing the production of permanent forage pasture and improving its quality by correcting soil fertility deficiencies were studied.

High yields of the nutritious forage have the greatest mineral requirement of any commonly grown crops. Where land has been pastured a large portion of the plant nutrients have been retained or returned to the soil. Where forage has been removed for hay, the soil minerals have been depleted more rapidly than where grain crops were grown. This increased rate of removal by grasses and legumes has been shown forcibly by soil tests made after 63 years of cropping systems.

Where continuous hay crops have been grown or where rotations have contained a high percentage of forage removed for hay, phosphorus, potassium, and magnesium were generally lower than where grain crops have been produced. Except for nitrogen added and the cover provided by legumes and grasses these crops have been more exploitive of soil fertility than grain crops.

The level of nitrogen and soil minerals has influenced not only the yield of forage but also has been a

determining factor in the species of plants that grow. Determinations made in July 1951 showed that addition of nitrogen promoted growth of grass species while mineral treatments without nitrogen favored growth of legumes.

When nitrogen was applied the grass partially crowded out the legumes. When only initial applications of nitrogen were made, the treatment enhanced the legume growth. (Project 99).

TABLE 30 -- EFFECT OF SOIL TREATMENT ON YIELD AND SPECIES OF PLANTS IN PERMANENT STAND SEEDED TO GRASS AND TO LESPEDEZA

Soil Treatment	Yield per acre - lb.	% of plants		
		Grass	Lespedeza	Weeds
None	5685	37	51	22
Nitrogen	7430	97	1	2
Phosphorus	6865	74	21	5
Nitrogen-Phosphorus	7960	95	1	4
Phosphorus-Potash	6760	69	38	3
Nitrogen-Phosphorus Potash	9390	97	1	2
Lime	6135	44	55	1
Lime Phosphate	7470	76	23	1
Lime Phosphate Potash	7635	71	26	3
Nitrogen Phosphate Potash-Lime	8350	44	55	1

Nitrogen as Amino and Other Forms of Organic Matter. (*W. A. Albrecht, V. L. Sheldon, L. W. Reed*). In this work the bio-synthesis of amino acids in relation to soil fertility has been studied. A microbiological assay for tryptophane showed that this organic substance varied in amounts according to the inorganic composition of the substrata upon which the plants synthesizing the tryptophane were grown. Tryptophane has been shown to be a required amino acid in the diet of the white rat. Alfalfa, soybean, and redtop hays were used to measure the amino acid synthesizing value of various inorganic substrata. Tryptophane synthesis was decreased when magnesium, and iron were withheld from the solutions supporting alfalfa and soybeans. The formation of tryptophane was found to be proportional to the available boron when this anion was the limiting element in the culture solution. Increasing the calcium increased the production of tryptophane. Effects of the inorganic nutrient elements on tryptophane formation were shown to be of the same kind whether the plants were grown in nutrient solution or in colloidal clay.

The possibility was suggested that sulfates, carried unwittingly as a part of super phosphates, have had an active part in building proteins more complete for the animal diet. (Project 105).

Soil Erosion. (*C. M. Woodruff*). Seven plots were designed to study the potential of reclaiming eroded land. The fertilized land was replanted to corn

in 1951 following corn in the 1950 season. Stalks from the preceding crop were left on the surface and the corn was hill planted with a hoe. This procedure was followed to permit leaving stalk residues on top of the ground. Purpose was to evaluate protection they afford in erosion prevention. The corn was not cultivated. Nitrogen fertilizer was used to supplement that released from the soil and to supply adequate plant foods to feed the competing grass, weeds, and corn.

Results for the year—

Plot No.	Treatment	Yield. bu. per acre
1	All minerals except nitrogen	none
2	No treatment	none
3	Minerals including nitrogen	33
4	Minerals except lime with Nitrogen	37
5	All minerals including nitrogen, stalks removed	18
6	Minerals except lime, nitrogen added	52
7	All minerals including nitrogen	43

Where nitrogen was added the yields were from 33 to 52 bushels per acre. These yields were obtained without cultivation. However, where the stalks were removed grasses grew vigorously and restricted the yield of corn to 18 bushels per acre. The cover on all plots provided complete protection against erosion.

Although the best yields were low compared with corn yields in soils handled in a normal manner, the method of growing corn without plowing offers promise as a means of controlling erosion. The response on eroded clay pan subsoil was encouraging. (Project 106).

Suspended Material in Runoff. (*C. M. Woodruff*). Suspended silt and clay in runoff water from eroded land produces muddy ponds. Initial studies of the salt content of water collected from such ponds suggested that anion content of the water was too low to promote flocculation of the clay. Further investigations indicated it was impractical to use enough fertilizer on the water-shed to correct the condition. Attention was directed toward treatment of water in the ponds.

Two suitable materials for clearing muddy pond water were investigated. Calcium sulfate (gypsum) was added to muddy water in a two and one-half acre pond in increments until the water cleared. Usable water can be obtained with treatments of 12 to 15 pounds of gypsum per 1,000 cu. ft. of water, these studies indicate.

Aluminum sulfate was added to a second pond, with good results, at concentration of 3 to 4 pounds

TABLE 31 -- EFFECT OF DIFFERENT CROPPING SYSTEMS ON MINERAL CONTENT OF SOIL AFTER 63 YEARS; NO SOIL TREATMENT

	Total N	P ₂ O ₅	K	Mg	Ca	pH	Lime Req.
Continuous Corn	1420	70	228	400	2900	4.3	8,000
Continuous Oats	2060	98	152	140	2180	4.5	5,000
Continuous Wheat	1710	74	260	280	2912	4.2	7,500
Continuous Timothy	2500	32	280+	180	2060	4.3	7,000
6-Year Rotation	1920	26	152	160	2600	4.5	7,000
4-Year Rotation	2060	34	228	180	2576	4.5	8,500

per 1,000 cu. ft. of water. However, because of the acidity of the water after treatment with aluminum sulfate, addition of hydrated lime in amounts of one pound for each 3 to 4 pounds of aluminum sulfate

was necessary. Aluminum sulfate killed fish in ponds that were stocked at the time of treatment. (Project 106).

VETERINARY MEDICINE

A. H. Groth, Dean

Hog Cholera Immunization. (*Cecil Elder, D. E. Rodabaugh*). This study was initiated in an effort to determine factors which influence antibody production in hog cholera immunization. The effect of nutrition was the first factor studied. Nine sows were placed on experiment in January, 1951. The sows were divided into two lots. One lot made up of four bred sows was placed on pasture and fed a complete, well-balanced ration; the other five were bred, placed in a small dry lot, and fed a limited ration. The limited ration consisted of 95 percent corn and 5 percent linseed oil meal plus a mineral mixture.

Sows were maintained on these rations throughout gestation and lactation. The pigs were weaned at eight weeks and were continued on the same ration as that given their dams. The pigs were vaccinated two weeks after weaning with the usual recommended dosage of hog cholera serum and virus. For 30 days following vaccination, the pigs were maintained on the same ration then placed on a good fattening ration.

In order to determine the strength of the immunity produced, all pigs were challenged with hog cholera virus 90 days after they had been vaccinated. Non-vaccinated control pigs were challenged at the same time to determine virulence of the virus. Daily temperatures were recorded for all pigs following the challenged dosage. Control pigs died, showing typical symptoms and lesions of hog cholera. All other experimental pigs both on normal and low protein diets remained healthy. Results indicated that a solid immunity to cholera was established even in pigs raised on a protein deficient ration. (Project 140).

Blackhead in Turkeys; Cecal Abligation for Prevention. (*A. J. Durant*). In this study sodium

morrhuate demonstrated that it definitely will destroy or prevent growth of the ceca in adult White Leghorn hens, in the case birds abligated for the prevention of Blackhead. Sodium morrhuate in an alkalinized solution (which is used to treat caries of the mouth of humans) was used for the destruction or prevention of the growth of the ceca in 33 turkeys and one chicken. In 24 of the 33 turkeys, sodium morrhuate was used. Out of 16 of the 24 birds (on which there were complete records) receiving sodium morrhuate, 4 were treated successfully and 12 unsuccessfully. The successfully treated birds received 2cc of sodium morrhuate and ranged in age from 20 to 35 days; whereas the 12 unsuccessfully treated birds received 2 to 10cc of sodium morrhuate and ranged in age from 46 to 200 days. Of the 9 turkeys which received the strong alkalinized solution 7 responded successfully. The age of the birds ranged from 20 to 60 days.

Results indicated that the best age for abligation in treatment with sodium morrhuate for successful prevention of ceca enlargement was 20 to 35 days of age; and in the case of a strong alkali 20 to 60 days of age. (Project 25).

Effect of Single Doses of Copper Sulfate Plus Nicotine Sulfate and Liquid Phenothiazine on Lambs. (*Cecil Elder, D. E. Rodabaugh*). Experimental lambs were separated from their mothers and placed in separate pastures for a period of 10 days prior to treatment. Previous experience had shown considerable variation in the worm egg count of lambs soon after separation from their mothers.

Daily fecal examinations were made on all animals during the period of the 8th to 15th day of weaning. On the 11th day of weaning, four of the lambs were given a therapeutic dose of liquid phenothiazine;

four of the lambs received a therapeutic dose of a mixture containing 1 ½ percent copper sulfate and 1 percent nicotine sulfate and the four remaining lambs were kept as untreated controls. Within 24 hours after treatment, both treated groups showed a marked drop in worm egg counts of the stomach worm types. Egg counts continued to drop until fecal samples became almost negative for stomach worm ova. Egg counts for the controls remained almost unchanged throughout the experiment.

In the case of strongyloides, the egg counts following treatment with copper sulfate and nicotine sulfate not only showed a definite drop in number but revealed that larvae were dead with remaining eggs. The liquid phenothiazine was not as effective against the strongyloides. (Project 108).

Effect of Lead Arsenate Treatment on Lambs. (*Cecil Elder, D. E. Rodabaugh*). Lambs which received ½ gram of lead arsenate, even though pastured on infected land, showed no evidence of tape worm segments in the daily droppings during the period of study. This indicated a low rate of infection for the group which received this treatment. Lambs known to be infected with tape worms were brought into a dry lot and treated with ½ gram of lead arsenate. These lambs eliminated enormous quantities of tape worm segments. (Project 108).

Age Resistance to Parasites. (*Cecil Elder, D. E. Rodabaugh*). Two lambs which had been raised as parasite-free lambs were placed on contaminated pasture in the spring of 1951. This was done in an effort to study the possibility for increased resistance to worms due to increase in age. The lambs were approximately one year in age at the time they were transferred to the pasture. On the basis of feces worm eggs counts these two lambs showed egg counts comparable to sheep of this age which had not been raised as parasite-free lambs. (Project 108).

Salt Consumption. (*Cecil Elder, D. E. Rodabaugh*). Phenothiazine in the salt supplied to lambs had no influence upon total salt consumed, when at a ratio of 1 to 10 parts salt. (Project 108).

Attempts to Infect Parasite-free Lambs With Pure Worm Cultures of *Ostertagia circumcincta* and *Esophagostomum columbianum*. (*Cecil Elder, D. E. Rodabaugh*). Investigators were unable to bring about parasitic contaminations by giving the lambs pure cultures of *Ostertagia circumcincta*. However, a lamb dosed with approximately 12,000 nodular worm

larvae over a period of several days became sick in 14 days from the initial dosing. The lamb stopped eating and its droppings became very soft. After the lamb refused feed for several days it was killed and an autopsy investigation performed.

The post-mortem findings were as follows: Hyperemia of the conjunctival mucous membrane. Wool and skin were dry and harsh. There were some ascites in the peritoneal cavity. Kidneys were hyperemic. The small intestines showed multiple nodules throughout. The nodules were about the size of a pin head. There was no evidence of gross inflammation. Large intestines were edematous throughout and contained a large number of nodules. The invasion of the parasites resulted in penetration of the intestinal wall. Necrosis followed in some cases. Seepage of intestinal contents into the abdominal cavity resulted in localized peritonitis. The mucosa of the cecum was hemorrhagic. The mesenteric lymph glands were enlarged and edematous.

Sections of the lower cecum collected from microscopic examinations measured approximately 5 millimeters in thickness. Deep red stained areas in the sections indicated passage of the parasites. Microscopically, the mucous membrane was swelled and watery (edematous) with marked leucocytic infiltration. Hemorrhages and hyperema were found in the interstitial tissues. There was marked hyperplasia of the lymphoid interstitial tissues. There was marked hyperplasia of lymphoid tissues and infiltration into the connective tissue. The sub-mucosa was edematous and measured approximately 3 millimeters in thickness. The sub-mucosa particularly around the red stained areas contained great numbers of eosinophilic granulocytes. One of the red areas contained a cross section of a nodular worm larvae. These areas of necrosis were partially walled off by a band of connective tissue. One such area already had undergone some calcification. (Project 108).

Value of Calf-hood Vaccination in Bang's Disease Eradication Program. (*Cecil Elder, D. E. Rodabaugh, J. E. Comfort*). The University beef herd has been used to collect data on possible controls for Bang's disease. A study has demonstrated a practical and efficient method of ridding a beef cattle herd of Bang's disease by a combination of blood testing and calfhod vaccination. This objective was accomplished in two years. Valuable blood lines which had become infected were kept in separate pastures completely isolated from the negative, disease free herd. By this means, valuable blood lines were not lost. Calves produced by the infected blood lines were vaccinated dur-

ing calfhood and were used for herd replacements. (Project 8).

Effects of Antibiotics Upon Bang's Test. (*Cecil Elder, D. E. Rodabaugh*). This work was designed to determine if any drug or drug-like product would affect the blood agglutination titer to Bang's disease when used in the treatment of cattle. Nine adult cows and bred heifers were vaccinated using *Brucella abortus* strain 19 vaccine two months prior to beginning of the observation tests. Blood samples were collected daily prior to the administration of the drug in order to determine the average blood titer and daily following the medication to determine any influence the medication may have had upon the blood titer.

Two cows were given an intravenous injection 1000 mg. of terramycin in 200cc of physiological saline; two cows were given 5mg. aureomycin in 500cc of water intravenously; and two cows were given 10,000 units bacitracin in 20cc of physiological saline solution intramuscularly. The remaining three cows were used as controls.

Cows which received the aureomycin displayed a very systemic reaction, approximately 15 minutes after injection. This reaction lasted 30 minutes.

None of the treated animals displayed any appreciable change in blood titer. These tests, though incomplete, indicated that use of these drugs would have no effect on the blood agglutination titer for Bang's disease. (Project 8).

SERVICE PROJECTS

By the Departments

Fertilizer Inspection and Analysis (Director's Office and Agricultural Chemistry Department). For the 59th consecutive year the Experiment Station collected samples and made chemical analyses required for administration of the Missouri Fertilizer Control Law. The total number of samples collected and determinations made are reported below:

Total Fertilizer Samples Collected	2,161
Potash (K_2O) Determinations, Total	
Analyses	1,725
Total Phosphorus (P_2O_5), Total Analyses	3,400
Insoluble Phosphorus (P_2O_5), Total	
Analyses	3,222
Total Nitrogen (N_2), Total Analyses	3,115
Total Fertilizer Analyses	18,001

The results of this analytical work were published by the Experiment Station in Bulletin 585—Fertilizer Inspection in Fall of 1951 and Bulletin 588—Fertilizer Inspection in Spring of 1952. In these publications 23 manufacturers were reported to have violated some provision of the control law in their fall sales, and 29 were reported similarly negligent in the spring of 1952. 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, forestry, entomology, 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 Association of Official Agricultural Chemists (referee work).

Farm Building Plans, a Blueprint Service (Agricultural Engineering Department). Two new plans were added to the blueprint service during the year, bringing the total number of available plans up to 352. All plans are available at a few cents per copy.

Identification of Plant Diseases (Botany Department, Plant Pathology Section). More than 400 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 fireblight of apples and pears.

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 3,211 cows a month in 165 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 Botany department report.

Soil 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 4,194 seed samples were examined by the laboratory staff. The total number of test applied, including tests for purity and germination, was 8,671.

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 85. 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 near 100,000.

Soil Survey and Classification (Department of Soils). A soil survey manual on Boone County was completed during the current year. Soil maps are now

available for 31 Missouri counties. The survey of Moniteau was almost completed this year.

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 establishment of the School of Veterinary Medicine at the University, this service has been greatly enlarged. A veterinary hospital and clinic are maintained at Columbia.

Field Days, Producers Conferences, and Short Courses (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 3,500 farmers and vocational agriculture students attended summer field days conducted by the departments of crops and soils, at least 3,000 attended the spring and fall livestock feeder days, and 1,100 came to spring and fall dairy days. A total of 4,408 Missouri farmers, housewives and businessmen attended short courses held at the station on agricultural and home economics subjects.

Personal Service on Farm and Home Problems (All Departments). Staff members of the Experiment Station during the year answered more than 140,000 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, Associate Editor

In the year ending June 30, 1952, the Experiment Station printed 54 publications. These included 22 technical bulletins, 27 popular bulletins, and 5 progress reports. The total number of copies printed was 226,250. A complete file containing only one copy of each of these publications would contain 1740 pages. Members of the station staff also prepared 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 New Service*, and a monthly mailing piece, the *Announcer*, which went out regularly to some 26,000 farm families carrying announcements of new publications and events of interest to farmers and homemakers.

Following is a list of publications and scientific articles issued by the Station during the year.

Research Bulletins

- 478 A Nutritious Bread, by Elizabeth R. Harding, Elizabeth Hamilton Bay, Dorothy Tyrrel, Adelia Weis and Bertha Bisbey, July 1951, 28 pages, 1500 copies.
- 479 Environmental Physiology XIV, by H. J. Thompson, R. M. McCroskey and Samuel Brody, July 1951, 28 pages, 1500 copies.
- 480 Testing Missouri Soft Wheat Flours for Quality: Methods, and Variety Comparisons, by Ferne Bowman, Leta Maharg, and J. M. Poehlman, July 1951, 72 pages, 2050 copies.
- 481 Environmental Physiology XV, by H. J. Thompson, D. M. Worstell and Samuel Brody, July 1951. 20 pages, 1500 copies.
- 482 The Vitamin Content of Chicken Tissue As Affected by the Method of Preparation and of Storage After Canning, by Audrey Erdsiek, Margaret Kanapaux, Grace V. Richmond, Adelia Weis and Bertha Bisbey, July 1951, 16 pages. 1500 copies.
- 483 The Vitamin Content of Eggs As Affected by Dehydration and Storage, by Corinne Whitford, Carmel Pickering, Katheryn Summers, Adelia Weis and Bertha Bisbey, August 1951, 12 pages, 1500 copies.
- 484 Environmental Physiology XVI, by R. E. Stewart, E. E. Pickett and Samuel Brody, October 1951, 24 pages, 1500 copies.
- 485 Influence of Environmental Temperatures on the Composition of Milk of the Dairy Cow, by J. W. Cobble and H. A. Herman, November 1951, 52 pages, 1500 copies.
- 486 Some Tests of Jacketed Space Heaters for Heating Small Farm Dwellings, by Carl A. Reaves and R. E. Stewart, November 1951, 40 pages, 1500 copies.
- 487 Bacterial Pustule Disease in Soybeans: Artificial Inoculation, Varietal Resistance, and Inheritance of Resistance, by Carl V. Feaster, November 1951, 28 pages, 1500 copies.
- 488 Environmental Physiology XVII, by Clifton Blincoe and Samuel Brody in collaboration with Gloria Burge, H. G. Turner, Dorothy Worstell and J. R. Elliott, November 1951, 44 pages, 1500 copies.
- 489 Environmental Physiology XVIII, by H. J. Thompson, D. M. Worstell and Samuel Brody, January 1952, 24 pages, 1500 copies.
- 490 Assessment of Property for Tax Purposes in Missouri, by W. E. Chryst and Frank Miller, February 1952, 24 pages, 2500 copies.
- 491 Weed Control in Horticultural Crops, by W. W. Roberts and D. D. Hemphill, March 1952, 36 pages, 1650 copies.
- 492 Deterioration in Frozen Pork As Related to Fat Composition, Storage Temperature, Length of Storage Period and Packaging Treatment, by A. Z. Palmer, D. E. Brady, H. D. Naumann, and L. N. Tucker, April 1952, 68 pages, 1700 copies.
- 493 Influence of Heterosis and Plane of Nutrition on Rate and Economy of Gains, Digestion and Carcass Composition of Pigs, by K. E. Gregory and G. E. Dickerson, April 1952, 48 pages, 1750 copies.
- 494 Influence of Inbreeding, Age and Growth Rate of Sows on Sexual Maturity, Rate of Ovulation, Fertilization and Embryonic Survival, by C. D. Squires, G. E. Dickerson, and D. T. Mayer, April 1952, 40 pages, 1500 copies.
- 495 A Study of Curtain Marquisettes, by Adella Ginter and Bernice Blue, April 1952, 36 pages, 1500 copies.
- 496 The Detection of Syngamin, an Indigenous Plant Hormone, by Culture of Immature Corn Embryos, by S. R. McLane and A. E. Murneek, April 1952, 92 pages, 1500 copies.
- 497 Environmental Physiology XIX, by H. H. Kibler and Samuel Brody, June 1952, 32 pages, 1500 copies.
- 498 The Relationship of Certain Factors to County Agent Success, by Ivan Nye, June 1952, 44 pages, 1600 copies.
- 499 Effect of Date of Seeding on the Yield and Test-Weight of Oat Varieties, by Wm. P. Sappenfield and J. M. Poehlman, June 1952, 16 pages, 1500 copies.

Reprints

- 476 The Nutritive Value of Black Walnuts, by Dorothy P. Tyrrell, Mary H. Jenkins and Adelia Weis, October 1951, 12 pages, 1500 copies.

Bulletins

- 557 Fertilizer Inspection and Analysis; Fall, 1950, by R. C. Prewitt, C. W. Gehrke and E. W. Cowan, July 1951, 60 pages, 7000 copies.
- 558 What Missourians Think of Frozen Food Storage, by J. Wendall McKinsey, September 1951, 20 pages, 3500 copies.
- 559 Buildings for the Dairy Enterprise, by J. C. Woolley, K. B. Huff, R. E. Stewart and A. C. Ragsdale, September 1951, 24 pages, 3500 copies.
- 560 Changing Conditions of Rural Life, by M. F.

- Miller, October 1951, 40 pages, 20,000 copies.
- 561 Hay and Ensilage Harvesting Costs, by C. L. Day, October 1951, 20 pages, 3500 copies.
- 562 Practical Methods of Evaluation in 4-H Club Work, by T. T. Martin, November 1951, 32 pages, 2000 copies.
- 563 The Agricultural Labor Problem, by O. R. Johnson, November 1951, 24 pages, 2500 copies.
- 564 Fertilizer Inspection and Analysis; Spring, 1951, by R. C. Prewitt, C. W. Gehrke and E. W. Cowan, December 1951, 68 pages, 7000 copies.
- 565 Seedbed Preparation of Wheat Following Lespedeza, by C. L. Day and M. M. Jones, January 1952, 8 pages, 3500 copies.
- 566 Characteristics of Farm Ponds As Affected by Topography and Design, by R. P. Beasey, January 1952, 36 pages, 3500 copies.
- 567 The Marketing of Dairy Products in Southwest Missouri, by M. B. Kirtley and C. C. Erwin, February 1952, 36 pages, 3500 copies.
- 568 Chemical Weed Control in Horticultural Crops, by D. D. Hemphill, A. E. Murneek, J. E. Smith, January 1952, 28 pages, 3500 copies.
- 569 B-400 A New, Early Variety of Winter Barley for Missouri, by J. M. Poehlman, February 1952, 12 pages, 3500 copies.
- 570 1951 Yield Trials With Corn Hybrids in Missouri, by M. S. Zuber, March 1952, 24 pages, 4000 copies.
- 571 Using Nonfat Dry Milk Solids in Home Prepared Foods, by Leta Maharg and Margaret Mangel, March 1952, 16 pages, 3500 copies.
- 572 Monthly Precipitation in Missouri, by Wayne L. Decker, March 1952, 80 pages, 3500 copies.
- 573 A New Chemical for Weed Control in Strawberries, by D. D. Hemphill, March 1952, 4 pages, 3500 copies.
- 574 Obstacles to Conservation on Midwestern Farms, by committee (Regional Pub. 28), June 1952, 60 pages, 10,000 copies.
- 575 Brucellosis With a Control Plan for Beef Cattle, by D. E. Rodabaugh, J. E. Comfort, and Cecil Elder, April 1952, 12 pages, 3500 copies.
- 576 Performance of New Strawberry Varieties in Missouri, by D. D. Hemphill, June 1952, 4 pages, 3500 copies.
- 577 Water and Its Conservation, by M. F. Miller, June 1952, 40 pages, 20,000 copies.
- 578 The Business of Farming, by Frank Miller and M. F. Miller, June 1952, 32 pages, 20,000 copies.
- 579 The Chemical Analysis of Grass, Silage, Hay, Straw, Concentrates and Miscellaneous Feedstuffs, by L. D. Haigh, June 1952, 20 pages, 3500 copies.
- 580 Hybrid Seed Corn Production in Missouri, by M. S. Zuber, June 1952, 24 pages, 3500 copies.
- 581 Oak Pruning in the Missouri Ozarks, by Paul Y. Burns and J. M. Nichols, April 1952, 8 pages, 3500 copies.
- 582 Correcting Soil Deficiencies for More and Better Forage From Permanent Pastures, by A. W. Klemme and W. A. Albrecht, June 1952, 32 pages, 5000 copies.
- 583 Soil Fertility and Corn Production, by G. E. Smith, June 1952, 68 pages, 3500 copies.

Reprints

- 534 O-200 A New Early Variety of Oats for Missouri by Poehlman, September 1951, 16 pages, 5000 copies.
- 547 Good Pastures Pay, by E. M. Brown, October 1951, 24 pages, 5000 copies.
- 546 Good Hybrids Adapted for Missouri, by Zuber and Grogan, February 1952, 12 pages, 3500 copies.
- 547 Good Pastures Pay, by E. M. Brown, January 1952, 24 pages, 5000 copies.
- 542 Success With Strawberries, by A. D. Hibbard and D. D. Hemphill, January 1952, 32 pages, 5000 copies.
- 559 Buildings for the Dairy Enterprise, by Wooley, Huff, Stewart, Ragsdale, January 1952, 24 pages, 3500 copies.
- 330 The Feeding of Livestock, by A. G. Hogan, April 1952, 44 pages, 3500 copies.
- 552 Fertility Level of Missouri Soils, Graham and Sheldon, March 1952, 28 pages, 3500 copies.
- 562 Practical Methods of Evaluation in 4-H Club Work, by Martin, June 1952, 28 pages, 1000 copies.
- 553 Chemical Thinning of Apples, by Murneek, June 1952, 16 pages, 3500 copies.
- 550 Fruit Tree Fertilization With Nitrogen, by Murneek, June 1952, 24 pages, 3500 copies.
- 341 Factors Influencing Hatchability in the Domestic Fowl, Funk, June 1952, 24 pages, 3500 copies.
- 419 The Land Grant College Movement, by F. B. Mumford, June 1952, 140 pages, 1000 copies.
- 554 Effect of Humidity and Turning of Eggs Before Incubation on Hatching Results, by Funk and Forward, June 1952, 24 pages, 3500 copies.

Progress Reports

- 15 Missouri Fertilizer Consumption 1941-1950, by R. C. Prewitt and W. L. Baker, July 1951, 12 pages, 6000 copies.
- 16 Fifth Annual Fall Livestock Day, by Animal Husbandry staff members, September 1951, 24 pages, 6000 copies.

- 17 Spring Feeders Day, by Animal Husbandry staff members, April 1952, 16 pages, 6000 copies.
- 19 Soils of Livingston County, by Soils staff members, May 1952, 12 pages, 3000 copies.
- 20 Some Soil and Crop Facts, by Soils and Crops staff members, May 1952, 20 pages, 1500 copies.

Contributions to Scientific Journals

- 1264 Essential Amino Acids in Self-Selected Diets of Older Women by E. T. Mertz, J. Baxter, L. E. Jackson, C. E. Roderick, 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, 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. For publication in CHROMOSOMA. August, 1951.
- 1269 The Behavior of Isochromosomes and Telocentrics in Wheat, 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. Submitted for publication in CHROMOSOMA. August, 1951.
- 1270 The Use of Isolated Soybean Protein in Synthetic Diets for Chicks, by B. L. O'Dell, M. D. Boston, J. E. Savage and A. G. Hogan, Department of Agricultural Chemistry, University of Missouri. Submitted for publication in Poultry Science. September 10, 1951.
- 1271 The Electrochemistry of Ionizing Colloidal Systems, by C. E. Marshall, Department of Soils, University of Missouri. Submitted for publication in the Journal of Physical Chemistry. September, 1951.
- 1272 Preliminary Insecticide-Fertilizer Soil Treatments by Philip C. Stone and George E. Smith, Departments of Entomology and Soils, respectively. Submitted for publication in the Journal of Economic Entomology and accepted for release in the issue of December, 1951.
- 1273 The Perithecial Stage of *Charlara Quercina* Henry, by T. W. Bretz, Pathologist, Division of Forest Pathology, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture in cooperation with the Missouri Agricultural Experiment Station. Submitted for publication in Phytopathology, September, 1951.
- 1274 New Hosts For The Oak Wilt Fungus, *Chalara Quercina* Henry, by T. W. Bretz, Pathologist, Division of Forest Pathology, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture in cooperation with the Missouri Agricultural Experiment Station. Submitted for publication in Phytopathology. September, 1951.
- 1275 Estimation of the Probability of Freeze Damage to Agricultural Crops, by Wayne L. Decker, Asst. Prof. of Climatology, University of Missouri, for publication in Bulletin of the American Meteorological Society, October, 1951.
- 1276 A Few Aspects of the Dwarf Tapeworm—*Echinoccus Granulosa*, by George C. Shelton, D.V.M., School of Veterinary Medicine, University of Missouri. Submitted for publication in Journal of the American Veterinary Medical Association. October, 1951.
- 1277 Genetics of Plants by L. J. Stadler, U. S. Department of Agriculture and the University of Missouri, October, 1951.
- 1278 The Proteins of Boar Spermatozoa by Dennis T. Mayer and Lloyd E. Thomas, Departments of Agricultural Chemistry and Animal Husbandry, Missouri Agricultural Experiment Station and the Department of Biochemistry, School of Medicine, University of Missouri. For publication in Journal of Biological Chemistry. October, 1951.
- 1279 Chemical Weed Control in Green Beans by D. B. Meador and D. D. Hemphill, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November, 1951.
- 1280 Pre-emergence Weed Control in Sweet Corn by D. B. Meador and D. D. Hemphill, Dept. of Horticulture, University of Missouri. For pub-

- lication in Research Report North Central Weed Control Conference 1951. November, 1951.
- 1281 Pre-emergence Weed Control in Watermelons, by D. B. Meador and D. D. Hemphill, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November 1951.
- 1282 Pre-emergence Weed Control in Potatoes, by D. B. Meador and D. D. Hemphill, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November 1951.
- 1283 Pre-emergence Weed Control in Cantaloupes, by D. B. Meador and D. D. Hemphill, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November, 1951.
- 1284 Pre-emergence Weed Control in Cucumbers, by D. B. Meador and D. D. Hemphill, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November 1951.
- 1285 Selective Weed Control in Sweet Potatoes, by D. B. Meador and D. D. Hemphill, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November 1951.
- 1286 Chemical Weed Control Studies in Strawberries—1951. By D. D. Hemphill and W. W. Roberts, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November, 1951.
- 1287 Effects of Certain Herbicides on Strawberry Runner Production and Yields, by D. D. Hemphill and W. W. Roberts, Dept. of Horticulture, University of Missouri. For publication in Research Report North Central Weed Control Conference 1951. November, 1951.
- 1288 Heat and Moisture Exchanges in Dairy Barns, by H. J. Thompson and R. E. Stewart, Department of Agricultural Engineering, University of Missouri. For publication in Agricultural Engineering. November, 1951.
- 1289 A Lipoprotein from Rat Liver Nuclei, by Tung-Yue Wang, Dennis T. Mayer and Lloyd E. Thomas, Departments of Biochemistry and Agricultural Chemistry, University of Missouri. For publication in the Journal of Biological Chemistry. December, 1951.
- 1290 Recent Developments In Spraying Grapes, by H. G. Swartwout, Department of Horticulture, University of Missouri. For publication in the Proceedings of the Kansas State Horticultural Society. December 1951.
- 1291 Some Special Disease Problems With Tree Fruits, by H. G. Swartwout, Department of Horticulture, University of Missouri. For publication in the Proceedings of the Kansas State Horticultural Society. December, 1951.
- 1292 Chemical Weed Control in Strawberries, by D. D. Hemphill and W. W. Roberts, Department of Horticulture, Missouri Agriculture Experiment Station. For publication in Proceedings of the North Central Weed Control Conference. December, 1951.
- 1293 Pre-emergence Weed Control in Cucurbits, by D. B. Meador and D. D. Hemphill, Department of Horticulture, Missouri Agriculture Experiment Station. For publication in Proceedings of the North Central Weed Control Conference. December, 1951.
- 1294 Chemical Spray-Thinning of Apples by A. E. Murneek, Department of Horticulture, University of Missouri. For publication in Transactions, a publication of the Illinois State Horticultural Society, Quincy, Illinois. January, 1952.
- 1295 The Effect of p-Chlorophenoxyacetic acid (C1PA) and 3-indoleacetic acid (IA) on Certain De-hydrogenase Systems of the Tomato Fruit, *L. esculentum*. by F. G. Teubner and A. E. Murneek, Department of Horticulture, University of Missouri. For publication in "Science". January, 1952.
- 1296 Oak Wilt by T. W. Bretz, Department of Botany, University of Missouri. For publication in the 1953 Department of Agriculture Yearbook. February, 1952.
- 1297 Use of PunchCards to Process Small Grain Yield Data, by J. M. Poehlman, Department of Field Crops, University of Missouri. To be published in AGRONOMY JOURNAL. February, 1952.
- 1298 The Ascigerous Stage of the Oak Wilt Fungus, by T. W. Bretz, Division of Forest Pathology, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture in cooperation with the Missouri Agricultural Experiment Station, University of Missouri. To be published in Phytopathology. February, 1952.
- 1299 The Digestibility of Coarsely Ground and Finely Ground Alfalfa for Dairy Heifers, by Eric W. Swanson and H. A. Herman, Department of Dairy Husbandry, Missouri Agricultural Experiment Station. To be submitted to the Journal of Animal Science. March, 1952.
- 1300 The Intracrypt Space In The Placentome of The

- Cow, by H. W. Weeth and H. A. Herman, Department of Dairy Husbandry, University of Missouri. To be published in the *Journal of Dairy Science*, March, 1952.
- 1301 A Study of some Causative Mechanisms in Bovine Streptococcal Mastitis, by C. P. Merilan and H. A. Herman, Department of Dairy Husbandry, University of Missouri. To be published in the *Journal of Dairy Science*. March, 1952.
- 1302 The Partition of Evaporative Cooling Between the Respiratory and Outer Surfaces in European and Indian Cattle, by H. H. Kibler and Samuel Brody, Department of Dairy Husbandry, University of Missouri. For publication in the *Journal of Dairy Science*. March, 1952.
- 1303 Ionization of Soils and Soil Colloids. IV. Humic and humatomelanolic acids and their salts, by C. E. Marshall and N. Patnaik, Department of Soils, University of Missouri. To be published in "Soil Science." April, 1952.
- 1304 Facts, Fables, and Fallacies on Feeding the World Population, by Samuel Brody, Department of Dairy Husbandry, University of Missouri. For Publication in the *Federal Proceedings*. April, 1952.
- 1305 Carbohydrate Metabolism in the Tomato Fruit as Affected by Pollination, Fertilization and Application of Growth-Regulating Substances, by E. Marre and A. E. Murneek, University of Missouri. To be published in "Plant Physiology." May, 1952.
- 1306 Factors Influencing The Amount Of Milk "Let-Down" Hormone In The Posterior Lobe of Jersey Cattle, by W. G. Whittlestone, E. G. Bassett and C. W. Turner (Fulbright Research Scholar) for the Ruakura Animal Research Station, Hamilton, New Zealand, and the Missouri Agricultural Experiment Station. For publication in the *Journal of Dairy Science*. May, 1952.
- 1307 A Phylogenetic Study of the Milk "Let-Down" Hormone, by W. G. Whittlestone, E. G. Bassett and C. W. Turner. Contribution from the Dairy Husbandry Department, Missouri Agricultural Experiment Station. To be published in "Proceedings of the Society for Experimental Biology and Medicine." May, 1952.
- 1308 The Effect of Acetylcholine on the Mammary Gland of the Lactating Sow, by W. G. Whittlestone and C. W. Turner. Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station. To be published in "Proceedings of the Society for Experimental Biology and Medicine." May, 1952.
- 1309 Frequency of Discharge of Pituitary Milk "Let Down" Hormone, by W. G. Whittlestone, Mrs. D. R. Perrin, R. D. Parkinson and C. W. Turner. Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station. For publication in "Journal of Dairy Science." May, 1952.
- 1310 Source of Secretion of the Milk "Let-Down" Hormone In Domestic Mammals, by W. G. Whittlestone, E. G. Bassett and C. W. Turner. Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station. To be published in "Proceedings of the Society for Experimental Biology and Medicine." May, 1952.
- 1311 Soil Acidity As Calcium (Fertility) Deficiency, by Wm. A. Albrecht and G. E. Smith, Department of Soils, Missouri Agricultural Experiment Station, University of Missouri. To be published in "Proceedings of International Soil Congress." (Dublin, Ireland). May, 1952.
- 1312 Intakes of Retentions of Nitrogen, Calcium and Phosphorus by 136 Women between 30 and 85 years of Age. By Margaret A. Ohlson, Wilma D. Brewer, Pearl P. Swanson, P. Harriet Roberts (by invitation), Margaret Mangel (by invitation), Ruth M. Leverton and May S. Reynolds. To be published in "Proceedings of the Federation of Biological Science." May, 1952.
- 1313 A Twenty-Year Appraisal of Engineering Practices at the Soil Conservation Experiment Station, Bethany, Missouri by D. D. Smith (Project Supervisor, Soil Conservation Service Research). Contribution of the cooperative project, Midwest Claypan Soil Conservation Experiment Farm, McCredie, Missouri, United States Department of Agriculture, Soil Conservation Service. To be presented at Kansas City A. S. A. E. Meeting June 18. To be published in "Agricultural Engineering." June, 1952.
- 1314 Hormones and Growth-regulators When Fruit Is Set by A. E. Murneek, Department of Horticulture, University of Missouri. To be presented at the 13th International Horticultural Congress, London, England, and printed in the *Proceedings*. June, 1952.
- 1315 Determining The Effect Of Topography and Design On The Characteristics of Farm Ponds by R. P. Beasley Department of Agricultural Engineering, University of Missouri. To be presented at the annual meeting of the American Society of Agricultural Engineers. June, 1952.
- 1316 Relation of Farm Dairy Housing To Animal Health by A. H. Groth, D. V. M. and Merle L. Esmay, Ph.D. Contributed by the School of Veterinary Medicine and Agricultural Engineering Department, University of Missouri. To be presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City. June 18, 1952.

RESEARCH GRANTS

U. S. Public Health Service

For study of the project "Relation of Nutrition to Hydrocephalus in Infant Rats."

Parke, 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.

American Dry Milk Institute

For research to compare the nutritive value of bread, prepared with and without non-fat dry milk solids, as sources of protein and of B-complex vitamins.

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 of Missouri

For continued support of the investigations concerning "The Use of Whey Solids in Ice Cream and Sherbets."

Cerophyl Laboratories

For continuation of the support of endocrine studies.

National American Dairy Association

For continued support of the investigation dealing with "A Study of Methods of Manufacturing a Cultured Cream Salad Dressing."

Office of Naval Research

For continued support of a project on the investigation of the influence 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 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.

Scott County Milling Company

For purchase of equipment to be used in connection with a research project on wheat.

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.

American Potash Institute

For research dealing with the relationship of potash to soil fertility.

International Minerals and Chemical Corporation

For support of magnesium studies carried on in the Department of Soils.

Spencer Chemical Company

For research in connection with pasture studies.

Missouri Farmers Association

For summarizing data on the fertility of soils in Missouri.

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."

Pacific Coast Borax Company

For the support of research work in connection with trace elements.

Tennessee Corporation

For research on the function of the so-called trace elements, copper, manganese, and zinc.

Missouri Turkey Federation

For continued support of research on Salmonellosis in Missouri turkeys.

Rockefeller Foundation

For support of preliminary work in connection with a proposed study in Missouri of the rural church as a social institution.

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.

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.

Armour and Company

For the support of research work on diluting and storage media for mammalian spermatozoa.

Herman Frasch Foundation

For research dealing with the composition of food and the accumulation of calcium phosphate in animal tissue.

United States Public Health Service

For a research project entitled "The Biochemistry and Physiology of Mammalian Spermatozoa."

Sears Roebuck Foundation

For support of beef cattle breeding research project.

American Cyanamid Company Lederle Laboratories Division

For support of research on the role of aureomycin in the nutrition of swine.

United States Army—Quartermaster Food and Container Institute

For support of a research project pertaining to "protein changes occurring during storage of dehydrated pork."

United States Army—Quartermaster Food and Container Institute

For research on "The Relationship of Ionic Concentration to the Stability of Evaporated Milk."

National Oak Wilt Research Committee

To help support investigation of oak wilt disease in Missouri.

Atomic Energy Commission

For a research project pertaining to a study on "Effect of Irradiation upon the Frequency and Type of Mutation of Specific Genes and to Differentiate between Mutations Induced by Radiation of Different Types."

CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1952

Appointments

D. R. Bausler, Assistant Analyst, Department of Agricultural Chemistry

George T. Blume, Assistant Instructor in Rural Sociology

Donald B. Brooker, Assistant Professor of Agricultural Engineering

Norman Brown, Assistant Instructor in Field Crops

Joseph H. Bruemmer, Assistant Instructor in Agricultural Chemistry

William C. Chandler, Assistant Instructor in Agricultural Engineering

James J. Cole, Assistant Instructor in Agricultural Chemistry

Paul R. Cornelison, Assistant Professor of Dairy Husbandry

Joseph R. Elliott, Research Assistant in Dairy Husbandry.

Margaret H. Emmerling, Assistant Instructor in Field Crops (Genetics)

Merle L. Esmay, Associate Professor of Agricultural Engineering

Theodore R. Fisher, Instructor in Soils

Charles F. Foreman, Assistant Instructor in Dairy Husbandry

Chester T. Foy, Assistant Instructor in Field Crops

Henry N. Fukui, Assistant Instructor in Agricultural Chemistry

Cecil K. Goberdham, Analyst, Department of Agricultural Chemistry

Jean Louise Goodall, Assistant Instructor in Home Economics

Myles C. Grabau, Assistant Analyst, Department of Agricultural Chemistry

Virgil D. Grace, Research Assistant in Dairy Husbandry

Robert L. Henrickson, Instructor in Animal Husbandry

Frances L. Hoxworth, Assistant Instructor in Home Economics

Leonard M. Kamm, Assistant Instructor in Animal Husbandry

Leonard Karoll, Assistant Analyst, Department of Agricultural Chemistry

Johnny B. Kimmons, Research Assistant in Agricultural Economics

Joan Klingner, Assistant Instructor in Field Crops (Genetics)

Carl Koehler, Instructor in Field Crops

John H. Lane, Assistant Professor of Rural Sociology

Fred G. Lasley, Assistant Instructor in Agricultural Economics

Robert S. Lipe, Assistant Instructor in Animal Husbandry
 George C. Luethge, Assistant Analyst, Department of Agricultural Chemistry
 Daniel B. Meador, Assistant Instructor in Horticulture
 S. W. McBirney, Research Associate in Agricultural Engineering
 Peter K. New, Assistant Instructor in Rural Sociology
 W. R. Oatman, Assistant Instructor in Entomology
 William J. O'Neil, Associate Professor of Forestry
 Donald M. Pappenfort, Instructor in Rural Sociology
 Verdon W. Payne, Assistant Instructor in Animal Husbandry
 Ross A. Phillips, Assistant Instructor in Animal Husbandry
 Paul Rood, Research Assistant in Horticulture
 Kathleen Mary Ryan, Instructor in Home Economics
 Wayne Leo Ryan, Assistant Instructor in Animal Husbandry
 Ivan L. Sander, Assistant Instructor in Forestry
 Harry L. Sawyer, Assistant Analyst, Department of Agricultural Chemistry
 Elizabeth C. Selke, Associate Professor of Home Economics
 Milton D. Shanklin, Assistant Instructor in Agricultural Engineering
 Clarence E. Simpson, Instructor in Agricultural Economics
 Leonard M. Stahler, Research Associate in Field Crops
 Harvey F. Strothman, Assistant Instructor in Field Crops
 Mary Katharine Tims, Instructor in Home Economics
 Howard F. Tucker, Assistant Instructor in Animal Husbandry
 Joseph M. Vandepopuliere, Analyst, Department of Agricultural Chemistry
 William W. Warren, Assistant Instructor in Animal Husbandry
 D. B. Watt, Assistant Instructor in Animal Husbandry
 Stephen F. Whitted, Assistant Instructor in Agricultural Economics
 Herman F. Williams, Assistant Professor of Agricultural Engineering
 Leonard F. Williams, Assistant Professor of Field Crops
 Edward K. Wojciechowski, Assistant Instructor in Animal Husbandry
 Gerald V. Wright, Instructor in Animal Husbandry
 Robert G. Yeck, Research Associate in Agricultural Engineering

Withdrawals and Resignations

Fred B. Anderson, Research Assistant in Agricultural Economics
 Tracy H. Barrett, Assistant Analyst, Department of Agricultural Chemistry
 Denver O. Baxter, Research Assistant in Agricultural Engineering
 Paul E. Blesi, Research Assistant in Agricultural Economics
 B. J. Butler, Instructor in Agricultural Engineering
 W. Leon Cameron, Research Assistant in Agricultural Engineering
 C. Milton Coughenor, Instructor in Rural Sociology
 Marialice Cunningham, Assistant Instructor in Home Economics
 Richard D. Darley, Research Assistant in Agricultural Economics
 Richard J. Deters, Instructor in Animal Husbandry
 Edward P. DeVido, Research Assistant in Entomology
 Sina Faye Fowler, Assistant Professor of Home Economics
 John W. Fronabarger, Assistant Analyst, Department of Agricultural Chemistry
 Virgil D. Grace, Research Assistant in Dairy Husbandry
 Orrine C. Gregory, Assistant Professor of Home Economics
 Clarence O. Grogan, Assistant Instructor in Field Crops
 Herman M. Haag, Professor of Agricultural Economics (part-time)
 Isaac F. Harder, Assistant Analyst, Department of Agricultural Chemistry
 Inez Harrill, Instructor in Home Economics
 August A. Haselhorst, Fertilizer Inspector
 Ross Hortin, Instructor in Forestry
 Warren B. House, Research Assistant in Agricultural Chemistry
 Frances L. Hoxworth, Assistant Instructor in Home Economics
 Johnny B. Kimmons, Research Assistant in Agricultural Economics
 M. B. Kirtley, Assistant Instructor in Agricultural Engineering
 Walter R. Langford, Assistant Professor of Field Crops
 Fred Lasley, Research Assistant in Agricultural Economics
 R. K. Leavitt, Assistant Instructor in Animal Husbandry
 Robert S. Lipe, Assistant Instructor in Animal Husbandry

D. B. Meador, Instructor in Horticulture
Charles P. Merilan, Instructor in Dairy Husbandry
R. Dale Moore, Research Assistant in Agricultural Economics
Arthur J. Muehling, Research Assistant in Agricultural Engineering
S. W. McBirney, Research Associate in Agricultural Engineering
James K. McDermott, Associate Agricultural Editor
Verdon W. Payne, Assistant Instructor in Animal Husbandry
Ross A. Phillips, Assistant Instructor in Agricultural Engineering
Carl A. Reaves, Instructor in Agricultural Engineering
Charles V. Runyon, Assistant Analyst in the Department of Agricultural Chemistry
Clarence E. Simpson, Instructor in Agricultural Economics

Louis H. Tempel, Instructor in Agricultural Engineering
Howard Tucker, Assistant Instructor in Animal Husbandry
William W. Warren, Assistant Instructor in Animal Husbandry
Desmond B. Watt, Assistant Instructor in Animal Husbandry
Howard J. Weeth, Assistant Instructor in Dairy Husbandry
Adelia Weis, Associate Professor of Home Economics
Margaret Britton Wingo, Instructor in Home Economics
James R. Whitley, Assistant Instructor in Agricultural Chemistry

FINANCIAL STATEMENT
University of Missouri
Agricultural Experiment Station
July 1, 1951 to June 30, 1952

	Hatch Fund	Adams Fund	Purnell Fund	Bankhead- Jones Sec. 5 Fund	Bankhead- Jones 9 b 1 & 2 Fund	Bankhead- Jones 9 b 3 Fund	AMA Fund	State Ap- propria- tions	Fertilizer Fees	Station Sales	Station Grants	TOTAL
Balance from 1950 - 51	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	156,060.56	59,383.46	43,778.06	259,222.08
Receipts from the United States Treasury, Appropriation for the Fiscal Year ended June 30, 1952.....	15,000.00	15,000.00	60,000.00	78,849.57	101,148.44	23,350.00	6,000.00	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	299,348.01
Receipts from State Appropriations for the Fiscal Year ended June 30, 1952.....	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	255,941.61	xxxxxxx	xxxxxxx	xxxxxxx	255,941.61
Cash Receipts for the Fiscal Year ended June 30, 1952.....	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	257,585.99	166,245.65	118,021.38	541,853.02
Total Receipts	15,000.00	15,000.00	60,000.00	78,849.57	101,148.44	23,350.00	6,000.00	255,941.61	257,585.99	166,245.65	118,021.38	1,097,142.64
Personal Service.....	12,884.26	11,215.31	47,700.22	54,506.17	79,593.55	17,828.44	1,190.51	150,036.41	101,857.60	40,043.99	64,868.93	581,725.39
Travel.....	141.69	64.88	1,403.06	624.82	2,800.27	675.58	386.54	9,623.05	7,647.72	4,993.14	2,981.19	31,341.94
Transportation of Things...	44.61	55.33	165.37	121.67	403.26	212.24	32.70	535.30	274.44	1,841.98	227.94	3,914.84
Communication Service....	-----	-----	92.47	287.74	223.51	231.50	4.98	2,541.30	634.48	864.89	202.92	5,083.79
Rents and Utility Services..	-----	10.80	143.19	850.52	434.24	97.96	-----	4,195.21	5.16	2,056.71	236.15	8,029.94
Printing and Binding.....	-----	-----	78.80	36.24	63.97	-----	-----	17,556.14	5,854.93	1,446.30	170.80	25,207.18
Other Contractual Services	119.57	784.24	1,169.48	3,712.55	6,553.55	658.22	249.77	28,926.12	18,277.04	13,594.01	2,684.00	76,728.55
Supplies and Materials.....	637.71	2,525.71	7,547.99	15,198.99	5,490.81	2,457.21	3,798.04	29,459.82	24,639.11	85,339.78	17,627.66	194,722.83
Equipment.....	821.96	268.54	1,355.14	2,936.38	4,862.78	1,038.16	337.46	12,177.97	11,464.91	10,759.83	3,791.32	49,814.45
Land and Structures.....	252.00	-----	-----	137.42	-----	23.20	-----	890.29	1,595.13	1,169.73	-----	4,067.77
Contributions to Retirement	98.20	75.19	344.28	437.07	722.50	127.49	-----	xxxxxxx	(1)	(1)	(1)	1,804.73
Total Expenditures.....	15,000.00	15,000.00	60,000.00	78,849.57	101,148.44	23,350.00	6,000.00	255,941.61	172,250.52	162,110.36	92,790.91	982,441.41
Unexpended Balances June 30, 1952.....	-----	-----	-----	-----	-----	-----	-----	-----	241,396.03	63,518.75	69,008.53	373,923.31

(1) Included in Salaries