RESEARCH for Farm and Home

J. H. Longwell and S. B. Shirky

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UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
J. H. Longwell, Director
BULLETIN 535 DECEMBER, 1949

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, 1949. 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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Front Cover: Some of the dairy cattle and buildings used in connection with growth studies, teaching and other research work.

This report was prepared by Ovid U. Bay, Assistant Agricultural Editor.

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J. H. LONGWELL and S. B. SHIRKY

INTRODUCTION

Big headlines in today's newspapers tend to play up the more spectacular—atomic power—the hydrogen bomb—airplanes faster than sound!

Equally scientific and more constructive are the "headlines" made by research workers at the Missouri Experiment Station in their findings for the FARM AND HOME. For example, the use of hybrid corn on the soils of the state combined with improved field crops and soil management has cut the corn acreage of Missouri about one-third while the total production of corn in bushels has steadily increased.

Productive land released from corn has in turn been most profitably utilized in pasture and roughage crops which have been used in the maximum production of more livestock, especially cattle. The transfer of corn land to pasture crops also means that this land will be less subject to erosion and will maintain a higher level of fertility.

Actually such developments as the introduction of Korean lespedeza, hybrid corn, better insecticides, improved rations for livestock, new varieties, and strains of field and horticultural crops, improved methods of soil management, and other techniques of agricultural production should have received big headlines. These developments because of the effect on total food production are affecting the lives and the standard of living of most Missourians today.

Thus while agricultural research is RESEARCH FOR FARM AND HOME it also is research for all people.

Research workers at the University of Missouri College of Agriculture Experiment Station have continued to stress the practical application of their findings to the FARM and HOME. Much work has been continued on the processing and storage of food, vitamin B_{12} for livestock and poultry, marketing studies, hay dryers in barns, more economical livestock feeding practices and rations, ways to conserve the soil and improve and maintain its fertility, milk and growth investigations, influence of soil minerals on insects, rehabilitation of Missouri forests, home economics nutrition studies, maintaining the quality of eggs and many other investigations reported in this publication.

AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

Abnormal Bleeding in Swine—A Hemorrhagic Factor in Moldy Lespedeza Hay (M. E. Muhrer and R. F. Gentry). Cases of hemorrhage in Missouri livestock have been reported which were suggestive of "sweet clover disease" even though the diets did not contain sweet clover. A case of losses from hemorrhage following dehorning of cattle receiving a ration of mill feed, sorgo silage, and moldy lespedeza hay was investigated. This hay was the only ingredient of the diet that would produce a similar condition when fed to rabbits.

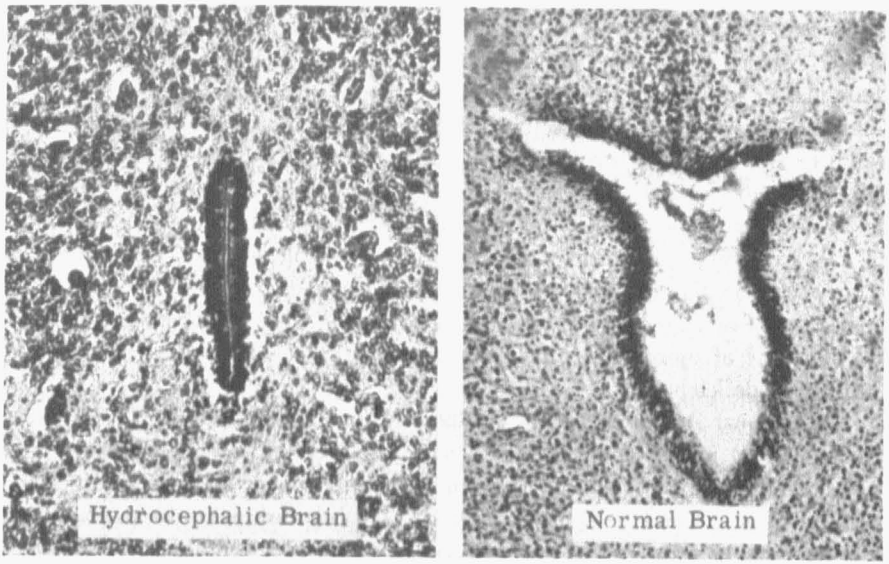
The rabbits refused to eat a sufficient quantity of the moldy hay to produce a severe bleeding condition unless it was mixed with "cerelose" (corn sugar). A bleeding condition severe enough to cause death from a minor injury was produced in some of the rabbits after long periods on the sweetened moldy lespedeza hay. However, lespedeza hay that was properly cured did not produce the hemorrhagic condition.

Nutrients Required During the Reproductive Cycle by the Rat and by the Hamster (A. G. Hogan, B. L. O'Dell, and J. R. Whitley). This was a continuation of the work on the nutrients required for a complete life cycle. A synthetic-type diet and an all-vegetable-protein diet deficient in the animal protein factor were used.

Since previous results indicated that pteroylglutamic acid (PGA) was beneficial not only for improving lactation but also for decreasing the incidence of hydrocephalus among infant rats, the effect of two folic acid antagonists, sulfasuxidine and 7-methylpteroylglutamic acid, on lactation was studied.

When 0.5 per cent sulfasuxidine was added to the diet no young were weaned. Some of the dams died before their litters were of weaning age and in other cases the young rats seemed to starve to death. The surviving dams became emaciated, developed anorexia, showed porphyrin-caked whiskers and by the end of the seventh week showed leucopenia with marked granulocytopenia. When 0.1 per cent sulfasuxidine was added, 32 per cent of the young were weaned and although some of the dams died, the gross physiological symptoms were not as severe. When the level was reduced to 0.01 per cent, the weaning percentage was 88 but the weaning weights were low. No litters were produced when crude methylpteroylglutamic acid was fed at levels of 0.05 or 0.01 per cent. Methyl-PGA produced a leucopenia which was relieved by the addition of 1 mg. per 100 grams of PGA to the diet. The addition of PGA also allowed part of the females to reproduce. When methyl-PGA was fed at the 0.005 per cent level, one-half of the females reproduced and showed a fairly good lactation index (3560).

Female rats maintained on the vegetable-protein diet reproduced at a normal rate and weaned 82 per cent of the offspring but the weaning weights



There was a higher incidence of hydrocephalus on a diet deficient in the animal protein factor but containing adequate folic acid than on any other diet.

were subnormal. The data showed that this diet was deficient in a factor necessary for the optimum growth of second generation rats.

Hydrocephalus studies were continued. The addition of folic acid antagonists, sulfasuxidine and methyl-PGA, did not produce hydrocephalus, but there were three cases observed on the vegetable-protein ration. Since soybean meal, a good source of folic acid, furnished at least 250 micrograms of folic acid per 100 grams an adequate amount of this material was present. Thus on a diet deficient in the animal protein factor but containing adequate folic acid there was a higher incidence of hydrocephalus (0.6%) than on any other diet. Since folic acid and the animal protein factor (B_{12}) appeared to be related in some of their physiological functions, such as the remission of certain anemias, perhaps both factors may be related to the prevention of hydrocephalus in rats. No hydrocephalus was observed when the dams received liver fractions or the complete stock rations.

An experiment on the effect of diet on maze learning ability of rats was conducted using the Stone multiple T type maze which was filled with water to a depth of about six inches. The rats were given five trials daily until they negotiated the entire maze without making an error. It appeared from the limited number of animals tested that rats reared on a synthetic ration plus liver extract, or a synthetic ration plus folic acid, learned the maze as quickly as did those from the stock colony. An investigation has been started to determine whether or not there is a difference between the brain wave patterns of rats raised on stock and on synthetic rations.

The reproductive records of hamsters were decidedly poor when the animals consumed the basal synthetic diet and when this diet was modified by the addition of fresh skim milk there was little or no improvement. Dried skim milk was equally ineffective. When the basal diet was supplemented with fresh green grass, or with dried grass, there was definite improvement although in both cases the results were decidedly unsatisfactory.

No explanation for the consistently poor reproductive record, is completely acceptable. The excitable temperament of the animals probably had some effect on the weaning percentage, but it was believed that nutritional inadequacy was of major importance. The low incidence of conceptions and the high rate of mortality in the young during the suckling stage indicated a nutritional deficiency.

Nutritional Requirements of Poultry (J. E. Savage and A. G. Hogan). Studies with a mixture of casein and gelatin in poultry rations indicated that the maximum rate of growth of chicks was obtained when the diet contained 25 per cent of casein and 10 per cent of gelatin. With turkey poults the heaviest weights were obtained when the diet contained 30 per cent of caesin and 5 per cent of gelatin.

Residue of liver extract was highly important in the study of unrecognized nutrients required by poultry.

The addition of either liver residue or liver extract to the diets of chicks or turkey poults improved the rate of gain. The addition of both liver residue and liver extract to the diet of the chicks gave greater gain than either alone and the addition of both to the turkey poult ration gave a marked acceleration in the growth rate. The turkey poults receiving both the residue and the extract weighed 638 grams at six weeks of age as compared to 443 grams for those on one of the diets which contained neither residue nor extracts. Poults receiving the residue only weighed 536 grams and those receiving liver extract added to the diet weighed 550 grams.

A test was run to study the effectiveness of a Vitamin B_{12} concentrate when included in a synthetic diet for turkeys as compared to the liver extract and liver residue. The turkey poults made better gains when the extract and residue were added to the ration than they did when only Vitamin B_{12} concentrate was added. The poults on the ration with the liver residue and extract added weighed 687 grams at four weeks of age as compared to 505 grams for poults which received the Vitamin B_{12} concentrate. This indicated that there may be an unrecognized factor that is required by the poults, in addition to Vitamin B_{12}.

A trial was conducted to study the effect of the addition of Vitamin B_{12} concentrate to the basal diet of laying hens and its effect upon egg production. Hens on a basal diet had a surprisingly good egg production record of 48.1 per cent. However, the production percentage rose to 59.5 per cent when

Vitamin B_{12} concentrate was added to the ration. When fish meal was included in the ration, there was another slight increase.

Vitamin B_{12} definitely improved the synthetic diet, but it was still uncertain that addition of this vitamin made the diet entirely adequate.

The Use of Pentothal Sodium as an Anesthetic For Bleeder Animals (M. E. Muhrer, R. F. Gentry). A study was made of the use of pentothal sodium on bleeder animals. In maintaining a herd of bleeder animals it is often necessary to have an animal anesthetized. Pentothal sodium was tried on several pigs varying from 10 pounds to 600 pounds in weight. A desirable rate of injection and dosage has been worked out. This anesthetic has been used in connection with 5 hernial operations, 43 castrations, and 11 spleenectomies. It also was used in a variety of other cases in connection with hemorrhage in the oral cavity, tooth extractions, trimming tusks, and discouraging fighting of bleeder boars. With the aid of pentothal sodium a large boar can be castrated, rung, and detusked with less man power and with less danger to the operator. If the animal was immobilized, operations could be done with greater skill and greater care. Unnecessary injury and excessive hemorrhage were prevented.

Conservation of Nutritive Values of Foods (Laura M. Flynn, A. G. Hogan, and V. B. Williams). The studies on this project included improvement of assay methods for folic acid and the vitamin content of cabbage, broccoli, and kale.

A culture medium was developed for bacteria used in the micro-biological assay of vitamins. The advantages of this medium were: (1) the constituents were commercially available and successive preparations of the medium were uniform; (2) except for one adsorption to purify the casein hydrolysate no charcoal adsorptions were required; (3) the controls were low and a wide range of growth response may be measured turbidimetrically or acidimetrically; (4) cultures containing only the crystalline vitamins grew in this medium at a rate comparable to that obtained in cultures containing extracts of natural materials; (5) the medium was versatile in that it was easily adapted for the culture of four different lactic acid bacteria. These features permitted a marked saving of time.

During the year assays for riboflavin, nicotinic acid, and folic acid were carried out successfully in this modified medium. The different bacteria used in these assays were *L. casei, L. arabinosus,* and *S. faecalis.* Preliminary tests have indicated that with minor changes this medium will support the growth of *L. leichmannii* and may thus be used in assays of Vitamin B_{12}.

Folic acid potencies of typical foodstuffs were estimated by both microbiological and chick methods. The discrepancies between results by the two methods (for example—egg yolk, milk solids, and mustard greens) proved the need for further studies of extraction methods.

Uniform cultures of bacteria, an enzyme preparation, and directions for folic acid assays using Missouri's modified medium were sent to twenty laboratories, as a collaborative project under the sponsorship of the Association of Official Agricultural Chemists. Five laboratories assayed the samples by the chick method. Results from the various laboratories were in good agreement, showing that the microbiological procedures suggested were dependable and readily reproducible. Assay results were the same regardless of which organism was used for the microbiological test, *L. casei* or *S. faecalis*.

Studies were made to determine the distribution of ascorbic acid, carotene, nicotinic acid, riboflavin, and thiamine in different parts of the cabbage, broccoli, and kale plant. The cabbage had been blanched and frozen and all calculations were made on the basis of vitamin content per 100 grams fresh weight of the tissue tested. More vitamins were found in the four outside leaves than the second four leaves for all of the vitamins tested. In the case of ascorbic acid, there were 10.1 more mg. per 100 grams of tissue tested in favor of the four outside leaves. The riboflavin content was more than doubled in the four outside leaves being 38.25 mcg. compared to 17.25 mcg. in the second four leaves. The thiamine content in the four outside leaves was 23.5 mcg. compared to 15.2 mcg. for the second four leaves.

Table 1 shows the distribution of vitamins in kale which had been blanched and frozen:

TABLE 1.--DISTRIBUTION OF VITAMINS IN KALE WHICH HAS BEEN BLANCHED AND FROZEN;
(All calculations were made on the basis of vitamin content per 100 gram fresh weight of the tissue tested.)

Vitamin	Units	Center Stock	Eight Outer Leaves	Second Eight Leaves	Inside Leaves (Heart)	Stems & Stalks	Whole Plant
Dry Matter	%	7.8	9.4	9.1	7.7	8.4	8.1
Total Ascorbic Acid	mg.	39.5	43.4	69.3	70.7	54.3	56.5
Carotene	mcg.	84	6134	6413	4900	287	3646
Nicotinic Acid	mg.	0.19	0.38	0.50	0.26	0.12	0.43
Riboflavin	mcg.	19.8	251	342	212	21.6	171.5
Thiamine	mcg.	48	43.8	71.9	69.8	13.1	44.7
Folic Acid	mcg.	-----	53.1	96.96	44.87	-----	------

The research on the distribution of vitamins in broccoli which had been blanched and frozen showed that there was 148 mg. of ascorbic acid in the heads per 100 gram fresh weight of tissue tested as compared to 70 mg. in the stalk and 81 mg. in the leaves. The amount of carotene found was 1.51 mg. per 100 grams in the head; 0.55 mg. in the stalk; and 4.24 mg. in the leaves. The amount of riboflavin found was 80.6 mcg. per 100 grams in the head; 56.6 mcg. in the stalk; and 122.6 mcg in the leaves.

The test on kale showed that the second eight leaves and the inside leaves contained more total ascorbic acid per 100 gram fresh weight of the tissue tested than did the outer leaves.

Cooking tests were conducted on several samples of frozen kale and vitamin assays made on the cooked kale. The leaves which were intermediate in size and maturity, the "second eight leaves," were highest in vitamin content. Therefore, they were used in the cooking tests. Leaves were cooked in two ways, (1) boiled for 10 minutes, counting from the time when the water came to a boil with the kale immersed, (2) fried for 7 minutes with lard in a cast iron skillet, then steamed with added water for 5 minutes. All vitamin values were brought to a dry basis for comparison of the raw and cooked vegetables.

Table 2 shows the loss of nutrients on cooking:

TABLE 2.--LOSS OF VITAMINS FROM KALE COOKED BY TWO METHODS.

Vitamin	Content per 100 gm. raw vegetable	Loss in boiling	Loss in frying and steaming
		%	%
Carotene	4982 mcg.	(Increased 23.46)	31.6
Reduced Ascorbic Acid	28.81 mg.	23.3	62
Dehydro-Ascorbic Acid	44.21 mg.	75.5	68.82
Thiamine	77.02 mcg.	14.2	39.74
Nicotinic Acid	422.6 mcg.	14.7	35.32
Riboflavin	197.44 mcg.	18.87	53.7
Folic Acid	80.8 mcg.	none	33.3

These tests showed that: (1) cabbage was an excellent source of ascorbic acid, (2) broccoli was a good source of both carotene and ascorbic acid, and (3) kale contributed large amounts of ascorbic acid and was a very good source of carotene, riboflavin, and folic acid. The cookery data showed that the usual procedure for cooking green leafy vegetables (boiling for a short time) permitted the retention of most of the vitamins present in the uncooked vegetable providing that the cooking liquids were not discarded. Although the percentage of ascorbic acid lost was high, a serving of the cooked vegetable still made an appreciable contribution of this vitamin to the diet. This was due to the very large amount of the vitamin found in green leafy vegetables, such as kale even after the blanching, freezing, storing, and cooking processes had decreased the amount of the vitamin which was present when it was harvested.

Unrecognized Vitamins Required by Herbivors (A. G. Hogan and W. B. House). Previous investigations have shown that a rather high level (0.4 mg. per 100 gram of feed) of folic acid is required by guinea pigs. Since Vitamin B_{12} has become available as a concentrate, its effectiveness alone or in conjunction with folic acid was studied.

It was found that Vitamin B_{12} without folic acid did not sustain growth or permit survival. When Vitamin B_{12} concentrate at a level of 0.5 per cent was fed in addition to 0.6 mg. of folic acid per 100 gram of the ration there

was a slight acceleration of the growth rate in the initial four weeks, but this advantage was largely lost by the end of six weeks.

These results did not indicate that Vitamin B_{12} had a function in guinea pig nutrition, but it may have been supplied at too low a level to exhibit maximum effectiveness. The data also confirmed earlier conclusions that higher levels of folic acid than 0.4 mg. per 100 gram of ration did not improve growth. The animals on this project will be carried through the reproductive stage.

Dried skim milk was tested as a source of unrecognized nutrients required by guinea pigs for growth and reproduction. Dried milk was selected for intensive study first because it was cheap, readily available, and commonly supposed to have unique nutritional properties.

The first 16 weeks of the investigation were given over to the study of growth rates. After this period the males and females, while continued on the same rations, were allowed to breed to observe the effect of dried skim milk on gestation and lactation.

At the end of the 16 week growth period the animals on the synthetic diet with added folic acid had grown as well as those that received fresh skim milk, both averaging 595 gram. When 10 per cent dry skim milk solids were added no significant improvement was noted since the group average was 618 gram. The ration with 65.2 per cent dry skim milk solids induced a 50 gram average increase over the synthetic and fresh skim milk rations. All the animals on the ration which contained 65.2 per cent dried skim milk solids survived while there was a loss of one or more animals on each of the other rations.

The addition of dry skim milk solids brought about a slight improvement in growth but the improvement was not remarkable. The feeding of liquid skim milk gave no improvement. There was no doubt that dried skim milk contained a factor or factors necessary for normal reproduction of the guinea pig. However, it did not contain this factor in any large quantity.

Abnormal Increases in the Mineral Content of Body Tissues in Relation to Age and Nutrition (A. G. Hogan and W. B. House). Studies have been continued on wrist soreness and stiffness with deposits of calcium phosphate which have developed frequently when guinea pigs consumed experimental diets that were nutritionally inadequate. Some workers have reported that raw cream and sugar cane juice were excellent sources of the antistiffness factor. Also, they reported the isolation of the active agent, in crystalline form from cane juice. Since early attempts at this Station to confirm the activity of raw cream and cane juice have failed, experiments were repeated using cane press juice compound and grass juice. The data showed that the cane press juice did not prevent wrist-soreness, though it did reduce the number of animals that were affected. However, only one of the four that received cane press juice had developed wrist-stiffness by the 8th week. Probably this material

reduced the incidence and severity of wrist stiffness. At the end of 16 weeks only one animal on the cane press juice had wrists that were marked severely stiff. Two animals of the three on grass juice were severely stiff.

Fertilizer Control and Analytical Analyses (E. W. Cowan and Jacquelyn Hearne). The department of agricultural chemistry ran a total of 10,435 analyses on over 4000 samples of material during the year January 1, 1948 to December 31, 1948 on feed, limestone, fertilizer samples, and miscellaneous testing. A total of 2331 samples of limestone and 1592 fertilizer samples were analyzed. Fifty-six samples of feed were also analyzed.

Environmental Factors Affecting Ascorbic Acid Content in Apples and Tomatoes (A. E. Murneek). The specific objective of this investigation was the determination of the effects of certain environmental factors on ascorbic acid content of apples and tomatoes while ripening on or off the plant.

When conservation of the nutritive value of foods is being considered, attention must be paid not only to the factors affecting the vitamin content of food products during the marketing or cooking periods, but also while fruits or vegetables are developing in the orchard or garden and while they are being prepared for market. Within the same variety, the vitamin content of a harvested product may differ greatly due to the effects of environmental factors during the pre-harvesting on immediate post-harvesting periods.

The results showed that the ascorbic acid concentration in the *apple* was affected considerably as follows: (1) in winter varieties there was a seasonal increase while maturing on the tree up to the "hard ripe" stage followed by a decrease. In summer varieties there was steady and rapid seasonal decrease; (2) marked decrease occurred during a brief (4-8 day) period of storage; (3) a relatively higher concentration was produced when the crop of the tree was light than when it was heavy; (4) a higher concentration resulted when the fruit was growing on the "outside" as compared with the "inside" branches of the same tree; (5) there was a higher concentration in small versus large fruit; (6) a higher concentration was found in the exposed half (to direct sunlight) as compared with the shaded half of the same fruit; and (7) a reduced concentration occurred as a result of heavy fertilization with nitrogen.

In the *tomato* varieties Marglobe and Break O'Day ascorbic acid concentration was found to vary as follows: (1) a seasonal increase, from July to September; (2) an increase with advanced maturity, both on the vine and when allowed to ripen off the plant at 70-80° F.; (3) a higher concentration when grown in direct exposure to light than in shade; (4) a slightly higher concentration when harvested after a period of bright sunshine versus a period of cloudy weather; (5) there was more in the half of a fruit exposed to direct light, than in the shaded half of the same fruit; and (6) a reduction with increasing supply of nitrogenous fertilizer. There was no influence on ascorbic acid content when plants were treated with "hormone" sprays (Naphthoxy- and phenoxy-acetic acids).

AGRICULTURAL ECONOMICS

O. R. JOHNSON, *Chairman*

Cycles and Seasonal Variation in Prices of Missouri Farm Products (E. H. Matzen). Two research bulletins have been published as a result of this study: Research Bulletin 406, "Trends in Contributions to Missouri and U. S. Cash Farm Income, 1924-45"; and Research Bulletin 420, "Purchasing Power of Missouri Farm Products."

It was found that almost 50 cents of each dollar of Missouri cash farm income was received from marketing of cattle, hogs, and sheep; while the livestock industry, meat animals, dairy, and poultry, accounted for almost 75 cents of the Missouri cash farm income dollar.

The purchasing power of livestock did not fluctuate as violently from year to year as did the purchasing power of crops. The reaction of producers to high or low purchasing power caused the production of various livestock to move in more or less regular cycles.

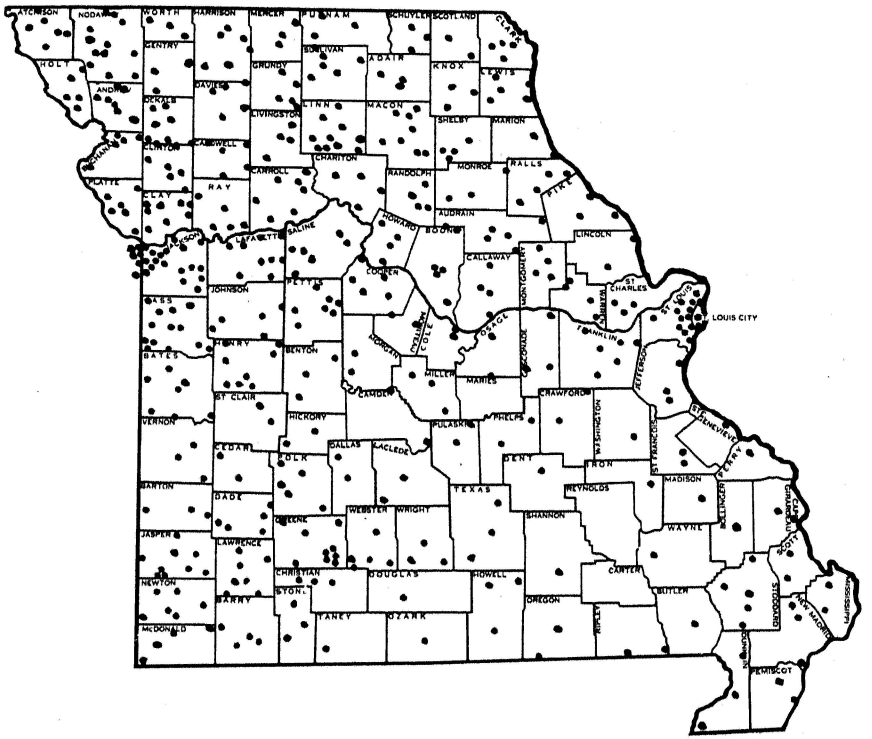
The purchasing power of 36 Missouri farm products was calculated and a complete report is found in Research Bulletin 420, "Purchasing Power of Missouri Farm Products."

Frozen Food Locker Plants and Home Freezers—Their Importance in and Influence on Marketing and Consumption of Farm Products in Missouri (J. W. McKinsey). The locker plant industry, which began in Missouri with the opening of three plants in 1935, has grown to a total of 469 plants, containing slightly more than two hundred thousand lockers. In 1947, these plants served approximately 185,000 patrons, who stored an estimated 53,000,000 pounds of food products, which is an average of 230 pounds per patron.

The purposes of this study, the first to be made in Missouri, were to determine the history and present status of the industry, the extent of services offered by locker plants, the charges for these services, and the extent to which the services were being used.

There was an extremely wide variation in the charges made for processing food for locker storage, some plants charging four times as much as others. The charge most frequently made was two cents per pound for chilling, cutting, wrapping, and quick freezing meats, and three cents a quart for quick freezing fruits and vegetables.

This wide variation in charges, supported by experience gained in collecting the data, suggested that many locker plant operators did not have adequate knowledge of actual costs of performing the various operations. Many operators were concerned primarily with the maintenance of a satisfactory net income from their entire operation and were not aware, nor seemingly concerned, that each operation yield a profit. Even though the net income on the entire operation was satisfactory, the charge was frequently too high for one service and too low for another. These findings suggested that further study regarding the costs of various locker plant operations would be very beneficial to the industry as a whole.



Location of frozen food locker plants in Missouri in 1948. The first three plants opened in 1935 and now the industry serves approximately 185,000 patrons.

Although there was a wide variety in the products stored in frozen food locker plants, meats constituted by far the larger part of the total volume. Beef alone accounted for almost one-half of the total; and all meats, including poultry and game, amounted to about 85 per cent. Fruits and vegetables stored in largest quantities were strawberries, peaches, cherries, berries, peas, corn, and beans.

Farmers who depend primarily upon curing as a means of meat preservation usually rely heavily upon pork for the year's supply of meat. Many farmers, finding freezing a satisfactory method of preserving both beef and poultry, have substituted these products for a part of the pork which formerly constituted the major portion of the year's meat supply.

This study showed that another advantage of freezer lockers, especially to farmers, was the possibility of slaughtering meat animals any time, during the year rather than only during winter months when temperatures were low. The use of lockers made possible a greater variety in the meat supply because it did not have to be kept so long, and because slaughtering could be done at the time the animal was of proper weight and finish.

Farm Real Estate Situation (H. J. Meenen). Land prices in the seven North Central states continued to increase during the semi-annual period, October-March, 1947-48. In most counties, sale prices were higher in 1948 than in 1947. In the twenty-one sample counties in this area voluntary transfers in the six months, October-March 1947-48, were down about four per cent for the same six months period in 1946-47.

It was found about 49 per cent of the sales were made with the full cash payment. Sellers held mortgages on nine per cent of the transfers and 42 per cent of the sales were financed partially with other kinds of mortgages. Individuals furnished the highest percentage of credit. In the 14 counties for which data were available, 46 per cent of the loans were made at an interest rate of four per cent or less.

Trends in Missouri's Poultry Industry (E. H. Matzen and Alvah L. Perry). Poultry is one of the most common enterprises found on Missouri farms and since 1925 has contributed from 11 to 17 per cent of the state's total cash farm income. However, the trend in poultry's contribution to Missouri's cash farm income has been downward while dairying and meat animals have become of greater relative importance. In the 1925-29 period poultry contributed 16.7 per cent of the state's total cash farm income as compared with 13.4 per cent in the 1940-44 period and 10.7 per cent in 1947. The downward trend in the importance of poultry in Missouri and the increasing importance of meat animals and dairy was probably the result of the trend toward a greater dependence in Missouri on pasture farming than on crop farming which has tended to influence the expansion of roughage consuming livestock.

Missouri was the leading state in eggs produced in 1925 but had dropped to fifth position by 1947. The number of eggs produced in Missouri increased 18 per cent from 1925 to 1947. This was considerably below the average United States increase of 58 per cent. Missouri produced 6.7 per cent of the nation's eggs in the 1925-29 period as compared with 4.9 per cent in 1947.

Egg production per layer in the United States increased from an average of 92 eggs per hen and pullet on farms January 1 in the 1925-29 period to 138 eggs in 1947—an increase of 38 per cent. Missouri's egg production per hen and pullet on this basis increased 42 per cent during this period.

The differences in farm prices of eggs between Missouri and other regions tended to be greater during the period of high seasonal prices than during the spring when egg prices everywhere in the United States were seasonally low.

Prices of baby chicks varied by states, tending to be highest in the far western and the northeastern states. Missouri's 1942-46 average price of $11.86 per hundred was the lowest of any state in United States with the exception of Arkansas. Production of broilers in Missouri has declined in respect to its percentage contribution to total United States production.

The percentage of farms raising turkeys in the United States has declined while the number raised per farm has increased. Total production has about doubled since 1930. The greatest increase in production has been in the Middle Atlantic and East North Central states. In 1947 Missouri produced 1.3 million turkeys and was seventh among the states in the number raised. From 1930 to 1947 the number of turkeys produced in Missouri increased 422 per cent.

A Study of Marketing One Variety Cotton in Missouri (J. R. Paulling). Improvement in the Missouri cotton crop by increasing the yield and lengthening the staple has doubled the value of the crop in recent years. However, this study was conducted to show that there was considerable opportunity to further increase the value of the Missouri cotton crop by correct marketing.

Some 56 per cent of the cotton crop was sold on the day ginned, 32 per cent a day or so later, and only 12 per cent was withheld until after the "green card" or classing report was received. Only 29 per cent of the producers said they received or took notice of their classing cards at all. In contrast the Western grower sold only 24 per cent of his cotton immediately, holding the remainder long enough to find out what he had, where, and when he could sell to the best advantage.

Another significant comparison was found in the use of government grade and staple information. Missouri buyers consistently reported that they had difficulty buying on this basis because the central market handlers to whom they must sell will not follow suit. Yet, in both the Plains Region and the West, from 88 to 98 per cent of the cotton is marketed on the "green card" (the government classification report to the grower) without even resampling. It would appear that the local cotton interests in this newer part of the belt have been alert to insist that trading be done on known values.

Land Tenure in Missouri (O. R. Johnson. C. E. Klingner, and H. J. Meenen). Totals of 190 farm leases and 100 father and son farm business agreements were studied in an effort to determine a practical and satisfactory method of transferring the family farm from one generation to the next generation.

The four chief objectives in these leases and agreements were: (1) To enable well adapted young men and women to succeed the preceding generation in operation of adequate farm units; (2) to avoid burdening such young people with fixed charge debt obligations which they may be unable to carry, thereby completely preventing their succession to a good farm unit because they cannot provide an acceptable initial down payment; (3) to assure them of permanent occupancy so long as they can operate the farm effectively; and (4) to protect the interests of all parties having shares in estates transferred.

The final analysis on this material was published in Bulletin 515, "Transferring the Farm to the Next Generation."

Marketing Feeder Livestock (Elmer R. Kiehl). This research was in cooperation with the North Central Regional Committee and field work began in 1948. A total of 354 interview-type schedules were taken in 16 different counties in the State. Information requested from farmers and feeders concerned the marketing of feeder cattle, sheep, and pigs. Auction companies, local cooperative marketing associations and local livestock dealers were interviewed in these counties.

Interview schedules were secured at the five major terminal markets from the stockyards companies, commission agencies, and livestock dealers on the market. Also, cost of marketing data were secured at Springfield, St. Joseph, and Kansas City Terminal Markets from a number of commission firms. This was accomplished by selecting at random and securing all cost data and related information available on 60 lots each of feeder cattle, sheep, and pigs from each firm selected.

An analysis was made of the importance of various market channels and agencies to producers of feeder animals and to feeders of livestock in Missouri. It was found that the commercial cattle feeder in this State purchased the major portion of his feeders through the public stockyards market agencies, or directly from farmers and ranchers. Less than 20 per cent of his feedlot requirements were purchased through auctions or from country dealers.

Sheep feeders secured the largest single share of their purchases directly from ranchers and the next important source of supply was the country dealer. Public stockyards market agencies furnished 23 per cent of the purchases.

More than half of the feeder pigs were purchased from producers and more than one-fourth were purchased from auctions.

The relative importance of the marketing agencies for selling feeder livestock was considerably different from their importance as buying agencies. Country dealers were most important to Missouri cattle feeder producers, accounting for 40 per cent of total sales. Stockyards market agencies furnished 22 per cent and sales made directly to feeders 20 per cent.

Missouri has not been an important feeder lamb producing state. The sheep produced usually have been grown and fattened on the same farms. In some instances, where native lambs have not reached sufficient slaughter finish for various reasons they have been sold for feeder purposes. Farmers sold to country dealers 90 per cent of their feeder lambs according to this study. The other agencies accounted for the balance.

Nearly two-thirds of the feeder pigs were sold to country dealers. Sales made directly to feeders represented 17 per cent of the total.

Sources of supply by areas for feeder livestock varied widely among species. Forty-two per cent of the cattle originated on the Southwestern ranges and 7 per cent of those fed in Missouri were from the West and Northwestern ranges. Slightly less than half were native produced.

Almost two-thirds of the feeder sheep purchased were from sources outside of the State, chiefly from the Southwestern and Western ranges.

Sources of feeder pigs were almost entirely within the State. The larger portion of those purchased outside Missouri were from Arkansas and Oklahoma.

Marketing of Hogs in Missouri (E. H. Matzen). Missouri farmers sold over three-fifths of their slaughter hogs through the terminal markets, one-fifth sold directly to packing plants, and one-fifth through various other outlets. Terminal market outlets were more important in the northwestern and northeastern regions. The dealers and trucker outlets were more important in southern than in northern Missouri.

This study showed that annual price differences between weight groups on a particular market varied widely. Light hogs tended to sell to the best advantage on the St. Louis market. Heavier weight groups and sows tended to sell to the best advantage on the Kansas City and St. Joseph markets. Average weights of barrows and gilts were lightest on the St. Louis markets —20 pounds below Chicago, and 9 pounds below Kansas City and St. Joseph.

Trends in the Dairy Industry of Missouri (Charles E. French and E. H. Matzen). This research showed that the Missouri dairy industry has gained importance relative to the nation's total dairy industry. The following changes occurred in the state's national rank from 1925 to 1947; milk cow numbers from 9th to 10th; total milk production from 13th to 10th; cheese production from 18th to 4th; creamery butter production from 9th to 5th; ice cream production from 11th to 10th and evaporated and condensed milk from 16th to 5th.

Marked changes occurred in the disposition and utilization of Missouri's milk from 1924 to 1947. Whole milk sales to dairy plants had a marked upward trend. Sales through all other outlets had a downward trend. In regard to milk used on farms, the trend was toward larger consumption of milk and cream and away from consumption of farm butter. The changes that occurred in the disposition of Missouri milk were magnified in the percentage contributions made by various products to the gross farm income from dairy products.

The trends in the utilization of Missouri milk during the period 1925 to 1947 showed a decreasing percentage being used for creamery butter production and an increasing percentage being used for manufacture of other products such as condensed and evaporated whole milk, non-fat dry milk solids, cheese, and ice cream. Trends in the disposition and utilization of Missouri milk were evident for several years and were only temporarily affected by the depression of the 1930's and World War II.

Average prices received by Missouri farmers from combined sales of milk, cream, and butter from 1924 to 1947 averaged lower than similar prices received by United States farmers. However, the spread between these prices narrowed during this period as Missouri increased the percentage of its milk being sold in fluid form.

The Marketing of Missouri Eggs (E. H. Matzen and Alvah L. Perry). This study showed that heavy production was not achieved as early as would be desirable. The rate at which pullets achieved 40-50 per cent production was as follows: 9% in September, 14% in October, 26% in November, 14% in December, 15% in January, 10% in February, 12% in other months. More than three-fourths of the baby chicks were started during April and May.

More than 60 per cent of the flocks were cared for by the housewife. The husband shared this duty with his wife in 18 per cent of the cases. Seventeen per cent of the flocks were cared for by the farm operator alone.

Only 16 per cent of the operators gathered eggs in wire mesh baskets. The remainder used impervious containers. Sixty-seven per cent of the operators stored the eggs between gathering and marketing time in a cave; 14 per cent stored them inside the house and 12 per cent kept them on the porch.

Forty-one per cent of the operators culled the eggs before packing them in cases. The remainder put them directly into cases after gathering them. Only 29 per cent sorted the eggs; 71 per cent packed them without sorting.

Ninety-three per cent of the producers delivered their eggs in cases. About 20 per cent of the producers used half cases, and three-fourths used standard size cases. Practically all farmers delivered eggs at least once a week; 46 per cent delivered them two or more times per week. Practically all eggs were handled on a "current receipt" basis.

AGRICULTURAL ENGINEERING

M. M. JONES, *Chairman*

Design of Dairy Barns and Related Structures (K. B. Huff, R. E. Stewart, and J. C. Wooley). The loafing barn-milking parlor has become the generally accepted dairy housing system for the production of quality milk in Missouri. Very little experimental data on this system has been available, so this type of dairy housing was chosen for study.

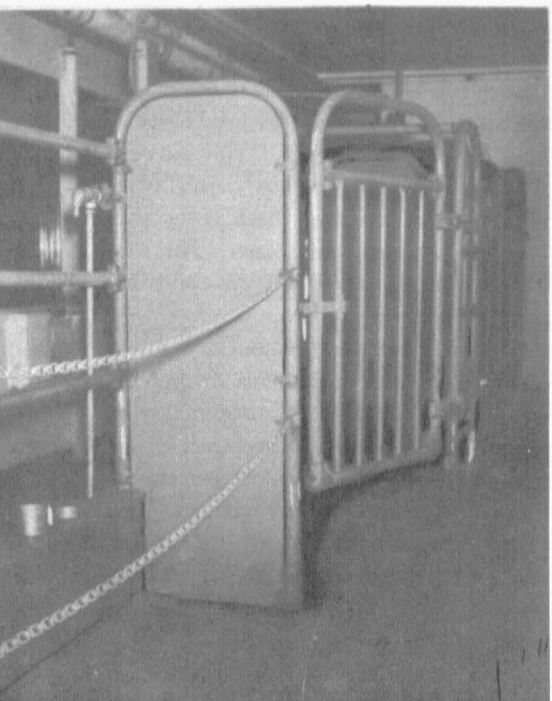
The method of investigation has consisted of conducting field surveys on dairy farms which use the loafing barn-milking parlor system. The field studies have been conducted in Boone, Greene, Lawrence, Morgan, and Bates counties.

The Missouri State Division of Health has cooperated in preparing a plan for a combination milking barn and milk house which should meet with the approval of all milk-purchasing agencies and public health agencies throughout the State. Such a plan has not been available in the past due to different interpretations placed on the structural sanitation requirements of the U. S. Public Health Service Code.

Missouri has become one of the leading dairy states in the nation. A standardized and satisfactory loafing barn-milking parlor should be of real help to dairy farmers in the State. The simplified building plans for the combination milkhouse and milking barn have been made available free upon request.

This building plan has proved so popular that the State Board of Health has distributed several thousand copies and a commercial feed company also has distributed several thousand copies through its farm service department.

Right: New combination loafing barn and milking parlor in Morgan County. Simplified building plans are available upon request. Lower left: Factory made milking stalls as used in some types of elevated milking rooms. Lower right: Milking stalls similar in design to the factory built ones but homemade in Lawrence County.



Tentatively it has been found that labor efficiency in milking herds of from 15 to 60 cows was affected by the following factors having to do with the basic structure of the milking barn: (1) whether or not the room is of the pit or floor-level type (2) the arrangement of stalls (3) the type of stalls (4) the number of stalls (5) the location of the milkhouse with respect to the milking barn.

In addition to the above factors which affect design only, it has been found that the number of persons milking, and the number of milking machine units used have a marked effect on labor efficiency.

Economic Use of Power, Labor, and Machinery in Seed Bed Preparation For Small Grain Following Lespedeza (M. M. Jones, G. W. Steinbruegge, H. J. Thompson, and Robert McCrosky). Trials of different methods of preparing seedbeds for wheat following lespedeza were continued during the year 1947-48. The methods tried were: (1) plowing, spike-tooth harrowing tandem-discing, spike-tooth harrowing; (2) field cultivating twice, followed by spike-tooth harrowing; (3) tandem-discing twice, followed by spike-tooth harrowing; and (4) "plowing" twice with heavy-duty field cultivator type plow.

The surface soil was not as well protected from erosion on the plowed plots as on all the other plots where considerable crop debris was left on the surface. All methods tried were reasonably satisfactory, and there were no significant differences in yields for the different methods. Plowing required more work and time than the other methods, and therefore the cost was somewhat higher.

Plots that were "plowed" with the heavy-duty field-cultivator type of plow appeared to have a drier and firmer surface in the spring and at wheat harvesting time, than the plowed plots. The plowed plots were freer of cheat than the others, and also had poorer stands of lespedeza, except where reseeded in the spring.

Economic Use of Power and Labor With the Newer Types of Hay and Ensilage Harvesting Machinery (C. L. Day and M. M. Jones). The purpose of this project was to determine operating costs of some of the newer types of hay and ensilage harvesting machinery, and to compare these costs with those of machines which have been in general use for some time. The new machines of particular interest were the field ensilage harvester, the field hay chopper, and the hay and ensilage blower.

Data included herein were obtained from farmers in Boone County and students enrolled in the University who worked on Missouri farms during the summer of 1948.

The charges for the various operations were based, where possible, on the actual custom rate or labor charged to farmers. In cases where the farmer used his own machine, charges for the machines were estimated by using the current prices of the various machines and making allowances for depreciation, repairs, interest, housing, insurance, taxes, and daily operating

TABLE 3.--COST PER TON FOR HARVESTING HAY BY VARIOUS METHODS.
(Less than 1 ton per acre.) The costs for these operations should be the same for methods 1 and 2.

Method	(1) Cut with tractor mower; raked with side delivery rake; baled with pick-up baler; hauled with tractors and wagons or trucks.	(2) Cut with tractor mower; raked with side delivery rake; chopped with field hay chopper; hauled with wagons and tractors; stored by blowing in barn.	(3) Cut with tractor mower; raked with sulky rake and team; hauled with wagon and team; stored in barn with hay fork.
No. Reporting	10	1	1
Average total cost per ton	$ 7.89	$5.53	$8.18
Average cost per ton for:			
Mowing	$1.06 (13.5%)	$1.44 (26%)	$0.90 (11%)
Raking	$0.75 (9.5%)	$1.05 (19%)	$0.82 (10%)
Hauling) Loading) Storing)	$1.98 (25%)	$1.27 (23%)	$6.46 (79%)
Baling or Chopping	$4.10 (52%)	$1.77 (32%)	

costs, plus a percentage for the responsibilities of ownership. Where labor rates were not reported, the rate was assumed to be $0.75 per hour.

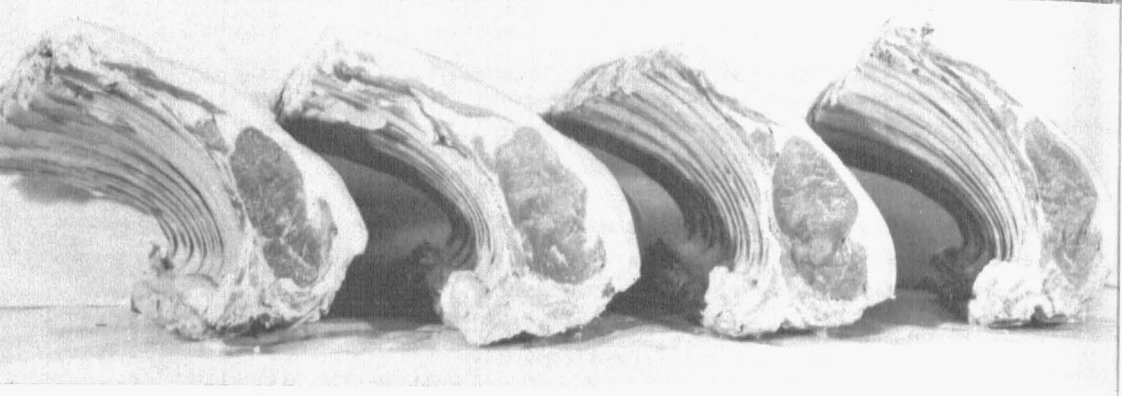
The table shown gives the costs per ton for harvesting hay by various methods. The only conclusive results were those for the pick-up baler since the other two had only one farmer reporting.

The costs of harvesting silage by various methods are given in the table which follows. These costs could be conveniently broken down into different operations, but were designed to show the relative costs for labor, machinery, and power. On the basis of the results thus far obtained, there was no appreciable difference in the cost of harvesting using the field ensilage harvester and the cost using the corn binder and stationary chopper. The principal difference was a shift from labor costs to power and machinery costs when the field ensilage harvester was used.

TABLE 4.--RELATIVE COSTS FOR LABOR, MACHINERY AND POWER IN HARVESTING SILAGE BY VARIOUS METHODS.

Method	(1) Cut and chopped with field ensilage harvester; hauled with tractors and wagons (or trucks); stored in upright silo by blowing.	(2) Cut and chopped with field ensilage harvester; hauled with tractors and wagons; stored in trench silo.	(3) Cut with corn binder; hauled with tractors* and wagons (or trucks); chopped and blown into upright silo using stationary ensilage cutter.
No. Reporting	5	2	4
Average total cost per ton	$2.56	$2.35	$2.55
Average cost per ton for:			
Labor	$0.58 (23%)	$0.66 (28%)	$1.02 (40%)
Machinery	$0.90 (35%)	$0.82 (35%)	$0.64 (25%)
Power	$1.08 (42%)	$0.87 (37%)	$0.89 (35%)

* One used teams



These 2-year-old steers were fattened by using roughage and pasture primarily and 13 bushels of corn properly supplemented at the last of the feeding period. Bottom: Ribs of beef from yearling steers and heifers used in this test.

ANIMAL HUSBANDRY

L. A. WEAVER, *Chairman*

The Production of Beef by the Maximum Use of Pasture and Other Roughage and a Minimum of Grain (A. J. Dyer, Paul Q. Guyer, and L. A. Weaver). Experiments utilizing the maximum amount of roughage in the production of beef were continued with an emphasis on producing fat yearlings with roughage and pasture. A test also was run on the comparative gain and economy of gain of steers and heifers.

A study was made of the effect that rate of winter gain had upon rate of summer gain. Also, the effect that fertilizer and lime application to pasture land had upon total gain of beef per acre and average daily gain made by yearling steers was investigated.

All cattle used in this experiment were secured at weaning time but from 3 different sources: namely, two lots from the range, two lots from an extension feeder calf sale at West Plains, (south) Missouri, and two lots from a similar sale held at Edina, (north) Missouri. The average initial weights ranged from 413 pounds for the lightest lot of cattle to 450 pounds for the

heaviest lot. Final weights ranged from 1212 to 1306 pounds. More than 60 per cent of the total gain was made from summer pasture—mainly wheat-Korean lespedeza, 29 per cent from winter rations consisting primarily of roughage, and 11 per cent from full feeding of grain in dry lot.

The length of feeding periods were: 1st winter—Dec. 27, 1946 to May 3, 1947; 1st summer—May 3 to Dec. 10; 2nd winter—Dec. 10 to April 14; 2nd summer—April 14 to Sept. 30; and fattening period—Sept. 30 to Nov. 20, 1948.

Only 12.7 bushels (average) of shelled corn fed with protein concentrate and legume hay were required in the fattening period to finish these cattle to a grade of "good." The dressing per cent was over 60% and sale price ranged from $27.50 per hundred to $32.00.

In order to study the effect that rate of winter gain had upon rate of summer gain, three of the six lots of cattle, during the second winter, were fed to gain 87 pounds and the remaining three lots to gain 133 pounds. The effects are listed in Table 5. These data indicated that the rate of winter gain influences greatly the rate of summer gain.

TABLE 5.--THE RELATION OF WINTER GAIN TO SUMMER GAIN.

Winter Gain (lbs.)	Summer Gain (lbs.)	Total (lbs.)
133	177	310
87	226	313

During the summer, half the cattle grazed forage grown on limed and fertilized ground (300 pounds 4-12-4 per acre) and half on unlimed and unfertilized soil as shown in Tables 6 and 7. The rate of gain was not affected by soil treatment but the total gain in pounds of beef per acre was

TABLE 6.--THE EFFECT OF FERTILIZER AND LIME APPLICATION ON DAILY RATE OF GAIN.

Period	Pasture	Two-year Old Steers	Yearling Steers	Yearling Heifers
		Average Daily Gain		
April 4 to June 3	Wheat on limed ground, fertilized	1.2 lb.	1.3 lb.	1.2 lb.
	Wheat on untreated land	1.7 lb.	-----	-----
Aug. 5 to Sept. 2	Lespedeza on limed ground, fertilized	1.9 lb.	-----	-----
	Lespedeza on untreated land	1.7 lb.	-----	-----

TABLE 7.--THE EFFECT OF FERTILIZER AND LIME APPLICATION ON TOTAL GAIN PER ACRE.

	Pounds Beef per Acre
Wheat-lespedeza on limed and fertilized ground	288 lbs.
Wheat-lespedeza on untreated ground	169 lbs.

increased by 70 per cent. The fertilized and limed field produced more feed, but not of a higher nutritional value, as measured by gains on cattle.

TABLE 8.--PRODUCING FAT YEARLINGS WITH LESS CORN.
(Steers vs. Heifers)

Periods	Rations	Feed Consumed (per head)		Average Gain			
				Steers		Heifers	
		Steers	Heifers	lbs	%	lbs	%
Winter							
Nov. 6, 1947	Corn Silage (lbs)	3954	2682				
to	Legume Hay (lbs)	1090	952	160	30	127	27
April 15, 1948	Soybean Meal (lbs)	80	79				
Summer	Pasture						
April 15, 1948	Wheat-lespedeza	5 1/2	5 1/2	236	44	217	47
to	and	mo.	mo.				
Sept. 30, 1948	Bluegrass-lespedeza						
Fattening Period							
Sept. 30, 1948	Shelled Corn (bus)	19	16.3				
to	Soybean Meal (lbs)	68	57	137	26	119	26
Dec. 10, 1948	Legume Hay (lbs)	791	718				

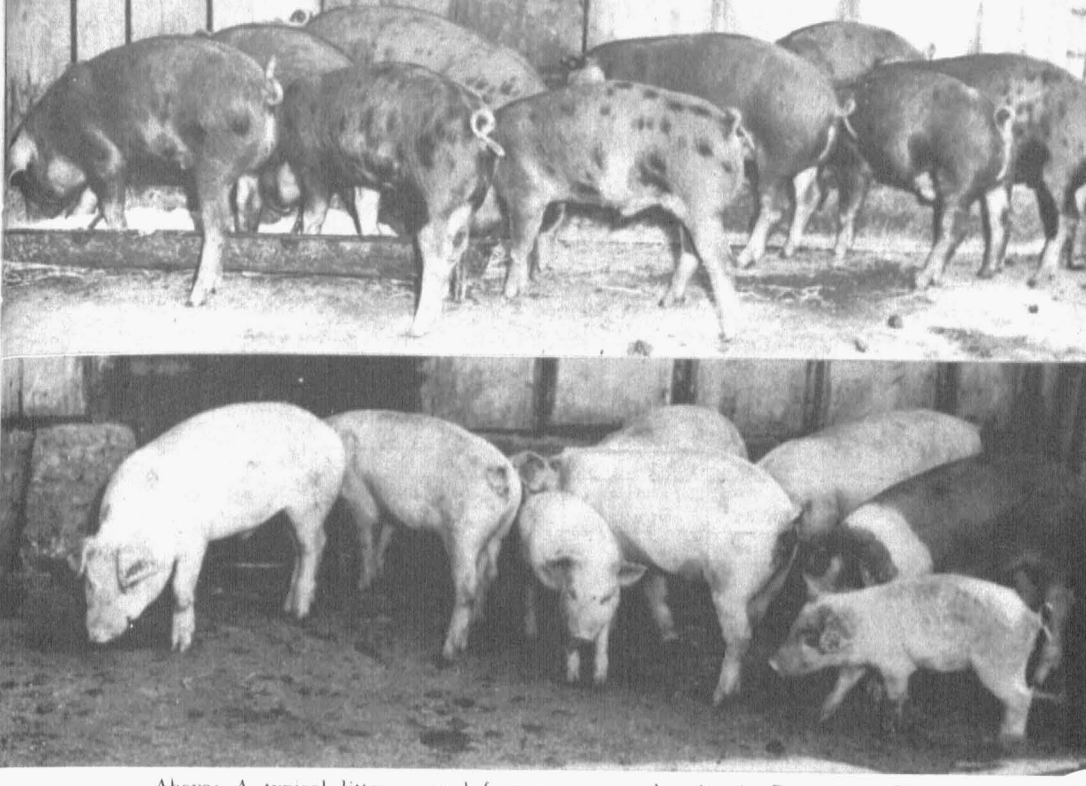
Summary:	Final Results	
	Steers	Heifers
Avg. Initial Weight (lbs.)	611	449
Avg. Final Weight (lbs.)	1144	912
Avg. Total Gain (lbs.)	533	463
Total Feed Consumed:		
Shelled Corn (bus.)	19.0	16.3
Soybean Meal (lbs.)	148	136
Corn Silage (tons)	1.8	1.3
Legume Hay (tons)	.9	.8
Pasture (mos.)	5.5	5.5
Cost per Cwt. Gain*	$15.51	$15.40
Selling Price (cwt.)	$25.50	$24.00
Dressing Percentage (warm weight)	57.3	57.0
Pounds Beef Mktd. Per Bushel Corn Fed	60	56

* Prices Used For Feeds: Corn, $1.25 per bu.; Soybean Oil Meal, $100 per ton; Corn Silage, $10 per ton; Legume Hay, $25 per ton; Pasture, $2.00 per head per month.

Choice feeder steer calves weighing 610 pounds and choice feeder heifer calves weighing 450 pounds were developed into 1144 pound fat yearling steers and 912 pound fat yearling heifers with about 19 and 16 bushels of corn respectively. Steers and heifers were on feed the same length of time.

This test was a continuation of attempts to reduce the amount of corn required to produce fat yearlings. Large steer calves were used because it was thought they utilized roughage and pasture to a better advantage than small ones; heifer calves because they have a tendency to fatten more quickly than steers, can be purchased at lower initial cost, and fatten at lighter weights. Of the total increase in weight, steers and heifers made 74 per cent and 75 per cent, respectively, on roughage and pasture. Steers made larger gains, were some fatter, commanded a higher selling price, and made more profit than heifers. Cost of gains were practically the same for both steers and heifers.

A complete summary of this steer and heifer data is found in Table 8. With 20 bushels or less of corn, fat yearlings can be produced. Two-year-olds can be produced with 10 to 15 bushels of corn. This was a reduction in the corn requirement by 50 to 65 per cent from usual dry lot feeding methods. A high interest in this work concerning the best ways to utilize roughage and pasture in beef production is evidenced by many farmers.



Above: A typical litter weaned from a sow on the vitamin B_{12} ration. Pigs were uniform and thrifty and averaged 37 pounds at 56 days. All litters averaged 8 pigs and 36.2 pounds. Below: A typical litter weaned from a sow on the corn-soybean oil meal ration. Pigs varied in size and thrift and averaged 26 pounds at 56 days. All litters averaged 7.2 pigs and 28.0 pounds.

Effect of Vitamin B_{12} On the Growth Rate of Pigs (G. C. Anderson and A. G. Hogan). Experiments conducted at this and at other stations have shown that the addition of all available vitamins to rations composed of commonly used feeds did not materially improve the performance of brood sows or pigs. However, when certain supplements such as fish meal, liver meal, and dried skim milk were added to these rations sows and pigs performed satisfactorily. It was believed that these supplements contained unknown nutritional factors that were required by swine. One of these factors was commonly known as the "animal protein factor." A fraction of it was isolated in pure form and designated Vitamin B_{12}, but other unknown factors evidently are present.

Eight 2-day old pigs were divided into three groups. Groups A and B, with three pigs in each, were fed the synthetic diet. Group A received in addition a small amount of Vitamin B_{12}. The third group, C, contained 2 pigs and was supplied with fortified cow's milk. Fortified cow's milk contained 60 gms. sugar, 2.5 gms. ferrous sulfate, 0.2 gm. copper sulfate, 0.2 gm. manganous sulfate, and 0.02 gm. potassium iodide per quart.

At the end of three weeks the pigs receiving Vitamin B_{12} (Group A) had smoother and glossier hair coats, and a more thrifty appearance than those in Group B, which had not received the vitamin. A difference in

growth rate, however, was not noted until the sixth week, after which time the treated pigs (A) grew faster than their controls (B). (Table 9). However, since the pigs which received Vitamin B_{12} did not grow as rapidly as those fed fortified cow's milk, it seemed that the list of vitamins was still incomplete, and that the pig required one or more vitamins not yet discovered.

TABLE 9.--EFFECT OF VITAMIN B_{12} ON THE GROWTH RATE OF PIGS (Averages).

Group	A	B	C
Ration	327 + vitamin B_{12}	327	Fortified cow's milk
Age, weeks	lbs.	lbs.	lbs.
0	2.5	2.9	2.8
5	15.2	14.5	19.1
8	32.6	28.4	50.4
21	159.0	109.0	---

A second experiment was designed to test the value of Vitamin B_{12} in rations for weanling pigs. The largest and most thrifty pigs available for the study were placed in the control group and received a corn-soybean oil meal ration which was thought to be deficient in Vitamin B_{12}. The experimental group which was composed of the smallest and most unthrifty pigs received the corn-soybean oil meal ration plus 0.5 per cent of a Vitamin B_{12} centrate. The third group contained pigs which were intermediate between the other two in size and thrift. This group received a fish meal ration which contained adequate quantities of Vitamin B_{12}.

All groups grew at about the same rate until the end of the first six weeks. During the remaining four weeks the pigs that received the Vitamin B_{12} concentrate and fish meal ate more feed, grew faster, and required less feed per pound gain than did the pigs that received no supplement of the animal protein factor. (Table 10).

TABLE 10.--EFFECT OF VITAMIN B_{12} ON THE GROWTH RATE OF YOUNG PIGS (Averages).

Ration & no. of pigs per group	351 Basal (8)				352 Basal + B_{12} (8)				350 Fish Meal (7)			
Week	Wt.	Daily gain	Daily feed intake	Feed per 100 lbs. gain	Wt.	Daily gain	Daily feed intake	Feed per 100 lbs. gain	Wt.	Daily gain	Daily feed intake	Feed per 100 lbs. gain
	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
0	39				29				32			
0-6	64	0.60	2.43	404	54	0.60	2.15	361	59	0.64	2.46	383
6-10	88	0.86	3.44	401	86	1.14	4.2	370	97	1.36	5.6	414

There was scouring in all groups during the first four weeks, but by the end of the fifth week the condition disappeared in the Vitamin B_{12} and fish meal groups and the pigs improved markedly in appearance. Pigs in the basal or corn-soybean meal group improved but they continued to scour throughout the experiment.

The observations made in these two experiments indicated that swine require Vitamin B_{12} in the ration for efficient production. Many natural feeds are known to contain Vitamin B_{12}. Pigs on palatable, succulent pasture receiving at least some animal protein, such as fish meal, will obtain sufficient amounts of Vitamin B_{12} for satisfactory performance.

The Effect of Different Storage Temperatures and Different Storage Periods on the Quality of Frozen Foods (D. E. Brady, R. A. Schroeder, A. E. Murneek, A. D. Hibbard, Grace Hoover, and Nelson Tucker). This work is being continued and intensified and is in cooperation with the departments of Agricultural Chemistry, Horticulture, Poultry, and Home Economics.

The continued use of home freezer units and freezer lockers by Missouri families makes this study on the effect of different storage temperatures and different storage periods on the quality of frozen foods exceptionally timely and important to both the producer and the consumer.

Tests this year gave the following results:

Vegetables—Lima bean varieties were judged after 12 months storage at -18° C. by a committee from the departments of Home Economics and Horticulture. The varieties Thorogreen and Peerless were rated highest by the judges. However, the other varieties tested, Fordhook, U. S. 343, and Fordhook 242, were acceptable as a frozen product. After 12 months storage the judges scored most of the varieties acceptable for aroma, color, appearance, texture, and flavor.

Fruits—Varieties of peaches and apples, both hard ripe and fully mature, were judged for quality after twelve months of storage at -12° C. and -18° C. Due to a breakdown in the refrigeration some of the varieties stored in the -18° C. locker were not scored. The pre-freezing treatments for the peaches and apples were given in the 1948 Progress Report. An over-all rating for the peach varieties, determined from the average scores and ratings at 3, 6, and 12 months storage at -12° C. is as follows: 1. Belle of Georgia, 2. Halehaven, 3. Triogem, 4. Eclipse, 5. Pacemaker, 6. Elberta, 7. New Day, 8. Golden Jubilee. The over-all rating of varieties of apples as determined for peaches is: 1. Jonathan, 2. Winesap, 3. Golden Delicious, 4. York, 5. Wealthy, 6. Rome.

There appeared to be no significant difference for the two maturities of the apples and peaches after 12 months storage. Peaches packaged with syrup plus ACM (a commercial Ascorbic Citric acid Mixture) rated higher than those packed with syrup alone. The color of apples was greatly improved when packed with sugar plus ACM. Pre-soaking peaches in ACM-$CaCl_2$ water was slightly more effective than other pre-freezing treatments in preserving color, texture, and flavor. However, apples showed little benefit from this pre-soaking treatment. The apples and peaches with good freezing qualities were scored acceptable by the committee after 12 months storage.

The addition of ACM to the dry sugar pack was effective in preserving a good color in cherries. The color of strawberries was not improved by ACM. There was no apparent difference as a result of the two storage temperatures, -12° and -18° C., and cherries and strawberries were scored desirable after 12 months storage.

The Physiology of Reproduction in Farm Animals (Dennis T. Mayer, G. E. Dickerson, Dale Squiers, E. R. Hauser, Ralph Kampschmidt, and William R. Miller). Work on the physiology of reproduction in farm animals has been conducted by the Animal Husbandry department in cooperation with the departments of Agricultural Chemistry, Biochemistry and Dairy Husbandry. During preceding years work has been completed on the respiration, glycolysis, and the physical requirements of the spermatozoa of farm animals. A phase of the work on the proteins of boar spermatozoa was completed during the past year.

Using a rather complicated procedure developed in this laboratory, nucleic acid and three hitherto unreported protein fractions from boar spermatozoa were isolated. The major portion of the protein existed as a relatively loosely bound fraction soluble in alkaline solutions and precipitable at the isoelectric point of pH 6. It corresponded to a protein fraction, possibly albumin or globulin in nature, obtained from cellular nuclei by Mayer and Gulick (1942). A second protein fraction precipitated at pH 4.5 Amino acid analyses were made by a microbiological technique and the nitrogen analyses suggest that both pH 6 and the pH 4.5 fraction differed little from blood or tissue proteins and that they were not basic proteins of the protamine or histone type.

The most unusual result of this investigation was the discovery that, after the removal of nucleic acid and the two proteins described, an alkali and acid insoluble residue remained which was possibly a keratin-like protein. Previously, Green (1940) had suggested that the membrane, surrounding ram spermatozoa was a keratin-like protein high in nitrogen content. The residual protein fraction of boar spermatozoa had a high nitrogen content and contained most of the basic animo acid, arginine, present in the whole spermatozoa. Its arginine content by chemical analysis was 32 per cent. Acid amino acids such as aspartic and glutamic were not present in the residual protein.

A primary factor hindering the development of an accurate quantitative chemical method for estimating the concentration of hormones in the urines of the various farm animals has been the inability to remove interfering urinary pigments and other contaminating substances from these urine specimens.

As a preliminary step in the development of needed methods, a thorough study of urinary pigments and of methods whereby they may be separated from the urinary hormones has been made. This resulted in disclosing 3

methods which may be applied to the complete separation of urinary contaminants and urinary hormones.

These procedures have made possible the recovery of a greater quantity of pure estrogens from mare pregnancy urine than has been possible previously. Since the urine of the pregnant mare has furnished the principle source of all estrogens produced commercially and since many breeders keep mares and sell the urine to the industrial plants, these results are of economic value.

Storage and Shipping of Bull Semen

It has been a general observation for some time that, during the storage or shipment of semen diluted with egg yolk, most of the solid materials of the egg yolk and semen settled to the bottom of the tube in many cases. It became a common belief among inseminators that those samples in which "settling" or sedimentation of the solids had occurred were inferior in fertility tests.

A determination of the percentage of live spermatozoa in the egg yolk-citrate diluted samples showed that 57.09 per cent of the spermatozoa at the top of the tube and 53.4 per cent of those at the bottom of the tube were alive after 24 hours of storage. After 48 hours the percentage of live spermatozoa at the top and bottom of the tubes was 55.3 per cent and 55.1 per cent, respectively. The results of this series of 28 experiments indicated that live and dead spermatozoa were both settling at about the same rate and that the sedimented cells were not dead cells.

The rate of settling of the spermatozoa was measured in special storage tubes and found to be surprisingly rapid. In 27 samples the average percentage of spermatozoa settling to the bottom of the tube was 38.4 per cent in 24 hours and 63.6 per cent in 48 hours. If, at the end of a 48-hour storage period, 1 ml. of the 12 ml. sample of diluted semen was drained from the bottom of the tubes from 29.4 per cent to 99.5 per cent of the total spermatozoa were removed from the various samples. Therefore, since the greater portion of the cells settled to the bottom of the tube during storage, it was evident that a thorough mixing of every sample was a necessity before withdrawing semen for inseminating the female or for experimental purposes. No relationship could be shown between settling rate and any of the results of any of the usual evaluation techniques. It might be concluded from the results of the trials with live and dead spermatozoa stored at low temperatures where movement of the live cells was at a minimum, that both live and dead cells were settling at a rate similar to that of inert particles of the same size under identical conditions.

Glucose was superior to all sugars investigated when isotonic solutions of the various sugars were incorporated in various proportions into diluters composed of egg yolk and isotonic solutions either of sodium citrate, phosphate buffer, or sodium bicarbonate.

Systems of Breeding for the Improvement of Swine (G. E. Dickerson, K. E. Gregory, E. R. Hauser, and D. R. Warner). This work is in cooperation with the Bureau of Animal Industry, United States Department of Agriculture. Selection for performance has been continued in the two inbred strains of Poland Chinas and the one Hampshire strain. A system of forming sublines, selecting between them, and recombining the better ones, has been used to increase the effectiveness of selection in lines VI (Poland) and V (Hampshire). Additional inbreeding was held to a minimum in the older and more highly inbred Line II (Poland), and emphasis was placed on improving productivity of sows and viability of pigs. The level of inbreeding and the performance of the inbred lines, themselves, is shown in Table 11 for the 1948 Spring Farrow and for the average of 3 years, 1946-1948.

TABLE 11.--SUMMARY OF RESULTS FOR 1948 SPRING FARROWED PIGS AND AVERAGE OF LINES FOR PAST THREE YEARS.

	Line II		Line V		Line VI	
	1948s	3 yr. avg.	1948s	3 yr. avg.	1948s	3 yr. avg.
No. Litters	17	52	21	59	22	68
Avg. Inbreeding %						
(a) Sows	39.7	33.7	16.2	11.1	19.5	11.0
(b) Litters	40.8	38.7	28.7	19.5	33.1	23.0
Avg. No. Pigs per Litter						
(a) Farrowed	5.9	6.6	7.6	9.4	8.7	8.5
(b) 21 days*	3.7	4.2	4.5	5.9	5.4	5.9
(c) Weaned, 56 days	3.2	4.5	4.5	6.5	5.2	6.3
Avg. Wt. per Pig lb.						
(a) Birth	3.3	3.3	2.6	2.6	2.8	3.0
(b) 21 days*	11.8	12.0	10.3	10.5	10.7	11.0
(c) Weaning, 56 days	28.4	27.7	29.3	28.0	30.1	29.7
(d) 154 days	132	122	121	115	142	135

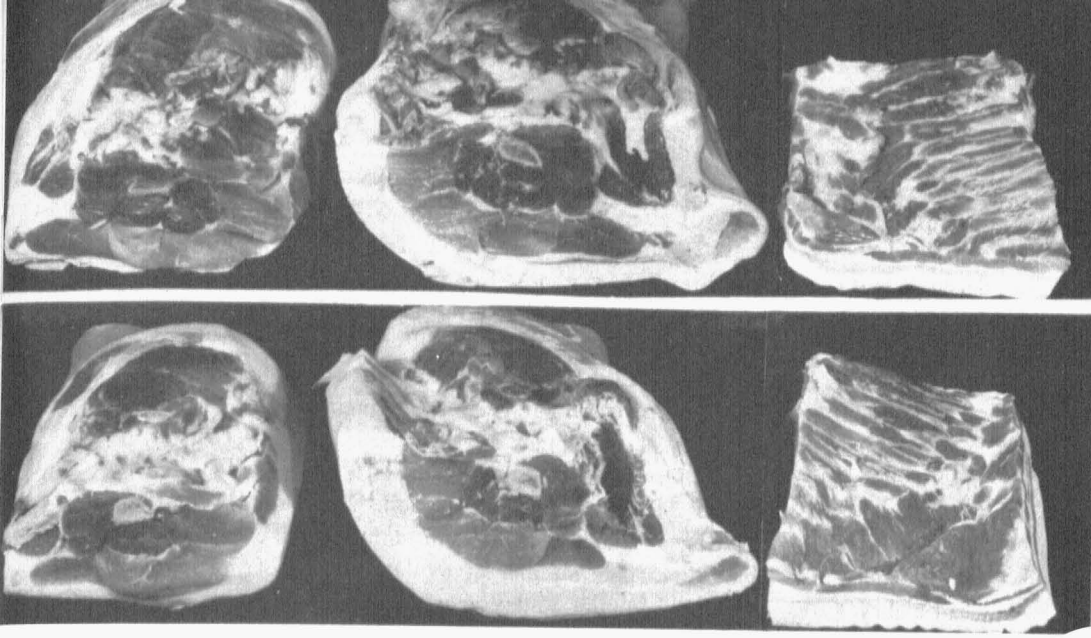
* Two year average, no data for 21 days in 1946.

Severe weather during farrowing contributed to heavy mortality among 1948 spring pigs. Line VI (Poland) inbred litters were superior to the other two strains in both size of litters and growthiness of pigs. The Line II (Poland) litters were weakest in size of litters and the Line V (Hampshire) were lowest in growth rate of pigs.

Since subline 3 of Line VI (Poland) has been consistently inferior to sublines 1 and 2, subline 3 has been discarded and the 1949 spring litters were largely crosses between sublines 1 and 2. This reduced inbreeding in most 1949 spring litters to about 15 per cent in Line VI.

In Line V (Hampshire), subline 2 performed so poorly in 1948 spring that it was discarded and the best subline (1) was divided into two (1a, 1b) and continued with subline 3 in the 1949 spring farrow.

In the fall of 1948 comprehensive crossing tests were conducted. In these trials, size of litters farrowed and weaned was considerably better for the Poland linecrosses (II and VI) than for either Poland line crossed with the Hampshire strain (V). Growth to weaning was excellent for Line VI (Poland) when crossed with either II (Poland) or V (Hampshire), but was



There were wide differences in carcass values. The Line II Poland-Hampshire V crosses as shown in the top row of carcass cuts was higher in yield of valuable cuts and quality than representative cuts from one of the common breeds in the Corn Belt as shown in the lower row.

poorer for the cross of II (Poland) with V (Hampshire). The high mortality and poor growth rate of the inbred litters was further evidence of the major effect of inbreeding of litters on swine performance.

In the topcrosses of inbred sires on Duroc sows from the College herd, litter size and weight to weaning were best for VI Poland, next for II Poland and poorest for V Hampshire sires. The purebred Durocs were superior to the topcrosses in litter size but inferior in growth of pigs up to weaning.

In total litter weight at 5 months the Poland linecrosses, II x VI, performed as well as the cross of V Hampshire with VI Poland and better than V Hampshire with II Poland. Its advantage in litter size made up its deficiency in rate of gain after weaning. The purebred Duroc litters were larger than any of the crosses except the VI Poland topcross on Duroc sows. Hence, only the VI Poland x Duroc cross was clearly superior to the Durocs in total litter weight at 5 months. However, the numbers of litters of each cross were small and the observed differences in litter size and mortality were not nearly as dependable as the differences in growth rate of individual pigs. Also, the linecross litters were farrowed and suckled by inbred sows, which undoubtedly reduced litter size somewhat.

Detailed carcass evaluation has been obtained on more than 80 hogs representing the various types of matings. Wide differences in carcass value were apparent. Highest in yields of the valuable cuts and in quality were the Poland-Hampshire crosses, followed by Poland linecrosses and by topcrosses of inbred Poland and Hampshire on Duroc sows. Topcrossing Poland or Hampshire on Duroc definitely improved carcass yield and quality over the straight Durocs.

Inbreeding and Strain Differences in Reproductive Performance of Boars and Sows (C. D. Squiers, E. R. Hauser and G. E. Dickerson). In order to develop more effective breeding methods for improving reproductive performance in swine, a better understanding of the causes of variation in fertility and in size of litters is necessary.

The nature of inbreeding, strain, and other influences on (1) age at puberty, (2) ovulation rate, (3) fertilization rate, and (4) incidence of embryonic mortality at different stages of pregnancy in sows was studied. Gilts were bred at the 1st and 2nd observed heat and alternate gilts were slaughtered at 24 hours and 25 days after the end of the heat period. Number of ovulations and the number of fertilized (i.e. dividing) and unfertilized ova were obtained from the 24-hour gilts. The number of ovulations and of normal and dead embryos was determined for the 25-day group.

Sows

Age at first heat: Observations on 56 gilts yielded the following results. Average age in days at first heat was: Line V Hampshire—216.7; Line VI Poland—215.2; Line II Poland—235.0; Line II x VI—213.2; Line II x V—188.2 and Line V x VI—217.7 days.

Ovulation rates: Number of ova produced per heat averaged 11.71 for 156 gilts and 15.7 for 48 sows, with ranges between groups from 10.4-13.00 for gilts and from 13.9-17.8 for sows. Data indicated that (1) the differences between groups are much larger than would appear by chance, (2) the left ovary was slightly more active than the right, and (3) relative activity of right and left ovaries varied greatly from sow to sow, probably because of alternation between ovaries in successive estrus periods.

Fertility: Only 32 to 54 per cent of eggs shed by 83 gilts and 45 to 66 per cent of eggs shed by 25 sows were represented by normal embryos at the 25th day of pregnancy. Practically all ova were fertilized but many died at an early stage of development. The gilts were bred earlier (at about 7 months) than usual, but even so the figures indicate that most prenatal mortality occurs early in pregnancy.

Boars

Current studies of boar performance are concerned with the influence of inbreeding, strain and other factors on reproductive development and fertility.

Testicular development: To obtain maximum information on rate of development from 51 boars studied, unilateral castrations were performed at intervals of 10 to 40 days between 125 and 175 days of age. Removal of one testes caused accelerated growth of the remaining testes, suggesting that the amount of testicular tissue present influences the amount of gonad-simulating hormone produced. Definite strain differences were evident, but more data on comparisons of inbred and non-inbred boars are necessary.

Fertility: Fertility and semen characters were studied for 30 boars in 115 matings in two breeding seasons. Only 5 per cent of the ova from 19 gilts slaughtered 24 hours post-estrus were found unfertilized. An additional 25 per cent of the ova were unaccounted for at 25 days in 89 pregnant gilts.

The results of this study in general indicated that no significant difference existed between boars in their ability to produce sperm capable of fertilizing an egg—provided that completely infertile boars were not included.

Contrary to general opinion of swine breeders the heavy use of the boars (two services per day) at the height of the breeding season did not seem to affect litter size, even though concentration of sperm in semen was lowered markedly. No relationship was found to exist between the number of pigs born and the semen characteristics studied.

It appears that the major factors affecting litter size are the ovulation rate and uterine environment of the sow and the genetic ability of the fertilized ova or embryos to survive. Differences in fertility among boars are mainly of an "all or none" character with respect to a given mating. Exceptionally poor semen production caused infertile matings rather than smaller litter size. Young boars seemed gradually to reach a "threshold" where fertility was achieved.

Methods of Wintering Pregnant Ewes and Fattening Their Lambs for Early Market (C. V. Ross and A. J. Dyer). Fifty-one head of four-year-old Northwestern ewes were bred to pure-bred Hampshire rams for early lambs and used in this experiment. On November 16, the ewes were divided into two lots based on breeding dates, body weight, and rams to which bred. In addition, in all cases possible, ewes which had been in dry lot the previous year were put on pasture for the 1947-48 trials.

From November until lambing, one lot was wintered in dry lot on legume hay. The other comparable lot was wintered on bluegrass pasture except when snow and ice covered the pasture; at these times, this lot was fed legume hay. Comparison of the two lots was made by a study of the following data: body weight of ewes, birth weight of lambs, vigor of lambs, fleece weights and grades, and feed consumption.

It was found that the average winter gain was approximately the same for both lots of ewes. Lambs weaned by ewes wintered on pasture were somewhat larger and stronger than those out of ewes wintered in dry lot. Fleece weights and grades were approximately the same for both lots of ewes. Ewes wintered on pasture consumed 75.44 per cent less legume hay during the gestation period than those wintered in dry lot.

On March 1, half the lambs from ewes wintered on bluegrass pasture were put on creep-fed rations of shelled corn in addition to sucking their dams on blue-grass pasture. The rest of the lambs suckled their dams on the pasture and all lambs fat enough to grade at least choice were marketed June 5.

On June 5, the creep fed lambs which had consumed an average of 49 pounds grain were 3 pounds heavier and were generally fatter and more uniform in size than those in the other lot. Thirty-six per cent of the grain fed lambs compared to 21 per cent of the other lambs graded choice and were marketed. Although both lots of lambs sold for the same price, the grain fed lambs shrank less and graded somewhat higher in the carcass.

On July 2, all lambs were graded, weaned, and put in dry lots for feeding. By weaning time 48 per cent of the grain fed lambs compared to only 21 per cent of those which had not received grain were ready for market or already had been marketed. Furthermore, the lambs in the grain fed lot were more uniform in size and finish than the other lambs.

On August 8, a total of 86 per cent of the creep fed lambs had been marketed compared to 38 per cent of lambs from the other lot. It required an average of 13 pounds more grain and 9 more days to fatten the lambs which had not been creep fed. This indicated that the creep fed lambs were definitely fatter at weaning time.

Factors Influencing Efficiency of Beef Production (James E. Comfort and G. E. Dickerson). This is a new project and a study of methods of breeding for improvement of performance in beef cattle, in cooperation with the Bureau of Animal Industry U. S. Department of Agriculture and in cooperation with other State Agricultural Experiment Stations in the North Central Region.

Thirty Hereford heifer calves and 6 bulls have been selected from six different herds for use in this experiment.

Work has been started devising methods and measurements that can be used in the project, using a limited number of cattle in the College beef herd. Three Hereford bull calves have been fed individually with accompanying feed and growth records.

Pastures on the Weldon Springs Experimental Farm have been heavily fertilized and seeded, ponds have been made, and fences erected. This beef cattle experimental breeding work will be done principally at Weldon Springs.

Energy Metabolism, Work Capacities, and Related Factors Involved in Muscular Work in Horses and Mules (H. H. Kibler, Samuel Brody, and Orley Miller). This work was in cooperation with the Dairy Husbandry department. Studies with heat production and cardiorespiratory activities in growing mules (birth to five years of age) yielded the following information: Pulse and respiration rates showed early downward age trends; in the respiration rate, however, this trend appeared to be arrested or reversed at about two years of age; body weight, pulmonary ventilation rate (volume of air respired per minute), resting heat production, and tidal air (volume per respiration) all increased rapidly during the first year, thereafter the ventilation rate increased slightly but the tidal air showed no further trend.

The heat production, however, continued to increase with increasing body weight; it was relatively high during periods of lush pasture when the mules were gaining weight, and low during periods of poor pasture.

BOTANY

C. M. TUCKER, *Chairman*

Studies on the Mechanisms of Resistance or Immunity to Infection by the Wilt Fungus, *Fusarium Oxysporum* F. *Lycopersici*, and the Methods of Their Inheritance in Tomato Hybrids. (A. M. Finley and C. M. Tucker). The tomato wilt fungus, *Fusarium oxysporum* f. *lycopersici*, will attack, to a greater or lesser extent, all commercial varieties of tomatoes. Hybrids between an accession of *Lycopersicon pimpinellifolium*, a wild species native to South America, and some of the more popular commercial varieties have been produced which were highly resistant to the fungus.

The development of these resistant hybrids led to the discovery, in 1945, of a new physiological race which was capable of attacking these resistant hybrids. Cultures of the fungus which cannot attack these hybrids have been designated race 1 and those which can attack them have been designated as race 2. Members of both races have attacked the commercial varieties with equal severity. At present no known means of distinguishing between these two races has been found except by their pathogenicity.

A study was started to determine, if possible, differences between races 1 and 2 of *Fusarium oxysporum* f. *lycopersici* which might account for their difference in pathogenicity. For this study six single spore isolates, three of race 1 and three of race 2, of varying degrees of virulence were selected from existing stocks.

The variations among the isolates were often quite marked but there was as much variation among the isolates within the races as between the races.

Since a cultural technique by which the two races could be distinguished had not been found, it was decided to examine the host plants for a solution. The object was to correlate resistance or susceptibility to the pathogen with morphological structure of the plant or with the production of a specific antibiotic by the plant which inhibited the less pathogenic race 1 but not race 2.

Identification of Plant Diseases (C. H. Kingsolver and C. M. Tucker). Four hundred letters were written during the year in response to inquiries and requests for identification of abnormal plant material and for information on control of plant diseases.

The season was fairly normal with respect to crop disease incidence. However, the abnormally high rainfall of the early summer encouraged the development of certain diseases resulting in unusual damage. The leaf spot of elm (*Gnomonia ulmea*) caused extensive defoliation. Because of the presence of the virus disease, phloem necrosis, within the State, the defoliation resulting from leaf-spot infection caused much alarm. Phloem necrosis continued to spread in the areas where it was previously reported.

Apple scab (*Venturia inaequalis*) and black rot (*Physalospora malorum*) were unusually prevalent. Leaf spot of tomato (*Septoria lycopersici*) caused

much premature defoliation, as did the cherry leaf spot fungus, *Coccomyces hiemalis*.

Among the small grain crops more inquiries were made concerning root disease problems than any other. Leaf rust of oats, wheat, barley, were comparatively light and caused little damage. Stem rust caused damage only on wheat and that in the extreme southeast portion of the State. Varieties of oats susceptible to *Helminthosporium victori* were severely damaged. *Bacterium xanthomonas translucens*, the cause of black chaff, was observed attacking wheat in north central Missouri causing considerable foliage loss. This was believed to be the first report on foliage attack by this pathogen in Missouri.

The corn crop was relatively free of disease with the exception of some reports on leaf injury. Several specimens of corn, which had been malformed by excessive use of 2-4-D spray were received for the first time.

Several diseases of alfalfa seemed to be more abundant than in average years, among them spring black stem, bacterial wilt, and leaf and stem diseases caused by Leptosphaeria and Phoma. Specimens of Lotus which exhibited wilting and root rot symptoms were observed in several locations; the fungus concerned has not been positively identified.

Development of Tomato Varieties From Hybrids for Resistance to Fusarium Wilt and Other Diseases (C. M. Tucker, R. A. Schroeder, and A. D. Hibbard). This work is in cooperation with the Department of Horticulture. The tomato planting was made this year in a field near Campbell, Missouri, and the yield plot included 63 tomato lines and varieties. Of these 49 were new lines produced by crossing various varieties with a highly wilt-resistant selection of *Lycopersicon pimpinellifolium* and backcrossing to commercial varieties. Included in the tests for the first time were 9 lines selected by the participants in the Southern Tomato Exchange Program. Commercial varieties were represented by 5 varieties.

The 49 new strains developed included many not previously tested for yield ability. However, they produced an average yield of 6.52 tons per acre of marketable fruit. The 5 commercial varieties had an average yield of 5.31 tons and the 9 lines from the Southern Tomato Exchange Program, 5.16 tons. Hybrid lines which proved high yielders in previous years on a heavy soil type at Midway did not, in some instances, produce as well on the sandy soil at Campbell, while some others which did not appear very promising at Midway produced much more abundantly at Campbell.

Approximately 300 hybrid lines in various stages of selfing were grown in triplicate plots for further selection. Nearly 500 plants were selected for individual records and seed collection.

Breeding work directed toward the development of early strains adapted for growth as staked plants was continued with promising results. Strains with wilt resistance, although lacking uniformity were much in demand among growers in southwest Missouri whose soils were severely infested by the wilt

fungus. Earliness is a prime factor in varieties for staking; consequently, an early variety of unknown origin commonly planted in that area has been used as a parent in crosses with some of the more desirable wilt resistant lines.

The development of tomato strains suitable for greenhouse culture has been continued. In addition to resistance to wilt a factor for resistance to leaf mold, caused by *Cladosporium fulvum* has been incorporated into some of the lines by crossing with Bay State, a variety resistant to the physiologic strain of the fungus common in this area. Fifteen hybrid lines and 3 commercial varieties were included in a yield test in the greeenhouse.

Investigations on Diseases of Forest and Shade Trees (T. W. Bretz and W. G. Long). Considerable difficulty has been experienced in maintaining the rooted American elm cuttings after transplanting from cutting bench to individual pots. An average of only 31 per cent of the rooted stock has survived, despite attempts to provide adequate care in the process of removal from the cutting bench and potting, and subsequent handling.

A total of 184 trees, representing duplicate material of approximately one-half of the phloem necrosis resistant selections on hand at Kansas City have been developed from softwood cuttings. These will, when of sufficient size, be tested for resistance to the Dutch elm disease.

A need for the establishment of clonal lines, to provide genetically uniform stock for certain types of investigation, has been recognized. A start has been made along this line in building the foundation of such a clone by producing, through vegetative propagation, some 80 *U. americana* trees originating from a single parent. This line will be increased further and it is anticipated that other clonal lines will be established as investigations demand.

No evidence has been secured to date to indicate that virus transmission from diseased to healthy trees can be accomplished by the use of dodder species. Two species of *Cuscuta, C. subinclusa* and *C. americana,* which will parasitize elm, have been used in efforts to transmit the elm mosiac virus. Trees exposed to mosiac infection by this means of transmission have not yet developed disease symptoms, although it is believed that sufficient time has elapsed since exposure for symptom expression in some of them. It was concluded, therefore, that either the species of dodder used are incapable of transmitting this particular virus or the technique employed has been at fault. The dodder species have been maintained and additional attempts to transmit mosaic will be made, using a somewhat modified technique.

Studies of Virus Diseases of Stone Fruits (Daniel Millikan, A. D. Hibbard, and C. M. Tucker). This stone-fruit virus study included three categories: (1) disease incidence; (2) symptom expression under Missouri conditions, and (3) effectiveness of various methods of indexing under local conditions.

Climatic conditions during the spring of 1948 were favorable for expression of symptoms of cherry yellows. Observations were made in cherry

plantings at Louisiana, Columbia, and Monett. Yellows was identified first at Louisiana, on May 27, and reported at Monett and Columbia a week later. The incidence of the disease at Louisiana was approximately 20 per cent. All trees in the Columbia plantings were infected. Virus infection varied from 30 to 100 per cent among the 30 varieties indexed.

Green house and outdoor investigations were undertaken to study the development of symptoms of virus infection under local climatic conditions. Nine strains of cherry viruses of various degrees of virulence were inoculated by budding into peach and virus-free Montmorency cherry. In every instance, the Montmorency cherry stock developed mild to severe chlorotic rings, necrosis, and shot-holes—all symptoms of ring spot infection. The reactions produced on peach were quite erratic with typical yellows symptoms occasionally developed following the use of inoculum believed to contain the ring spot virus only. In one variety (Queen strain Elberta) no symptoms of any sort developed either in the greenhouse or outdoors. Another peach variety, Cumberland, compared favorably with the cherry as a test host. This has been saved for use in further experiments.

Two methods of indexing were compared: the direct method, involving the use of cherry and peach, and the indirect method, using cherry only. The direct method involved placing tissue, preferably a bud from the stock to be tested, into a virus-free cherry or peach. If typical disease symptoms developed, it was assumed that the tree from which the inoculum, in this case a bud, was removed was infected by the virus causing symptoms on the previously disease-free cherry or peach. If disease symptoms did not develop, it was assumed that the plant so indexed was free from yellows and ring spot. In all experiments involving the use of the direct method, cherry was the more reliable host although the Cumberland peach and Lovell peach seedlings were very useful hosts.

Studies on the Morphology and Physiology of the Genus Phytophthora (C. M. Tucker). Studies on isolates of Phytophthora were received from various sources for identification. Laboratory and greenhouse investigations were carried out on their morphology, temperature-growth relations, and pathogenicity. Most species of the genus are important parasites of cultivated crops.

Among the more interesting or unusual isolates studied were the following: *Phytophthora parasitica* from soil of tomato greenhouses in Missouri; an unidentified species from *Pinus echinata* in Georgia; *P. himalayensis* from potato in India; P. *erythroseptica* from sugar cane in Louisiana; *P. parasitica* from Cinchona in Guatemala; *P. cinnamomi* from Erica in California.

DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

Increasing the Effectiveness of Artificial Insemination as a Means of Improving Dairy Cattle (H. A. Herman, A. C. Ragsdale, M. E. Dickensheet, J. E. Edmondson, Glenn R. Pursley, Donald B. Roark, Kenneth L. Tallman, and Howard J. Weeth). This investigation was continued by comparing the semen characteristics: initial motility, survival time of sperm under storage conditions, various "quality tests," and the breeding record of the sires used in the four artificial breeding organizations in Missouri. These organizations were located at Springfield, Carthage, Trenton, and O'Fallon. Some 90 sires were used and approximately 80,000 cows were inseminated during the year. Semen samples from each sire were sent to the Station for analysis when routine collections were being made. Breeding records were furnished at monthly intervals from each association. To date semen data on 104 sires and 80,522 cows artificially inseminated have been collected. Observations as to quality and fertility have been made on 5710 samples of semen.

In 1947 the analyses on over 40,000 cows indicated that 60.8 per cent settled on the first insemination on the basis of 60 day non-returns. For 1948 the average was lower with about 52 per cent non-returns on a first service basis.

The average length of life of spermatozoa under storage conditions in 1947-48 was 106 hours for all sires. In 1948-49 it was 117 hours. Therefore, it seemed that the decline in settling efficiency of the cows in 1948-49 was not necessarily due to poorer quality semen, but rather to conditions associated with the cows or possibly the insemination practice in the field.

The relationship between the survival time of spermatozoa and the sires breeding record have been found to be very significantly correlated in numerous studies. This seemed to be one of the most reliable indexes of fertility in the bull.

Through cooperation with the department of Agricultural Chemistry efforts have been made to develop a diluting fluid for dairy bull semen to increase the length of life and fertility under storage conditions.

A comparison of diluters in use at present, including the phosphate-egg yolk, citrate-egg yolk, and the pablum diluter suggested by the Wisconsin Station, indicated slightly more favorable results for the citrate-egg yolk diluter. Some difficulty has been encountered in maintaining the non-toxic properties of pablum.

Preliminary results as indicated by number of hours each diluter maintained the semen at a 2 motility or better showed that the addition of 10-12 per cent egg-yolk in replacement of asolectin in the pablum increased the longevity of the spermatozoa. These results also indicated that the substi-

tution of sodium citrate buffer in place of sodium and phosphate salts and also the replacement of asolectin with 10-12 per cent egg-yolk in the pablum diluters increased the longevity of the spermatozoa. Egg yolk citrate has proved equally as effective as these two altered pablum diluters. The use of egg yolk in addition to the asolectin in the pablum diluter made no change in the longevity of the samples.

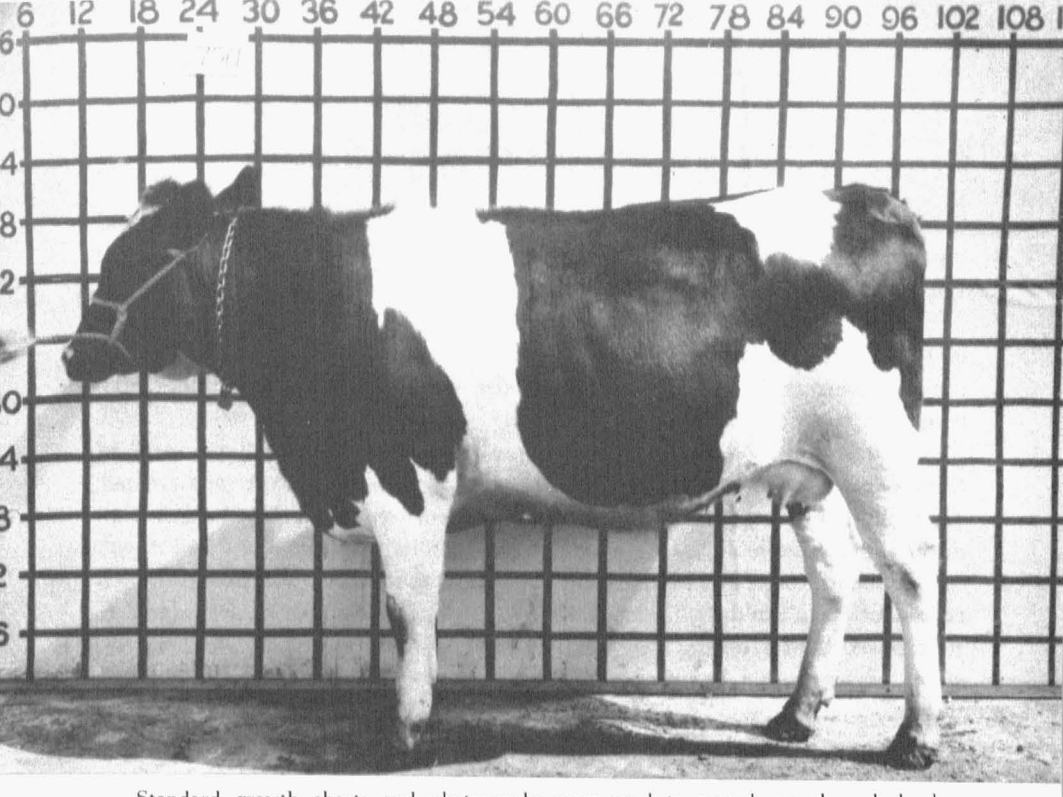
Highest conception rates were obtained during the fall. The other seasons in order of declining fertility were spring, summer, and winter. These variations in fertility appeared to coincide with differences in condition of the cattle and feeding practices at various times of the year.

Significant differences in fertility were observed among the individual sires used in artificial insemination. Average concepton rates of a sire compared with the breed average appeared to be a reliable method of evaluating his breeding efficiency.

Nutritional Studies on Growth of Dairy Heifers and Milk Production (H. A. Herman, O. T. Stallcup, A. C. Ragsdale, J. W. Cobble, J. E. Edmondson, J. H. Edmondson, and C. P. Merilan). The economy of using grain and roughage as a substitute for a part of the milk requirements in growing heifers to normal size by means of the "limited whole milk—dry calf starter" feeding program was amply demonstrated in this experiment. This indicated the savings of thousands of dollars to dairymen of Missouri who must raise approximately 250,000 heifers annually to maintain the present milk cow population.

Calves receiving limited whole milk and the dry calf starter ration were 8.8 pounds below the normal growth standards at 6 months of age and were 14 pounds lighter than the skim milk group, which averaged 5.2 pounds heavier than the normal group. However, in skeletal growth the two groups compared very favorably and were approximately normal. The whole milk fed calves consumed an average of 101 pounds more grain and 121 pounds more hay to 6 months of age than the skim milk fed group. The whole milk fed calves consumed an average of 661 pounds of whole milk, whereas the skim milk group consumed 325 pounds whole milk and 2186 pounds of skim milk.

These studies indicated that normal growth was secured in dairy heifers by raising them on a"limited whole milk" feeding plan to 6 or 7 weeks of age with adequate concentrate and high quality roughage supplements. The calves were then placed on grain and roughage until they were 6 to 8 months of age. Thereafter they were placed largely on roughages and pasture. Satisfactory growth was secured when pasture furnished 55 per cent of of the total nutrients and protein for animals above 6 to 8 months of age, and heifers were raised from 6 to 24 months of age with a minimum of 900 pounds of grain where good roughage and pasture were available in abundance.



Standard growth charts and photographs were used to record growth and development of dairy heifers.

The data covered a 10 year period in which approximately a total of 50 dairy heifers were raised on low, intermediate, and extremely high planes of nutrition, and it was found that heifers grown on a heavy concentrate feeding program with an abundance of whole milk, were 5 to 30 per cent heavier in body weight, 5 to 10 per cent larger in skeletal growth than normal, but were very expensive to raise, and were no better producers than heifers raised on a low plane of nutrition.

In an effort to measure the value of Korean lespedeza as a source of carotene, the blood of the dam and the newly born calf has been analyzed for carotene in 12 cows and calves. Both pre and post partum data have been obtained on the dam, in the colostrum milk, and in the blood of the calf. The data collected on Korean lespedeza and alfalfa hay to date indicated higher carotene and Vitamin A values in the blood of both the dam and calf and in colostrum for cows receiving Korean lespedeza roughage previous to calving.

Effects of Temperature

The effects of temperature on the solids-not-fat content of milk, and changes in composition produced by temperature variations have been studied for changes in freezing point and for changes in the content of lactose, chlorides, total nitrogen, solids-not-fat, and butterfat content.

Under conditions of high temperature ranging from 50 to 105° F. the following preliminary conclusions have been reached: (a) solids-not fat were

lowered; (b) fat percentages were increased; (c) total milk production was lowered; (d) lactose was decreased; (e) chlorides were increased; and (f) nitrogen showed a small decrease.

Under conditions of low temperature (50° F. to 0°F.) the percentage of fat tended to increase and there was some decrease in total milk production. In general the composition of the milk was more stable than under high temperature conditions.

In the mastitis diagnostic tests, it was found that about 38 per cent of the cows under observation recovered, even though they were not treated. The results indicated that recoveries may occur either during lactation or during the dry period.

Influence of Climatic Factors on Productivity and Physiological Reactions of Farm Animals (Samuel Brody, H. H. Kibler, A. C. Ragsdale, C. R. Blincoe, Gloria Burge, Orley Miller and co-workers). This work on the effect of controlled environmental temperatures and humidity on productivity and physiological reactions of farm animals was carried on in cooperation with the United States Department of Agriculture and the Office of Naval Research.

A large body of data, preliminary in character, was obtained on the effect of controlled environmental temperatures from 0° to 105°, on:

A. Milk production
B. Feed and water consumption
C. Blood composition
D. Cardiorespiratory activities with special reference to heat production
E. Urine output
F. Water consumption
G. Surface temperature
H. Insensible loss and therefrom, with the help of the respiratory exchange data, total evaporation from the body
I. Evaporation from the respiratory tract
J. Evaporation from parts of the skin

The respiration rate was the first to be affected by rising temperature; at 70° F it was above that at 60° F; at 80°, above 70°, and so on. The respiration rate (panting) in animals has a cooling function, and the hotter the environmental temperature the higher the respiration rate.

The respiration rates at 50° F. were about 22 in small (Jersey) cows and 27 in the large (Holstein) cows. The maximal respiration rates were about 85 in the acclimatized and 110 in the unacclimatized Holsteins; about 120 in the acclimatized and 150 in the unacclimatized Jerseys. The highest respiration rate was 5.6-fold of the lowest level in the Jerseys and 4-fold in the Holsteins.

The rectal temperature begins to rise at about 70° F. chamber temperature much more rapidly in the large (Holstein) than small (Jersey) cows. At

chamber temperature 105° F., the rectal temperature attained a level of 108° F. in Holsteins and 106° F. in Jerseys.

When the rectal temperature began to rise, the milk production (and feed consumption) began to decline approaching virtually zero at 105°. There was also a loss in body weight. The larger the animal the steeper the decline in milk production, feed consumption, and body weight. In brief, 70-80° F. environmental temperature was the "critical temperature" for European dairy cattle depending on body size. Beginning with this temperature, the productivity of dairy cattle began to deteriorate, at ever increasing rates.

This low critical temperature, 70-80° F., for European cattle, at which the rectal temperature began to rise, (in man the rectal temperature does not rise even at 100° F.) was associated with its low rate of moisture vaporization from the skin. However, drinking cold water served as a cooling medium, and Cow 212 which increased her cold water (60°) consumption from 10 gallons at 50° F. to 47 gallons at 100° F., maintained a lower body temperature and higher milk yield level than cows that did not drink as much water.

The pulse rate increased somewhat between 50° and 80° F. Thereafter, unlike in man, it decreased in the Jerseys, but increased in the Holsteins. In brief, the reaction in pulse rate to rising temperatures is quite unlike that in man.

The most dramatic change occurred in the heat production. A rise in rectal temperature was normally associated with a rise in heat production in accordance with the Van't-Arrhenius rule. In the acclimatized (experimental) cows, however, the heat production rate declined steadily from environmental temperature 80° F., so that at environmental temperature 100° F. the heat production was about 40 per cent less than at 80° F. These data were not regarded as sufficient for conclusions for the control cows (whose chamber temperature was raised rapidly to 100° F.). The following explanations may be offered: (a) reduction of the heat increments of feeding and lactation since the feed consumption and milk production declined rapidly with increasing temperature above 80° F.; and (b) the rapid reduction of thyroid activity when temperature was increased as demonstrated in 1943 on rats by Dempsey and Astwood.

The most dramatic change in milk composition with increasing temperature was the rise in its chloride content.

The most dramatic change in blood composition with increasing temperature was the decline in cholesterol and especially the rise in creatinine. This was explained by the decline in metabolism with consequent lowering in the rate of creatine-phosphate turnover in the phosphorylation cycle, and therefore increased production of creatinine from creatine. The decline in blood cholosterol with increasing temperature was thought to be associated, in part, with the decline in milk yield.

In Research Bulletin 425 the background for this work was outlined and data were presented on the effect of environmental temperature, 50 to 105° F., on the milk production (total milk; milk corrected to 4 per cent fat; absolute fat yield; percentage fat), feed consumption, and body weight of 12 cows (6 lactating Jerseys, 4 lactating Holsteins, and 2 non-lactating, non-pregnant Holsteins) in the Psychroenergetic (or Climatic) Laboratory (two chambers, one "Control" and one "Experimental").

For the control group of six cows all conditions were kept constant (ambient temperature 50 to 60° F.) for about five months, then the ambient temperature was raised (by 5 to 10° F. daily intervals) to 100° for 27 hours and brought back to 60° F. For the Experimental group of six cows all conditions were kept constant except temperature which was changed from 50° to ever higher levels up to 105° at relatively long intervals, then brought down and held at approximately 60° F. for two weeks.

The critical high temperature, at which the depressing effect on milk production, feed consumption, and body weight became evident was, under the given conditions, 75 to 80° F. for Holstein cattle and 80 to 85° F. for Jersey cattle. Increasing environmental temperature above these temperatures rapidly depressed the feed consumption and milk production so that at 105° F. both virtually stopped. On reducing the temperature to the control level (50-60° F.) the feed consumption and milk production promptly returned to normal.

Other detailed information on this work has been published in Research Bulletin 423, Environmental Physiology, I. Physiological Backgrounds; Research Bulletin 433, Environmental Physiology III. Influence of Ambient Temperature, 50° to 100° F., on the Blood Composition of Jersey and Holstein Cows; and Research Bulletin 435, Environmental Physiology IV. Influence of Temperature, 50° to 105° F., on Heat Production and Cardio-respiratory Activities in Dairy Cattle. Also a number of articles have been printed in scientific journals.

The Endocrinology of Milk Secretion (C. W. Turner, R. A. Monroe, T. Y. Liu, and J. D. S. Kumaran). The theory has been suggested that the anterior lobe of the hypophysis plays some role in the growth of the mammary gland as well as in lactation. This theory has gained wide acceptance, but the question as to whether or not the gonadal hormones were primary or secondary in importance has been raised in review articles on the subject.

Observations at this Station indicated that there was one pituitary mammogenic hormone of protein nature. It was secreted more or less constantly into the blood stream at a low level in sexually mature animals. Estrogen, either systematically or by local application in physiological amounts, increased the vascularity of the stromal tissue and the permeability of the capillaries so as to permit increased amounts of the circulating mammogen to bathe the growing mammary ducts.

In pregnant animals or those injected with progesterone or related compounds, the pituitary was stimulated to secrete increased amounts of mammogenic hormone. In the absence of circulating estrogen, the level of mammogen may be sufficiently high to stimulate duct and lobule-alveolar growth, but in the presence of estrogen the permeability of the capillaries was increased and very rapid mammary gland growth occurred. Progesterone secretion declined or was overridden physiologically during the latter part of pregnancy, and the secretion of mammogen declined but the secretion of lactogen increased due to the increasing secretion of estrogenic hormone.

Effects of Feeding Thyroprotein

A group of 16 White Leghorn hens in their sixth laying year were continued on a ration containing 10 gm. of thyroprotein per 100 pounds of feed. Fourteen of these hens laid an average of 118.5 eggs in comparison with 93.4 eggs laid the previous year. In this group, 5 birds have received thyroprotein continuously for five years, 7 for four years, and 4 for three years.

In comparison, a control group of 12 hens of similar age were maintained. Eight hens survived the year and laid an average of 35.1 eggs. The previous year these hens laid an average of 58.4 eggs. Control group laid only 29.6 per cent as many eggs as were laid by the thyroprotein-fed birds.

The maintenance of egg production at the higher rate in the thyroprotein-fed group indicated that the normal thyroid secretion rate declined with advancing age and that the thyroid hormone became a limiting factor in egg production. The continuous feeding of thyroprotein maintained the circulating thyroid hormone at a uniform level and presented this limitation.

The synthetic estrogenic hormone, the dimethyl ether of diethylstilbestrol (or dianisylhexene), was fed to laying hens in varying amounts to determine the oral level compatible with egg production.

When 1 gram of dimethyl ether of diethylstilbestrol per 1 kilogram of feed was administered, the birds quickly stopped laying, their combs became pale and shrunken and muscular weakness and death occurred in some cases. Half this amount 0.5 gm. per kg. of feed caused egg production to stop in about two weeks. The feeding of 0.25 gm./kg. of feed was still observed to be excessive. When 0.125 gm./kg. of feed was given to laying hens, egg production declined but this dosage appeared to be close to the upper limits of tolerance.

It was concluded that amounts of dianisylhexene ranging from 0.05 gm./kg. (2.27 g./100 pounds) to 0.125 gm./kg. (0.56 gm./100 pounds) could be fed to laying hens without seriously depressing egg production. Actually, on the lower levels, it maintained egg production during the normal fall decline.

A group of White Plymouth Rock pullets was fed 10 gm. of thyroprotein, and 0.9 gm. of dianisylhexene per 100 pounds of complete battery feed together with 5 per cent dried cow manure in place of 5 per cent cerogras. Two

other lots were fed: (1) the control feed; and (2) a ration containing 10 gm. of thyroprotein per 100 lb. of feed. The weekly egg production of the two groups receiving thyroprotein rose more rapidly and maintained a higher level of egg production throughout much of the year. They averaged 49 per cent for the year in comparison to 38.52 per cent for the controls.

The Constituents of Milk and the Energy Requirements of Milk Secretion (C. W. Turner, G. W. Pipes, R. A. Monroe, Syed Kamal, and G. Kauffman). Several phases have been involved in the study of thyroxine metabolism: absorption, secretion, excretion, and intermediary metabolism.

It has been found that in the goat approximately 1.0 per cent of subcutaneously injected D, L-thyroxine in alkaline solution was excreted daily in the feces. No thyroxine was detected in the urine.

Studies have been conducted on the chick on the relative effectiveness of orally administered crystalline D, L-thyroxine and its solid sodium salts. It was found that the mono-and disodium salts were about equally effective and that both salts were approximately twice as effective as the pure crystalline compound. By inference, it appeared that crystalline thyroxine administered orally was about 20 per cent as effective as thyroxine injected subcutaneously in alkaline solution. Likewise, the sodium salts, when fed, were about 45 per cent as effective as injected thyroxine.

It has been thought for a long time that the action of the thyroid hormone in the body was of long duration. However, this work indicates that thyroxine remained in the body for only a short time. The duration of thyroxine in the body of the chick, after administration of the hormone at a level of 0.0001 per cent in the feed, could not be measured. At a 0.00015 per cent level, it remained for only three days; and at 0.0002 per cent -0.0008 per cent, five days. Up to a point (0.0002 per cent level), therefore, dosage did have a bearing on the duration of activity. From this point on to the lower levels of toxicity, no effect of dosage on the duration of activity was noted.

An investigation has been conducted to determine the relative effectiveness of crystalline monosodium, and disodium D,L-thyroxine in the domestic fowl when administered orally.

It was found that 0.000074 per cent of crystalline D,L-thyroxine in the feed was the amount necessary to maintain the thyroids of thiouracil treated male chicks at normal weight. Likewise, 0.000078 per cent was the amount required by the females. The requirements of the male chicks for the monosodium and disodium salts were found to be 0.000035 per cent and 0.000038 per cent, respectively. The comparative figures for the females were 0.000036 per cent and 0.000039 per cent.

It was calculated that crystalline thyroxine was absorbed to the extent of approximately 20 per cent, and the sodium salts about 45 per cent.

Some data have been collected in this laboratory relevant to the extent of thyroprotein absorption by the goat. It was concluded that at the dosage fed (1.5 gm. per goat per day) approximately 70 per cent of the thyroprotein administered was absorbed from the digestive tract. This compared with absorption data reported for other thyroxine compounds.

This work has been reported further in Missouri Agricultural Experiment Station Research Bulletin 422, "The Retention of Goitrogens in the Blood and Tissues of Several Domestic Animals."

Studies in Milk Secretion (C. W. Turner, Gene Kauffman, Syed Kamal, T. Y. Liu, and G. W. Pipes). The value of thyroprotein in stimulating an increase in milk and fat production during the declining phase of milk secretion in dairy cows and goats has been established. Most cows responded by producing a variable increase in milk yield which continued for two or three months before returning to the pre-administration level. The rate of decline of milk production then followed the usual pattern.

It was thought that the decline in milk production was due to the decline in the secretion of the lactogenic hormone. It would be highly desirable to stimulate not only an increased yield of milk with thyroprotein but also to hold this increased yield by maintaining a high level of secretion of the lactogenic hormone. The production of the lactogenic hormone of the pituitary has been stimulated by estrogen. Therefore, a low level of estrogen administered with thyroprotein might stimulate and maintain a high level of lactation.

After preliminary experiments with varying dosages of estrogen a tentative level for both goats and cows was decided upon for the first year's experiment. The results were disappointing. No evidence of increased persistency was observed. It appeared that the dosage of estrogen was too high in the current experiments.

It has been reported that cows fed thyroprotein for one lactation period did not produce as well as the beginning of the next lactation. Two cows in a previous experiment have freshened and their production in the current lactation was 25 per cent higher than in corresponding periods of the previous lactation. One of these cows was 9 years old and her production was higher than ever before.

One sterile Jersey heifer has been treated for a period in order to determine the extent that lactation can be induced experimentally. Her production has increased until she is producing about 25 pounds of milk per day.

Missouri Agricultural Experiment Station Research Bulletin 415, "Studies Concerning the Induction and Maintenance of Lactation;" Bulletin 416, "Studies Concerning the Induction and Maintenance of Lactation II;" and Bulletin 427, "Relation of Endocrine Gland Weight to Body Weight in Growing and Mature Female Dairy Goats" have been published on this work as well as several articles in scientific journals.

Improvement of Dairy Cattle by Breeding (H. A. Herman, A. C. Ragsdale, Donald B. Anderson, J. H. Edmondson, R. C. Laben, and Donald B. Roark). The effects of inbreeding and outcrossing on milk and butterfat production in dairy cattle have been investigated. This study involved a genetic analysis of the records of production of the Holstein herd maintained at this Station since 1902. For the past 20 years one objective of the breeding program has been to keep the degree of relationship to the bull *Sir Pietertje Ormsby Mercedes* as high as possible. Some outcrosses have been made, but many animals have a fairly high coefficient of inbreeding to this great sire of some 25 years ago.

The objectives of the present investigation were to determine the effect of inbreeding and outcrossing as it has been practiced in this herd on milk and butterfat production; to study heritability of production; and to study the amount and effectiveness of selection practiced in the herd. About 350 cows which have approximately 3 lactation records each were involved. All records have been computed to a standardized 305 day, 2 time milking basis. Correction factors for the influence of age and times milked daily have been computed from this data before final analysis.

A second and major phase of this project has been a continuation of the Ormsby line-breeding program, with a planned system of out-crossing to a good linebred family other than animals tracing more or less directly to *Sir Pietertje Ormsby Mercedes.*

A similar breeding program and investigation has been established for the Station Jersey herd of some 60 head and for the Hatch Dairy Experiment Station Herd of about 50 females. Three sires of similar breeding have been used in these two herds and they have been rotated so as to build up relationships in keeping with the desirability and performance of their offspring.

A study has been made of the transmitting ability of Jersey sires used in the Station herd over a 50 year period. This herd was established in 1887 by the purchase of four heifers and no females have been purchased since. Partial records were kept until 1902, but complete milk and butterfat, and reproduction records have been maintained since that time.

The records of 24 sires which sired at least 5 tested daughters with one or more records of production have been studied. Included were 258 daughter-dam comparisons. These included about 1200 lactation records.

With the increased use of artificial insemination in breeding dairy cattle many questions have been asked as to the length of time between parturition and the first estrus period. Some dairymen have suggested that high producing cows come in heat later than lower producers.

Through the detailed records kept on the Station dairy herd, it has been possible to study this problem. The breeding records of 347 cows with 968 parturitions were studied. The results were:

(1) The average length of the interval from parturition to the first subsequent estrus period was 57.0 days with a standard deviation of 28 days. Of the 968 periods studied 59.0 per cent came into heat within 60 days; 30.0 per cent between 60 and 90 days; 7.6 per cent between 90 and 120 days; and 3.4 per cent over 120 days;

(2) There seemed to be no relationship between the seasons of the year and the length of time from calving to the first estrus period after calving;

(3) The level of milk production did not appear to affect the interval between calving and occurrence of first estrus; and

(4) A study of the effect of age on the length of the interval from calving to first heat showed that this interval became shorter with age until the fourth year was reached and increased in length for the 6th and 7th years after which it decreased again;

(5) The interval between first, second, third, and fourth calves, etc., followed a pattern similar to that associated with age. However, the similarity was not pronounced after the 4th and 5th calf.

Sterility was found to be responsible for the greatest reduction in reproductive efficiency of the herd covering a 50 year period. There was no significant relationship between the production of milk and reproductive efficiency in a study conducted on about 500 animals.

The reproductive efficiency of the dairy herd varied from 75 to 89 per cent over a 45 year period. Since 1935 the reproductive efficiency has averaged from 85 to 90 per cent, a fact which demonstrates that proper management and disease control were major factors in maintaining high reproductive efficiency in the dairy herd.

ENTOMOLOGY

LEONARD HASEMAN, *Chairman*

Influence of Soil Minerals on Insects (Leonard Haseman, Philip C. Stone, and Harry E. Brown). An attempt has been made to determine the influence of the different levels of nutrition and soil minerals on either the rate of insect multiplication as shown by numerical counts, or on the physical well-being of reared insects as shown by variation in size, wing development, and other physical characters.

Cabbage plants and two species of aphids, *Brevicoryne brassicae* and *Myzuz persicae* were used in this investigation. Known varying amounts of different plant foods and soil minerals were used to grow plants in pots of "Zonolite." Five replications of six different nutrient solutions were used. The check series received full normal nutrient solutions and distilled water as needed. The other five series received the same full nutrient solution minus nitrogen, or magnesium, or potash, or calcium, or phosphorus in turn. In one test the young cabbage plants were all quite heavily infested with aphids.

In a second test three nearly mature aphids were placed on each plant. After growing the infested cabbage plants for a month on the known nutrient solutions aphid counts on the second test were as follows:

Full nutrients	74 aphids
Full nutrients minus nitrogen	87 aphids
Full nutrients minus magnesium	54 aphids
Full nutrients minus potassium	220 aphids
Full nutrients minus calcium	105 aphids
Full nutrients minus phosphorus	89 aphids

These data indicated that the reproduction of aphids on cabbage plants was slowed down when magnesium was withheld from the plant nutrients used. Also, when potassium was withheld they developed more abundantly. These results indicated that the withholding of magnesium and the addition of potassium would help reduce aphid reproduction.

In another series of tests where these same minerals were added to fertile soil for growing cabbage plants infested with aphids the result agreed with these findings. Cabbage plants receiving additional magnesium were more heavily infested while the series of plants receiving additional potash were the more lightly infested.

When these minerals were added to fertile soil for growing plants the following additional results were observed:

(1) Amaryllis plants, infested with red spider and common mealy bugs, showed definite reduction in both red spider and mealy bug attack when given additional nitrogen.

(2) Garden plantings of sweet corn, potatoes, and cabbage, did not show any change in the average abundance of corn earworms, potato beetles, or cabbage worms, respectively when given extra feedings of mixed fertilizers, such as 4-10-4.

Codling Moth Investigation and Control (Lee Jenkins, C. W. Wingo, G. W. Thomas, W. R. Enns, and Leonard Haseman). During the spring and summer a new method of keeping fruit growers informed on the insect and disease problems was started. Information was gathered weekly from all parts of the State by telephone and letters from co-operators and combined with observations made by the Station Staff and Extension Workers to make up a report each week which was sent to a mailing list of over 400 fruit growers.

Results obtained at the Experiment Station have been used to revise recommendations to fruit growers. Fruit growers who now are following the present revised orchard spray recommendations have been able to bring the menacing codling moth under complete control.

DDT continued to be the best insecticide for codling moth control. A combination of one quart of summer oil with 2 pounds of 50 per cent

wettable DDT applied in the last three cover sprays, caused considerable spotting of the fruit on Jonathans.

DDT at 2 pounds of 50 per cent wettable plus one-half pound of 25 per cent parathion gave slightly better codling moth control than the DDT alone with no injury to the fruit or foliage.

Parathion at the rate of 1⅛ pounds of a 25 per cent preparation in 100 gallons of water caused considerable russet on Jonathan apples when used in the second through the ninth covers.

Two pounds of 50 per cent wettable Methoxychlor in 100 gallons of spray gave codling moth control almost as good as the same concentration of DDT and caused no injury to the fruit or foliage.

For the control of mites DN111 was the best for use on apples and peaches when all the important considerations were taken into account such as effective control, lack of plant injury, and safety to the operator.

IN4200 was effective on mites but was tested in only limited scale. C800 (bis [p-chloro-phenoxy] methane) caused severe russeting to the fruit of Golden Delicious apples when used in two applications. Parathion at ½ pound of 25 per cent preparation in 100 gallons of water was very effective for mite control but was considered to be more hazardous to the operator than the DN111.

Parathion at 2¼ pounds of 25 per cent gave 83 per cent kill of Forbes scale when applied on Rome Beauty apples on August 11.

A spray of 1 per cent summer oil applied to the fruit and foliage of Rome Beauty apples gave 87 per cent kill when applied on August 11.

Services Rendered Farmers (George D. Jones, Lee Jenkins, Roland Portman, Curtis W. Wingo, Philip C. Stone, Harry E. Brown, Wilbur R. Enns, Leonard Haseman, and George W. Thomas). Weekly newsletters were sent to over 400 interested fruit growers keeping them advised of codling moth and other fruit insect development and activity and giving timely recommendations on their control. Horses, cattle, and hogs suffered perhaps the worst horsefly attack this State has ever known. Several hundred phone calls and letters asking help with the pest were handled. The findings on abundance and distribution of grasshoppers, Hessian fly, chinch bug, and European corn borer as shown by State-wide surveys were broadcast to Missouri farmers to keep them advised on possible outbreaks and control measures to be followed.

Continued extensive calls for the latest information and recommendations on the use of DDT and the other related new insecticides for controlling insect pests of all sorts attacking crops, livestock, man, and household and stored products were received and serviced as fully as present available information permitted.

This service of the Station staff linked with the Extension entomology field program has meant a great saving to farmers and others.

Insecticide Investigations (Lee Jenkins, Roland W. Portman, Harry E. Brown, Philip C. Stone, Curtis W. Wingo, Wilbur R. Enns, Leonard Haseman, O. S. Crisler, and George W. Thomas). The effect of DDT on dairy cattle and milk was investigated in cooperation with the departments of Dairy Husbandry and Veterinary Science. This research was extremely timely due to the attention this subject has received recently in the press.

Two Holstein cows were given DDT each day by means of capsules and balling gum over a 29-day period with the exception of Sundays. One cow received twenty-five 20 gram doses of DDT during the period. This was a total of 500 grams or an average daily dose of 43 milligrams per kilogram of body weight.

The other cow received twenty-one 5 gram doses of DDT during a 24-day period. This was a total of 105 grams, or 12.2 milligrams per kilogram of body weight per day. During the following 5-day period the daily dose for this cow was increased to 40 grams per day for 4 days.

Both cows were milked only once a day and were given the standard dairy ration being fed to the University herd. Samples from each day's milking were bioassayed for evidences of DDT using houseflies as test animals. The veterinarian observed the cows each day for clinical symptoms of DDT poisoning or other abnormalities.

No symptoms of acute DDT poisoning were evident in either cow during the experiment. Both cows became slightly nervous during the first week and showed stiffness in the hind quarters during that time. Milk production of both animals was reduced by half at the end of the experiment. This loss in milk may have been occasioned by the change from two milkings per day to one milking per day during the experiment. Each of the cows gained approximately 100 pounds weight which may have been a result of the one-time-a-day milking.

Milk from the first cow showed a high degree of toxicity to houseflies 24 hours after the initial 20 gram dose of DDT was administered. High toxicity persisted until 140 grams has been ingested by the cow. Thereafter, the toxicity of the milk to the flies was quite variable from day to day indicating that excretion of the DDT through the milk fluctuated markedly. Ten days after the last 20 gram dose was administered to the cow the milk ceased to be significantly toxic to the test flies.

Milk from the second cow receiving the 12.2 milligrams per kilogram of body weight per day, failed to show high toxicity to test flies except on the eighth day. Preceding that day and thereafter no significant toxicity was recorded among the tests. Later when the DDT dosage was increased from 5 grams per days to 40 grams per day (12.2) milligrams per kilogram of body weight per day to 97 milligrams per kilogram of body weight per day) the milk became highly toxic to the test flies within 24 hours and remained so

for 3 days. Fifteen days after the last 40 gram dose was administered to Cow No. 103 the milk ceased to be toxic to the test flies.

Piperonyl butoxide in addition to pyrethrum was tested quite extensively as a control for horseflies and results secured indicated that it may prove to be the most valuable control for these pests yet developed. Further tests are necessary.

The following new materials were tested for mite control in the orchard: Parathion (0, 0-Diethyl-0-p-nitrophenyl thiophosphate), Neotran (di (4-4'-chlorophenoxy) methane—designated as C-890), and IN4200 (lorol-2-thiozolinyl sulfide). Parathion, at one-half pound of a 25 per cent preparation in 100 gallons of water, was very effective in the control of Two-Spotted and European red mites. However, none of the new materials were superior to DN111 (Ninitro-o-cyclohexylphenol, dicyclohexylamine salt) when all factors were considered.

Parathion, at 2¼ pounds of a 25 per cent preparation in 100 gallons of water, applied on August 11 to a heavy infestation of Forbes scale gave 83 per cent kill of scales present.

Since parathion is extremely dangerous to the operator, it is not recommended for general use. Only those equipped to handle it and take precautions recommended by the manufacturer should even use it.

The following new materials were tested in vegetable gardens in 1948: chlorinated camphene; piperonyl cylonene; hexaethyl tetraphosphate; tetraethyl pyrophosphate; rotenone-pyrethrum pyrenones; and methoxychlor.

Chlorinated camphene was found to be effective for the control of hornworms on tomatoes, blister beetles on solanaceous crops, and for most of the pests of cole crops. It cannot be used on cucurbits.

Piperonyl cyclonene was found to be very effective in controlling pests of beans, eggplants, cole crops, and some of the pests of cucurbits. Further testing is needed to fully evaluate its practicality.

The organic phosphates were very effective in controlling aphids and red spider mites but were dangerous to handle and may injure certain plants such as tomatoes.

The rotenone-pyrethrum formulations were effective and safe for use on vegetable crops.

Methoxychlor was effective for many garden pests and seems safer than DDT both to plants and to man and animals. Further tests are needed.

Factors Influencing the Periodical Outbreak and Control of the Chinch Bug (Philip C. Stone, Harry E. Brown, and Leonard Haseman). The chinch bug infestation in central Missouri has continued very light this past season. Corn was damaged little in any part of the State when the first generation nymphs moved from maturing small grains. The heaviest infested fields visited were in Putnam County near Unionville where there had been practically no rain until the first generation chinch bugs were mature.

The fall chinch bug survey carried out in cooperation with the United States Department of Agriculture showed rather a substantial increase in bug population in one area including parts of Johnson, Barton, and Pettis counties. Also, north of the river a second small area in DeKalb County and in southeastern Missouri a third area showed up in New Madrid County. These surveys were made by checking on the abundance of hibernating bugs in grass clumps. They give a very accurate picture of the probable bug abundance to be expected the following summer. At present, in Missouri the chinch bug is in one of those still unexplained low population levels.

Missouri Ticks and Their Control (R. W. Portman, P. C. Stone, and Leonard Haseman). As in former years this investigation has been carried on largely in the Ozark section and has dealt mainly with the lone star tick, *Amblyomma americanum,* as the principal summer tick; the black legged tick *Ixodes scapularis;* and the brown winter tick *Dermacentor albipictus.* The study of the killing action of a number of new insecticides and combination of these insecticides on all stages of these ticks has been continued.

The low rainfall during the winter of 1947 and the early months of 1948 prevented ticks from being as abundant and active as usual during the summer and fall of 1948.

The four concentrations of methoxychlor (2,2-bis [p-methoxyphenyl] 1, 1, 1-trichloroethane) (one-quarter, one-half, three-quarters, and one per cent) prevented the animals from being attacked by ticks for eight days. None of these concentrations affected those attached and feeding. Methoxychlor was slow acting and the engorged blood in a feeding tick seemingly acted as a buffer and the tick was not affected by the toxicant.

Two groups of animals were treated with a combination of Benzene Hexachloride (BHC) and Rhothane (dichlorodiphenyl dichlormethane) (DDD). One group was treated with five hundreths per cent BHC and one-half per cent Rhothane. In neither case was the material strong enough to kill the feeding ticks, although all flat unengorged ticks were killed. The period of protection from attack in this case, was about five days.

Formulations of DDT (dichlorodiphenyl trichloroethane) emulsion produced by various companies were tested at one and three per cent concentrations. Only the flat unengorged ticks were killed. The animals remained free of flat ticks for about five days.

The combination of DDT with BHC seemed to be more toxic than the combinations containing one-quarter per cent BHC with one-quarter, one-half, and three-quarters per cent of either marolate or methoxychlor or DDD. It was thought quite possible that the action of the emulsifying or wetting agents may have covered the true results of the toxicants.

The BHC emulsion and wettable powder formulations at a one-half per cent concentration appeared to be equally toxic. Both gave good kills

and were effective for about one week. The emulsion formulation was preferred because it was not so disagreeable to handle and does not have the rank penetrating odor of the powder formulation.

Of the two materials tested, BHC and toxaphene (Chlorinated camphene), the toxaphene emulsion proved to be the better all around toxicant for the control of ticks infesting livestock. The emulsion was preferred since it can be more accurately and simply prepared into a spray by farmers. Also one application killed all the infesting ticks and afforded protection to the treated animals for some nine days.

Investigation of Sulfa Drugs for Controlling American Foulbrood in Honey Bees (Leonard Haseman). Missouri beekeepers quite uniformly are now using the sulfathiazole treatment effectively. This treatment makes it possible once more to have bees on every Missouri farm for supplying honey and for assisting with the much needed pollination of legume crops and orchard and garden crops.

The study of the sulfathiazole treatment for foulbrood was continued with package bees when they hived on clean combs but with access to American foulbrood infection in exposed combs and when they were hived on infected combs which they were required to clean out and use for brood rearing. Similar studies also were continued with overwintered colonies of bees exposed to infection but fortified against the disease by receiving sulfathiazole fed to them in sugar syrup or in diluted honey.

The results corroborated earlier findings showing that sugar syrup or honey treated with a regular one-half gram tablet of sulfathiazole crushed and dissolved in a cup of hot water and then added to each gallon, was fed to a colony of bees which was not infected with American foulbrood. This colony was fortified against the disease even when it is exposed to contact with infected combs. Furthermore, the results also show that a colony of bees in the last stages of destruction by foulbrood, will, when fed the sulfa-treated syrup, promptly set about cleaning up its infected combs and begin rearing normal, healthy broods in the cleaned out cells. The treated syrup used in experimental colonies was approximately a 15 milligram per cent solution of sulfathiazole in sugar syrup as medical bacteriologists designate such experimental drug solutions, or one-half gram of sulfathiazole to one gallon of sugar syrup.

FIELD CROPS

W. C. ETHERIDGE, *Chairman*

Breeding Better Oats for Missouri (J. M. Poehlman). Missouri 0-200, a new variety of oats for Missouri was increased and 2000 bushels of seed distributed to farmers for production in 1949. This variety, a selection from a Columbia x Bond-Iogold cross, is early, high in yield and test weight, and resistant to crown rust, stem rust, loose smut, and Helminthosporium blight. By these qualities Missouri 0-200 is expected to increase very substantially the value of Missouri's oat crop.

Oat breeding nurseries were grown at nine locations in the State. High yielding strains were selections from a Columbia x Victoria-Richland cross. These also were superior in stiffness of straw and test weight. In addition to the yield nurseries 6000 F_3 to F_5 selections were grown in head and plant rows, and 14 F_2 bulk hybrids were increased. Many of these are being tested for resistance to crown rust, stem rust, and smut; high yield; earliness; and stiff straw. Artificial epiphytotics of crown and stem rust were established in the field and all seed was inoculated with smut before planting. Only resistant, early selections were harvested.

Improvement of Pastures (E. Marion Brown, Joe D. Baldridge). Emphasis has been given to a comparison of various legumes in the amount of feed and the amount of beef produced per acre. The persistence and yield of each of 9 legumes: sweet clover, alfalfa, alsike, Ladino clover, birdsfoot trefoil, Korean lespedeza, Kobe lespedeza, and hop clover sown in 1945 in sods of each of 4 grasses: bromegrass, bluegrass, orchard grass, and redtop was determined. Average yields produced by birdsfoot trefoil, second-year sweetclover, Ladino, and Korean lespedeza with all 4 grasses were 3397, 2933, 2784, and 2275 pounds of oven-dry herbage per acre respectively under semi-monthly lawn-mowing.

At Columbia, the pasture value of different grass-legume mixtures grown on depleted soils limed and fertilized with phosphate and potash was determined. Beef cattle gained 265 pounds an acre on tall fescue and sweet clover, 252 pounds on redtop and lespedeza, 216 pounds on tall fescue and lespedeza, and 177 pounds on orchard grass and lespedeza and on bromegrass and lespedeza. Bluegrass produced 258 pounds beef cattle gain an acre under supplemented grazing, and 189 pounds under continuous grazing.

At Lathrop, beef cattle gained 316 pounds an acre on bromegrass-lespedeza-Ladino-alfalfa, 290 pounds on wheat-lespedeza, 236 pounds on bluegrass and sweet clover, 232 pounds on bluegrass and lespedeza, and 230 pounds on rye and sweet clover. Bluegrass and lespedeza fertilized annually with ammonium nitrate produced 281 pounds of beef cattle gain an acre, but most of the gain was made before July and the grass tended to suppress lespedeza and other legumes.

This bluegrass pasture at Lathrop was renovated with Ladino clover. This photograph was taken May 25.

At Sikeston, tall fescue and second-year sweet clover produced 353 pounds beef cattle gain an acre, bromegrass and alfalfa 336 pounds, and winter oats and lespedeza 254 pounds. Wheat supplied little pasture because late harvesting of the preceding soybean crop delayed sowing until November 26, but cattle gained 203 pounds an acre on the lespedeza after wheat had been pastured out. They also gained 145 pounds an acre on lespedeza in rye stubble.

In tests at Columbia, New York broadleaf birdsfoot trefoil produced 7395 pounds of hay and 25 pounds of seed an acre; European birdsfoot trefoil produced 4432 pounds of hay and 5 pounds of seed. New York narrowleaf birdsfoot trefoil produced 7159 pounds of hay and 80 pounds of seed an acre; West Coast narrowleaf birdsfoot trefoil produced 4700 pounds of hay and 33 pounds of seed.

Clipping birdsfoot trefoil on and before May 16 increased seed yield but cutting for hay June 24 greatly reduced it.

Lespedeza Breeding

At Columbia, 14 improved strains of *Lespedeza stipulacea* and of *L. striata* produced from 25 to 118 per cent more hay than the Korean lespedeza check plot. The degree of resistance to bacterial wilt had much to do with the differences in yield. Climax, a late maturing variety of Korean lespedeza produced 28 per cent more hay but 30 per cent less seed at Sikeston than ordinary Korean.

Breeding Winter Barley for Missouri (J. M. Poehlman). Variety and strains of barley were studied on a nursery scale at Columbia, Bethany, Lathrop, Perryville, Pierce City, and Sikeston. Twenty-five units were included at each location. In all cases the objective was unit comparison in yield, maturity, strength of straw, winter hardiness, resistance to mildew, loose smut, and covered smut. Selections from crosses of Kentucky 5 x Missouri Early Beardless and Admire x Missouri Early Beardless were outstanding in yield and disease resistance.

Nearly 200 introductions in addition to varieties grown commercially were studied. All were tested in separate nurseries for resistance to the three forms of barley smut.

Thirty-six new crosses were made to provide breeding material for hardy, high yielding, and disease resistant lines.

A selection from a Kentucky 5 x Missouri Early Beardless cross has been chosen for increase for distribution. This selection combined high yield and resistance to loose smut, mildew, and spot blotch — qualities not heretofore found in a single variety of winter barley.

Genetic Studies With Crop Plants (J. G. O'Mara, E. R. Sears, and L. J. Stadler). Studies have been continued at the Missouri Station on the mechanism of heredity of corn, genetic studies concerned with methods of corn breeding, cytogenetic studies with wheat, and cytogenetic studies with oats.

The Mechanism of Heredity in Corn

The continued analysis of spontaneous mutation of the gene R^r by L. J. Stadler has shown that its mutation frequency is affected by many other genes, some causing a pronounced increase in mutation frequency and some a pronounced decrease. In a cross of a high-mutation stock with a linkage tester stock, in which 7 chromosome segments were marked, 3 of the 7 proved to carry dominant factors with large effect on mutation rate of R^r. These were a chromosome VI factor and a chromosome VIII factor increasing the rate, and a chromosome X factor decreasing the rate.

These results indicated that it may be possible to extract strains in which the mutation rate of R^r is high enough to permit direct experimental study of the mutation process.

A mutation-reducing factor in chromosome X was identified also in another stock carrying the linked factors R^g and g, thus making it possible to determine the locus of the modifier and to measure more accurately its effect upon the mutation rate of R^r. Further data are necessary to fix the locus, which appears to be between R^g and g. The results indicate that the frequency of mutation in plants lacking the modifier is at least 8 times as great as in plants heterozygous for the modifier.

The gene R^r affects both seed and plant color, and its spontaneous mutation regularly results in loss of either seed color or plant color, not both.

The mutant allele r^r, which results from seed-color mutation, produces exactly the same effect on plant color as the parent allele R^r, and the mutant R^g, from plant-color mutation, has the same effect on seed color as the parent allele. In other words, R^r acts as if it were in fact two genes, one affecting seed color and the other plant color. These two effects of the gene or complex are very closely linked if they are separable at all. A similar situation is found in several genes, in various organisms.

Cytogenetic Studies with Wheat

In research by E. R. Sears in common wheat the number of different nullisomics (with only 20 pairs of chromosomes instead of the normal 21 pairs) was brought at least to 20, and probably to 21. By use of the nullisomics, a number of genes were located on specific chromosomes. These included genes for stem-rust resistance on chromosomes X (10) of Timstein, a gene for stem-rust resistance on chromosome VI of Red Egyptian, a gene for mildew resistance on chromosome XI of Axminster, and various genes affecting morphological characters. Work is continuing for the location of the gene or genes for stem-rust resistance in Hope and Thatcher, for bunt resistance in Martin, and for mildew resistance in Indian.

A pair of chromosomes added to spring wheat from *Aegilops umbellulata* conferred high resistance to leaf rust but gave increased earliness and other characteristics some of which adversely affected yield. This pair of chromosomes will be transferred to a winter wheat to see if it decreases yield there, too. There was evidence that the *umbellulata* chromosomes had some homology with a particular wheat chromosome, and this suggests the possibility of separating the resistance from the adverse effect by transferring the resistance gene or genes to the wheat chromosome.

Cytogenetic Studies with Oats

Various monosomes of *Avena sativa* were grown in much larger numbers than had been possible previously to determine whether the early observations were correct. This work was done by J. G. O'Mara. These earlier observations indicated that most of the available Avena monosomes produced a much higher proportion of nullisomic plants than did the monosomes of *Triticum vulgare*.... These more extensive trials indicated that several of the monosomes produced approximately 50 per cent nullisomic plants. One monosome thus far has produced no nullisomic individual in progenies composed of over fifty plants.

The exact structure and behavior of the *Secale cereale* chromosome which has been added to *T. vulgare* has been determined. The observations of last year—that the obvious constriction is not the centromere constriction—has been verified with the isolation of plants with phenotypes which are in accord with their chromosome constitutions. Such plants have 21 *T. vulgare* bivalents plus, from *S. cereale*, (1) a complete chromosome, (2) a chromo-

some which is telocentric for the long arm, (3) a chromosome which is telocentric for the short arm, (4) an isochromosome for the long arm, (5) an isochromosome for the short arm.

The converse experiment—which is much more difficult—was initiated with some encouragement. This consists in adding wheat chromosomes to rye. The *T. vulgare-S. cereale* amphidiploid has been backcrossed by *S. cereale*, and this plant has again been backcrossed to *S. cereale*. From many pollinations two small seeds were secured. During the past year a technique has been developed for growing such weak seeds in sterile cultures. A high percentage of otherwise useless seeds have developed into normal plants by use of the method.

Methods in the culture of immature cereal embryos were further refined during the year. The chief accomplishment in these experiments was the development of a medium containing but one salt, on which oat embryos taken 14-16 days after pollination will develop into normal plants. The medium was equally satisfactory with maize embryos, but was not suitable for wheat.

Breeding Corn for Missouri (Marcus S. Zuber, William A. Crane, and L. J. Gundy). Extensive research in corn breeding was continued and yield trials of experimental hybrids were conducted in nine locations in the State. This year's testing of hybrids was the most successful in number of tests planted and harvested. Valuable data on yields were obtained.

Twenty-five midseason yellow double crosses were tested in nine locations in the State. In the various regions the outstanding hybrids were:

Northern Region: 1. Mo. 826 (L317 x P8) (Hy x Oh 07); 2. Mo. 840 (L304A x N6) (Hy x 38-11); 3. Kan. 1639 (WF9 x 38-11) (K148 x K150)

Central Region: 1. U. S. 475 (Oh 03 x L317) (WF9 x 38-11); 2. Nebr. 701 (Oh x Hy) (WF9 x 38-11); 3. Mo. 840 (L304A x N6) (Hy x 38-11)

Southern Region: 1 Mo. 826 (L317 x P8) (Hy x Oh 07); 2. Mo. 840 (L304A x N6) (Hy x 38-11); 3. Mo. 836 (P8 x 38-11) (L317 x Hy).

Late white doubles were tested in nine locations. However, these hybrids were too late in maturing for the northern region.

Improvement of Soft Red Winter Wheat in Missouri (J. M. Poehlman). Thirty varieties of wheat were studied at Columbia, Lathrop, Elsberry, and Sikeston. In addition to a comparison of yields, the varieties were noted for height, maturity, leaf rust resistance, lodging percentage, test weight, and pearling index. Ten additional wheat nurseries included early and uniform varieties and new selections from crosses. A total of 354 strains and varieties were included in these tests.

Twenty-four hundred head and plant selections were grown and examined for earliness, strength of straw, leaf rust resistance, and plant type. The superior lines were harvested and studied for quality through measurements of pearling index. Thirty-six bulk hybrids were advanced one genera-

tion and eighteen new crosses were made. All of these crosses combined resistance to leaf rust and loose smut, with high yield, winter hardiness, and good soft wheat quality. A few of the crosses brought in resistance to Hessian fly.

Grain harvested from twenty varieties and strains was submitted to the Department of Home Economics for evaluation of the quality of the flour produced.

Plans have been completed to establish a Hessian fly nursery in cooperation with the U. S. Bureau of Entomology. Informal cooperation with the Kansas Agricultural Experiment Station has been established to provide for additional testing of promising soft wheat strains developed at Columbia and at the Southeast Kansas Experiment Field.

Improvement of the Missouri Soybean Crop (Carl V. Feaster). The Wabash soybean, a variety being released this year, was yield tested at Columbia, Norborne, Shelbyville, Elsberry, and Sikeston. This soybean was developed at Purdue University in cooperation with the Regional Soybean Laboratory and 714 bushels of it were distributed for planting in the 1949 season.

In addition to the soybean strains grown in cooperation with the Regional Soybean group tests, approximately 400 other strains were tested at the locations named above. Strains from Lincoln x S-100 and Patoka x S-100 were most outstanding at Columbia. Strains from Ralsoy x Lincoln, that were similar to Ralsoy in plant type but about two weeks earlier, appeared most outstanding at Sikeston.

F_2 seed from 19 hybrid populations were grown at Columbia and Sikeston and 4,000 plant selections were made. Sixteen crosses were grown in the F_1 generation and 15 new crosses were made.

The breeding of strains resistant to bacterial pustule was continued. Resistant segregates were selected from the F_2 populations of C.N.S. x Lincoln. C.N.S. x Boone, and C.N.S. x Ogden.

Important practical benefits have resulted from this soybean research. S-100, one of the most productive and popular varieties of soybeans ever grown in Missouri, was developed four or five years ago and now occupies the larger part of the soybean acreage of southeast Missouri. Several other new varieties have been developed and are approaching the period of release and multiplication for general production.

Seed Testing (Viola Stanway). Slightly more than 6000 separate tests were made on the 3908 samples of seeds and plants which were tested and examined by the Missouri Seed Testing Laboratory during the year ending June 30, 1949.

This total represents an increase of 78.2 per cent in the number of samples received as compared with that of the preceding year. Of the 3908 samples received, 2398 were tested for Missouri farmers, 1229 for the Missouri Seed Improvement Association and 281 for Missouri seedsman.

FORESTRY

R. H. WESTVELD, *Chairman*

Rehabilitation of Missouri Forests (J. Milford Nichols and R. H. Westveld). A preliminary investigation to serve as a basis for future work on acorn production was made to develop a satisfactory technique for sampling the fall of acorns from oak trees.

The species studied included white oak, black oak, and scarlet oak. Two trees of each of these species were used in this study. Thirty-two acorn traps were constructed and the area of sample with each trap was 1/4 milacre. Sixteen traps were used in a regular pattern under each tree. Under those trees for which traps were not available, wooden frames of the same area were placed on the ground in the same pattern.

Following the preliminary work the study to determine the effect of litter on the germination of acorns and the survival of seedlings was started. Three contrasting areas were selected for sample plot locations including excellent, medium, and poor site conditions for tree growth. The plots established were 120 feet by 120 feet in dimension with 400 staked seed spots located in each plot raked clean of all litter. One healthy acorn each of scarlet oak, black oak, and white oak was planted at a depth of one inch in a uniform pattern at each seed spot. The planting was accomplished between November 3 and November 8, 1948.

Permanent Fire Plots

Permanent fire plots were established to determine the effect of fire upon the trees and the soil.

Six plots, each four-tenths acre in size, have been located. All trees on these plots 1.6 inches and above in diameter at breast height have been identified with numbered metal tags. Tree reproduction has been identified on eight randomized milacre plots within each of the six fire plots.

Two of the six plots will be kept in their natural condition, two will be burned yearly starting in March, 1949, and the remaining two will be burned at a longer time interval, probably five years, starting in March, 1949.

Soil and litter samples were taken from five randomized areas within each of the two plots which will not be burned and within each of two out of the four which were burned in March, 1949. The soil sampling will be continued at intervals.

Missouri Forest Plantations (Richard W. Dingle and R. H. Westveld). The plantation survey was begun in the fall of 1948.

State planting records from 1937 to 1948 have been secured from the Extension Forester and from the State Forester. The records supply the name of the man to whom seedlings were sold, the date of shipment, the county and post office address of the planter, the number and species of trees, and the purpose of the plantation.

Catalpa produces good yields of fence posts on good soils. This 30-year-old catalpa plantation yielded 400 posts per acre when it was thinned and supported practically a full stand as shown here.

Data from the state planting records were studied in order to determine the number of plantations by species within four-year-age groups so that the older plantations would be adequately represented in the sampling. Soil-type classifications have been made according to major soil areas by the soils department.

Christmas Trees as a Crop (R. E. McDermott). The Christmas tree research program showed that much of Missouri's demand for Christmas trees could be met by Missouri farmers.

At the present time between 4000 and 5000 conifers have been grown on the University 2000 acre wildlife area near Ashland.

Plans have been made to plant several thousand trees on the University experimental farm at Weldon Springs. At the present time Scott and jack pine have proved to be the best varieties for Missouri Christmas tree production.

It has been found that it takes about five years to grow an average size Christmas tree and about 2500 trees can be grown per acre.

Different methods of pruning have been tested and the practice which showed the most promise was the developing of a second tree from a lower branch. This involved cutting the first tree just above the lower branches rather than below them, then training a lower branch to grow upward and thus produce another tree from the old stump. This saved labor and expense of starting a new planting after each cutting and provided a strong, well-established root system to start a new tree.

Jack pine is generally satisfactory throughout Missouri for windbreaks. In this 10-year planting in Boone County it has formed a compact mass more than 15 feet tall.

HOME ECONOMICS

STARLEY M. HUNTER, *Chairman*

The Nutritive Value of Chicken Meat as Affected by Different Methods of Preparation (Bertha Bisbey, Adelia Weis, Audrey Erdsiek, Margaret Kanapaux, and Grace Richmond). This is a summary of the project which was begun in September, 1946.

Information on the nutritive value of poultry and poultry products is of special interest in Missouri since it is one of the leading states in the production of poultry. Chicken is an important source of meat for the rural population, especially in the summer months.

Meat of chicken is known to contain a number of vitamins and essential minerals in addition to furnishing high quality protein. Methods of preparation have been shown to exert a significant influence on the quantity and availability of nutrients in foods. Quantitative information as to the extent of this influence in regard to chicken meat is not available.

This project was undertaken to provide knowledge of the relative efficiency with which the vitamins in chicken meat were conserved by the methods of cooking used in common household practice.

Comparisons of fried, stewed, baked, and canned chicken in reference to the Vitamin A, thiamine, riboflavin, and niacin content were made.

The chickens used in the thiamine studies were 55 Barred Plymouth Rock roosters, 11 weeks old, secured from a commercial poultry farm. The ration was a standard broiler mash. The average dressed weight of each chicken was 2.5 pounds. The carcasses were divided into four groups, selection for each group made at random.

All of the groups were divided into dark meat, light meat, livers, and gizzards. The dark meat included legs, thighs, and backs; the light meat, wings and breasts. After packaging, the meat was frozen at -24° C., after which it was stored at -12° C. until approximately 24 hours before cooking time, during which time it was thawed at 3° C.

The baked chickens were cooked in gas ovens at 160° C. for one hour and twenty minutes. Stewing was done in a pressure sauce pan at 15 pounds pressure for 10 minutes. The fried chicken was fried in fat in a frying pan at 170-175° C. for 25 minutes. The canned chicken was processed in glass jars by the pressure cooker method. The livers were cooked at 15 pounds pressure for 10 minutes and the gizzards for 25 minutes.

After the various cooking procedures had been completed the meat was prepared for assaying. It was removed from the bones, ground in a meat chopper and the cooking liquid (minus the fat which was removed) poured over the meat. The meat was then dehydrated in a current of warm air at a maximum temperature of 41° C. The dried meat was finely ground in an electric grinder, then stored in glass jars at 5° C. until assayed.

The biological assay was made by means of the rat-growth method. A reference curve was established on the basis of the growth response of rats to graduated doses of crystalline thiamine. Concurrently similar groups were fed weighed amounts of the chicken meat being assayed as their sole source of thiamine. The thiamine content of the meat was obtained by plotting the growth responses of the test groups on the reference curve and thus determining the corresponding thiamine value, expressed in micrograms of thiamine per day. From the amount of meat fed per day the thiamine content was calculated in micrograms of thiamine per gram of chicken meat. The results of this assay are shown in the following table:

Micrograms of Thiamine per gram of Dehydrated Chicken Meat

	Light Meat	Dark Meat	Liver	Gizzard
Stewed	2.6	4.0	16.0	0.4
Baked	2.4	3.5	—	—
Fried	1.6	2.2	—	—
Canned	1.0	1.2	—	—

The finding that in each case dark meat contains a higher concentration of thiamine than light meat was in agreement with the reports of other investigators.

Chicken liver, which contained 16.0 micrograms per gram, was the richest source of thiamine of the materials tested. The only other organ assayed,

the gizzard, was the poorest. For both light and dark meat the cooking methods ranked in the same order: Stewed chicken had the highest thiamine content, baked next, fried third, and canned last. It was believed that the lower thiamine content of the fried chicken did not reflect a greater destruction of the vitamin by this method of preparation, but rather that a considerable amount of fat was absorbed by the meat in this cooking procedure, thus lowering the percentage of thiamin. The long processing time (65 minutes) in water at the high temperature necessary in the canning procedure, appeared to be the cause of the comparatively low thiamine content of the meat prepared by this method.

Chemical analyses for thiamine, using the thiochrome method gave lower values than those reported from the biological assay. Other investigators have reported similar findings.

In the riboflavin, niacin, and Vitamin A content part of the study, 60 White Rock chickens were secured from a commercial poultry farm. They were fed commercial broiler mash. They were killed and dressed under the supervision of the department of poultry husbandry. Records were kept of the live weight, dressed weight, and waste. The chickens were divided into four groups at random. For the fresh light meat assay a 32-gram sample was taken from each of 15 chickens: 26 grams from the breast, and 6 grams from the wing. For the fresh dark meat assay, 16 grams were removed from the leg and 16 grams from the thigh of 15 chickens. The center portions of the thigh, breast, leg, and wing were removed for analyses.

The same procedure as described for the thiamine studies was followed in the preparation of the meat used for assay.

Both microbiological and fluorometric methods were used in the assay of riboflavin and microbiological only in the assay of niacin. The values (microbiological) for the fresh chicken tissues on a moisture-free, fat-free basis were as follows:

	Light	Dark	Liver
	mcg/gm	mcg/gm	mcg/gm
Riboflavin	4.71	9.48	86.59
Niacin	500.97	272.64	495.84

The riboflavin and niacin values obtained for cooked chicken indicated that both vitamins were lost to some extent in the cooking processes. The highest percentage of riboflavin was retained by frying while stewing gave the highest retention for niacin.

The biological method was used in assaying the tissue for Vitamin A content. The amounts found were negligible. Very little fat was stored in the tissues.

The edible tissue of chicken based on the live weight was 56.6 per cent.

Testing Flours From Promising Selections and Varieties of Missouri Soft Red Winter Wheat for Their Adaptiveness to Different Culinary Uses (Leta G. Maharg and Marybelle Sapp). This was a cooperative project between the home economics and the field crops departments and flours from 13 varieties of wheat were continuations from the 1947-48 tests. Seven flours were from new varieties.

Results of tests on cakes baked from flours obtained from seven varieties of wheat which were grown for three consecutive years gave the average scores and volumes shown in Table 12.

TABLE 12.--BAKING RESULTS ON SOFT RED WINTER WHEAT.

Wheat Variety	Scores			Volumes		
	1946 %	1947 %	1948 %	1946 %	1947 %	1948 %
Clarkan	92	93	93	100	97	95
Early Premium	93	94	93	100	98	98
Kawvale	81	84	83	92	89	92
W 5423	93	90	87	98	100	100
W 5477	84	87	87	85	93	92
W 5478	86	86	88	87	94	96
W 5488	92	87	92	100	97	97

These baking results indicated that the variety of wheat seemed to be a controlling factor in the quality of a cake flour. In general, cakes which were scored the highest, were also highest in volume. The flours seemed to show consistent qualities in baking performance for each of the three years.

The Nutritive Value of Black Walnut Meats (Adelia Weis and Dorothy Tyrrell). A technique for extracting the vitamins from the black walnut meats has been developed.

Preliminary assays for riboflavin, using the microbiological and fluorometric methods, have been made on black walnut meats purchased at a local grocery store. In these preliminary assays the riboflavin values were very low—less than 1 microgram per gram of nut meats.

Preliminary microbiological assays for niacin showed approximately 4 micrograms per gram nut meats.

Black walnut meats for continuation of this study have been obtained from the power cracking plant at Exeter, Missouri, by the department of Horticulture. The following varieties were obtained: Stabler (cultivated), Thomas (cultivated), seedlings (regular run from the cracking plant), and seedlings (from two known localities).

A total of 1800 pounds of black walnut meats were produced at the Exeter plant this year. Since the laborious task of hand cracking and hand picking the kernels has been eliminated and since the price of the nut meats at the grocery stores is approximately 8c per ounce, it would seem that this should be a worthwhile cash crop to develop for the state of Missouri.

Meat Color Project—The Rate of Change of Hemoglobin to Methemoglobin in Frozen Ground Beef Under Different Conditions of Storage (Margaret Mangel and Grace Hoover). Preliminary work to determine the effect of time, temperature, acidity, and concentration on the results of the spectrophotometric tests has been completed. The extent to which results could be reproduced by one or more workers has also been determined.

The ground beef has been frozen and stored at 0° F., +10° F., -10° F. (on the coils) and with ascorbic acid at 0° F. Additional samples have been stored under carbon dioxide, oxygen, nitrogen, and air. Two series of samples have been prepared and are being treated by fluctuating temperatures from 0° F. to +10° F. and from 0° F. to +35°F.

Tests have been run on samples of fresh, just frozen, and after eight weeks storage at 0° F., +10° F., -10° F. and with ascorbic acid. The results have not been summarized to date.

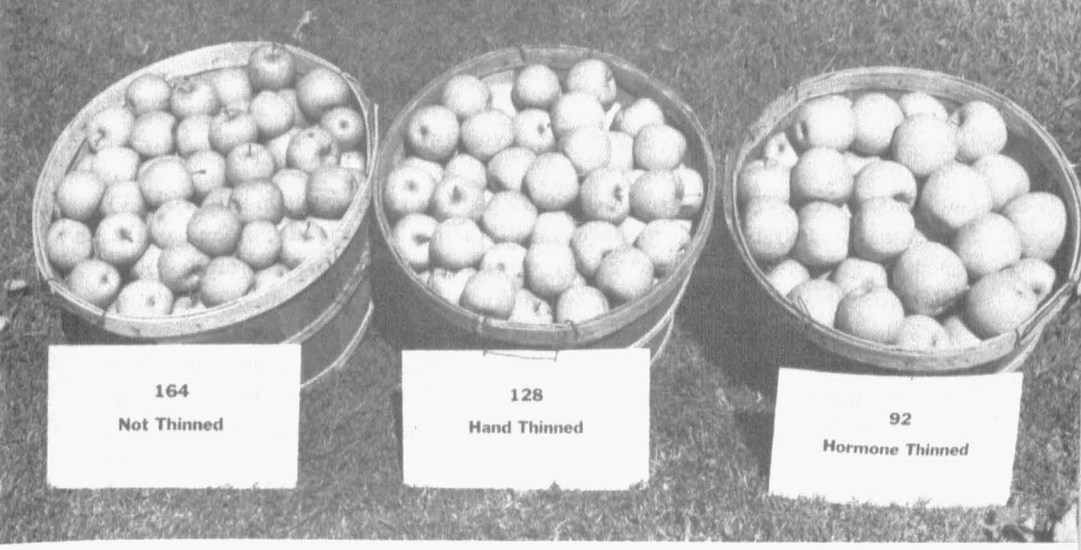
A Study of the Serviceability of Some Staple or Common Household Textiles as Measured by Laboratory Tests and Home Service (Adella Ginter). In a serviceability study five cotton marquisettes (3 with a permanent set and 2 without) were made into curtains and put into use in the Home Management House in the fall of 1947. A plan was devised using several more curtains than the number normally required to hang at the windows each time, so that after definite periods of wear a curtain could be removed for testing. The curtains were used twelve weeks, then washed and rehung. After six wear periods in which the curtains were rotated in position to get the effect of different light exposures, a curtain of each group was removed for testing. Lengths of fabrics of similar materials, laundered but not used at the windows, were removed for testing after the same number of launderings.

The remaining curtains and fabrics have been continued in use and another set will be removed after 9 wear periods (108 weeks). A final set will be tested after 12 wear periods (144 weeks).

Five varieties each of cotton, nylon, and rayon marquisette curtain fabrics with permanent finishes have been laundered 20 times. The fabrics were tested as purchased, and after 1, 2, 3, 4, 6, 8, 12, 16, and 20 launderings. The tests included the following: (1) shrinkage; (2) crispness; (3) tensile strength (wet and dry); (4) weight; and (5) count.

The tests have been practically completed but analysis of data has not. Some of the general tendencies observed were:

1. The greatest shrinkages were noted in the rayon marquisettes; the least in the nylons.
2. There was progressive shrinkage in all fabrics.
3. Crispness decreased in all fabrics with successive launderings.
4. Slight tensile strength changes were noted with successive launderings.



Golden Delicious apples showing the results of no thinning, hand thinning and hormone thinning. Spray thinned fruit was larger and required fewer apples per basket.

HORTICULTURE

T. J. TALBERT, *Chairman*

Factors Affecting Fruit Setting of the Apple (A. E. Murneek). As a result of spray-thinning studies at this Station, tentative recommendations for chemical spray-thinning of apples and peaches have been prepared and sent to interested fruit growers in the State. The information has been based not only on the results obtained in 1948 but more largely on that of several years. Various factors determining the efficiency and economy of chemical thinning of fruit have been fully discussed and appended to those recommendations.

Experimental apple thinning with chemical sprays was conducted in the Turner Station Experimental orchard on Old York trees, and on young and vigorous Jonathan, Winesap, and Golden Delicious trees.

Forty per cent dinitro-ortho-cyclohexylphenol (DN-1), ¾ pound to 100 gallons of water, applied at "full bloom" did not thin York apples sufficiently, but overthinned Jonathans and Winesaps. Naphthaleneacetic acid (NA), at 20 parts per million (p.p.m.) thinned York and Golden Delicious trees to the right amount when the spray was applied 6 or 10 days after full bloom. Winesaps were thinned best with NA at 10 p.p.m. applied 10 days after full bloom and at 20 p.p.m. 17 days after full bloom. Jonathans were overthinned when sprayed with NA, 10 or 20 p.p.m., either 6, 10, or 17 days after full bloom.

Experiments on chemical thinning of peaches, variety Elberta, were conducted in the Experiment Station orchard at Campbell. The trees were sprayed with NA, at 20, 40, and 60 p.p.m., 20, 27, and 34 days after full bloom. A group of adjoining trees were hand-thinned for comparison. Naphthaleneacetic acid at 40 p.p.m. thinned these trees satisfactorily when the spray was applied either 27 or 34 days after full bloom.

Comparative tests as preharvest sprays for drop reduction of Jonathan and Winesap apples were made on the relative efficiency and economy of

Naphthaleneacetic acid (NA) at 10 p.p.m., p-chlorophenoxyacetic acid (CIPA) 20 p.p.m., 2 methyl, 4 chlorophenoxyacetic acid (Toloxy) 20 p.p.m. and 2, 4-Dichlorophenoxyacetic acid (2,4-D) 10 p.p.m. The sprays were applied when fruit was starting to drop and harvesting of the crop was delayed 2 to 3 weeks to obtain improved color and increased size of the fruit.

In full agreement with previous results obtained at this station, 2,4-D at 10 p.p.m. was found an unusually effective "preharvest" spray for the Winesap variety (It was equally satisfactory for Staymans in 1947, which could not be tested again in 1948 because of lack of bearing trees). Toloxy and ClPA, at above concentrations were superior materials for this purpose to NA, when the period of effectiveness is considered.

New Sprays and Spraying Methods (H. G. Swartwout). Evaluation studies of several of the newer organic fungicides and of spray schedules for the control of black rot of grapes were conducted in commercial vineyards in Phelps and Crawford counties and in the Station's experimental vineyards near Columbia. Since ferric dimethyl dithiocarbamate (Fermate) which is now the standard fungicide in Missouri for the control of black rot on the Concord variety was not highly effective against downy mildew, (2,3 dichloro—1,4—naphthoquinone) (Phygon-XL) was included in this year's tests to determine from a phytotoxic standpoint whether or not it was acceptable in combination with the iron thiocarbamates where a mildew fungicide was needed.

Karbam which like Fermate is based upon ferric dimethyl dithiocarbamate as the toxicant was found to be as effective in controlling black rot as Fermate. In the several vineyards where comparisons were made, control of the disease was practically the same with both formulations of the iron thiocarbamate. Two quarts dithane D-14 (disodium ethylene bisdithiocarbamate) mixed with one pound powdered zinc sulfate (per 100 gallons) was not as effective in controlling black rot as Fermate and Karbam. Stanofide at ½ pint per 100 gallons gave poor control.

Phygon-Fermate combinations of ¼-1, 1/3-1, and ½-¾, all gave control of black rot comparable with Fermate and Karbam. There was Phygon russeting of the fruit in all plots. Russeting was most intense in those vineyards where the material was applied when atmospheric humidity was high. In all but one plot the russeting was severe enough to be objectionable from a commercial standpoint. In that plot the Phygon-Fermate mixture of 1/3-1 was applied when the air was relatively dry.

To determine the safeness of using sulfur with the iron thiocarbamates for the control of downy mildew, small scale tests with microfine sulfur at ¼-, ½-, and 1 pound dosages (per 100 gallons) were made on Herbert and Concord varieties in midsummer. No injury was observed from two applications. Last year, however, some foliage injury occurred on Concord

vines sprayed with microfine sulfur at 1 pound to 100 gallons water during a period of high temperatures.

Bordeau of 6-8-100 formula was used in two vineyards. In the vineyard where a short schedule was followed, Bordeau was a little more effective than Fermate in the control of black rot. In the other vineyard both fungicides were used later into the season and in this vineyard the Fermate was the more effective.

In the vineyards where thorough black rot cleanup spray programs had been followed for several years, good control of black rot was obtained with a 2-spray program (before bloom and three weeks later) and excellent control with a 3-spray program (before bloom, after bloom and two weeks later). In a heavily infected vineyard without previous treatment, only the 5-spray program beginning with shoots 1½ inches long and extending to two weeks after bloom gave good control of black rot.

Wet weather late in the season in 1948 resulted in late development of fruit rot. Under these conditions a later spray (4 weeks after bloom) gave some additional control of black rot but it was doubtful if the additional control obtained was worth the cost. During the past five years a 5-spray program beginning when the grape shoots are ½ to 1½ inches long and extending to about two weeks after bloom has given excellent control of black rot. With such a program, extra sprays later in the season have given little if any additional control.

Due to dry weather during April, May, and early June, practically no scab developed, making it impossible to measure the effectiveness of the several new organic fungicides used in this year's tests. Also, no reliable information could be obtained on the scab eradication tests with the phenyl mercury fungicide, Puratized Agricultural Spray.

A promising new miticide, Neotran (di(4-4'-chlorophenoxy) methane) caused a rather intense spotted type of russeting of Golden Delicious apples and a less evident but objectionable spotting of Jonathans.

Continuing the work started in 1947, determinations were made of mercury residues at harvest time from the phenyl mercury fungicide, Puratized Agricultural Spray, applied at different times during the season. The efficacy of a washing treatment to remove the mercury also was determined. Puratized at 1 pint to 100 gallons of water in pre-bloom sprays left no detectable mercury as determined by the titration dithizone method. A calyx application with the fruit bagged to prevent removal of the mercury by rain until the calyx cups had closed, also showed no detectable residue at harvest time. Residues of mercury were present but very small, where 1st and 2nd cover sprays and 2nd and 3rd cover sprays were applied. Rainfall was heavy during the summer months of 1948 which may have reduced the mercury load from the later sprays to a lower level than would usually be the case. A wash solution of one per cent nitric acid and plus one-half per cent deter-

gent (Santomerse or Vatsol) reduced small mercury residues to zero readings. A hydrochloric acid-Vatsol wash was not very effective.

Physiology of Reproduction in Horticultural Plants (A. E. Murneek). The yields of greenhouse-grown tomatoes have been increased 37 per cent and field-grown tomato yields have been increased 15 per cent as a result of the new "Missouri method" of pruning tomatoes. This "new method of pruning" tomatoes has been adopted by growers of tomatoes both for greenhouse and outdoor culture.

A pruning method was devised by means of which additional foliage was provided for the plant. An auxilliary shoot was permitted to develop below each flower cluster, but was pinched back allowing two leaves to remain per stub.

While synthetic growth-substances usually increased the yield of tomatoes, the ultimate size of the crop was limited by two other factors: (1) The leaf area in relation to number of fruit set and (2) the amount of light received by the plant. Both of these factors determined to a large extent the quantity of "food" produced by the plant and available for growth of the fruit.

In treatment of plants with synthetic growth substances for the purpose of increasing fruit set and size, which has become a fairly common practice, close attention must be paid to the stage of flower development. Too early treatment reduced fruit yield while spraying at the right time increased it.

An extensive and detailed study has been completed to determine the best time for effective application of synthetic growth substances to greenhouse-grown tomatoes. The chemicals used were: (a) P-chlorophenoxyacetic acid, at a concentration of 10 parts per million (p.p.m.); Beta-naphthoxyacetic acid, 20 p.p.m. and Naphthaleneacetic acid, 20 p.p.m.

The above 3 chemicals, at given concentrations, reduced fruit set and development when the application was made as early as 8 days before anthesis. The majority of the tomatoes were small, seedless, and poorly shaped. When these synthetic substances, however, were applied at full bloom to 4 days after full bloom, the fruit set and size were strikingly increased. Similar effects were obtained from treatment of Concord variety of grape flowers.

Histological studies of tomato buds and flowers showed that an early flowerbud spray destroyed about 50 per cent of the pollen grains and that treatments as late as four days before anthesis resulted in abnormal pollen tube growth and retarded growth of the ovules.

The Speas Horticultural Farm, St. Joseph (H. G. Swartwout). In addition to the usual cultural operations, pruning and spraying, the Canadian side-graft method has been tried on a number of trees with about 85 per cent

success and good growth of the scions. It was observed that scions at least eight inches long gave a more desirable branched growth than short scions. The operation of side-grafting was somewhat slower than T-budding but is a useful method where buds of the preceding year have failed and to supplement budding.

Of buds inserted in July on Hibernal a larger per cent remained quiescent than on Virginia Crab. Buds were easier to force into growth the current budding year on the Virginia Crab. Quiescent buds in general forced about equally the following spring on moderately vigorous Virginia and on Hibernal. More of the buds were overgrown or "smothered" and could not be forced on very vigorously growing Virginia stock.

Nutrition of Fruit Plants (A. E. Murneek). An effort has been made to determine the moisture conserving and fertilizing value of straw, hay, and corn stover mulches for apple trees. Records of soil temperature changes throughout the year were obtained under sod and straw mulch, by means of thermographs.

Soil temperature records at a 6 to 10 inch depth, while showing the usual seasonal fluctuations, continued to be more or less consistently 10-12° F. lower in summer and that much higher in winter under mulch than in soil under sod culture. As mulches absorb rainwater much more effectively than sod does and prevent evaporation from soil surface, the moisture content of the surface soil under mulch was much higher, especially after a period of dry weather. Differences in moisture content of the sub-soil were not nearly as great, due undoubtedly to a continuous intake by roots and less fluctuation as a result of rainfalls.

Soil aggregation determinations on fall and spring samples showed a larger percentage of water stable aggregates above 0.25 mm. in diameter under mulch than sod culture. Total soil nitrogen was slightly lower at all levels in the sod than in mulched plots. Available phosphorus and replaceable potassium were considerably lower under sod in the surface 0-2 inch layer and slightly lower at other depths. Though showing the same general trend, these differences due to mulching were not nearly so great for replaceable calcium. The above differences in available soil nutrients showed quite clearly that mulches have a considerable fertilizing value for fruit trees.

The total nitrogen content of apple twigs obtained from trees from mulched plots was somewhat higher than for twigs from sod plots on November 6, but considerably higher on June 6, especially in the twig tips and in leaves. There were no marked differences in concentration of carbohydrates (sugars, starch, and hemicelluloses) in twigs, either from the spring or fall sampling, of the mulched or sod trees. This was to be expected since carbohydrate production was primarily the function of photosynthesis and was not directly related to soil nutrition.

Nutrition of Vegetables and Their Dietary Value as Influenced by Soil Treatments (R. A. Schroeder and V. N. Lambeth). It has been established that a nutrient-element balance was of more importance than total quantity of a nutrient accessible to the crop. The results to date showed that magnesium, just as previously determined for other nutrients, was of great importance in the growth, physiological development, and composition of kale. In the study of kale two levels each of nitrogen, phosphorus, potassium, and calcium were used. The magnesium was varied through four levels beginning with zero as one treatment.

Bibb lettuce using the colloidal clay-vermiculite substrate technique was grown in the greenhouse. Three levels each of nitrogen, phosphorus and potassium were used. The nitrogen was applied at different times as the crop was growing to determine the influence of such applications.

Yield records, as in previous experiments, demonstrated the importance of a balance of nutrients rather than the total quantity of any one or group of nutrients. The addition of nitrogen to a leafy crop such as lettuce can result in a decrease in growth under certain conditions of nutrient-element balance. This was somewhat contrary to some popular belief.

Carrots in Missouri frequently have a low sugar content. A study of the influence of nutrient-element balance upon sugar content of carrots has been started. Carrots have been grown at three levels each of nitrogen, potassium, and calcium. All possible combinations made a total of 27 treatments. There were visible differences in amount of top growth. The chemical determinations for sugar and other elements have not yet been made.

POULTRY HUSBANDRY

H. L. KEMPSTER, *Chairman*

Thermo-Stabilization of Shell Eggs (E. M. Funk, James Forward, and Martha Lorah). Due to the trouble experienced by a produce company using the process of thermo-stabilization for maintaining the quality of shell eggs which were shipped to Southern cities, extensive work was done this year on preventing stuck yolks and inedible eggs in thermo-stabilized eggs. An examination of the eggs candled out of carlots shipped South and returned to Chicago showed stuck yolks and some inedible eggs. Since this was contrary to experience at this Station, experiments were initiated to find out the cause of these troubles.

It previously had been found that after 6 months storage stuck yolks were more common in stabilized than in non-stabilized eggs. It also has been observed that as heating was increased the number of stuck yolks increased.

Since the incidence of such yolks was found to be high with late August and early September eggs which were often of low quality because of hot weather, it was deemed advisable to investigate the relationship of stuck

yolks to the quality of eggs when stabilized. The results showed that if the quality of shell eggs was lowered by exposure to heat the incidence of stuck yolks was greatly increased. Therefore, only high quality eggs should be stabilized.

It now is believed that the occurrence of stuck yolks in eggs was due at least in part to some low quality eggs (Table 13) being stabilized.

TABLE 13.--EFFECT OF QUALITY OF EGGS WHEN STABILIZED UPON THE OCCURRENCE OF STUCK YOLKS.
(Stabilized December 27, 1948, and held at 76° - 78°F.)

	Stuck Yolks Observed by Candling					Breaking
	No. Eggs	Jan. 3	Jan. 10	Jan 17	Jan. 24	Jan. 24
Lot 1 - Fresh Eggs (15 x 130°F.)	21	0	0	0	0	0
Lot 2 - Held 3 days at 80°F. before stabilizing (15 x 130°F.)	23	0	1	1	3	3
Lot 3 - Held 7 days at 80°F. before stabilizing (15 x 130°F.)	23	8	15	20	20	19
Lot 4 - No treatment	24	0	8	8	11	9
Lot 5 - 24-hr. old eggs stabilized (10 x 130°F.)	23	0	0	0	0	2
Lot 6 - Same as Lot 5 (15 x 130°F.)	23	0	0	0	2	2
Lot 7 - Same as Lot 5 (10 x 140°F.)	24	0	2	5	6	6
Lot 8 - Same as Lot 5* (10 x 145°F.)	24	1	1	1	1	1

· Eggs used in Lots 1, 2, and 3 were laid by old hens and those used in Lots 4 to 8 were laid by birds in their first laying year.
* Albumen coagulated.

In applying this process commercially some spoiled eggs were found after 6 to 8 months storage. Such loss was less than in eggs not stabilized, but there occurred an occasional spoiled egg in lots of stabilized eggs moving through the regular channels of trade. This has been quite disturbing to those using the process.

Preliminary tests have been made with a bacteria, *Serratia rosea*, which causes spoilage in shell eggs, but is not killed by thermo-stabilization. These tests were designed to determine the relation of the rate of cooling after stabilizing to the occurrence of spoiled eggs in shell eggs recently stabilized. These preliminary results showed that stabilized eggs cooled soon thereafter keep much better than those which remained warm for 24 to 48 hours after stabilizing. Thus, if stabilized eggs were cooled soon after processing occasional spoiled eggs were prevented. Much more work on this problem will be required both in the laboratory and in the commercial plants where the process is being used.

Again it was demonstrated that soiled eggs cannot be cleaned so they will keep well in storage without using enough heat to pasteurize them for most of the organisms that cause spoilage in storage.

Rations for Growing Chicks (Quinton B. Kinder, and Harvey Strothman). Due to the demand for rations suitable for broiler production rations were designed with low fiber and high energy content. Lowering the fiber content, chiefly through the omission of alfalfa leaf meal, necessitated the inclusion of crystalline riboflavin to supplement the needs for this vitamin. Apparently crystalline riboflavin fulfilled this need and the ration produced faster growth.

The present data are limited but the following indications have been noted:

1. Omitting alfalfa leaf meal and supplementing the ration with crystalline riboflavin increased the net energy value of the ration, reduced the fiber content, and resulted in more rapid and economical gains.
2. Fish meal apparently was superior and provided a factor or factors that resulted in more rapid and efficient growth.
3. Inclusion of protomone in rations with a high animal protein factor did not increase growth rate and apparently decreased growth rate on the all vegetable protein ration.

Effect of Washing Soiled Eggs on Hatchability (E. M. Funk and James F. Forward). Many hatching eggs become soiled and breeders and hatcherymen are confronted with cleaning such eggs or selling them on the market.

Soiled hatching eggs were washed without injury to hatchability and turning was not necessary unless the eggs were held longer than 10 days before selling.

All soiled eggs were washed by first soaking and then rubbing with a cloth in a .38 per cent 10% Quaternary Ammonium Compound Roccal solution which was held at room temperature which varied as follows: from January 2 to April 27 from 60° F. to 80° F. and from April 28 to August 3 from 64° F. to 92° F. All experimental eggs were stored at 55° F. for 1-14 days.

Before setting all eggs were dipped in .38% Roccal (10%) solution. Eggs were set at two-week intervals in a forced-draft incubator at a temperature of 99¾° F. and a wet bulb reading of 86° F. The eggs were turned six times daily.

During the 28-week period, January 21st to August 3rd, 6.3% of the 19,296 hatching eggs were classified as soiled. These 1215 eggs were cleaned by washing. The 18,081 clean, unwashed eggs hatched 69.9% of all eggs set as compared to 69.1% for the soiled and washed eggs. This small difference in hatch was not considered significant.

In the spring hatching period, January 21st to April 27, a total of 769 soiled hatching eggs were washed. Their average hatch was 71.3%. The 9332 clean, unwashed eggs set during this 14-week period hatched 71.8%.

There were 446 soiled hatching eggs washed and set from April 28th to August 3rd. These eggs hatched 65.5%. The 8749 clean, unwashed eggs set during this period hatched 67.8%. This difference in hatch was statistically significant; however, from a hatcheryman's viewpoint this difference was not so important. Though no unwashed soiled eggs were set in these tests, past experience has shown that eggs badly soiled hatch relatively few chicks.

Systems of Breeding for Performance in Poultry (G. E. Dickerson, H. L. Kempster, Q. B. Kinder, W. F. Krueger and Jack Hill). This is a new cooperative experiment of the Poultry and Animal Husbandry departments in cooperation with the Regional Poultry Breeding Project, including the United States Department of Agriculture and the state agricultural experiment stations of the North Central Region.

The experiment was essentially a comparison of different methods of breeding for performance characters in poultry: (1) Intra-flock selection with minimum inbreeding; and (2) Recurrent selection for maximum performance in cross combination of strains. During 1948-49, foundation stock was reared; breeding and laying houses were built; and chicks were hatched from the first year's matings.

The foundation stocks were raised during the summer of 1948 and the chicks were from 18 strains obtained as hatching eggs from other Experiment Stations and from Record of Performance breeders (7 Leghorn, 3 New Hampshire, 2 Rhode Island Red, and 6 White Plymouth Rock strains). In addition, breeding pens of 4 Leghorn and 3 Rhode Island Red strains were secured from the United States Department of Agriculture in the fall of 1948. These stocks supplemented families selected from the University of Missouri flocks (11 Leghorns, 5 Rhode Island Reds, 3 New Hampshires, 3 White Plymouth Rocks, and 1 Barred Plymouth Rocks).

Matings for the first hatching season (1949) were as follows: The intra-flock selection (Five Breeds) consisted of twenty mating pens of older birds selected on full laying year family and individual performance and part or full year progeny test and made up of about 160 breeding birds. A total of 40 mating pens of pullets also were selected on part year family and individual performance. These were mainly family crosses involving new families or inbred strains, and were selected to provide foundation stock for continued intra-flock selection (19 Leghorn, 9 Rhode Island Red, 6 New Hampshire, 6 White Plymouth Rock) totaling about 370 breeding birds.

From the 1949 matings, about 10,000 eggs were pedigree incubated, 5000 to 6000 chicks hatched, and 1500 to 2000 pullets housed. Provision has been made for records of fertility, hatchability (stage of mortality), feathering, color pattern, growth, mortality, conformation, carcass characters of males, egg production, and egg weight, shape, color, interior, and exterior quality.

Time of Hatching in Relation to Egg Production (H. L. Kempster). It was found that White Leghorns hatched in March and April proved to be slightly superior in egg production to those hatched in February. The pullets hatched in February laid an average of 179 eggs during the season while those hatched in March averaged 190 eggs and the April pullets, 204 eggs.

The best hatching date for Production-bred Rhode Island Reds proved to be February or the first half of March. The February Production-bred pullets averaged 213 eggs for the season while the March pullets averaged 198 and the April pullets averaged only 168 eggs.

For New Hampshires there was no significant difference in the egg production for those hatched during the various months. The chickens were hatched at weekly intervals from February 15 to April 19. The data confirmed previous work which showed that for fall and winter egg production under Missouri conditions the general purpose breeds, except possibly the New Hampshires, should be hatched in February or March and that Leghorns should be hatched in March or early April.

RURAL SOCIOLOGY

C. E. LIVELY, *Chairman*

Rural Community Trends (C. E. Lively and Lawrence Hepple). This study was made in Shelby County. Apparently the farmers of Shelby County preferred a county church to a village church, although they believed that the latter ultimately would supplant the former. Most farmers interviewed listen to church services by radio but they were not agreed upon the effect of radio upon the church. Most felt that the church should sponsor a recreational program. Farmers identified with the church believed that the minister should know something about agriculture, and that he should deal with current issues as well as with questions of theology.

The general trends in the rural church situation in Shelby County showed: (1) a decline in the number of churches since 1900; (2) a decline in church membership; (3) a decline in full-time church services and number of resident pastors; (4) a decline in number and variety of church activities; and an increased tendency for rural people to go to church irregularly, i.e., only when services were held in the country church. A relatively small proportion attended the village church which supposedly was supplanting the country church.

Other accompanying changes in rural organization found as a result of this study included: (1) more cooperation among farm organizations to promote better agriculture; (2) decline of fraternal orders; (3) tendency for organizations to rely on paid rather than lay leadership to keep organizations going; (4) steady increase in proportion of youth attending high school; (5) loss of social status of rural school teachers—they were found to be largely technicians who drive out from the villages to teach during the

day; and (6) increased support from, and dependence upon, the State for rural school maintenance.

The Rural Health Facilities of Missouri (Robert L. McNamara, C. E. Lively, Zetta Bankert, and J. B. Mitchell). The data collected in this investigation was collected in five counties. The survey covered illness and use of medical service. The evidence showed that there was significant variation in illness among the farm people in different sections of the State and it was clear that chronic illness was widespread among farmers.

In the five counties studied, 42 per cent of 1544 households had one or more members who had been ill 3 months or longer. It amounted to 51 per cent of the 6017 persons living in these households. Of the 904 chronically ill persons, 20 per cent were aged 65 or over, but 47 per cent were under 45. Two-fifths of the chronically ill were heads of households; an additional third consisted of the wives of the head of the household.

The nursing situation in Missouri was shown to be critical. Estimates showed that more than 3000 graduate nurses were needed in the State to service properly the hospitals at 80 per cent capacity. In addition the hospital construction program will provide new hospitals that will need to be manned by additional nurses. Although Missouri has shown an increase in number of graduate nurses in ratio to population, the demand still far exceeded the supply.

The following recommendations have been made as a result of this study and it is believed that an effort should be made to:

1. Coordinate and strengthen efforts to recruit both professional and non-professional student nurses.
2. Develop more facilities for training professional and non-professional nurses.
3. Safeguard and enrich educational and clinical content of training courses for professional and non-professional nurses.
4. Broaden the base of financial support by using scholarships and part-time employment for student nurses.
5. Improve the economic status of the nurse.
6. Establish an overall planning committee to consider priority of need of kinds of nurses, direct and plan research in connection with recruiting new students, and evaluate experiments and progress.

A complete study of nursing needs and resources in Missouri is found in Missouri Agricultural Experiment Station Research Bulletin 437, "Nursing Needs and Resources in Missouri."

Studies With Low Income Farmers (Herbert F. Lionberger and C. E. Lively). This study and analysis of interviews with 459 low-income farm operators living in four counties in Missouri showed that these farmers were encouraging their boys and girls to seek a higher education. Almost half

(46%) of the farmers interviewed thought farm boys should have a high school education, 30 per cent recommended a college education, and 8 per cent said a boy ought to have all the education he can get. Two-thirds of these families thought training in vocational agriculture made better farmers and nine out of ten said the same thing about 4-H club work.

These farmers' faith in education found practical expression in the attainments of their own children. About 55 per cent of the daughters aged 15 through 24 and out of school had completed 12 or more years of schooling. Another 22 per cent had completed 9 to 11 grades. In other words, 77 per cent of the daughters and 69 per cent of the sons out of school had completed more than the first 8 grades.

This showed that more low-income farmers were reached by newspapers than by any other means. Ninety-five per cent of the households subscribed to either a local or metropolitan newspaper, 70 per cent subscribed to farm journals which they considered useful as a source of farm and home information, but only 8 per cent made use of books. About 20 per cent got farm bulletins by request and about 28 per cent, some of whom were persons who also had requested bulletins, got them through the initiative of someone else. Slightly over three-fourths of the households had radios in operation and about 98 per cent of this number listened regularly to one or more radio stations over which farm and home information was broadcast.

It was found that reading and radio contacts were less affected by communicative barriers than personal contacts; also all three kinds of contacts were more affected by schooling completed by operator and by gross farm income, than by age of operator, tenure status, county, and factors indicative of physical isolation. This suggested the need for increased effort directed toward the education of youth who expect to farm.

Only 31 per cent of the operators interviewed were members of a farm organization and in only 37 per cent of the households did either the operator or his wife confer with a county agent during the survey year. Although one-sixth of them had met a vocational agriculture teacher, only 3 per cent conferred with them. Two out of three interviewed were church members and almost one-fifth of the operators were 65 years of age or older.

Three out of four farmers owned their farms and four out of five had radios and three out of five had telephones. Nineteen out of 20 said they liked to farm and three-fourths of them said they would choose farming again if they had the choice to make over.

Six out of 7 interviewed expressed a desire for more information on farming and about three-fifths of those desiring more information thought it could best be furnished through some branch of the College of Agriculture.

A complete summary of this study on low-income farmers has been reported in Missouri Research Bulletin 413, "Low Income Farmers of Missouri."

SOILS

W. A. ALBRECHT, *Chairman*

The Maintenance and Improvement of the Fertility Level of Missouri Soils (C. E. Marshall, C. M. Woodruff, D. D. Smith, W. A. Albrecht, D. A. Brown, E. R. Graham, W. G. Blue, V. L. Sheldon, A. W. Klemme, B. B. Konnur, and W. D. Keller). This work was centered on magnesium as a factor in the fertility level of Missouri soils. The following activities were directed toward this one particular element.

Soils were tested from various parts of the State to learn of the level of this element in exchangeable form, and this level in relation to that of other elements.

Plants were observed on various soils and subjected to tissue tests when they revealed symptoms suggesting magnesium deficiency.

Magnesium was applied on various soils out in the State to learn of possible responses to this treatment.

Plants grown with magnesium applied, and with none applied, were subjected to amino acid assay (microbiological) to learn of their utilization of nitrogen.

This element was observed, tested, and used in treatments on outlying fields, on farms by farmers, county agents, and others in order to multiply the evidence of symptoms and effects.

Some 18,000 soil samples have been tested. Southeastern and southwestern Missouri were shown to need magnesium. Plant and animal symptoms suggest some connection with magnesium deficiencies in the soil.

Phenomenal crop yields were obtained on corn, soybeans, and wheat on the plots which had received applications of lime and rock phosphate in the fall of 1947 applied 7 inches deep. Corn yields were 130 bushels per acre, soybeans 33 bushels per acre, and wheat 35 bushels per acre, whereas in the past six years corn yields had not exceeded 45 bushels per acre. Soybeans and wheat were grown for the first time in this study. The yields of corn and soybeans were the result of a combination of approximately 100 pounds per acre of each of the three fertilizer constituents plowed under ahead of each crop, and a season of adequate rainfall. There were no significant differences in yields as the result of the deeper placements of lime and rock phosphate.

The benefits of deep treatments, if any, should become apparent this next season. Alfalfa yields, where a moderate amount of lime (1 ton per acre) was incorporated in the subsoil, were 4.25 tons per acre contrasted with 3.5 tons per acre without deep liming.

These results showed that the claypan soils produced excellent yields when adequate fertility and moisture were present. The value of high levels of fertility in the deeper layers of soils during dry seasons remains to be determined.

During the year a total of 1152 soil samples were tested for exchangeable magnesium. These samples represented 220 different farm fields. The tabulated results showed: (a) that 7% of the farms tested were at a definitely deficient magnesium level regardless of the saturation of the colloid by ions other than magnesium; and (b) that 40% of the farms could easily be magnesium deficient, especially if the calcium and potassium levels were raised high enough for good legume production.

The region showing the highest level of exchangeable magnesium was the young soil area of northwest Missouri. The region showing the lowest level was the southwest part of the State. In the Ozark region magnesium was lower on improved farm acres.

Soil samples from vegetable gardens which have been treated with manure and mixed fertilizer almost always showed low level of exchangeable magnesium.

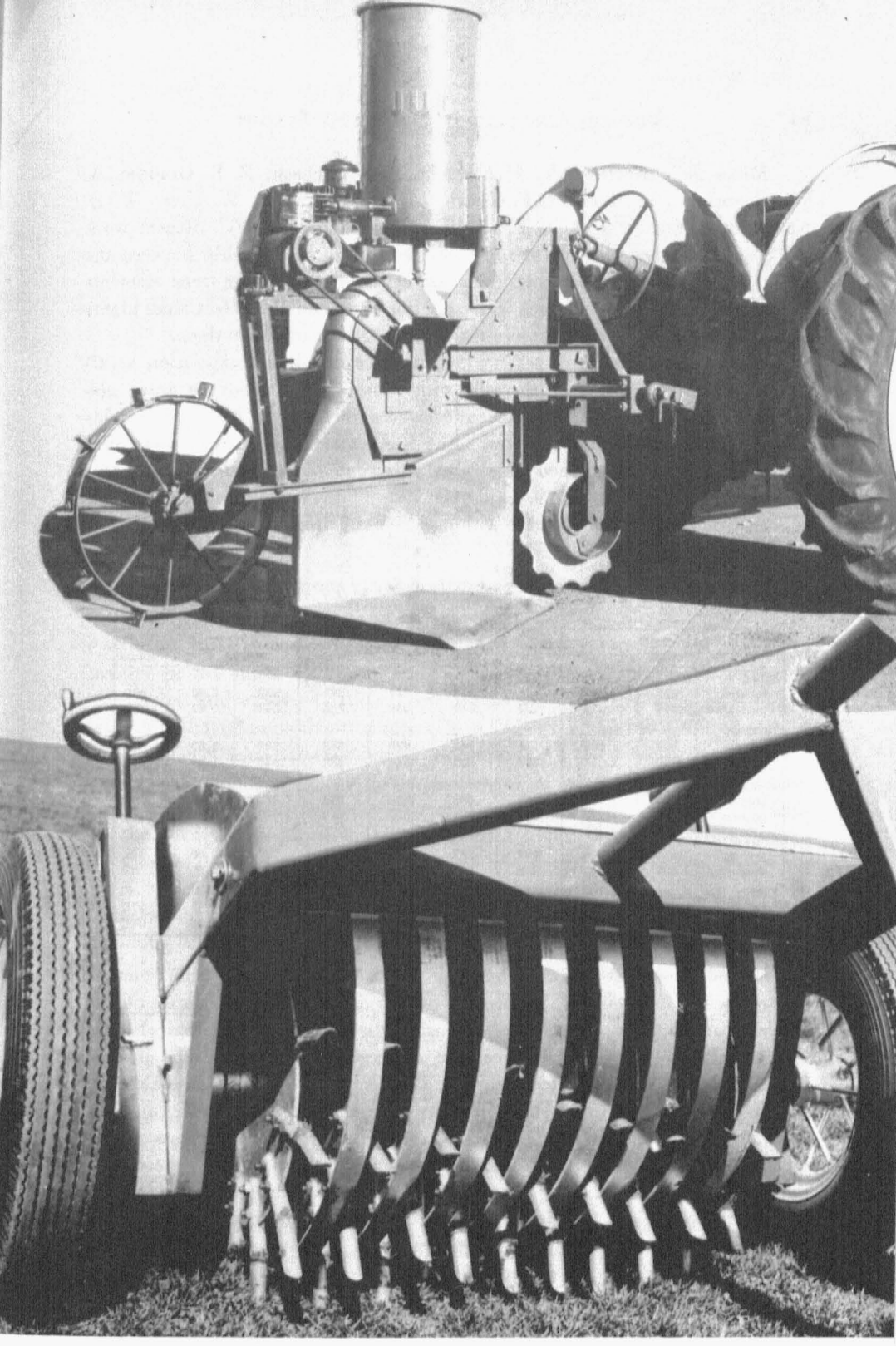
Since Missouri has extensive deposits of dolomitic limestone, there should be no serious difficulty in correcting the magnesium deficiencies in her soil.

Testing Soils (E. R. Graham, A. W. Klemme, and O. T. Coleman). Chemical tests for estimating the level of plant nutrients in our soils have increased in use extensively. Considerable progress has been made in developing methods that are analytically possible, rapid, and accurate enough for practical purposes. Progress has been made in correlating the test with crop responses and plant food requirements.

A total of 51 organized county groups have developed testing laboratories for their own use. The Department of Soils furnishes these laboratories with standards and supervision. An improved test for calcium has been added during the past year. The results are checked for the entire State at the Soils department laboratory and tests are conducted on manganese, cobalt, and copper. Some 30,000 samples were run for the major elements and approximately 1500 have been tested for minor elements. Of the minor element tests to date, magnesium appeared to be the one major deficient item.

A rather extensive program for checking crop responses against soil tests has been carried out with county extension agents, vocational agriculture teachers, commercial concerns, and farmers. Both yields and tissue tests on plants grown on the various plots have been observed and recorded. An excellent correlation has been found between the tests and the crop responses to potash, calcium, magnesium, and phosphorus. In approximately all cases the response to nitrogen has been in accord with the soil test for organic matter and cropping history.

This program is based on the philosophy that all farmers can understand soil fertility levels and can learn to diagnose, then to act according to his own understanding rather than relying on the Experiment Station to write a prescription for his soils.



Two special implements of recent design used in deep application of fertilizer.

Minor Soil Elements (W. A. Albrecht, E. O. McLean, E. R. Graham, A. W. Klemme, C. E. Marshall, F. Koehler, B. B. Konnur, A. W. Uren, W. D. Keller, R. L. Fox, E. Pickett, V. L. Sheldon, and W. G. Blue). Recent work has been directed toward minor soil elements and the relationship between the amount of some of the elements which are considered minor or trace elements in the soil, in the plants which grow on this soil, and the effect that plants grown on this soil may have upon the animals which consume them.

Studies have been made testing the influence on plant composition as affected by the treatments of the soil with some of the minor or trace elements. Protein production has been measured in terms of the amino acids rather than merely as total nitrogen. The less common but distinctly essential amino acids were determined in alfalfa grown on soils treated with boron, copper, zinc and cobalt. Amino acid assays have been made on soybean grown as forage on soils treated separate with manganese, boron, iron, sulfur and zinc.

TABLE 14.--AMINO ACID CONTENT OF LESPEDEZA HAY ACCORDING TO DIFFERENT SOIL TYPES AND TREATMENTS.
(Per Cent Dry Weight)

Soil type and treatment	Valine	Leucine	Argi-nine	Histi-dine	Threo-nine	Trypto-phane	Lycine	Isoleu-cine	Meth-ionine
Eldon									
treated	.895	1.055	.646	.375	.632	.294	.992	2.08	.092
untreated	.917	.978	.429	.343	.569	.205	.943	1.67	.086
Lintonia									
treated	.922	1.038	.451	.342	.625	.279	.872	1.63	.077
untreated	.780	1.014	.329	.306	.544	.181	.878	1.68	.077
Putnam									
treated	1.023	1.280	.716	.362	.639	.244	.894	1.89	.084
untreated	.986	1.289	.563	.503	.606	.227	1.007	2.26	.080
Grundy									
treated	1.010	1.174	.627	.367	.690	.196	.797	2.00	.079
untreated	1.137	1.460	.456	.381	.671	.195	.938	2.00	.082
Clarksville									
treated	.853	1.025	.340	.389	.585	.258	.930	1.59	.076
untreated	.941	1.199	.367	.356	.557	.215	.870	1.38	.074

Lespedeza was grown at 5 outlying locations representing the 5 major soil regions of Missouri. The protein quality of this crop in terms of the different amino acids was assayed by using the newer microbiological techniques. The diversity in the percentage of these constituents of the protein molecule of the plant as affected by the different soils is shown in Table 14.

In order to determine what fertility elements might be the cause of these diversities, alfalfa was grown on a single soil given treatments of the separate trace elements, manganese and boron, and a mixture of these with some others, as supplements to the common fertilizer elements calcium, phosphorus, and potassium. Wide diversity in the amino acid array in the protein could scarcely be expected when relatively small amounts of these trace elements were applied to the surface of the soil, yet the quality of the alfalfa protein in terms of its constituent amino acids was modified by these soil

TABLE 15.--AMINO ACID CONTENT OF ALFALFA HAY ACCORDING TO SOIL TREATMENTS WITH TRACE ELEMENTS.
(Percentage of Dry Leaves)

Plot No.	Treatment	Valine	Leucine	Argi-nine	Histi-dine	Threo-nine	Trypto-phane	Lycine	Isoleu-cine	Meth-ionine
1	Calcium	2.19	4.37	0.380	0.654	0.862	0.546	1.57	2.64	0.100
2	Calcium and Manganese	2.40	4.89	0.434	0.807	0.954	0.640	2.12	3.63	0.242
3	Calcium and Boron	2.13	5.55	0.418	0.726	1.071	0.856	2.13	4.09	0.173
4	Calcium and Mixture*	2.59	5.24	0.415	0.835	1.014	0.670	1.87	3.44	0.229

* Mixture of cobalt, copper, zinc, manganese, and boron.

treatments, as shown in Table 15. While a marked diversity manifested itself in the case of each amino acid, the methionine content varied most widely of all the amino acids measured in this study. Seemingly these results substantiated the hypothesis that these two trace elements namely, manganese and boron, functioned in the conversion of the carbohydrate into protein.

The data illustrated the wide variations in concentrations of these amino acids because of: (a) differences in the crops; and (b) differences in the fertility of the soils.

Barley and alfalfa fertilized with minor elements and used as feed for dairy cows have been submitted to amino assay in the hope of connecting these soil treatments with possible animal ailments.

In order to learn of the decomposition of minerals containing trace elements, weathering studies were carried out to determine the action of acid clay on manganiferous minerals. Collodial acid-clay was active in weathering some of the manganiferous minerals while it had little, if any, effect on others. Wherever manganese was combined as a carbonate in the mineral it weathered rapidly. Manganese combined as an ovide weathered slowly. The data suggested that the carbonate forms of low grade manganese ore might be more useful than the sulfate forms in mixed fertilizer.

Experiments in Crop Rotations and Fertilizers on Sanborn Field (W. A. Albrecht, E. R. Graham, A. W. Klemme, C. M. Woodruff, and John Falloon). The data emphasized the fact that mere crop rotation had little or no value in bringing yield differences after this long period of cropping. Wheat in a six year rotation with soil treatments was little different from continuous wheat with soil treatments. On soils without treatments the rotation yield while much below economic limits of production was above that under continuous cropping to wheat. During the past year where wheat has been continuous the yield on the no soil treatment plots was 5.3 bushels per acre, while the yield on the six year rotation and no soil treatment plots was 8.8 bushels per acre. This compares with 30.3 bushels per acre on the continuous wheat with soil treatment plots and 29.3 bushels per acre on the six year rotation and soil treatment plots.

The Investigation of Nitrogen Fixation and of the Nitrogen and Carbon Behaviors Under Different Soil Treatments (W. A. Albrecht, E. R. Graham, A. W. Klemme, C. M. Woodruff, W. G. Blue, V. L. Sheldon, and N. C. Smith). The general idea of measuring the carbon and nitrogen ratio has not shown itself sufficiently refined to tell much about variation in the chemical composition of either a legume or non-legume in relation to the soil treatment. The carbon, as percentage of the plant, varied little. The nitrogen varied considerably both with respect to variety of the plant and to soil treatments. When put into a carbon:nitrogen ratio these differences were reduced. As a consequence it has been deemed necessary to study not only variation in percentage of nitrogen in the forage, but to study the percentage of nitrogen as distributed in its different amino acids. Microbiological assays of different legumes and non-legumes have been made determining the different amounts of amino acids in them as related to certain elements exchangeable in the soil. Alfalfa from the South Farms and South Missouri forages from outlying fields, and others under special treatment have been assayed.

The protein quality of alfalfa was influenced by soil treatments of 100 lbs. per acre of magnesium sulfate. The following data show the results of two cuttings from a South Missouri field.

Milligrams of Amino Acid Per Gram of Dry Alfalfa Forage

Cutting 6/12/48

	% N	Valine	Methionine	Histidine	Threonine	Isoleucine	Leucine	Lysine
No. mg.	3.42	17.2	3.1	6.2	13.2	33.1	14.8	23.5
Mg.	3.60	19.9	3.4	7.0	13.3	32.5	11.6	25.2

Cutting 7/31/48

	% N	Valine	Methionine	Histidine	Threonine	Isoleucine	Leucine	Lysine
No. mg.	3.59	17.7	3.2	5.7	11.0	25.2	13.4	21.1
Mg.	3.70	18.2	3.6	6.9	13.5	39.4	18.1	21.8

The carbon-nitrogen ratio in and under bluegrass on the campus lawn was studied in connection with the "fairy rings" or dark green circles shown associated with growth of the mushroom *Marasmius oreades*. The grass in the green ring contained a higher content of each of the seven amino acids for which it was tested in contrast to the grass inside of the ring. It was suggested that as the mycelia of the mushroom advanced through the soil to take out some of the organic or carbon-aceous compounds to build the mushroom, the nitrogen and possibly other nutrient elements were released in forms more available to the grass to make it grow larger and greener.

The following data showed the differences in amino acids in the bluegrass in and within the "fairy ring" of the mushroom *Marasmius oreades.*

	Milligrams Per Gram Oven Dry Material						
	Valine	Methionine	Histidine	Threonine	Isoleucine	Leucine	Lysine
In the green ring	19.8	4.7	6.5	16.4	36.2	22.4	28.3
Outside the ring	14.7	4.2	6.0	12.0	31.9	18.8	26.0

The Characteristics and Development of Heavy Clays in the Soils of Missouri (C. E. Marshall, E. O. McLean, S. A. Barber, B. Chatterjee, A. H. Beavers, and Yi Hseung). The mutual effects of mono- and divalent cations in their ionization from clays have been investigated. Potassium-calcium studies have been made on montmorillionite, beidellite, illite, and kaolinite and similarly the potassium-magnesium combination has been followed.

A plant nutrition experiment was concluded in which soybeans received calcium and potassium in varying proportions from two alternative media: one a true solution of the bicarbonates; the other a collodial clay culture giving the same calcium and potassium activities. Somewhat better growth was found in the clay cultures but the plant compositions were closely similar in the two series. This experiment will be repeated with a somewhat wider range of potassium and calcium activities.

The different clay minerals showed considerable differences when mixed cationic systems were measured. Whereas in montmorillonite potassium greatly depressed the calcium activity, in the case of beidellite, illite, and kaolinite the converse was true over part of the range. Hence, highly detailed studies of clay minerals and of soil organic matter will be needed in order to interpret the behavior of soils with respect to the furnishing of calcium and potassium to growing plants.

It has been shown that magnesium determinations can be made more accurately than seemed possible from the results previously obtained. Monovalent cations are accurately determined down to 10^{4} molar and divalent cations down to 10^{5} molar.

A detailed study of a loessial soil underlain by gumbotil and by glacial till was made. Mechanical analyses have been combined with detailed mineralogical studies of the sand and silt fractions in order to show relationships between the three materials. In particular evidence on the origin and mode of formation of the gumbotil has been sought. This study indicated that the gumbotil was a separate, water-laid deposit and was not simply highly weathered till.

The cataphoresis of clay minerals in presence and in absence of polyvalent cations (especially thorium) has been studied. The different clay minerals showed large differences in their behavior towards thorium chloride

solutions, so that methods of separation of the different species appeared feasible.

Soil Survey and Land Classification (H. H. Krusekopf, M. E. Springer, J. A. Frieze, and C. L. Schrivner). The purpose of the soil survey is the systematic classification of the soils of Missouri. An additional purpose is to interpret the features of the various soils in their relation to the productivity and use of the land. The soils of approximately one-half of the State's area have been classified.

Soil surveys are now made with a degree of refinement never before attempted. This has retarded the rate of work. Greater detail is required because of the attempt at more exact use of fertilizers and increasing refinement in land use practices. Both balanced farm planning and vocational guidance teaching have been handicapped by lack of adequate soil surveys and soils information. The true relation between the productivity of the land and planned land improvement is most apparent if a soil classification is available.

VETERINARY SCIENCE

A. J. DURANT, *Chairman*

Investigations of the Pathology and Comparative Damage Done by Stomach, Nodular, and Tapeworms in Sheep (Cecil Elder, D. E. Rodabaugh, and O. S. Crisler). A specially constructed plot was used for a study of the effects of winter weather in Missouri on sheep parasites on a pasture that was heavily contaminated. This plot was made rabbit tight and no sheep were allowed on it from late fall until grass appeared in the spring. Thus the plot was heavily infested with parasites when the sheep were taken off in the fall. Parasite free lambs were placed in the lot in the spring of 1948 and were killed and autopsied in June of that same year. Very few parasites were found and the indications were that only three species of parasites had survived the winter and these were present in very small numbers. This preliminary report shows that these three were *Haemonchus contortus*, *Ostertagia*, and *Nematodirus*.

It appeared that the winters of Missouri have a very detrimental effect upon pasture contamination providing the pastures were left idle and contamination did not reoccur during the winter.

Research was continued on the phenothiazine-salt mixture. The sheep on the phenothiazine-salt mixture had very low egg counts and the animals from these pastures that were killed and autopsied showed comparatively few parasites, proving the efficiency of this mixture, when made up of one part of phenothiazine to ten parts of salt and kept before the sheep continuously. This has been found a very satisfactory method of controlling internal parasites but previous work proved that the sheep should be reasonably free from parasites before being put on this mixture.

This pig which a post-mortem showed had cholera was one of the 2105 cases treated or examined during the year. Approximately one-half of the animals were examined by post-mortem.

A comparison of the phenothiazine-salt mixture consumption to that of whole salt consumption showed that the sheep in pasture No. 1 receiving the phenothiazine-salt mixture consumed an average of 0.125 ounces per head daily. Pastures No. 2 and 3, receiving salt alone, had an average daily consumption per head of 0.195 ounces and 0.194 ounces respectively. Pasture No. 4 receiving the phenothiazine-salt mixture consumed an average each day of 0.165 ounces per head. This indicated that the amount of salt consumed when it contained phenothiazine was slightly less than the consumption of salt alone. It did not appear that the reduction in salt consumption was great enough to be serious and therefore would tend to offset any complaint that the phenothiazine was objectionable to the sheep.

Data from this experiment indicated that it would be highly desirable to give sheep a single dose treatment immediately prior to placing them in clean pasture.

Tube Agglutination Blood Testing for Pullorum Disease in Chickens and Turkeys (H. C. McDougle). During this fiscal period 34,913 tests were made on chickens and turkeys for the detection of carriers of pullorum disease. This was an increase of 4678 over last year's blood testing report. The demand for tube agglutination blood testing continues, especially in flocks where difficulty is experienced in eradicating the disease by use of the rapid whole blood test.

Tests for Newcastle in Chickens (H. C. McDougle). During this fiscal period 241 blood tests for Newcastle disease were made. Of this number, 64 flocks were found to be infected and 137 were healthy, giving a total of 201 flocks examined.

Blood Studies in Bang's Disease (Cecil Elder and D. E. Rodabaugh). There has been considerable question regarding the effect of hemorrhagic septicemia serum upon the blood titre of Bang's disease, some thinking this probably caused an increase in the titre of the cattle. Three lots of anti-hemorrhagic septicemia serum were purchased from biological firms dealing in veterinary products. These serums were tested for the presence of brucella agglutinins and all were found to be negative to the blood test. Six head of cattle were selected and started on a 10-day bleeding series, being tested every day. On the first three days all six cows were found to be either negative or had only a very low titre. Each lot of serum was administered intravenously to each of two cows on the third day, each animal receiving a total of approximately 250 c. c. of serum. Following the injection, each cow was bled daily for the next seven days and tested for the presence of brucella agglutinins.

There was no change in blood titre, indicating the injected serum had not introduced any agglutinins which would change the reaction to the brucella antigen used. Neither had it stimulated the production of any agglutinins.

The six head of cattle experimentally injected with hemorrhagic septicemia serum still showed no change in blood titre at the end of another week and again at the end of a month. Therefore, it appeared that hemorrhagic septicemia serum did not produce reactions in cattle nor did it increase titres already present. These tests were made only on animals with a very low titre or on negative cattle.

Also, high reacting cattle were studied to determine if agglutinins from their blood could be transmitted to negative cattle in numbers sufficient to show definite reaction to the agglutination test. This was deemed advisable and important because of the possibility of producing blood titres as a result of blood transfusions which are often made by veterinarians. In an effort to produce a blood of sufficiently high titre, a cow was injected with strain 19 vaccine at weekly intervals for a period of three weeks. Following the last injection her titre had reached a maximum of 1 to 5120. At

this stage 600 c. c. of her blood were removed, oxalated, and prepared for injection, into two negative animals. Each of the two animals received approximately 250 c. c. of whole oxalated blood intravenously. Blood drawn from these animals 30 minutes after injection showed a slight agglutinin titre, whereas the same animals had been completely negative prior to injection. This titre remained for the balance of the 10-day period but had disappeared after another two weeks had elapsed. This reaction was entirely passive, as was proven by the fact the titre disappeared in a matter of from 14 to 24 days. In the field one would expect to find such a titre only in cases of recent transfusions and then only when they were made from cows carrying a high blood titre.

This may explain the reason some titres have been found in otherwise negative herds or in cows which previously had been negative and, so far as it is known, had not been exposed to infection.

Plans have been made to study the effect of trace minerals in the reduction of titres. Many reports have been made regarding cures or apparent cures for brucellosis based on the decrease or loss of blood titres, but this Station has been unable to increase the titre with any product used other than the passive injection of agglutinins from high reacting cattle.

It is reported in the literature that it has been possible to differentiate between a natural infection titre and a vaccinal titre. This was reportedly accomplished by injecting the animals in question with strain 19 vaccine, differentiation being made on the basis of the subsequent rise in titre. It has been claimed animals with natural infection do not show the same increase in titre as animals showing titre as a result of vaccination alone. The evidence at hand does not seem to be conclusive and an attempt has been made to make a differentiation, if possible.

Two vaccinated heifers and two naturally infected cows were used. Strain 19 was administered intramuscularly. This injection provoked a marked increase in the blood titre of the vaccinated heifers, raising the titre from approximately 1 to 100 to a dilution of 1 to 1600 in one heifer and 1 to 800 in the other. One of the naturally infected cows did not show any increase in titre. The other was not injected because, at the time, she began to show evidences of an ascending titre. At a later date two more infected cows with very low titres, ranging from a positive in a 1 to 20 dilution to an incomplete in 1 to 40 were studied. Following the injection of 5 c. c. of strain 19 vaccine intramuscularly, one of these two animals showed a very pronounced increase in titre, becoming complete in dilution of 1 to 1600. The other one showed a slight but a very definite increase, changing from an incomplete reaction in two tubes to an incomplete reaction in four tubes by the dilution method.

Plans have been made for further work along this line.

Bang's Disease Vaccination Experiment (Cecil Elder, D. E. Rodabaugh, and James E. Comfort). This project is an effort to determine a quick and satisfactory method of controlling Bang's disease infection in a beef cattle herd and is being conducted in cooperation with the Department of Animal Husbandry. The herd available for experimental study was composed of purebred cattle in which there was a high rate of infection, accompanied by high abortion rates. An attempt has been made to demonstrate the practicability of a blood testing program plus the use of calfhood vaccination on calves between the ages of 4 and 8 months as a method of quickly eliminating infection from the herd.

Summary of Findings, April 1, 1948 to March 1, 1949

Total number of cattle on experiment	142
Total number of Bang's agglutination tests	453
Total number calves vaccinated with Strain 19	20
Total number of adult cows in negative herd	38
Delivering normal calves	20
Having no calves during period	12
Becoming reactors during period	5
Aborting during period covered by report	2
Sold because of breeding difficulties	2
Sold for other reasons	2
Total number adult cows in reactor herd	55
Delivering normal calves	19
Having no calves during period	12
Aborting during period	9
Delivering premature calves	4
Sold because of breeding difficulties	6
Sold for other reasons	5
Total number vaccinated heifers on experiment	43
Returning to negative status following vaccination	24
Average number months required to return to negative	6.3
Remaining reactors after 18 months of age	5
Those under 18 months still reacting to vaccine	12
Number sold—records not available	2
Delivering normal calves	4
Abortions*	1
Sold because of breeding difficulties	1
Sold for breeding purposes	4
Sold for other reasons	3
Heifers not vaccinated because of infection titre	2

*Heifer was negative at time of abortion

Newcastle Disease Investigation (A. J. Durant and H. C. McDougle). Investigations on Newcastle disease in Missouri have been continued on epidemiology by means of field investigations and subsequent testing of blood samples from suspected flocks. These investigations indicated that Newcastle disease continued to be widespread in Missouri.

Thirty-two counties gave hemaglutination inhibition tests, indicating the presence of the disease. Eighteen counties showed no indication of the disease. Samples from fifty counties were examined. Sixty-four flocks were found infected and 137 were not infected, giving a total of 201 flocks examined. Virus was isolated in none of the counties.

Agglutination Blood Testing for Bang's Abortion Disease of Cattle and Swine (D. E. Rodabaugh and Cecil Elder). During this fiscal period a total of 596 tests were made by the tube agglutination method for Bang's disease in cattle. In addition to the Bang's disease tests, 50 tests for mastitis were conducted in the laboratory, as well as 30 fecal examinations for parasites of farm animals.

Diagnostic Service on Diseases of Animals and Poultry (A. J. Durant, Cecil Elder, H. C. McDougle, O. S. Crisler, A. A. Case, and D. E. Rodabaugh). During this fiscal period a total of 2105 cases were treated or examined. Of this total, approximately one-half of the animals were examined or treated and the other half examined by post-morten.

Rabies Diagnostic Service (H. H. Berrier and Cecil Elder). During this fiscal period 78 animal heads were examined for rabies. Of this number 40% were found to be infected with the disease.

PUBLICATIONS

A. A. JEFFREY, *Editor*

The University of Missouri Agricultural Experiment Station issued 91 publications during the year ending June 30, 1949, including 27 research bulletins, 37 popular bulletins, and 27 circulars. The total number of copies of publications printed during the year was 449,500.

In addition, the *Missouri Farm News Service* and the *Announcer* were published in cooperation with the Extension Service. The *Farm News Service* was printed weekly and mailed to newspapers, farm papers, county agents, vocational agricultural instructors and other farm leaders. It had a circulation of 1700 a week. The *Announcer* was sent monthly to farmers and others requesting it. It reached a circulation of about 25,000.

Research Bulletins

No. Title, Series, Author, and Number of Pages and Copies.

417 The Thyroid Secretion Rate in the Mouse and Its Relation to Various Physiological Processes, by Victor Hurst and C. W. Turner, May, 1948, 62 pages, 3000 copies.

418 The Experimental Development of the Mammary Gland with Special Reference to the Interaction of the Pituitary and Ovarian Hormones, by J. J. Trentin and C. W. Turner, May, 1948, 48 pages, 2500 copies.

419 Growth and Development LXIII Electrocardiograms of Mules, Horses, Cattle, Sheep, Swine and Goats, by Platner, H. H. Kibler, S. Brody, July, 1948, 12 pages, 2500 copies.

420 Purchasing Power of Missouri Farm Products, by R. L. Kohls, July, 1948, 33 pages, 2500 copies.

421 Economic Facts on the Hog Industry of Missouri, by R. L. Kohls, July, 1948, 48 pages, 7500 copies.

422 The Retention of Goitrogens in the Blood and Tissues of Several Domestic Animals, by Pipes and Turner, July, 1948, 36 pages, 2500 copies.

423 Environmental Physiology with Special Reference to Domestic Animals L. Physiological Backgrounds, by Samuel Brody, August, 1948, 44 pages, 2500 copies.

424 Growth and Development with Special Reference to Domestic Animals LXV. Heat Production and Cardiorespiratory Activities During Gestation and Lactation in Holstein Cattle, by Samuel Brody, D. M. Worstell, A. C. Ragsdale and H. H. Kibler, August, 1948, 16 pages, 2500 copies.

425 Environmental Physiology with Special Reference to Domestic Animals II. Influence of Temperature, 50° to 105° F., on Milk Production and Feed Consumption in Dairy Cattle, by A. C. Ragsdale, Samuel Brody, H. J. Thompson, and D. M. Worstell, November, 1948, 28 pages, 2500 copies.

426 Experiments in Cleaning Soiled Eggs for Storage, by E. M. Funk, December, 1948, 36 pages, 2500 copies.

427 Relation of Endocrine Gland Weight to Body Weight in Growing and Mature Female Dairy Goats, by A. B. Schultze and C. W. Turner, November, 1948, 24 pages, 2500 copies.

428 The Rural Population Resources of Missouri, by C. E. Lively and Margaret L. Bright November, 1948, 44 pages, 2500 copies.

429 A Hemorrhagic Factor in Moldy Lespedeza Hay, by M. E. Muhrer and R. F. Gentry, December, 1948, 12 pages, 2500 copies.

430 Inheritance of Earliness in Crosses Between Early Premium and Kawvale Varieties of Common Wheat, by J. M. Poehlman, January, 1929, 24 pages. 2500 copies.

431 Forecasting the Price of Corn on the Basis of Current Crop Reports, by Erwin T. Hadorn, February, 1949, 32 pages, 2500 copies.

432 Vitamin Deficiencies in Rations of Natural Feedstuffs, by Hubert Heitman, Jr., and A. G. Hogan, February, 1949, 16 pages, 2500 copies.

433 Environmental Physiology with Special Reference to Domestic Animals III. Influence of Ambient Temperature, 50° to 100° F., on the Blood Composition of Jersey and Holstein Cows, by Brody, February, 1949, 40 pages, 2500 copies.

434 The Effects of Plant Growth Regulating Substances on Flower Bud Development and Fruit Set, by D. D. Hemphill, February, 1949, 56 pages, 2500 copies.

435 Environmental Physiology, IV Influence of Temperature 50° to 105° F., on Heat Production and Cardiorespiratory Activities in Dairy Cattle, by H. H. Kibler, Samuel Brody and D. M. Worstell, May, 1949, 36 pages, 2500 copies.

436 Environmental Physiology V. Influence of Temperature, 50° to 105° F., on Water Consumption in Dairy Cattle, by H. J. Thompson, D. M. Worstell and Samuel Brody, May, 1949, 20 pages, 2500 copies.

437 Nursing Needs and Resources in Missouri, by Jennette Gruener, March, 1949, 68 pages, 2500 copies.

438 Growth and Development With Special Reference to Domestic Animals LXVI. Resting and Basal Metabolism and Cardiorespiratory Activities in Growing Mules, by Hudson H. Kibler and Samuel Brody, April, 1949, 24 pages, 2500 copies.

439 Selective Service Rejectees in Rural Missouri, 1940-1943, by Lawrence M. Hepple, May, 1949, 20 pages, 3000 copies.

440 Storage of Frozen Meats, Poultry, Eggs, Fruits and Vegetables, by D. E. Brady, G. V. Hoover and L. N. Tucker, May, 1949, 72 pages, 2500 copies.

441 Low-Income Farmers in Missouri Their Contacts with Potential Sources of Farm and Home Information, by Herbert F. Lionberger, May, 1949, 36 pages, 2500 copies.

Reprints

314 Comparative Accuracy and Efficiency in Determination of Carbohydrates in Plant Material, by Heinze and Murneek, July, 1948, 24 pages, 2500 copies.

268 Biochemical Studies of Photo-periodism in Plants, by A. E. Murneek, April, 1948, 84 pages, 2500 copies.

Bulletins

515 Transferring the Farm to the Next Generation, by O. R. Johnson, July, 1948, 38 pages, 1000 copies.

516 Fertilizer Inspection and Analysis; Fall 1947, by Trowbridge, L'Hote, Breuer, July, 1948, 40 pages, 6500 copies.

517 The Multiflora Rose as A Living Hedge Fence, by T. J. Talbert and J. E. Smith, Jr., August, 1948, 11 pages, 1000 copies.

518 Cropping Systems for Soil Conservation, by Dwight D. Smith, Darnell M. Whitt and Merritt F. Miller, September, 1948, 28 pages, 1000 copies.

519 Use of Commercial Plant Foods on Missouri Farms, by Longwell, Klemme, L'Hote, Breuer, October, 1948, 20 pages, 1000 copies.

520 Agricultural Research in Missouri, by E. A. Trowbridge and J. E. Crosby, Jr., (Ovid U. Bay) December, 1948, 48 pages, 2500 copies.

521 The S-100 Soybean, by C. V. Feaster, January, 1949, 8 pages, 1000 copies.

522 Evaluating Annual Changes in Soil Productivity, by A. W. Klemme and O. T. Coleman, January, 1949, 32 pages, 8000 copies.

523 The Growth of Dairy Heifers Raised Chiefly on Roughages, by O. T. Stallcup, H. A. Herman, and A. C. Ragsdale, March, 1949, 12 pages, 1000 copies.

524 Research for the Farmer, by E. A. Trowbridge, J. E. Crosby, Jr., and Ovid U. Bay, April, 1949, 56 pages, 2000 copies.

Reprints

406 Grasshopper Outbreaks in Missouri, by Jones, June, 1949, 32 pages, 5000 copies.

499 The Missouri Soil Saving Dam, by Wooley and Beasley, July, 1948, 24 pages, 10,000 copies.

314 Yearling Heifers and Steers for Beef Production, by Trowbridge and Moffett, August, 1948, 24 pages, 5000 copies.

454 Nut Tree Culture in Missouri, by T. J. Talbert, August, 1948, 32 pages, 10,000 copies.

375 Dairy Goats in Missouri, by Turner, Ragsdale, and Garrison, October, 1948, 24 pages, 6000 copies.

401 Operating Expenses of Cooperative Exchanges and Elevators, by Haag, February, 1949, 48 pages, 4000 copies.

461 Some Factors Influencing Efficient Production of Sows, by Weaver and Bogart, January, 1949, 16 pages, 10,000 copies.

492 Alfalfa in Missouri, by Etheridge and Helm, March, 1949, 16 pages, 10,000 copies.

507 Terracing for Erosion Control, by Clark and Wooley, March, 1949, 48 pages, 10,000 copies.

376 Rations for Weanling Pigs, by Weaver, March 1949, 8 pages, 8000 copies.

509 Peach Culture in Missouri, by Talbert, April, 1949, 36 pages, 10,000 copies.

412 Pregnancy Disease of Sheep, by Elder and Uren, May, 1949, 16 pages, 8000 copies.

330 The Feeding of Livestock, by Hogan, May, 1949, 44 pages, 6000 copies.

337 Raising the Dairy Calf, by Herman, May, 1949, 28 pages, 10,000 copies.

264 The Soils of Missouri, Miller and Krusekopf, May, 1949, 113 pages 2000 copies.

247 Pastures for Hogs, by Weaver, June, 1949, 40 pages 10,000 copies.

Circulars

330 Let's Look at the Soil, by M. F. Miller, July, 1948, 48 pages, 10,000 copies.
331 Plant Late for Fall Vegetables, Aubrey D. Hibbard and R. A. Schroeder, July, 1948, 12 pages, 6000 copies.
332 Controlling Garden Insects, by Leonard Haseman, October 1948, 4 pages, 10,000 copies.
333 Our Teeth and Our Soils, by Wm. A. Albrecht, December, 1948, 16 pages, 3000 copies.
334 The Two Winter Tick Pests of Missouri, Roland W. Portman, February, 1949, 4 pages, 10,000 copies.
335 An All-Year Pasture System For Missouri, by W. C. Etheridge, C. A. Helm, E. Marion Brown, February, 1949, 12 pages, 15,000 copies.
336 Keeping Up Soil Organic Matter, by M. F. Miller, March, 1949, 28 pages, 15,000 copies.
337 Combating Pests of Stored Grain and Food, by Leonard Haseman, May, 1949, 4 pages, 10,000 copies.
338 Controlling Fleas, by R. E. Roselle and Leonard Haseman, May, 1949, 4 pages, 10,000 copies.

Reprints

219 Ventilation of Animal Shelters, by J. C. Wooley, July, 1948, 8 pages, 6000 copies.
243 Smooth Bromegrass In Missouri, by E. M. Brown, September, 1948, 2 pages, 6000 copies.
235 Growing Sorghum and Making Sorghum Sirup, by Helm, September, 1948, 8 pages, 4000 copies.
210 Management of Korean Lespedeza, by Helm, September, 1948, 8 pages, 10,000 copies.
189 Testing Milk and Cream, by H. A. Herman, November, 1948, 16 pages, 10,000 copies.
313 The Correlation Between Some Characteristics of Dairy Bull Semen and Conception Rate, by Swanson and Herman, November, 1948, 8 pages, 3000 copies.
326 Spraying Home Fruit Plantings, by Swartwout, Martin, Jenkins, February 1949, 8 pages, 5000 copies.
324 Spray Programs for Grapes, by Swartwout, January, 1949, 4 pages, 5000 copies.
326 Spraying Home Fruit Plantings, by Swartwout, Martin, Jenkins, April, 1949, 8 pages, 10,000 copies.
319 Rations for Livestock and Poultry, Ragsdale, Weaver, Kempster, December, 1948, 12 pages, 12,000 copies.
306 Flower Gardening by Smith, February, 1949, 16 pages, 6000 copies.
269 Producing Rabbits for Meat, by Bogart, February, 1949, 12 pages, 3000 copies.
263 Controlling Bean Leaf Damage by Beetles, by Haseman, January, 1949, 2 pages, 10,000 copies.
333 Our Teeth and Our Soils, by Albrecht, March, 1949, 16 pages, 10,000 copies.
257 Prevent Ox Warble Losses, by Haseman, March, 1949, 2 pages, 10,000 copies.
391 Controlling Insect Pests of Melons, etc., Haseman, April, 1949, 16 pages, 10,000 copies.
213 The Appraisal of Farm Buildings, by Wooley and Beasley, March, 1949, 12 pages, 6000 copies.
265 Insects Destructive to Food in the Home, by Haseman, January, 1949, 8 pages, 10,000 copies.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS

1119 Potassium Helps Put More Nitrogen Into Sweet Clover, by William A. Albrecht, A. W. Klemme, and William Mierke. Submitted July 2, 1948, to Journal of American Society of Agronomy.
1120 Some Factors Influencing the Male Hormone Content of Cow Manure, by C. W. Turner. Submitted July 12, 1948, to Journal of American Society of Agronomy.

1121 The Mutual Effects of Potassium and Calcium Upon Their Activities in Polyionic Betonite Systems, by C. E. Marshall and E. O. McLean. Submitted July 26, 1948, to Proceedings of the Soil Science Society of America.

1122 Carbohydrate-Protein Ratio of Peas in Relation to Fertilization With Potassium, Calcium, and Nitrogen, by Charles G. Vidalen, R. A. Schroeder, and William A. Albrecht. Submitted July 27, 1948, to Proceedings of the Soil Science Society of America.

1123 Microbiological Assays of Hays For Their Amino Acids According to Soil Types and Treatments Including Trace Elements, by William G. Blue, Victor L. Sheldon, and William A. Albrecht. Submitted July 29, 1948, to Proceedings of Soil Science Society of America.

1124 Development of the Two Spotted Spider Mite in the Presence of DDT and Other Insecticides, by Curtis W. Wingo and George W. Thomas. Submitted August 3, 1948, to Journal of Economic Entomology.

1125 An Authentic Case of Ox Warble in Man, by Leonard Haseman. Submitted August 4, 1948, to Journal of Economic Entomology.

1126 Loess-Probable Origin in River Flood Plain, by Alvin H. Beavers and William A. Albrecht. Submitted August 5, 1948, to Proceedings of Soil Science Society of America.

1127 The Composition of the Silt Fraction as Related to the Development of Loessial Soils, by M. Elsworth Springer. Submitted August 17, 1948, to Proceedings of the Soil Science Society of America.

1128 The Influence of Body Size of Dairy Cattle on Their Reaction to High Ambient Temperatures, by Samuel Brody, A. C. Ragsdale, and H. J. Thompson. August, 1948, Abstract.

1129 Diversity of Amino Acids in Leguminosae According to Soil Fertility, by Victor L. Sheldon, William G. Blue, and William A. Albrecht. Submitted August 20, 1948, to American Journal of Botany.

1130 Relation of Folic Acid and Vitamin A to the Incidence of Hydrocephalus in Infant Rats, by B. L. O'Dell, J. R. Whitley, and A. G. Hogan. Submitted August 21, 1948, to Proceedings of the Society of Experimental Biology and Medicine.

1131 Oral Effectiveness of D, L-Thyroxine in Crystalline, Monosodium, and Disodium Forms, by R. A. Monroe and C. W. Turner. Submitted October 12, 1948, to American Journal of Physiology.

1132 Effect of Washing Soiled Eggs on Hatchability, by E. M. Funk and James F. Forward. Submitted October 20, 1948, to Poultry Science.

1133 The Normal Development of the Testes in the White Plymouth Rock, by J. D. S. Kumaran and C. W. Turner. Submitted November 19, 1948, to Poultry Science.

1134 The Relationship of Egg Shell Color to Hatchability in New Hampshire, by E. M. Funk and James F. Forward. Submitted December 22, 1948 to Poultry Science.

1135 The Endocrinology of Spermatogenesis in Birds, by J. D. S. Kumaran and C. W. Turner. Submitted December 28, 1948, to Poultry Science.

1136 The Effect of Turning Hatching Eggs Before Incubation on Hatching Results, by E. M. Funk and James F. Forward. Submitted December 29, 1948, to Poultry Science.

1137 Sources of Resistance to Loose Smut, *Ustilago nuda*, in Winter Barleys of Foreign Origin, by J. M. Poehlman. Submitted January 3, 1949, to Journal of American Society of Agronomy.

1138 Maintaining the Hatchability of Eggs During Hot Weather, by E. M. Funk and Norman Clizer. Submitted January 6, 1949, to Poultry Science.

1139 Spontaneous Mutation at the *R* Locus in Maize. III. Genetic Modification of Mutation Rate, by L. J. Stadler. Submitted January 8, 1949, to the American Naturalist.

1140 Endocrine Activity of the Testis of the White Plymouth Rock, by J. D. S. Kumaran and C. W. Turner. Submitted January 19, 1949, to Poultry Science.

1141 The Endocrinology of Spermatogenesis in Birds. III. Effect of Hypo- and Hyperthyroidism, by J. D. S. Kumaran and C. W. Turner. Submitted February 1, 1949, to Poultry Science.

1142 Cracked Ice and Preservation of Stored Fruits and Vegetables, by Laura M. Flynn, V. B. Williams, and A. G. Hogan. Submitted February 7, 1949, to Food Research.

1143 The Endocrinology of Spermatogenesis in Birds, by J. D. S. Kumaran and C. W. Turner. Submitted March 5, 1949, to Poultry Science.

1144 Missouri Experiments on Chemical Thinning of Apples and Peaches, by A. E. Murneek. Submitted March 5, 1949, to Proceedings of the Missouri State Horticultural Society.

1145 Size and Color of Apples, by A. E. Murneek. Submitted March 5, 1949, to Proceedings of Missouri State Horticultural Society.

1146 The Separation of Urinary Estrogenes From Contaminating Pigments and Interfering Impurities in Pregnancy Urines, by William A. Miller and Dennis T. Mayer. Submitted March 7, 1949, to The Archives of Biochemistry.

1147 Thyroprotein-Feeding to 7-Year-Old Hens, by C. W. Turner and H. L. Kempster. Submitted March 23, 1949, to Poultry Science.

1148 Gonadotrophic Hormone Stimulating Properties of Pyrimidine Sulphonamide Derivatives by C. W. Turner and J. D. S. Kumaran. Submitted March 29, 1949, to Poultry Science.

1149 Further Use of Punched Card Equipment in Predicting the Performances of Double-Crossed Corn Hybrids, by John B. Combs and M. S. Zuber. Submitted March 29, 1949, to Journal of American Society of Agronomy.

1150 Grain Size and Hull Percentage as Factors in the Milking Quality of Oats, by J. M. Peek and J. M. Poehlman. Submitted March 31, 1949, to Agronomy Journal.

1151 Effect of Temperature and Drying on Activation of Male Hormone of Cow Manure, by C. W. Turner. Submitted April 7, 1949, to Journal of Dairy Science.

1152 Spontaneous Mutation at the *R* Locus in Maize. IV. An *R*-Linked Modifer of *R* Mutation Rate, by L. J. Stadler. Submitted April, 1949, to Journal of Portugaliae Acta Biologica.

1153 Nutrition Via Soil Fertility, by William A. Albrecht. Submitted May 5, 1949, to Proceedings Council For Scientific and Industrial Research—The British Commonwealth Scientific Office, Victoria, Australia.

1154 The Importance of Time of Application of "Hormone" Sprays to Improve Tomato Yields, by D. D. Hemphill. Submitted May 17, 1949, to Proceedings of the American Society for Horticultural Science.

1155 Continued Feedng of Thyroprotein and Sex Hormones to Laying Hens, by C. W. Turner. Submitted June 3, 1949, to the Journal of Dairy Science.

1156 The Metabolism of the Lactogenic Hormone, by T. Y. Liu and C. W. Turner. Submitted June 3, 1949, to Journal of Dairy Science.

1157 The Proteins of Mammalian Spermatozoa and Cellular Nuclei, by Lloyd E. Thomas and Dennis T. Mayer. Submitted June 20, 1949, to Science.

INVESTIGATIONS UNDER COOPERATIVE PROJECTS

The Agricultural Experiment Station has cooperated with the United States Department of Agriculture in the following projects:

Marketing of Slaughter Livestock.
Factors Influencing Quality and Palatability of Meat.
The Improvement of Swine Through Breeding.
R. M. Climatic Laboratories.
The Improvement of Pastures in the Corn Belt.
Diseases of Orchard Fruit.
Agronomic, Physiologic, and Genetic Research with Soybeans.
Physiology, Edaphology, and Breeding of Pasture Plants.
Cereal Improvement with Special Emphasis on Corn.
Improvement of Varieties of Annual Lespedeza.
Soil Erosion and Its Control.
Current Land Market Activity in Missouri.
Control to Protect Crops from Grasshopper and Chinch Bug Damage.
Regional Land Tenure.

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.

Markle Foundation

For study of a hemophelia-like disease in swine.

American Dry Milk Institute

For research in the field of Nutrition.

National Mineral Wool Association

For the conduct of research in connection with the project on "Psychoenergetic laboratory studies," to establish certain fundamental data relating to the housing and production of dairy animals.

Office of Naval Research

For a research project covering the "Influences of Climatic Factors on Farm Animals."

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.

M.F.A. Oil Company

For research in connection with a study of methods of controlling horse flies, and particularly the species thereof known as *Tabanus Sulcifrons*.

Sherwin-Williams Company

For research in weed control.

Midwest Regional Turf Foundation and the Green Section of the U. S. Golf Association

For research in the improvement of fairway turf in the vicinity of St. Louis, Mo.

Dow Chemical Company

For support of studies on the use of plant hormones in orchard practice.

Missouri Conservation Commission

For farm forestry research.

College of Agriculture Foundation

For use on a project entitled "Unrecognized Nutrients Required by Laying Hens."

Abbott Research Laboratories

To study veterinary indications, dosage, and general uses of Pentothal Sodium.

American Dairy Association

For further research on the project "The Development of New Uses of Whey Solids."

Cerophyl Laboratories

For research on the relationships between male and female hormones as they may affect animal production.

De-Raef Corporation

For research relating to the manufacture of cheddar cheese.

Missouri Butter Institute

For the study of mold mycelia in cream and butter.

Corn Products Sales Company

For research in the field of dairy products.

Kraft Cheese Company

For the study of composition of milk, cheese and whey from Missouri cheese factories.

M. F. A. Artificial Breeding Association, Springfield, Missouri

Ortho Research Foundation

Midwest Breeding Farms, Trenton, Missouri

For use in connection with the project "The Inheritance and Transmission of the Characters Capacity for Fat Production and Dealing with the Artificial Insemination and Fertility of Dairy Cattle."

Coronet Phosphate Company

For research on the influence of plant food including "trace minerals" applied to the soil in the improvement of feed quality and animal health.

Schrock Fertilizer Service

For research on the influence of plant food including "trace minerals" applied to the soil in the improvement of feed quality and animal health.

Abbott Research Laboratories

For research involving the development of an accurate chemical method for the quantitative estimation of urinary estrogens and of a method or methods for the isolation and purification of estrone and other female sex hormones in mare pregnancy urine.

Spencer Chemical Company

For research in connection with pasture studies.

American Potash Institute

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

International Minerals and Chemical Corporation

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

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."

Ruhm Phosphate Company

For research in connection with phosphate absorption from the soil.

Middle West Soil Improvement Committee

To further extension projects in soils improvement.

Missouri Portland Cement Company

For use in the study of the application of precipitator dust from cement plants as a fertilizing material.

International Baby Chick Association

For research in connection with hatchability studies.

CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1949

Appointments

Mary L. Allen, Instructor in Home Economics.
Winfred L. Baker, Fertilizer Inspector.
Clarence M. Bradley, Assistant Instructor in Animal Husbandry.
Daniel E. Brady, Professor of Animal Husbandry.
Paul Y. Burns, Assistant Professor of Forestry.
Walter Chryst, Assistant Instructor in Agricultural Economics.
Lloyd L. Combs, Fertilizer Inspector.
Charles M. Coughenour, Instructor in Rural Sociology.
Richard J. Deeters, Instructor in Animal Husbandry.
Maurice E. Dickensheet, Graduate Assistant in Dairy Husbandry.
Richard W. Dingle, Instructor in Forestry.

Carl N. Emerson, Graduate Assistant in Animal Husbandry.
Merna Dean Fisher, Instructor in Home Economics.
Lyle Fitzgerald, Instructor in Agricultural Economics.
Peter W. Fletcher, Instructor in Forestry.
Charles Wm. Gehrke, Associate Professor of Agricultural Chemistry.
Keith Edward Gregory, Research Assistant in Animal Husbandry.
Jacquelyn W. Hearne, Analyst in Department of Agricultural Chemistry.
Delbert D. Hemphill, Assistant Professor of Horticulture.
Herbert W. Howell, Assistant Professor of Veterinary Medicine and Surgery.
Kenneth B. Huff, Professor of Agricultural Engineering.
Starley M. Hunter, Professor of Home Economics.
Raymond E. Kastendieck, Research Assistant in Agricultural Economics.
Loren D. Kintner, Instructor in Veterinary Pathology.
W. F. Krueger, Research Assistant in Poultry Husbandry.
Dorothy Lewis, Instructor in Home Economics.
Franklin G. Liming, Research Associate in Forestry.
J. H. Longwell, Dean and Director.
S. Clark Martin, Research Associate in Forestry.
John B. Mitchell, Instructor in Rural Sociology.
Robert Moody, Assistant Professor of Veterinary Medicine and Surgery.
Robert M. McCroskey, Research Assistant in Agricultural Engineering.
Robert L. McNamara, Professor of Rural Sociology.
Hugh D. Nauman, Graduate Assistant in Animal Husbandry.
Virgil H. Owens, Research Assistant in Entomology.
Lee Kent Paulsell, Instructor in Forestry (Forester, University of Missouri Weldon Spring Experiment Farm).
David H. Pinson, Instructor in Agricultural Economics.
Allan W. Purdy, Administrative Assistant in the Office of Dean and Director.
Glenn R. Pursley, Graduate Assistant in Dairy Husbandry.
Carl A. Reaves, Instructor in Agricultural Engineering.
James W. Reynolds, Assistant Instructor in Agricultural Economics.
George C. Shelton, Instructor in Clinical Pathology.
Robert E. Stewart, Research Assistant in Agricultural Engineering.
F. G. Teubner, Jr., Research Assistant in Horticulture.
George W. Thomas, Assistant Instructor in Entomology.
Louisa N. Tucker, Assistant Instructor in Animal Husbandry.
Dorothy Tyrrell, Research Assistant in Home Economics.
Andrew W. Uren, Associate Professor of Veterinary Science.
Howard J. Weeth, Graduate Assistant in Dairy Husbandry.
Nellie O. Weeth, Technical Assistant in Genetics.

Resignations and Withdrawals

John R. Breuer, Fertilizer Inspector.
Fern Bowman, Associate Professor of Home Economics.

Walter E. Chryst, Assistant Instructor in Agricultural Economics.
Kathryn S. Clark, Research Assistant in Agricultural Chemistry.
James E. Crosby, Jr., Assistant Director of the Agricultural Experiment Station.
Gerald D. Goetsch, Assistant Professor of Veterinary Physiology.
Florence Harrison, Professor of Home Economics.
D. A. Hill, Assistant Professor of Veterinary Bacteriology.
Raymond E. Kastendieck, Research Assistant in Agricultural Economics.
Eugene Kaufman, Graduate Assistant in Dairy Husbandry.
Betty Gomez Lance, Research Assistant in Agricultural Chemistry.
Buel Lampher, Research Assistant in Agricultural Economics.
E. H. Matzen, Associate Professor of Agricultural Economics.
John R. Paulling, Professor of Agricultural Economics.
Alvah L. Perry, Instructor in Agricultural Economics.
Mary E. Plumb, Technical Assistant in Genetics.
Marybelle Sapp, Research Assistant in Home Economics.
Loren O. Shaffer, Graduate Assistant in Dairy Husbandry.
Fern E. Staggs, Assistant Professor of Home Economics.
John J. Trentin, Graduate Assistant in Dairy Husbandry.
Dorothy Tyrrell, Research Assistant in Home Economics.
Nellie O. Weeth, Technical Assistant in Genetics.

FINANCIAL STATEMENT

UNIVERSITY OF MISSOURI
AGRICULTURAL EXPERIMENT STATION
in account with
THE UNITED STATES APPROPRIATION, 1949

	Hatch Fund	Adams Fund	Purnell Fund	Bankhead-Jones Fund	Research & Marketing Fund
Dr.					
To Balance from 1948-49	.....	.....	.....	.....	$15,439.59
Receipts from the Treasury of the United States as per appropriation for fiscal year ended June 30, 1949	$15,000.00	$15,000.00	$60,000.00	$89,383.63	$68,925.51
Total	15,000.00	15,000.00	60,000.00	89,383.63	84,365.10
Cr.					
Personal Service	11,826.50	11,864.70	45,069.71	60,531.25	52,079.74
Travel	186.40	6.77	1,180.39	1,278.76	2,592.82
Transportation of things	.....	25.89	80.70	114.00	300.40
Communication Service	18.83	2.00	47.11	259.17	116.23
Rents and Utility Services	66.85	38.67	109.60	878.98	295.15
Printing and Binding	.....	.....	1,101.14	1,826.97	154.16
Other Contractual Services	114.85	513.18	670,71	1,612.77	4,022.76
Supplies and Materials	1,054.05	2,068.20	6,724.51	18,087.70	7,642.96
Equipment	1,376.61	303.51	3,998.04	3,680.24	10,665.06
Land and Structures	110.08	.....	.....	.....	703.78
Contributions to Retirement	245.83	177.08	1,018.09	1,113.79	783.03
TOTAL EXPENDITURES	$15,000.00	$15,000.00	$60,000.00	$89,383.63	$79,356.09
Unexpended Bal. June 30, 1949	.....	.....	.....	.....	5,009.01