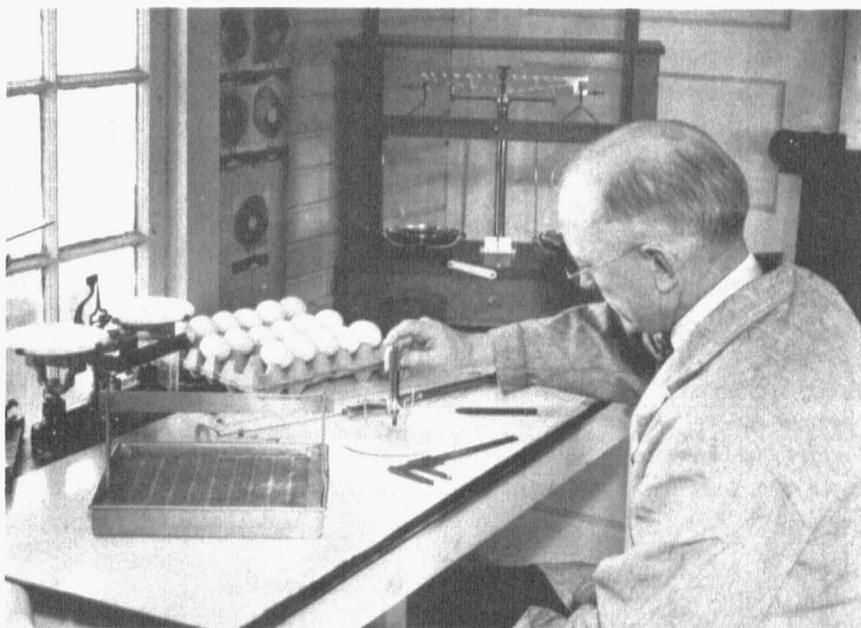


RESEARCH for THE FARMER

Annual Report of the
Missouri Experiment Station
1946-1947

E. A. Trowbridge and J. E. Crosby, Jr.



UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

J. H. Longwell, *Director*

BULLETIN 524

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LETTER OF TRANSMITTAL

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

Sir:

I am submitting herewith the report of the Agricultural Experiment Station for the year ending June 30, 1947. 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.

This publication has been delayed due to unavoidable circumstances related to and following the war.

Respectfully submitted
J. H. Longwell, *Director*
Missouri Agricultural Experimental Station

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Front Cover: Professor E. M. Funk of the Missouri Station has done considerable research on the thermo-stabilization of eggs.

RESEARCH for THE FARMER

E. A. Trowbridge and J. E. Crosby, Jr.

INTRODUCTION

Returning veterans reached a peak in numbers at the University of Missouri during the period of this report. Despite the fact that problems related to their renewing or starting college careers required extra time from the station staff everyone accepted the challenge and responsibility and much research was accomplished.

New research was initiated—old research was improved. The effect of DIFFERENT STORAGE TEMPERATURES and DIFFERENT STORAGE PERIODS on the quality of frozen foods is now receiving extensive study at this station. This project is being watched with increasing interest due to the popular use of freezer lockers by the public and the need for data on any change in quality and shrinkage of food while in frozen storage. Methods of processing are also being studied.

VITAMIN research was continued; PLANT and LIVESTOCK BREEDING investigations were continued; further studies were made on GROWTH AND MILK SECRETION AND PRODUCTION; research was continued on INSECTICIDES; the BAKING QUALITIES of different varieties of wheat were tested; several processes to improve the KEEPING QUALITY OF EGGS were further perfected; and extensive study was continued on the SHATTERING AND FERTILIZATION OF THE SUBSOIL.

Agriculture is a complicated and constantly changing profession. These are only a few of the many and varied research projects carried out during the year. Scientific investigations related to every phase of agricultural production are under study.

Agricultural research moves on at Missouri.

This manuscript was prepared and edited by Ovid U. Bay.

These steers were finished with a maximum of pasture and other roughage and a minimum amount of grain.



AGRICULTURAL CHEMISTRY

A. G. Hogan, *Chairman*

Nutritional Requirements of Poultry (A. G. Hogan and Betty Gomez Lance). This project was a study of the adequacy of completely synthetic diets for the baby chick and the turkey poult. The questions considered were: Do chicks and turkeys grow and develop on these synthetic diets? How much folic acid do chicks and turkeys require for normal growth? Do chicks and turkeys require unrecognized vitamins for optimum growth? How much nicotinic acid does the turkey poult require and does the chick require inositol?

Chicks and turkey poult were developed in a normal manner on synthetic diets and baby chicks required more than 25 and less than 50 mcg. of folic acid per 100 gm. of ration. Turkeys required over 100 mcg. and less than 200. It was found that when dried liver was added to a synthetic diet the rate of growth of chicks and poult was markedly accelerated. It was due either to a protein or to a vitamin factor.

When the ration of chicks contained less than 25% of casein and 10% of gelatin, or when the ration of turkeys contained less than 35% of casein and 5% of gelatin they did not make optimum development. There was less perosis in turkey poult when the diet contained 10 mg. of nicotinic acid than when it contained 5 mg. This study indicated that the chick does not require inositol.

The Effect of Different Storage Temperatures and Different Storage Periods Upon the Vitamin Content of Frozen Foods (Laura M. Flynn, A. G. Hogan, Fern Bowman, A. D. Hibbard, A. E. Murneek and Evelyn L. Warren). Blakemore strawberries, Monmorency cherries and Landreth snap beans were frozen and stored at three temperatures: -24°C , -18°C , and -12°C . Peaches (6 varieties), were packed in 50 per cent sucrose syrup, in sucrose syrup with 0.25 per cent crystalline ascorbic, and in sucrose syrup with ascorbic acid and .05 per cent citric acid. Apples (4 varieties) were blanched (boiled 5 min. and cooled) in syrups identical with those used for peaches. Frozen peaches and apples were stored at -12°C . Vitamin assays were run on fresh, just frozen and stored samples of the fruits and vegetables.

Strawberries contained 61 mg. total ascorbic acid per 100 gm. Storage at -18° or -24°C . for 7 months caused no vitamin loss. At -12°C . 39% of the ascorbic acid disappeared in 7 months. Seven months storage caused no loss of vitamins. Snap beans contained 35 mg. total ascorbic acid per 100 gm. Beans stored 3 months at -18° or -24°C . retained 21 mg. total ascorbic acid per 100 gm. Storage at -12°C . allowed retention of 16 mg. total ascorbic acid per 100 gm. Carotene in peaches varied from 35 to 300 mcg. per 100 gm. Added crystalline ascorbic acid brought the vitamin content of the frozen mixture to 100-110 mg. ascorbic acid per 100 gm. of syrup and peaches. The vitamins were retained during 6 months storage. With added crystalline ascorbic acid blanching syrups, the frozen apples contained 72-117 mg. ascorbic acid per



Extensive studies were made on the effect of different storage temperatures and different storage periods upon the vitamin content of frozen foods.

100 gm. Total ascorbic acid in the apple-syrup mixture was retained during 3 months storage.

Conservation of Nutritive Values of Foods (Laura M. Flynn). The studies on this project included: The amount of vitamins (carotene) thiamine, riboflavin, nicotinic acid, ascorbic acid (reduced and dehydro-) and pantothenic acid in fresh snap beans. Changes in vitamin content in home canning, using a pressure cooker. Effect of acid (vinegar) upon vitamin retention in canning and storage. Changes in vitamin content of canned beans with storage at room temperature, heating, refrigeration, and reheating. Improvement of the methods of vitamin assay to give greater precision.

Vitamin content of two lots of snap beans in mcg. per 100 gm. were: carotene 317 and 370, reduced ascorbic acid 22,000 and 650, total ascorbic acid 35,000 and 13,000, thiamine 73 and 99, riboflavin 79 and 84, nicotinic acid 760 and 614, pantothenic acid 196 and 110. Canning causes loss of 30 per cent of the pantothenic acid, 67 per cent of the total ascorbic; other vitamins were unchanged. Vinegar protected total ascorbic in canning, storage and reheating. Discarding liquids from reheated canned beans resulted in losses of 35-50 per cent of the B-vitamins, 40 per cent of total ascorbic acid. Fifty per cent of the total ascorbic in canned beans may be in dehydro- form. Further data are being tabulated upon effects of storage.

The Use of Cracked Ice in Preserving the Quality of Fruits and Vegetables Between the Time of Harvesting and Storage or Use (Laura M. Flynn, A. D. Hibbard, A. E. Murneek, Victor Williams, and Evelyn L. Warren). Tests were run with strawberries, peas, and snap beans. A graded uniform supply of each commodity was divided into two lots and stored for five days (six days for beans) or until the food became inedible. One lot of each commodity was stored at room temperature and the other was stored in a cabinet with cracked ice. Cooking tests were made in addition to daily determinations of dry matter and ascorbic acid (total and reduced).

It was found that foods held with ice five days equalled in quality those held at room temperature for two days. Tests made to determine changes in sugars during seven days storage showed that the sugar content of beans stored at room temperature declined (total sugars—20 gm. to 8.8 gm./100 gm. D. M.—sucrose—3.5 to 8.2 gm./100 gm. D. M.). While the strawberries remained edible their ascorbic acid content (56.68 mg. per 100 gm.) was retained. During the five-day test period the iced peas retained 90 per cent of the original total ascorbic acid (36.6 mg./100 gm.). Peas at room temperature lost one-third of their total ascorbic acid in 24 hours. By the sixth day the iced beans retained 50 per cent of total ascorbic, those at room temperature 35 per cent. The stored foods all contained ascorbic acid in dehydro- form (strawberries 20%, peas 25%, iced beans 34%, beans at room temperature 54%).

Unrecognized Vitamins Required by Livestock (A. G. Hogan and W. O. Regan). One object of this project was the discovery of unrecognized vitamins and the other the discovery of nutritional precautions which prevent calcification of soft body tissues. The nutritional requirements of the guinea pig and the hamster for reproduction were studied. Research on the adequacy of a completely synthetic diet for the growth of the guinea pig was continued.

During previous years this station consistently failed to secure reproduction in guinea pigs on synthetic diets, even though they contained yeast, or extracts of yeast or liver. However, this year a significant, but far from complete, degree of success was obtained in growing guinea pigs on completely synthetic diets. Hamsters did not reproduce successfully on completely synthetic diets. They probably require an unrecognized vitamin. Guinea pigs on synthetic diets which were high in phosphorus developed calcium phosphate deposits in connective tissue. Animals on the stock diet developed these to a minor degree. It is believed that an unrecognized vitamin is concerned.

Unrecognized Nutrients Required for the Complete Life Cycle of the Rat and of the Pigeon (A. G. Hogan and B. L. O'Dell). This project is a continuation of other works at the Missouri station on the requirements of the rat for normal gestation and lactation and the cause of hydrocephalus in the rat.

The simplest vitamin mixture used contained six water-soluble vitamins, thiamine, riboflavin, pyridoxine, pantothenic acid, nicotinic acid and choline. The animals which received it reared 87 per cent of the young which were

born alive, an excellent record. However, the best results were obtained on a ration that contained 9 water-soluble vitamins including Bc and ascorbic acid. The weaning percentage was 88, and the weaning weights were exceptionally high.

AGRICULTURAL ECONOMICS

O. R. Johnson, *Chairman*

Marketing and Price Investigations (E. H. Matzen and R. L. Kohls). In the study of marketing meat animals in Missouri it was found that Missouri produced 6.5 per cent of the total U. S. hog production in 1915-19 and also 1940-44, approximately maintaining its relative importance in hog production. However, relative importance in the districts in Missouri has changed, gaining in the southeast at the expense of southwest and central areas of the state.

This study shows that hog weights have increased and seasonal pattern of marketings and weights vary less than in markets to the north. But the prices follow a very similar pattern to other markets in the country.

In the study of cycles and seasonal variation in prices in Missouri farm products cash farm income on Missouri farms from 1924-45 was analyzed. It was found that incomes from hogs and poultry (heavy consumers of grain) and corn have declined in importance, while that from cattle, sheep, dairy products and cotton have increased in importance. The importance of income from whole milk has doubled at the expense of butterfat.

An analysis of live stock market differentials shows that price differentials between Missouri markets and Chicago have narrowed in favor of Missouri markets. The seasonal patterns are relatively similar between markets but the St. Louis market appears to have a stronger market for light-weight hogs than do any of the Missouri markets.

The data on the transportation of farm products was assembled for nine counties covering the in and out movements of commodities for a period of one week. The study was made to help determine the need for transportation facilities and it was found that the weight of goods going into the county exceeded that going out by 42 per cent.

A breakdown shows that of the commodities coming into these counties 43% was shipped by rail, 57% by truck, while the commodities going out 23% was shipped by rail and 77% by truck. A percentage moved by rail increased as the distance between origin and destination increased. The study shows that 34% of the commodities received by the nine counties came from a distance of less than 50 miles and that 31% of the commodities shipped out went to towns within 50 miles.

Adjustments in Farming from the Standpoint of Production Planning and Soil Conservation (O. R. Johnson & the Production Adjustment Committee of the Missouri College of Agriculture). An analysis of Missouri's land

use together with recommendations concerning adjustments in crop and livestock production was completed as in preceding years.

Comparatively little reallocation of acreage was indicated for the 1947 crop season. The biggest change recommended was the reduction in production of soybeans. Further expansion in rotation pastures was found to be desirable. Further expansion in other kinds of pastures indicate some expansion in the livestock carrying capacity of our pastures and pasture crops. It was recommended that some expansion in hogs be undertaken to restore hog numbers.

AGRICULTURAL ENGINEERING

J. C. Wooley, *Chairman*

The Use of Native Materials and Farm Labor in the Construction of Farm Buildings. (J. C. Wooley). The outside shell of a 26' by 40' quonset type dwelling was constructed using six $\frac{3}{4}$ " by $1\frac{1}{2}$ " oak strips nailed and bolted to form the wall and roof trusses. Wood shingles were used on the sides up to the window sills. At this point a 2" by 2" band with steel flashing was used to divide the wood from the asphalt shingles used on the upper part of the roof. Solid sheeting and tar paper serve as a base for shingles.

Nine hundred board feet of oak lumber was used in the trusses, a considerable reduction in the material as compared to standard construction. Since the roof is self-supporting there were no load bearing partitions in the interior enabling much lighter construction. The house will provide a laboratory for studies on low cost heat generating and distributing systems, for various arrangements of rooms, for simplified plumbing systems and for summer cooling studies. This project will be continued.

Economic Use of Power, Labor, and Machinery in Crop Production (G. W. Steinbruegge and M. M. Jones). This is a continuation of the project on barn hay drying systems and the construction of an experimental field hay drying machine.

Barn hay driers were found to be generally satisfactory and capable of being operated by farmers. It was found that there is need for a more positive means of forcing air through the central part of the hay mass, in order to avoid mold. Costs of operation on two driers tested averaged about \$2.00 per ton.

The experimental field hay drier was completed and is now ready for field trials.

A method was developed by means of which diffusional processes which cannot be handled by exact mathematical methods, could be approximated readily with sufficient accuracy for hay drying calculations.

Barn hay driers make possible improved quality and feeding value of hay at reasonable costs, and are practical for dairymen and others who find it desirable to feed hays which are leafy, and high in protein and carotene content.

ANIMAL HUSBANDRY

L. A. Weaver, *Chairman*

The Production of Beef with Sufficient Finish to Grade "Good" by the Maximum Use of Pasture and Other Roughage and a Minimum Use of Grain (A. J. Dyer and J. E. Comfort). This concludes the third test on the production of meat with a sufficient finish to grade "good" by the maximum use of pasture and other roughage and a minimum amount of grain. In this state, where pasture and roughage crops are on the increase; this system points a way to economical beef production and wise land use. It is being adopted in whole or in part on a very large scale. A huge saving on production costs is obtained by those who use roughage and pasture to the maximum in meat production.

In the fall of 1946, 68 head of choice steer calves were divided into lots for a comparison of winter rations. Their rations were corn silage and atlas sorgo silage each fed with legume hay, clover hay alone, and alfalfa hay alone.

Corn silage again proved to be best on either plane of nutrition followed by atlas sorgo and barley silage in order. As to their subsequent performance on pasture; the "low-plane" steers in winter (.68 pounds average daily gain) gained much more in summer than the "high-plane" (1.08 pounds average daily gain) winter steers; namely, 276 pounds as compared with 184 pounds total gain, a difference of 92 pounds. The deficit in weight at the close of the winter feeding trial was exceeded by the superior summer gains so that these cattle actually weighed more at the end of the summer than those steers fed liberally in winter. Even though they weighed more, they did not seem to be as fat. During the full feeding period in dry lot the steers that had been wintered on a low plane of nutrition ate more feed and gained faster than the steers which had been wintered on a high plane of nutrition. These results show that nothing was gained by wintering steers liberally when handled in this manner.

Two-year-old steers fed from weanling calves, using good roughage in winter and good pasture in abundant amount in summer were marketed after 47 days full feeding in dry lot in one case and after only 27 days full feeding in another at the top market price for fat cattle in St. Louis, on the days when they were marketed. Only 10½ bushels corn were used in the first situation and only 7 bushels in the last case. The cattle graded "good" on foot and in the carcass and the dressing percentage was more than 61 per cent based on warm weight. Pasture was responsible for more than 60 per cent of the total gain.

The Effect of Different Storage Temperatures and Different Storage Periods on the Quality of Frozen Foods: The Agricultural Chemistry, Agricultural Engineering, Animal Husbandry, Dairy Husbandry, Home Economics, Horticulture, and Poultry Department cooperated in the work on this project.

Professor Shirky is chairman of the committee and Professor J. E. Comfort reported on the meat work.

The committee consisted of the following: Laura Flynn, Marialice Cunningham, Leta Maharg, Ferne Bowman, Margaret Mangel, J. C. Wooley, J. E. Comfort, W. H. E. Reid, A. E. Murneek, A. D. Hibbard, E. M. Funk and S. B. Shirky.

Beef ribs, porterhouse steaks, hamburger, pork loin roasts, pork chops and unseasoned sausage were stored at three different temperatures for 12 months. The temperatures used were -12°C ., -18°C ., and -24°C . The meat was wrapped in lacquer coated moisture and vapor resistant cellophane that was heat sealed and was then rewrapped in locker paper or placed in rectangular pasteboard cartons. Beef ribs and porterhouse steaks were cooked by standard methods at intervals of 3, 6, 7, 8, 9, 10, 12, and 14 months and scored by a committee of four from the home economics and animal husbandry departments. Hamburger, sausage, pork chops and pork loin roasts were taken out of storage and cooked at monthly intervals. Appearance, odor or aroma, flavor of fat and lean, tenderness and juiciness of the cooked meats were scored by the committee. Loss of weight in storage pH and reduction-oxidation potentials were recorded on the fresh, defrosted and cooked meats. Very complete cooking records were made on each sample.

Shrinkage during storage was affected slightly by the length of storage period and by differences in storage temperatures. Pork chops one inch in thickness showed the greatest loss in weight. Pork chops stored at -12°C . lost 6.20%; those at -18° , 5.21%; those at -24° , 4.58%. Pork chops stored at -12° for one month lost 5.03% and those stored for 12 months at -12° lost 6.31%. The range in shrinkage loss on sausage was 4.34% at -12° to 4.04% at -24° . Hamburger shrinkage—3.78% at -12° ; 3.32% at -24° . Porterhouse steaks lost about 2.5% at all three temperatures. Large three-rib beef roasts and pork loin roasts had very low shrinkage losses. The average percentage loss on rib roasts at -12°C ., -18° and -24° was .78, .72, and .59. For pork loins the average percentage loss for the three storage temperatures was .73, .73 and .57.

The palatability factors that were affected most by differences in storage temperatures and lengths of time in storage were odor or aroma and flavor of fat and lean. Tenderness and juiciness in most cases were affected only slightly by the length of storage period and storage temperature.

There was a very noticeable decline in the palatability of sausage, hamburger and pork chops during the 12 months storage at all three temperatures. There was a slight decline in desirability of odor and flavor of sausage during the first 9 months of storage due to an "old" flavor and odor and later a rancid flavor and odor in the product. After 9 months of storage sausage became undesirable and finally at 12 months inedible. Sausage stored at the higher

temperature -12°C . became undesirable in flavor at 10 months whereas sausage stored at -18° and -24° was still acceptable in flavor after 11 months of storage.

The hamburger was not as palatable as the sausage at the beginning of the experiment and there was more variability in the flavor from month to month. There was a noticeable decline in the desirability of the flavor of hamburger that was stored longer than 5 months. Hamburger stored at -12°C . was undesirable in flavor at 9 months and inedible at 12 months. Samples stored at -18°C . and -24°C . were acceptable at 9 months but undesirable at 12 months and inedible at 14 months.

There was a noticeable difference in juiciness between fresh pork chops and frozen pork chops. This was the only one of the meat products that showed this extreme variation in juiciness, and it was very noticeable even on the sample that had been frozen only 48 hours. All of the pork chops that were frozen tended to be dry when cooked.

The scoring of tenderness and juiciness of porterhouse steaks remained relatively high during the entire storage period at all temperatures used. There was a little variability in the flavor of fat in the steaks stored at -18°C . after the 3th month of storage, but as a whole a slightly rancid or "old" flavor was noticeable in the fat of steaks stored at all three temperatures after 9 months of storage. The porterhouse steaks showed a definite decline in palatability with an increase in storage temperatures.

Beef rib roasts stored at all three temperatures were very desirable in appearance, juiciness, tenderness and flavor of lean up to 12 months. There was a very noticeable decline in palatability on all the beef roasts between the 12th and 14th months.

Greater shrinkage losses were experienced with ground meats such as hamburger and sausage and with thinner cuts such as pork chops than with thicker roasts where the loss is negligible. Sausage, hamburger, and pork chops became less palatable when stored longer than 5 or 6 months at a low temperature. Even thick beef roasts became less palatable when stored longer than a year.

Palatability factors affected most by differences in storage temperatures and lengths of time in storage were odor or aroma and flavor of fat and lean.



Systems of Breeding for the Improvement of Swine (L. A. Weaver, Ralph Bogart, George A. Harrison and Donald R. Warner). This project is the continuation of the development of three inbred lines at the University of Missouri in cooperation with the Regional Swine Breeding Laboratory.

Selections made to date have not significantly increased the number of pigs born. However, number of pigs weaned, litter weaning weights, individual weights at weaning, weight at 180 days, and live hog scores at 225 lbs. (vigor, quality, length of body, conformation, animal as a whole, and grade) have all shown improvement from selection.

By practicing rigid selection it is possible to inbreed to the extent of half brother x half sister matings for eight generations without serious loss of prolificacy, suckling ability of sows, growth rate, economy of production, and carcass value. Such inbred lines gave hybrid vigor when crossed together, resulting in the production of more efficient animals.

Results secured by inbreeding as a method of improving swine breeding stock can be duplicated by breeders if carefully followed, along with rigid, intelligent selection.

Physiology of Reproduction in Farm Animals (Ralph Bogart, Dennis T. Mayer and assistants). This study was a continuation of previous work at this station on the Physiology of Reproduction in Farm Animals and consisted of three sub-projects. The sub-projects were:

(A) Estrus, Ovulation, Resorption, and Abortion in the Female: Spermatogenesis and Related Phenomena in the Male.

(B) The Role of Endocrine Secretions in the Reproductive Physiology of the Male and Female.

(C) Improved Techniques for Natural and Artificial Breeding.

Much of the work on sub-project A was a continuation of previous research.

Fundamental studies in the morphology and physiology of sperm have resulted in knowledge aiding preparation of diluters for storage and insemination, additional insight into resistance of sperm and its effect on fertility and has given more knowledge concerning pathological conditions and possible ways of correcting them. Morphology has enabled the correction by hormone treatment certain reproductive abnormalities which result from hormonal unbalances.

It was found that thyroid hormone is a contributing factor in "summer sterility" in rams and it alleviates some of the symptoms by stimulating spermatogenesis. Gonadotropins were necessary for complete recovery. Their absence during the summer months was a second factor in "summer sterility." High summer temperatures act through the thyroid.

Thiouracil fed to growing chickens resulted in a slower gain per day, but the animals laid down more fat and developed more compactly. Reduction in

thyroid activity in lambs with thiouracil indicates that such treatment might improve their fattening ability.

A hypothyroid state is detrimental to reproductive processes in the rats. Necessity for a method of measuring level of thyroid activity in farm animals was indicated.

Thiouracil studies indicate that it increases fattening, causes a more compact type, and improves carcass quality but it may reduce rate of gain and feather and wool growth. Quantity of thiouracil in meat from animals fed the drug as determined biologically was relatively unimportant.

Much effort was directed toward the removal of pigments from urine and considering their chemical characteristics since the pigments interfere in methods for the purification and determination of urinary hormones.

The principal results of this project were: (1) Development of an assay technique for the resistance factor in egg yolks. (2) Substantiating reliability and modifying technique for live-dead differentiation of spermatozoa. (3) Further knowledge regarding the factors (chemical and physical) which alter the resistance of spermatozoa. (4) Accumulation of more data concerning the effect of various ions, the colloidal state, pH, and other physical characteristics of a storage or diluting medium upon spermatozoan viability. (5) Progress in the development of an index of the storage potentialities of a semen specimen. (6) Method for removal of pigments from sow and mare urine as part of work on chemical pregnancy tests and chemical assay techniques for estrogenic hormones. (7) Development of several improved steps in a procedure for the isolation of estrogens and their quantitative determination from samples of pregnancy urine.

Chemistry of the Nuclei of Mammalian Spermatozoa (Dennis T. Mayer and Lloyd B. Thomas). A cooperative project with the department of biochemistry of the Medical School was begun two years ago with a study of the proteins of spermatozoan nuclei and chromosomes as an objective.

The preliminary results of this investigation indicate that the proteins of boar spermatozoa differ from those described for fish spermatozoa and from those isolated from the nuclei of such tissues as liver, heart muscle, thymus, and several other somatic cells. Strikingly, no basic protein, such as postulated for all nuclear proteins thus far studied, can be demonstrated in boar spermatozoa. The distinct proteins with isoelectric points below pH 6 and nucleic acid have been isolated.

BOTANY

C. M. Tucker, *Chairman*

The Development of Tomato Varieties from Hybrids Involving *Lycopersicum Pimpinelli-Folium* as a Source of Factors for Resistance to Fusarium Wilt and Other Diseases (C. M. Tucker and R. A. Schroeder). This project was a continuation of previous work at this station. Wilt-resistant tomato strains were grown in comparative yield tests with standard commercial varieties at Midway, Monett, and Jefferson City. Complete yield data of marketable and cull fruits were obtained at each station. Approximately 3 acres of breeding plots and 3 replicated plots of each hybrid were planted at Midway and Jefferson City. Nearly 600 individual plants were selected for yield records and as seed sources.

Comparative yields are based on the variety Rutgers as 100. At Midway nine hybrid lines exceeded 200, fifteen were in the 150-200 groups, fifteen were in the 100-149 group and ten failed to produce as large yields as Rutgers. At Monett 40 hybrid lines were tested. One more than doubled the yield of Rutgers and 20 were in the 150-200 group. The remainder fell into the 100-149 class, none failing to exceed Rutgers. At Jefferson City, where yields were very small, one hybrid line exceeded a yield of 200, two were in the 150-200 group, eight in the 100-149 group and nine produced smaller yields than Rutgers. Greenhouse lines resistant to wilt produced yields similar to those of Break O'Day under conditions where wilt infection was not a factor in determining yields.

Mechanisms of Resistance or Immunity to Infection by the Wilt Fungus, *Fusarium Lycopersici*, and the Methods of Their Inheritance in Tomato Hybrids (C. M. Tucker, James W. Gerdemann, and Arthur M. Finley). Studies were continued on the occurrence of strains of *Fusarium oxysporum* F. *lycopersici* differing from each other in pathogenicity sufficiently to be regarded as physiologic forms. Isolations were made from infected plants possessing different types of resistance, and growing in fields heavily infested during several seasons with known types of the fungus. Single spore isolates of the two known races were used in studies on the effects of passing the organisms through different types of hosts on the pathogenicity of the isolates. Isolates were tested in the greenhouse for virulence to tomatoes with resistance of Types A and B.

The evolution of new races of parasites is a common phenomenon. It necessitates the breeding of varieties resistant to such races to reduce disease losses. The current work is an attempt to anticipate the appearance of more virulent races and to incorporate resistance in the new tomato varieties before they become generally distributed.

Variety Improvement of Tomatoes (C. M. Tucker and R. A. Schroeder). Approximately 10 acres of tomatoes were grown at Midway Horticulture Farm, in forwarding the work towards developing varieties of tomatoes possessing an

extremely high degree of resistance to fusarium wilt under this project. The yield obtained from certain selections continued to be much higher than that from commercial varieties and a few selections were released for trial to commercial growers throughout the state. Commercial growers having selections on trial were in the main favorably impressed.

Morphologic and Physiologic Studies on the Genus *Phytophthora* (C. M. Tucker). This work is maintained as a continuing project for the convenience of plant pathologists and mycologists and 53 cultures were received during the year from various parts of the world for identification.

Identification of Plant Diseases (C. M. Tucker and C. H. Kingsolver). During the year approximately five hundred letters were written in response to requests from farmers and others for information on the identity and control of plant diseases. In some instances fairly extensive experimental work was involved in identifying diseases and establishing the pathogenicity of the casual organisms. In addition, an experiment on the effects of corn seed treatment on emergence and seedling vigor of lots of normal seed and seed with injured seed coats was carried on in cooperation with other stations in the corn belt.

In St. Louis county a virus disease of Coleus, apparently undescribed, was identified. The disease is characterized by its dwarfing effect on the leaves. In the same area a root rot of Azalea caused by *Phytophthora cinnamomi* appeared. The disease was previously known only in the east and southeast. The seed corn experiment, which included four fungicides and four planting dates, indicated that all treatments used were more effective in increasing emergence and seedling vigor when the seed coats were injured than when uninjured seed was used. The oat blight caused by *Helminthosporium victoriae* proved to be widespread and damaging to oat varieties of Victoria parentage.

DAIRY HUSBANDRY

A. C. Ragsdale, *Chairman*

Nutritional Studies on Growth and Milk Production (H. A. Herman, E. W. Swanson, A. C. Ragsdale, and O. T. Stallcup). Previous experiments reported by this station on 16 heifers fed "rapid growth rations," ad libitum, which produced heifers 5 to 30 per cent above normal weight at freshening time, have shown that even though calving several months before the usual age for Holsteins (27 months in the U. of Mo. herd) they were expensive to raise and produced at a low level the first two or three lactations. This group is characterized by the deposition of considerable udder fat and in many cases have undesirable udder form. Heifers raised principally on roughages, though 5 to 10 per cent below normal size, were more economical producers and yielded equally as well at freshening time. Fourteen calves in later trials (1945-46) fed a limited wholemilk calf starch ration were not quite as large in skeletal development nor as heavy in body weight as calves fed skim milk to four

months of age. At 8 months of age there is little difference in size and condition of the two groups.

A total of 15 cows fed ground Korean lespedeza seed as a protein supplement (some of them for a full five-year period) produced equally as well as control cows consuming cottonseed and soybean oil meal. Korean lespedeza hay was found to vary greatly in its digestible nutrient content. Late cut matured hay may contain only one-half to two-thirds the nutrients of actively growing, early cut hay. This confirms earlier work that shows the stage of growth a more accurate criterion of the feeding value of Korean lespedeza hay than date of cutting.

Two veal calves were fed Thiouracil but failed to gain due to an inability to determine the proper dosage. This study will be continued.

The Endocrinology of Milk Secretion (C. W. Turner, R. A. Monroe, Victor Hurst, Joseph Meites, John Trentin, and T. Y. Liu). Under this project work was continued on the thyroxine secretion rate of lactating rats and research was initiated on the thyroxine secretion rate of growing, pregnant, and lactating mice. It was observed that thiouracil fed to the mother passes through the milk to the young but thyroxine injected is not permeable to the mammary glands. Suitable hormones incorporated in the diet of male mice have caused the growth of the mammary gland beyond the size and extent of glands of females observed at the middle of pregnancy.

A group of hens have been fed thyroprotein for six years to see if there would be any harmful effects. From every point of view, the thyroprotein-fed hens were superior. They layed more eggs and appeared to be in better physical condition. These results suggest that the continued feeding of thyroprotein to cows of advancing age may maintain yearly milk and fat production at higher levels than would be expected otherwise.

Studies in Milk Secretion (C. W. Turner, Joseph Meites, G. W. Pipes, and C. R. Blincoe). The object of this project was to stimulate the growth of the sterile cow's udder, then initiate and maintain lactation by the oral administration of hormones. The derivatives of diethylstilbestrol serve this function in part and are inexpensive. Progesterone-like compounds were used to complete the growth phase, but cheaper compounds of this type are being sought. The maintenance of a high degree of milk secretion by stilbestrol and thyroprotein offers promise.

This work confirmed the observation that lactating dairy cows excrete large amounts of male hormones. As a by-product of the research, the feeding value of dried cow manure for poultry was observed.

A Quantitative Study of the Precursors of the Constituents of Milk and the Energy Requirements of Milk Secretion (C. W. Turner, R. A. Monroe, G. W. Pipes, and Jose Cabrera). Work was initiated on the metabolism of thyroxine by the animal body as a means of explaining the losses of thyroxine

after oral administration. Further work will be required before satisfactory methods of producing hypothyroidism will be available. Of the various chemicals tested, thiobarbital appears to be most promising.

Thyroprotein has the potential possibility of increasing the country's milk supply by about 20 per cent with the present population of 25,000,000 dairy cows. Studies are intended to explain the mechanism in the cow by which this increase is affected. The goitrogenic compounds being studied will find wide adoption in the fattening of all classes of meat animals. Preliminary results indicate not only an improvement in carcass quality but increased efficiency in the use of the feed supply as well.

Energetic Efficiency of Growth and Related Transformations (S. Brody, H. H. Kibler, D. P. Sadhu, and June Cathay). This research was a continuation of previous studies on growth and metabolism of dairy cattle, rabbits, guinea pigs, hamsters, beef cattle and mules. Much work was done on age curves and energy costs of growth, gestation, and lactation.

The surface area in guinea pigs was found to vary with the 0.64 power of body weight and "Basal" and "resting" metabolism in relation to surface area was found to rise from birth to puberty, and then decline to a relatively stable level of about 700 Cal/sq. meter in guinea pigs and 1700 Cal/sq. meter in beef cattle.

Metabolism (resting maintenance energy cost) in relation to weight during growth has been found proportional to simple body weight up to puberty, then to the 0.6 power of body weight, as does surface area, indicating that increasing body weight 100 per cent increases maintenance cost only 60 per cent. Excess vitamin A administration depressed the basal metabolism and thyroid size in rats (under the given conditions) by about 20 per cent.

Energy Metabolism, Work Capacities, and Related Factors Involved in Muscular Work in Horses and Mules (H. Kibler, S. Brody, O. Miller, J. Cathay and H. Burson). This research is important because about half of the costs of animal and milk production is expended for energy and related needs.

Emphasis this year was given to a detailed study of the physiological reactions of mules during and following work, and the correlation of the speed of recovery from work with ability and condition. Marked variations were found between individual mules in the continuously recorded data for pulmonary ventilation rate and especially respiration rate; it appears that certain of these differences (the respiration rate declines rapidly after work in some mules but rises temporarily above the maximum working level in others) are correlated with work ability and endurance.

Research at Missouri has developed more extensive apparatus and methods for investigating the physiological reactions of work stock under stress than has been employed elsewhere on this work. This basic data should be of value to geneticists, physiologists, nutritionists, and air conditioning and agricultural engineers.

The Inheritance and Transmission of the Characters "Capacity for Fat Production" (H. A. Herman, A. C. Ragsdale, F. W. Madden, John Lahmeyer, Robert Spalding, Otis Horton, E. W. Swanson and J. E. Edmondson). This study of the physical and chemical characteristics of semen as correlated with fertility has been continued on 16 bulls in the station herd and some 50 sires in artificial breeding organizations. Studies have been conducted on this osmotic pressure and freezing point of various diluters used for semen.

Artificial insemination has proved practical in bringing better sires to over 5,000 Missouri dairy farmers. Studies on evaluation, dilution, and storage of semen are helping to increase the efficiency of artificial insemination. Artificial breeding using healthy bulls is a means of controlling infections.

Chief causes of wastage from the University herd have been sterility, Bang's disease and mastitis. Scours and pneumonia have accounted for nearly 75 per cent of all calf losses.

Mastitis Treatment of Dairy Cows (H. A. Herman, J. E. Edmondson, E. W. Swanson, O. S. Crisler and A. C. Ragsdale). Penicillin in saline solution, sulfanilamide (35%) in iodized mineral oil, and tyrothricin were used in routine treatment of cows in the station herd showing evidences of mastitis. All cows were treated by udder injection. More than 2,000 milk samples were diagnosed in the station herd and for several cooperating herds in the state.

Penicillin, sulvetil, and iodized mineral oil and sulfanilamide have all been successful in rendering about 85 per cent of the quarters treated free of mastitis. Penicillin has the advantage of being more easily injected and seems to be equally as effective. Silver oxide results in severe inflammation. Quarters not responding to one round of iodized mineral oil and sulfanilamide are exceedingly difficult to render free of streptococci and later diagnosis show the presence of streptococci so it appears that some streptococci are of a sulfa-resistant strain.

Mastitis in dairy cattle can be successfully controlled by good herd management and milking procedures. Infected quarters, of not too long standing may be rendered free of streptococci agalactice by udder infusions of penicillin, sulfanilamide in iodized mineral oil, or tyrothricin in some 80 per cent of the cases. Mastitis results in the destruction of some secretory tissue of the udder and milk production is lowered.

Hatch Dairy Experiment Station (R. E. Leighton, A. C. Ragsdale and J. R. Dawson). Studies were continued in the production and utilization of alfalfa-brome grass mixtures for silage and pasture and in the improvement and utilization of native blue grass pastures. An experiment studying effective concentration of DDT for fly control was conducted and further work was done in the use of blood transfusions for the control of intestinal infection in calves.

Artificial insemination was used in an effort to rid the herd of Vaginitis

and much progress has resulted. During the breeding season, 1945-46, 19 cows required 46 natural breedings before conception while during 1946-47 the same 19 cows conceived from 22 artificial inseminations. The seventeen virgin heifers conceived from twenty breedings.

The first daughters in the herd of the proved bull, Forfarshire Fauvic Prize, came into production and without exception the first eight of these daughters produced more butterfat than did their dams during the corresponding period of their first lactations.

In research with DDT it was found that a water emulsion containing only .25% DDT in a wettable powder was just as effective in controlling flies on the cattle as a stronger concentration of 2.5% DDT.

Alfalfa-brome grass fields yielded an average of 3295 pounds of digestible nutrients per acre in silage and pasture during the 1946 season. The blue grass pastures produced 1463 pounds of digestible nutrients per acre in pasture. On the basis of alfalfa hay prices, these digestible nutrients were valued at \$3.00 per hundredweight, or \$98.85 per acre in the alfalfa-brome grass fields and \$43.89 per acre in the blue grass pastures.

To date, 26 calves have been given 200 cc. of their dam's blood within 24 hours after birth. None of these have died from intestinal infections and only two from pneumonia. Fourteen calves were not given the blood and three of these died from intestinal infection. There has been some indication that the blood from some animals may not be as effective in controlling the disease as is the blood from other animals. One calf took the disease after receiving the dam's blood and was given another 200 cc. of blood from the same cow. Its condition gradually became worse, but it recovered rapidly after receiving blood from a full sister to its dam. This question is being investigated further.

This is part of the Jersey herd at the Hatch Farm.



Standardization of the Acidity of Milk in the Manufacture of Cheddar Cheese (W. H. E. Reid, J. E. Edmondson, L. O. Galyen and P. J. Ward). This investigation involves a study of the manufacture, aging and keeping qualities of cheddar cheese made from milk standardized at various acid levels, using variable amounts of starter and time intervals of ripening. A total of 28 batches of cheese was manufactured at five different acid levels.

It was found that cheese manufactured at an acidity of .20% showed greater flavor development than cheese manufactured at lower acid levels. Milk standardized at acid levels above .10% showed normal coagulation and acid development throughout the entire manufacturing process while milk standardized at .10% acidity and at lower levels showed the decrease in the acidity at time of coagulation and resulted in cheese with lower score values. Thus, the flavor differences seemed to be due more to the acidity of the milk before coagulation and the acidity development during the manufacturing process.

The use of high percentage of starter and especially the use of amounts above 5 per cent resulted in the production of inferior quality cheese. The use of high quality milk resulted in the production of superior quality cheese.

This project was designed to study the practicability of standardizing the acidity of milk prior to the application of the actual cheese making process thereby giving the manufacturer a more uniform starting acidity and thus permitting greater standardization of the manufacturing process.

The Effect of Pasteurization on the Stainability of Bacteria of Milk (J. E. Edmondson). This work shows that there is a decrease in the number of stainable bacterial cells in milk following pasteurization. The percentage of stainability depends upon the types of bacteria present in the milk before pasteurization. Effects of pasteurization upon the stainability of bacterial cells causes a variation in the microscopic count of pasteurized milk and so may not give the exact condition of the raw product before pasteurization. Such information will be an invaluable aid to the plant operator in the problem of quality control and give the milk sanitarian a better picture of the milk supply.

New Uses of Whey Solids (W. H. E. Reid and J. H. Gholson). This investigation involves a study of the use of spray process whey powder in the manufacture of different flavored ice creams with special attention directed to its effect upon processing, procedure, freezing, hardening and dipping of the ice creams. Its effect upon the physical properties of the ice cream is included.

The studies thus far are of a preliminary character. The use of whey solids up to 10 per cent which was the maximum added does not appear to effect the usual procedure practiced in compounding, processing, freezing or hardening of the ice creams manufactured. There was no apparent difference in the texture or body of the ice creams. When 10 per cent of whey solids were added a slight heat flavor was apparent but was not considered objectionable.

ENTOMOLOGY

Leonard Haseman, *Chairman*

Missouri Ticks and Their Control (Roland W. Portman, Philip C. Stone, and Leonard Haseman). Ticks are recognized as the worst pest we have on livestock in the Ozarks and a practical pasture-management or an economical dipping program or combination of the two will result in savings of thousands of dollars to the dairy and beef industries in this region, to say nothing of the added value of safeguarding the health of native people and vacationists in that area from the two tick-borne diseases, Rocky Mountain Spotted Fever and Tularemia.

The most effective method of controlling proves to be a dipping solution of $\frac{1}{2}$ per cent solution of benzene hexachloride ("666"). It proved not only effective in killing all ticks present on the animals, but the treatment continued effective in keeping animals free of lone star ticks for a week or longer after each dipping. The one vat used in this year's experiment on the Bright Elbow Ranch (Charles B. Reger) was filled in May and used effectively throughout the season without adding any material. In December when animals were dipped for the black-legged tick it was still effective against all stages of this tick and also cattle lice.

Insecticide Investigations (Lee Jenkins, Roland W. Portman, Harry E. Brown, Philip C. Stone, Curtis W. Wingo, Wilbur R. Enns, and Leonard Haseman). Work and research this year was largely confined to DDT and other new residual type insecticides. Various formulations and their effect on a wide range of insects were tested.

Ten per cent, five per cent and three per cent DDT dusts on strawberries controlled the tarnished plant bug under conditions of heavy infestation with no apparent ill effects to the plant. Three per cent DDT dust applied to the stem, root and ground around the plant at weekly intervals gave satisfactory control of the pickle worm on crookneck squash.

Water wettable DDT preparations for ear treatment in corn earworm control were found to be unsatisfactory. Snap beans dusted with 3 per cent DDT showed definite leaf injury, but the infesting bean leaf beetles were controlled.

Both sucking and chewing lice on goats were controlled with a single application of 10 per cent DDT dust, while sheep ticks and biting lice infesting sheep were controlled with 0.5 per cent DDT spray on sheep having a fairly full coat of fleece.

A proprietary product containing piperonyl cyclohexanone when applied to horses working in the field repelled horse flies (heavy infestation) for a maximum of seven hours.

In the orchard 5 per cent "1068" dusts and sprays ($\frac{1}{3}$ gallon 50 per cent emulsion in 100 gallons water) gave protection from heavy grasshopper infestations for thirty days.

Two 10 per cent benzene hexachloride dusts applied 25 to 30 pounds per acre to soybeans at 14-day intervals saved the crop from complete destruction and allowed a good set of beans to develop. "1068" applied at the same rate under the same conditions gave slower but more complete kill with longer residual effect.

A dip containing 0.5 per cent "666" killed lone star and black-legged ticks on cattle and the cattle remained free of ticks for at least seven days.

Sulfa Drugs for Controlling American Foulbrood of Bees (Leonard Haseman). Missouri's sulfa drug control for American foulbrood, a world-wide disease of bees for which previously there had been no safe control, in the last two years has taken the beekeeping world by storm. Within a year after announcing the discovery in Missouri Agricultural Experiment Station Bulletin 482 most of the larger honey producers of the United States and Canada had used it successfully in their apiaries. Now Europe, Russia, Egypt, Australia, South Africa and other honey producing countries are asking for information and beginning to use the treatment. Already this new control has saved thousand of colonies of bees and has returned hundreds of thousands of dollars to the beekeeping industry. No other recent discovery in the world has meant so much to the honey producing industry in this and the other states of the Union.

During the year further experiments were made with sulfathiazole and sodium sulfathiazole, also with sulfaguanidine. Likewise preliminary tests were made with the two antibiotics, streptomycin and penicillin. These materials were fed in sugar syrup to different colonies of bees each of which were given combs containing decaying grubs and dried "scales" infected with American foulbrood. To the gallon of sugar syrup was added the different materials as follows: Sulfathiazole, $\frac{1}{2}$ gram; Sodium Sulfathiazole, $\frac{1}{3}$ level teaspoon of the powder; Sulfaguanidine, 1 gram; Streptomycin, $\frac{1}{10}$ gram; and Penicillin, 20,000 units.

Investigation of DDT Toxicity to Livestock and Poultry (L. Haseman, C. W. Wingo, and S. Kyd). In this test day old chicks safely tolerated DDT in the diet in amounts less than 5 parts per 10,000 parts of feed. Death resulted from feed containing 10 parts (or more) per 10,000 parts of feed. Chicks receiving less than a lethal dose of DDT apparently recovered fully. This research shows that DDT, in the water-wettable spray or dust form, may be safely used around poultry as an insecticide if normal precautions and safeguards are used.

Dairy cows receiving oral doses of DDT (34 mg. per kg. of body weight and 8.5 mg. per kg. of body weight) equivalent to amounts they might receive from eating treated forage and from spray applications for insect control, showed no external symptoms of DDT intoxication. Milk from these cows contained some toxic substance, presumably DDT, as evidenced by bio-assay using houseflies as test animals. The dairy animal tests show the cautions to

be used in feeding the dairy cattle forage which has been treated heavily with DDT dust or spray.

Codling Moth Investigation and Control (Lee Jenkins, Curtis W. Wingo, Wilbur R. Enns, and Leonard Haseman). DDT alone or in combination with lead arsenate or nicotine is saving Missouri apple growers thousands of dollars worth of number one apples which in former years were wormy and used for cider. This year's apple crop was one of the cleanest in many years. During the year further tests were made with DDT alone and in combination with other insecticides and fungicides.

A number of materials were tested for red spider control in the orchards. Two new contact insecticides known as "666" and "1068" were tested for grasshopper control in orchards. Both "666" and "1068" were promising as a contact insecticide for grasshopper control. The 5 per cent "1068" at 25 to 30 pounds of dust per acre were effective over a longer period of time than the "666", protecting a treated area from grasshoppers for a 30-day period.

Omilite (Latex) furnished by the B. F. Goodrich Company at 2 pounds of 40 per cent Latex per 100 gallons caused considerable loss of foliage when used as a sticker and combined with lead arsenate, DDT or nicotine. Codling moth control using nicotine sulfate with omilite instead of bentonite and oil gave only about one-half as much clean fruit as tank mix nicotine. In combination with Black Leaf 155 the control was almost as good as 155 and two quarts of oil. Four pounds HE-761 from Rohm & Haas in combination with two quarts of oil gave codling moth control about equal to DDT, but caused severe russetting of the fruit. Neither fermate at 1 pound per 100 gallons all season nor 4-6-100 bordeaux in sixth, seventh and eighth covers caused any noticeable reduction in codling moth control when combined with DDT.

Lead arsenate, 2 pounds, plus 8 ounces 50 per cent wettable DDT gave codling moth control nearly equal to 2 pounds of 50 per cent DDT. The addition of fermate to the above combination reduced codling moth control but was still some better than lead arsenate alone.

Services Rendered Farmers (George D. Jones, Lee Jenkins, Roland Portman, Curtis W. Wingo, Philip C. Stone, Harry E. Brown, Wilbur R. Enns, and Leonard Haseman). In insect control work to be fore-warned is to be fore-armed, so each year it is essential that seasonal surveys are made on the major pests, grasshoppers, chinch bugs and Hessian fly. These surveys indicate the extent of potential danger from these three pests in most of the more important corn and wheat growing counties of the state.

Much work was done on the promotion of the state and nationwide use of the new sulfathiazole control for American foulbrood of bees.

Calls for information on the use of DDT were unusually heavy and thousands of insect bulletins were sent out to assist with the control of the various insects.

FIELD CROPS

W. C. Etheridge, *Chairman*

The Improvement of Pastures (E. Marion Brown and Joe D. Baldrige). Continuation of research at this station on the improvement of pastures was divided into three sub-projects. They were improving permanent pastures with legumes, interaction between species and mixtures, and testing and improvement of pasture species.

It was shown that the productivity of both new and old pastures can be increased by adding legumes to them. Grass-legume mixtures yielded from 2 to 5 times as much as pure stands of grass. On badly depleted soils treated with phosphate and lime, gains by beef cattle were 265 pounds an acre on red-top and lespedeza, 230 pounds on timothy and sweet clover, 178 pounds on tall fescue and lespedeza, and 166 pounds on orchard grass and lespedeza as compared with 238 pounds on wheat and lespedeza. On good grassland, cattle gained 268 pounds an acre, on brome grass, lespedeza, and alfalfa, 249 pounds on blue grass treated with ammonium nitrate, and 208 pounds on blue grass and lespedeza as compared with 308 pounds on wheat and lespedeza.

Birdsfoot trefoil appears to be well adapted to grow with perennial grasses on all soils and Ladino clover on the better soils. Korean and Kobe lespedeza can be more easily and cheaply established in grass sod, but because of their annual growth habit, require skillful management for maintenance of stands. Sweet clover is useful for the quick improvement of run-down permanent pastures, but maintenance of stands for more than 2 years is difficult.

Blue grass pastures were improved materially by establishing and maintaining Korean lespedeza in the sod. Better stands of lespedeza resulted from the initial seeding and more nitrogen was made available to the grass by the lespedeza when the seed and soil were thoroughly inoculated with rhizobium of the cowpea group.

In the testing and improvement of pasture species tall fescue was found to be well adapted to well drained upland soils in northwestern Missouri; to land subject to overflow, to well drained bottom land, to poorly drained upland and to infertile clay-pan soils of central Missouri; to very poor, rocky, sparsely wooded land of the Ozarks; and to light sandy and to heavy gumbo soils of the southeastern Missouri lowlands. It was less palatable during mid-summer but more palatable during late fall than other grasses.

Tall fescue, because of its adaptability to a wide range of soils, should be grown extensively in Missouri as soon as the seed supply becomes adequate. The usefulness of orchard grass in permanent pastures is limited by the short duration of the stand.

Improvement of the Missouri Soybean Crop (B. M. King). Yield tests were conducted on a total of 315 of the most promising varieties and strains

developed by the Missouri Experiment Station and other agencies. Southeast Missouri is one of the large soybean producing sections of the nation and among the more promising varieties developed at Sikeston are Dortchsoy #2 and Ogden. These are late types. S-100, a new strain developed by the Missouri Experiment Station, led the yield in the test of medium late types at the southern locations.

Missouri's average annual soybean yield has increased approximately 10 bushels of seed per acre during the past decade. A substantial part of this increase can be attributed to the widespread use of superior adapted varieties recommended by the Missouri Experiment Station.

Breeding Better Oats for Missouri (J. M. Poehlman). The value of early oats for Missouri conditions has long been recognized and varieties resistant to rusts and smuts are now being widely grown, some in Missouri. For instance, there are not any varieties that combine earliness and resistance to these diseases. Therefore, the new high-yielding selections or varieties being developed at Missouri should be superior for Missouri farmers. They will help protect the oat crop from damage in a hot dry season, and also from loss in seasons when these diseases are present.

Thirty-six varieties and selections were grown in nurseries at five locations in Missouri. Of the new selections, 22 were from the cross, Columbia x Victoria-Richland, and 8 from the cross, Columbia x Bond-Iogold. These selections combine earliness and resistance to rusts and smuts. Information was obtained about yield, test weight, maturity, lodging, per cent smut and height.

New high-yielding varieties and selections of oats are being developed and tested.



The 1946 season was the most favorable oat season in Missouri for many years and nursery yields were high. The variety 04014 Columbia x Victoria-Richland yielded 82.7 bushels per acre and had only one head of smut. The variety 04016 Columbia x Victoria-Richland yielded 97.6 bushels and had no smut. Variety 040456 Columbia x Bond-Iogold yielded 111.5 bushels and had three heads of smut. For comparison, the Columbia oats yielded 81.9 bushels and had 72 heads of smut and the Boone yielded 80.6 and had no heads of smut. The season was unfavorable for the development of rust.

Breeding Winter Barley for Missouri (J. M. Poehlman). New selections of winter barley being studied at this station are now producing grain yields 25 to 20 per cent greater than varieties now being grown. Yield increases of this magnitude will greatly enhance the value of the barley crop to the Missouri farmer.

Thirty-six varieties and strains of winter barley were grown in yield variety tests at Columbia, Perryville, and Lathrop. Approximately 2000 new selections were grown in head rows, from which 200 were harvested for additional testing. Among the new varieties showing the most promise are B595, a Kentucky 5 x Early Beardless cross which yielded 45.4 bushels per acre, and B574, Admire x Early Beardless cross which yielded 44.8 bushels per acre, compared with Missouri's Early Beardless which yielded 29.5 bushels per acre. The Reno, a common variety now grown, had 66.4 per cent ground loose smut compared with 5.2 per cent for the Kentucky 5 x Early Beardless cross. These comparisons emphasize the importance of selecting varieties which are resistant to smut.

Improvement of Soft Red Winter Wheat in Missouri (J. M. Poehlman). The Clarkan variety, now the most important wheat variety in Missouri, is high in yield and test weight but is susceptible to loose smut and leaf rust. Early Premium, also grown in Missouri, is early and high in milling quality but is low in yield. The development of new varieties, improving these qualities of Clarkan and Early Premium, would add to the value of the Missouri wheat crop.

During the year five wheat yield nurseries were grown as follows: (1) early varieties, (2) Eastern uniform soft wheats, (3) miscellaneous varieties, (4) selections from Kawvale x Early Premium, (5) selections from Mediterranean, Dunbar and Fultz. Data and notes recorded on these nurseries included yield, test weight, survival, date headed, height, leaf rust, loose smut, and pearling. Three disease nurseries were grown, spring and winter wheat rust nurseries, and a loose smut nursery. The latter included 362 varieties and selections, all of which had been inoculated with loose smut by artificial inoculation. An artificial epiphytotic of leaf rust was started to facilitate the testing of resistant and susceptible selections to this disease.

Clarkan continues to lead in yield and test weight among commercial varieties, but among the new selections being tested a large number could be

found that surpassed Clarkan. Among the new selections is one from a cross of Kawvale x Early Premium that is early, short strawed, and resistant to loose smut. In nursery tests over a six-year period, it has produced an average yield of 31.3 bushels. Yields of standard varieties for the same period are: Early Premium, 21.1 bu., Clarkan, 28.4 bu. and Kawvale, 27.6 bu.

Management of Short Rotations (C. A. Helm). This project was a study of crop management practices using one-year rotations of wheat-lespedeza and oats-lespedeza. Total production of the small grain-lespedeza short rotation continues high.

At Lathrop, oats produced 66 bushels of grain per acre and lespedeza in the oat stubble matured a seed crop of 840 pounds per acre. At Columbia, after harvesting a 37-bushel crop of oats, a yield of 1.2 tons of lespedeza hay was removed in time to permit sufficient reseeding of the lespedeza for renewing the stand for the next season.

Because of a poor season wheat in these rotations was generally low in production during 1947, averaging only 12.2 bushels per acre. However, this low yield was followed by 90 pounds of cattle pasture gain from lespedeza pasture on the same land.

HOME ECONOMICS

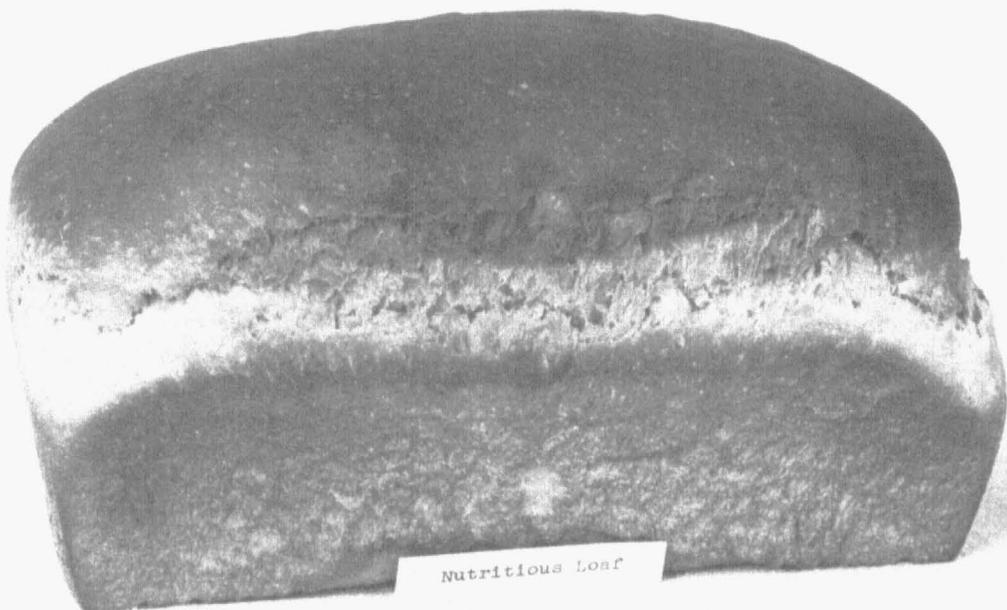
Florence Harrison, *Chairman*

Improvement of Soft Red Winter Wheat in Missouri. This is a continuation of an investigation to see to what extent wheat variety and soil fertility influence the baking performance of Missouri soft wheat flours. During the year mixogram curves and baking test on thirty flours from 1945 wheats were completed. It was found that soil fertility treatments of Clarkan and Poole varieties grown at Columbia had no significant influence upon the suitability of their flours for cakes.

These findings support those of previous years that variety of wheat has marked influence upon the qualities of cake flours. Baking and other laboratory tests used in this study indicate that locality and soil treatment are less significant in the production of quality flours than the choice of suitable varieties.

Investigation of the Nutritive Value and Chemical Analyses of the Nutritious Loaf (Elizabeth Hamilton Camfield, Bertha Bisbey, and Adelia Weis). Study on the nutritious loaf at Missouri began in November, 1944, and was completed this year. Biological assays were made to determine the effect of adding: (a) calcium lactate and (b) calcium lactate plus cod liver oil, to the nutritious loaf diet. The baked loaf was analyzed: (a) chemically for protein and calcium, (b) fluorometrically for thiamine and riboflavin and (c) micro-biologically for riboflavin and niacin.

The nutritious loaf was found to be a means of using quantities of de-



A one-pound nutritious loaf furnishes one-half the daily nutritive requirement of a moderately active man, with the exception of vitamin C.

hydrated eggs and milk, which might be expected to have considerable economic importance to the producer. A one-pound loaf furnishes one-half the daily nutritive requirement of a moderately active man, with the exception of vitamin C. Such a food would be a valuable contribution, especially in a situation in which a variety in foods is very limited. It is suggested as an excellent food for school lunches.

Reproduction records show that the survival time of rats of the first generation on the loaf diet or on the stock diet was comparable. Those fed the stock diet grew faster, reached maturity earlier and were slightly heavier than those fed the loaf diet.

No significant differences were observed in the average gains of young rats fed: (a) the loaf, (b) the loaf plus calcium lactate or (c) the loaf plus calcium lactate plus cod liver oil. The average gains during the 5-week period were 76.5, 75.2, and 74.3 gms. respectively. The average gain for those fed the stock diet was 129.6 gms.

The nutritive value per gram of dried loaf was 0.157 gms. protein, 0.00153 gms. calcium, 4.37 micrograms thiamine, 4.66 micrograms riboflavin (fluorometric), 4.76 micrograms riboflavin (microbiol.), and 41.9 micrograms niacin. These values agree closely with those calculated from tables.

The Effect of Handling on the Vitamin Content of Dehydrated Eggs (Adelia Weis, Bertha Bisbey, Corinne Whitford, Carmel Pickering, Kathryn Summers). Missouri ranks high in poultry and egg production and during seasons of heavy egg production the market value of eggs is normally greatly

decreased. Methods of preserving this surplus of eggs, to be used during the period of minimum production, would tend to stabilize egg prices. Therefore the study of the nutritive value of dehydrated eggs, one method of preserving them for future use, is very important.

Vitamin A. Biological assays showed no significant differences in growth of rats receiving fresh eggs, freshly dried eggs or freshly dried scrambled eggs. Eggs stored for 6 months at 35-40°F. or 70°F. lost approximately 50% of their original vitamin A potency, those stored at 100°F. for 6 months lost 82%. There was no further loss of vitamin A in the eggs stored for 12 months at 35-40°F., but at 70° and 100°F. more loss occurred. The loss in the two latter groups was 67 and 88% respectively. Carotene losses were observed to increase as the storage time was lengthened. Higher storage temperature caused the greater destruction.

Thiamine. Biological assays using the rat growth method showed: (1) that fresh liquid eggs contained the same amount of thiamine per gram (dry basis) as the freshly dehydrated eggs, 4.7 micrograms; (2) no significant differences in growth response to freshly dehydrated eggs or dehydrated eggs stored at 35-40° or 70°F. for 3 months, but significant differences in growth response of either of these two compared to those stored at 100°F. for 3 months; and (3) a loss of 45% of the original thiamine content of the dehydrated eggs stored for 3 months at 100°F. There was no further loss in thiamine at 6 or 12 months storage at 35° F. or 70°F., but at 100°F. further loss occurred. No cases of polyneuritis developed in rats fed 4.5 grams per rat per week of dried eggs stored either at 35° or 70°F. for 6 or 12 months while at 100°F. 75% and 50% of the rats developed polyneuritis.

Riboflavin. Comparable results were obtained with biological, fluorometric, and microbiological methods. Average riboflavin values in micrograms per gram of dried eggs were: Freshly dehydrated 17.0; 3 months storage 11.5, 11.9, 10.3; 6 months storage 12.0, 12.4, 12.4; and 12 months storage 12.4, 12.0, and 13.2 for the temperatures 35-40°, 70°, and 100°F. respectively for each storage period.

HORTICULTURE

T. J. Talbert, *Chairman*

Food Preservation Studies (A. E. Murneek, A. D. Hibbard, and Ferne Bowman). This project on vegetables and fruits was run in cooperation with the Home Economics Department. Green beans, sweet corn, lima beans, soybeans, and peas were grown on the station grounds, processed and placed in frozen storage at temperatures of -12°C ., -18°C ., and 24°C . The products were removed at intervals of one, three, six, nine, and twelve months. After cooking, without seasoning, palatability was determined by a panel of judges from the departments of Home Economics and Horticulture. Comparisons of hot water and steam blanching for soybeans and snap beans, also on storage of sweet corn, cut and on-the-cob, were made under the conditions of temperatures and time indicated above.

Blakemore strawberries and Montmorency cherries were processed in dry sugar (1 to 4) and stored at the same temperatures given for vegetables. The defrosted products were judged at three month intervals during the storage period. The peaches were frozen in 100% "Sweetose," 50% sucrose, sucrose plus .25% ascorbic acid, and sucrose, ascorbic acid plus .5% citric acid, syrups and stored at -18°C . The frozen peaches were defrosted and judged at three month intervals. The apple varieties Jonathan, Wealthy, Golden Delicious, York, and Winesap were treated with the following blanches after slicing: weak (1.5%) cool brine, hot 50% sucrose syrup alone, and with the addition of ascorbic acid, and with a mixture of ascorbic and citric acids. The slices were packed dry with sucrose and stored at -12°C . The product after cooking was judged at three month intervals.

A storage temperature of -12°C . is too high for frozen storage of the vegetable products studied. The differences between products stored at -18°C . and -24°C . were not great after twelve months. The hot water blanch was very much superior to steam in retaining the color in green snap beans. Corn cut from the cob was superior to corn on the cob. The pea varieties Thomas Laxton, Wando, Cody, Wyola and Glacier made better frozen products than the other varieties in the test. Laxton Progress made the best frozen product. Among the snap bean varieties Tenderpod was outstanding. Desirable products were produced from Tendergreen and Commodore. After nine months strawberries and cherries had deteriorated at the highest storage temperature. The cherries at -24°C . were slightly better than the others.

There was a definite improvement in the frozen peaches stored with ascorbic acid or a mixture of ascorbic and citric acids. The citric acid was of value in retaining the red color around the pit. The use of sucrose alone or "Sweetose" alone did not produce a satisfactory product. The varieties Eclipse and Belle of Georgia were given the highest scores by the judges. All of the varieties produced a desirable product with ascorbic acid. Apple slices blanched in

ascorbic acid or a mixture of ascorbic and citric acids showed no browning upon defrosting and cooking. Blanching in weak brine or hot sucrose syrup was less desirable since browning and the development of off flavors was not prevented. With tart varieties ascorbic acid alone seemed to be more desirable than the acid mixture. Golden Delicious and Jonathan produced the better frozen products.

New Sprays and Spraying Methods (H. G. Swartwout). Several new organic fungicides (puratized agricultural spray, fermate, isothan plus orthex, omilite and a puratized-fermate combination) were tested on apples for the control of scab and cedar rust this year. Spray tests were also made on cherries, grapes, and black raspberries.

Three years' results with fermate have shown that when it is thoroughly applied fermate will give essentially as good control of black rot of grapes as bordeaux mixture without the risk of injury that bordeaux sometimes causes. It is effective in controlling shoot or cane lesions ("carry-over") as well as fruit rot. It has been used under a wide range of weather conditions with no injury or with no more than a trace. It is in rainy weather favorable to black rot that protection is most needed. Puratized agricultural spray showed especial promise for the control of shoot lesions.

A delayed dormant (green tip) spray of lime sulfur, 1 to 7, followed by two summer applications of fermate has given excellent control of raspberry anthracnose with less injury than usually results from summer sprays at 10 to 12 day intervals.

In the control of cherry leaf spot, the copper fungicides or programs which included a copper material were more effective than the sulfur or the all-organic fungicide programs with the exception of fermate plus omilite. The fermate-omilite combination was highly effective.

Lime sulfur in the first scab spray followed by fermate at 1½-100 later, gave excellent control of scab. It was equal to the standard sulfur program of lime sulfur in the first scab spray followed by microfine wettable sulfur later. Omilite and isothan Q15 plus orthex were less effective than the sulfur fungicides; puratized and puratized plus fermate were more effective. Both puratized programs gave almost perfect scab control.

Nutrition of Vegetables and Their Dietary Value as Influenced by Soil Treatments (R. A. Schroeder and V. N. Lambeth). This project was continued using the "colloidal clay procedure", and particular attention was paid to the influence of nutrient-element balance upon the growth and chemical composition of the crop. The number of nutrient-element combinations varied with the individual vegetable, ranging from 95 treatments in the case of kale to 18 treatments for leaf lettuce. Limited funds and time did not permit complete chemical analysis of all the crops grown.

The fact that the balance between the nutrient-elements control to a very great extent the type and rate of development made by the individual plant

was demonstrated and emphasized by each crop grown. In general the total growth of the crop was either increased or decreased by increments of nitrogen or potassium as dependent upon the level of other nutrients. Increments of phosphate and calcium can result in increased growth but are not nearly so likely to result in decreased growth intensity as are increments of nitrogen and/or potassium. Previous data showing that the vitamin C content of leafy vegetables is decreased by nitrogen increments were further substantiated.

Spray Injury and Its Control (H. G. Swartwout). A special study was made of DDT injury to apple foliage. Three types or forms of DDT injury were observed on apple leaves. One was a purplish coloration on the under sides of the leaves. Another was a chlorotic mottling with the leaves soon falling. The third was in the form of brown scorch-like spots. Injury developed during a period of high summer temperatures, mostly during a period when the maximum temperatures were above 100°F. Stayman Winesap appeared to be the most susceptible of common varieties to injury from DDT alone. Black Twig and Ingrams also showed considerable injury from DDT alone. In special test blocks, 2 pounds of 50 per cent wettable DDT with summer oil caused moderately heavy to very severe injury to Jonathan, Golden Delicious and Stayman Winesap with moderate to heavy leaf drop. With only ½ pound of 50 per cent wettable DDT, injury was considerably less but greater than with DDT alone. DDT in combination with fermete caused very little if any more injury than did DDT alone. The use of ¼ pound hydrated lime with 2 pounds of a 50 per cent DDT wettable powder and oil mixture reduced injury somewhat but did not entirely prevent it. With a special DDT formulation used in combination with oil no injury developed until after the fourth application and even then it was light. No injury resulted in the special tests where oil sprays followed previous applications of DDT but in these tests the temperature at the time the oil was applied was below 100°F.

High summer temperatures seem to be an important factor. Trees with a dense foliage have shown injury with considerable leaf drop while rather open trees were not affected. There also appears to be, in some cases at least, a difference in variety susceptibility.

Physiology of Reproduction in Horticultural Plants (A. E. Murneek and assistants). Investigations were continued on the use of various synthetic growth substances (hormones) for improvement of fruit set and outdoor grown tomatoes, varieties Marglobe and Break O'Day. Hormone treatments also were applied to replicated rows of spring and summer crops of Tendergreen, Tenderpod and Sure Crop Wax varieties of bush snap beans.

With the spring crop of Tendergreen variety of beans significant yield increases above controls were obtained from dusts of 50 ppm. of p-chlorophenoxyacetic acid, 12 ppm. of beta (o-chlorophenoxy) propionic acid and 12 ppm. of 2,4,5-trichlorophenoxypropionic acid were effective in increasing yields. A 3% DDT dust used alone, without hormone, gave a 15% yield in-

crease. No crop increases were obtained from hormone treatment of the spring planting of Tenderpod variety, but the yield of a summer crop of this variety was increased 35% by the use of p-chlorophenoxyacetic acid at the concentration of 2 ppm., in water solution and at 50 ppm., in Pyrax talc and in 3% DDT. Increases in yield of the Sure Crop Wax bean, due to hormone treatment were comparable to the Tendergreen bush snap bean.

No increases in yield were obtained of tomatoes, grown under field conditions, from any of the listed hormone treatments. Contrary to greenhouse culture requirements tomatoes raised outdoors during summer apparently set well without the help of hormones.

Potato Research (V. N. Lambeth and R. A. Schroeder). The rates of fertilizer application were much higher this year than in previous testing, 4 tons of 10-6-4 an acre being heaviest application. Field fertilizer studies demonstrated again the necessity of heavier applications of nitrogenous fertilizers. Also that in order to obtain a proper nutrient-balance the potash applications should be reduced. Heavy phosphate applications were essential in order to obtain the maximum benefit from the increments of nitrogen and to establish a proper balance with available potash. The severity of Sand Rust was decreased upon plots receiving heavy nitrogen fertilization.

Greenhouse tests using "colloidal clay" procedure established the value of nutrient-element balance in that the growth rates of potatoes were markedly affected. Sand Rust was also completely eliminated with certain soil treatments. The 1946 record potato crop in the state was partly due to the use of complete fertilizers of high nitrogen content and top-dressing with nitrogen fertilizers during cultivation as recommended by the Missouri Experiment Station.

Severity of Sand Rust was decreased upon plots receiving heavy nitrogen fertilization.



Missouri Queen (A. D. Hibbard). The principal result of this season's work and the research carried on at the Horticulture Experiment Field at Gibson, Missouri, was the release to seedsmen and growers the new wilt-resistant variety of watermelon named the MISSOURI QUEEN.

The introduction of this variety makes possible the return of watermelon production to many acres of Southeastern Missouri land that had been abandoned for watermelon production because of the wilt disease.

Horticulture Experiment Fields, Campbell, Missouri (A. D. Hibbard). During the year work on the fertilization and spraying of grapes was started at the Campbell field and a new eleven-acre peach orchard for the study of soil management and erosion control was laid out and planted.

The research work on soil management, spraying, pruning and so forth of peaches and apples was continued.

It was found that winter legumes, hairy vetch and crimson clover, returned the largest yields of peaches while trees under clean cultivation fell behind in growth and production. Erosion was more severe on these clean cultivated plots.

In the pruning and spraying work it was found that 9-year trees receiving corrective pruning continued to out-yield those given the recommended amount. Fermate and zerlate were effective in controlling peach diseases but showed no advantage over sulphur. Limited cultivation of the young peach orchard until the ninth year at least with summer or winter legumes is conducive to higher yields and better tree growth than continuous cultivation throughout the growing season. It was found that there was an 80% saving in the cost of thinning the peaches by using the pole method.

Spraying grapes with fermate produced a crop as free from Black Rot as a regular bordeaux spray. The use of various fertilizers on grapes produced no noticeable results except that nitrogen containing fertilizers aggravated uneven ripening.

Fertilization studies showed that blocks receiving a complete fertilizer continued to give increased yields. Vitamin C content of the fruit was depressed with heavy nitrogen fertilization and both yield and Vitamin C content were high with complete fertilization.

Christmas Trees as a Crop (R. H. Peck and C. M. Bowen). Christmas trees are in demand in Missouri as in all other states. Most of the trees sold in the state are grown elsewhere, are cut early, and arrive at the market partially dry. Desirable Christmas trees can be produced in Missouri as a farm crop and this research is to select the best methods of growing and harvesting these trees under Missouri conditions.

Seventy-four Christmas trees ranging in size from three feet to twelve feet were removed from the plantations in the second systematic harvest. Observations were made on the rate of recovery of stems from which two hundred seventy-six trees were cut last season. This study will be continued.

Controlling Pine Tip Moth (C. M. Bowen). Windbreaks and Christmas tree plantations are often damaged seriously by the pine tip moth by stunting and deforming the trees. A small amount of DDT applied at the proper time when the trees are small makes an effective, inexpensive, and simple method of control.

Sub-Irrigation Nutrient Culture for Greenhouse Crops (James E. Smith, Jr.). This work at Missouri has dealt primarily with adapting the Missouri concrete greenhouse bench to this cultural procedure and developing a construction that would safeguard against flooding of the crop's roots and possible subsequent loss. Three methods of waterproofing the bench were set up: 1, Down-spout in trough; 2, Roll-roofing tray laid in the bottom of the bench with a row of 4-inch farm drain tile used also for conducting the water.

A bench of roses was grown two years in the bench equipped with down-spout in troughs with very satisfactory growth and a saving of at least 75 per cent of the usual amount of water, better than 50 per cent of the normal fertilizer application, and a 90 per cent saving in labor required for the watering operation.

A bench of tomatoes was grown to maturity in the old roll-roofing tray method. They were a desirable commercial product and were produced at savings comparable to the roses. No results are available on the modification method.

POULTRY HUSBANDRY

H. L. Kempster, *Chairman*

Keeping Quality of Eggs (E. M. Funk). It is estimated that the value of shell eggs in the United States is decreased by 10 to 20 million dollars annually because of soiling. Soiled shell eggs constitute a serious marketing problem particularly in the general farming regions where most of the eggs are produced. This project began in 1941 and has just been completed with several processes to improve the keeping quality of eggs having been developed during that time.

The process of thermo-stabilization provides the industry with a better means of preserving the quality of shell eggs than any other method developed to date. This process has the following features:

1. The thick white of an egg is stabilized and such eggs retain their fresh appearance longer than untreated eggs.
2. Fertile eggs are devitalized and, therefore, react as infertile eggs. This prevents any spoilage from embryonic development which might occur at high temperatures.
3. Such eggs are protected against spoilage in storage as a result of a pasteurizing effect of this process.

A process was also developed for cleaning soiled shell eggs by the use

of a one per cent lye (Na O H) solution which reduced losses during an 8 months storage period to less than one per cent which is negligible and the equivalent of normal loss in clean eggs.

Another process developed for cleaning soiled eggs was by washing eggs in water held at 130°F. to 140°F. This process also reduced spoilage to a minimum and approximately to the loss which occurs in clean eggs.

Prevention of Spoilage in Eggs by Their Bacterial Content (E. M. Funk). During the year Missouri cooperated with Swift and Company in their work of introducing thermo-stabilized eggs to the egg trade. Swift and Company distributed 400 to 600 cases of thermo-stabilized eggs weekly in Miami, Florida and also a similar quantity of these egg bi-monthly in Honolulu.

The results secured this year again show that the process of thermo-stabilization practically eliminates spoilage in shell eggs which would otherwise show heavy losses. It was established this year that flash pasteurization (immersing shell eggs for 20 seconds in processing oil held at 160°F.) did not reduce spoilage. It was found that it was necessary to supply sufficient heat to penetrate the egg in order to destroy the organisms which have entered the interior of the egg.

The Use of Vegetable Protein Concentrates and Crystalline Riboflavin in Practical Rations for Growing Chicks (H. L. Kempster). Several hundred chicks were raised to make the usual replacements in this project which is continuous. The result confirmed previous findings that practical chick starter ration can be designed using soybean oil meal as the sole source of protein. Crystalline riboflavin, yeast, and alfalfa meal were used successfully as a source of riboflavin.

No significant differences in weight up to the age of 4 and 8 weeks was noticed in the White Leghorns, Rhode Island Reds, New Hampshires or White Rock pullets.

The Effect of Using Moldy Corn in Chick Rations (M. R. Irwin and H. L. Kempster). Dry moldy corn similar to that which had previously been fed to laying hens with satisfactory results was ground and added to chick rations at the level of 46 per cent of the total ration. The control ration was the Missouri chick starting mash containing 46 per cent yellow corn meal. These rations were fed to Barred Plymouth Rocks in battery brooders to the age of eight weeks. Two duplicate trials were made using 20 chicks to each experimental group.

In the first trial, at the age of eight weeks, males on the control ration averaged 976 grams per bird while males on the moldy corn ration averaged 964 grams. Females averaged 813 and 821 grams on the control and moldy corn rations, respectively. In the second trial, males on the moldy corn ration averaged 856 grams compared to 773 grams for the control males. Females receiving moldy corn averaged 691 grams and the controls averaged 741 grams.

No mortality occurred and no ill effects were observed in the groups receiving moldy corn.

Chicken Scrap as a Protein Supplement in Chick Rations (M. R. Irwin).

In this experiment rations in which chicken scrap replaced meat scrap were fed to Barred Plymouth Rock chicks. The chicken scrap ration proved somewhat superior when gain in weight to 8 weeks of age was used as a measure of the value of the supplement. Fifty per cent of the chicks in one trial developed perosis on the ration containing 20 per cent meat scrap while only 1 chick or 5 per cent developed perosis on the 20 per cent chicken scrap ration. The chicken scrap analyzed 54.69 per cent protein. Vitamin assay gave the following values: niacin, 24.85 mgm. per lb., thiamine 114 mcg. per lb., riboflavin 5925 mcg. per lb.

Evisceration of poultry in midwestern packing plants prior to shipment to Eastern markets is becoming a general practice. The use of the dried offal as a protein supplement in poultry rations is a profitable and practical means of utilizing this material.

Twelve Years of Poultry Record Keeping in Missouri (Ted Joule, H. L. Kempster, and E. B. Winner). This study was an analysis of 1584 poultry record keeping flocks covering the period 1934 to 1945.

The labor income per hen rose from \$0.72 in 1940 to \$3.08 in 1945 and averaged \$1.19 for the 12-year period. Egg production was an important factor in determining labor income. Those flocks which averaged less than 150 eggs per hen experienced a labor income of \$0.33 to \$0.85 as compared to \$1.30 to \$1.89 for those flocks that averaged over 150 eggs.

The income from eggs constituted 81 per cent of the total income. Labor income per hen was higher for general purpose breeds but labor income per flock was higher for Leghorns. Adult mortality was higher for Leghorns. The average labor income for the 27-year period was \$1.45 per hen.

Record keeping was found to be an excellent method of teaching poultry raisers effective methods for improving their management practices.

RURAL SOCIOLOGY

C. E. Lively, *Chairman*

Effective Methods of Assisting Low Income Farmers (C. E. Lively and H. F. Lionberger). This study was made in DeKalb, Shelby, Boone, and Vernon counties, Missouri.

A large number of open-country families were reviewed in order to sort out full-time low income farmers. It was found that only 71 per cent spent one-half or more of their time farming; 8 per cent were part-time farmers; 4 per cent, nonfarm; and, 9 per cent retired. It was found that the low income farmers were older on the average than all farmers in the sample counties. Seventy-five per cent planted hybrid seed corn and 25 per cent used commercial fertilizer on one or more crops. Seventy-nine per cent had radios in operation and 50 per cent were receiving agricultural information from one or more sources. Sixty-four per cent wanted more information, and 84 per cent approved 4-H club work.

The Rural Health Facilities of Missouri (C. E. Lively, Zetta Bankert and C. L. Gregory). Work on this project included analysis of survey data collected on 1544 families in five counties. The analysis was centered on the matter of the money cost of illness and medical care.

When sorted by income the low-income groups of farm families were found to have spent a higher percentage of their total expenditure for physicians on office calls because low income families had proportionately fewer home calls than upper income families. Lower income families spent a higher percentage of their health budget for drugs than did higher income families; and of their drug expenditure, a higher per cent went for non-prescribed drugs.

The hospital study showed that registered hospitals served only half of the state geographically and the other half of the state is more than twenty miles from a registered hospital. The half not served by a registered hospital involves considerably less than half the population, however. It was found that a considerable number of hospitals in the state are not registered. In the aggregate there are about enough hospital beds in the state to serve the people of Missouri; but, they are not well distributed.

Rural Youth (C. E. Lively and Margaret Bright). This project consisted of further analysis of data taken from schedules taken in five counties of the state. Farm youth has decreased by 18 per cent from the period 1910-40 and the decrease is still continuing according to this study. It was found that youth are unequally distributed among the social classes of the farmers of the state. For example, the upper economic third of farm families have fewer than one-third of the youth on farms.

Army rejection rates in Missouri were the highest in the most rural areas, and the rejection rates were highest in those areas having the lowest farm plane of living index and lowest where the index was the highest. Over half of the farm youth who stay on farms have never attended high school.

SOILS

W. A. Albrecht, *Chairman*

Plant Root Penetration According to Chemical (and Physical) Conditions of the Deeper Soil Layers (C. M. Woodruff, D. D. Smith, and Wm. A. Albrecht). This project is a continuation of an extensive study here at Missouri in the shattering and fertilization of subsoil and its effect on production. As previous experiments have shown, the shattering of the subsoil had little effect on crop yield, while liming of the shattered subsoil resulted in significant increases in crop yield of sweet clover.

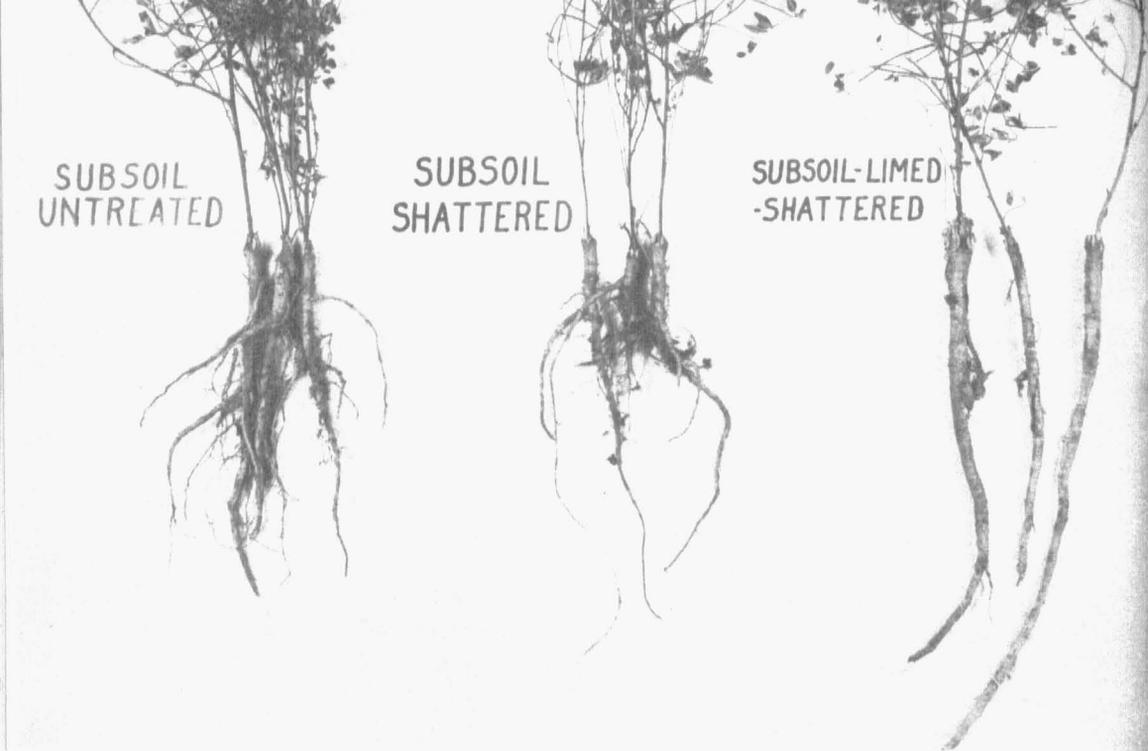
The results to date show that satisfactory yields of corn can not be maintained on this land if the rates of fertilization are low even though liming of the shattered subsoil is practiced.

Sweet clover plants growing on calcium-deficient soils that have been limed in the surface only develop a shallow branched system of roots whereas those growing on soils containing ample lime in the subsoil developed deep, large tap roots.

This research shows:

1. That yields of crops such as corn from the soils are low because of the low fertility in the subsoil.
2. The lack of fertility in the subsoil cannot be corrected by normal applications of fertilizer to the surface soil.
3. Drying of the shallow surface soil in mid-summer takes this area of the soil profile out of production forcing the crop roots into the infertile subsoil for moisture, resulting in nutrient deficiency symptoms which are usually attributed to drought rather than to a lack of fertility.
4. Liming of the subsoil induces normal deep rooting of sweet clover, a biennial plant which spends the first year of growth in storing nutrient reserves in its roots for growth and maturity during the second year.
5. Heavy fertilization preceding the sweet clover crop or any similar type of biennial or perennial legume, such as alfalfa on land to which lime has been applied to the subsoil provides a means of injecting fertilizer in an organic combination into the deeper soil layers through the roots of these plants.
6. Plowing under these heavily fertilized, deep rooted, biennial legumes in the early spring before translocation of the plant food from the roots to the tops occurs provides a means of keeping the nutrients in the deeper soil layers for the use of the crop which follows, thus reducing the hazards of crop failure commonly ascribed to drought and increasing the acreage yields to a satisfactory level.

The process of raising the level of production of the relatively large areas of poor claypan prairie soils that are subjected to repeated droughts, from



SUBSOIL
UNTREATED

SUBSOIL
SHATTERED

SUBSOIL-LIMED
-SHATTERED

This sweet clover shows the effects of shattering the subsoil into which lime and other fertilizers were placed to encourage root penetration (right) in place of branching shallow roots where this treatment was omitted (left), or where the subsoil was only shattered (center).

the low level that now exists, to a relatively high stable level of production appears possible and feasible. The non-erosive character of the terrain of these soils makes such a program desirable.

The Investigation of Nitrogen Fixation and of the Nitrogen and Carbon Behaviors Under Different Soil Treatments (Wm. A. Albrecht, S. L. Wilhite, and Lyman D. Amburgey). This work was initiated to study the wide differences in the physiology of the crops on Sanborn Field which have come about as the result of the soil changes during the fifty-eight years of various soil treatments. Previous studies using colloidal clay techniques demonstrated reduced protein production by the legume crop when the supplies of fertility were low, and when ratios of the amounts of nutrients offered were varied. A similar protein reduction with declining soil fertility has been anticipated for non-legumes. The reduced concentration of nitrogen in the crop gives a wider ratio of the carbon to the nitrogen, or to the element characterizing the protein. This wider ratio occurs when the yield of vegetative bulk may not be reduced or even when it may be increased. Hence our criterion of crop yields disregards the changes in its chemical composition.

Vegetation returned to the soil is the diet for the soil microbes as they bring about its decay. The carbon-nitrogen ratio is therefore an index of its services in nutrition of microbes, if not also in the nutrition of animals.

It was deemed well to determine the carbon-nitrogen ratio of the forage

crops and of the vegetative part of the grain crops as an index of differences in the physiology of the plant brought about by the different degrees of exhaustion—or by the shifts in the ratios of the remaining supplies—of the fertility in the soil.

The crops on eight plots were selected for this research. The values of the carbon-nitrogen ratios were as follows:

| | C/N |
|--|-----|
| Plot 23—Continuous timothy, no treatment..... | 95 |
| Plot 22—Continuous timothy, 6 tons manure annually..... | 84 |
| Plot 17—Continuous corn, no treatment..... | 32 |
| Plot 18—Continuous corn, 6 tons manure annually..... | 28 |
| Plot 31—Corn, 3-year rotation, lime, phosphate, potassium..... | 27 |
| Plot 32—Corn, 3-year rotation, lime phosphate..... | 30 |
| Plot 13—Corn, 6-year rotation, no treatment..... | 17 |
| Plot 12—Corn, 6-year rotation, lime, manure, phosphate..... | 20 |

The corn collected at tasselling time before significant shoots for ears had formed, had a ratio much less or narrower than the timothy. The very wide C/N ratio for the timothy suggests that this would decay very slowly in the soil since it has such a low concentration of nitrogen, or is highly carbonaceous. It would leave significant residues of decay, or of humus in the soil. These timothy plots contain the largest amount of carbon of all the plots on the field. The corn, quite to the contrary, would be expected to decay rapidly if turned under in the stages of growth as sampled. These are the plots that are very low in carbon on this old experiment field.

Since weeds are commonly not taken by grazing animals, and are turned under the soil as organic matter, a number of weeds from various soils were studied for their carbon-nitrogen ratios. There was a wide range in the carbon-nitrogen ratios which would indicate wide range in the rate of decay of these weeds when turned into the soil. These ratios of residues from Sanborn Field suggest that the different soil treatments are responsible for differences in the physiological activities of the crops.

The Maintenance and Improvement of the Fertility Level of Missouri Soils (Wm. A. Albrecht and E. R. Graham). The transfer of such important ions as calcium and magnesium from various mineral reserves in the soil to the active ionic form have been demonstrated and are established. The evaluation of transfers for phosphorus and potassium are now under investigation. To gain information on these very important ions several samples of raw rock phosphate, and crystalline pure igneous apatite have been selected. These samples have been treated with electrolyzed colloidal clay which has been extracted from the subsoil layer of Putnam silt loam. The potassium minerals under investigation are combined in the rock form. They are the microcline of Missouri granite, and leucite of Wyomingite.

The transfer of phosphorus from the igneous apatite was extremely rapid with periods as short as three days being long enough to measure changes. Raw rock phosphate reacted rather slowly. In fact, when near-saturated clays were used there was no measurable reaction with raw rock phosphate. The pH of the Wyomingite hydrogen clay mixture changed significantly in a period of two weeks. The unsaturated clay mixture had a pH change from 4.0 to 5.0, in that period, and the medium-saturated mixture had a pH change from 5.4 to 5.9 in the same period. This points to a significant metathesis of potassium.

The results of the phosphorus mineral studies show that the availability of mineral phosphorus depends greatly on the nature of the phosphorus mineral combinations. The results with the Wyomingite may lead to a new source of mineral fertilizer, which would contain potash, calcium, magnesium, and phosphorus.

Studies of Water Absorption, Runoff, Erosion, and Soil Moisture Movements Under Different Soil and Cropping Conditions (C. M. Woodruff). Run-off data from the plots on the station field have been collected for a five-year period. The results indicate that on eroded land that is low in fertility, crop production remains low and runoff excessive irrespective of the cropping system employed when moderately small amounts of lime and fertilizer are used. However, a significant reduction in runoff is realized from the use of moderate amounts of lime and fertilizer provided nothing is harvested from the land.

The Characteristics and Development of Heavy Clays in the Soils of Missouri (C. E. Marshall, A. D. Ayers and E. O. McLean). In this study of mineralogical and physico-chemical characteristics of the clays it was found, with the Putnam clay and the bentonite, that over a wide range of calcium additions the increase in calcium ion activity with increasing base was very slight. Thus at 30% saturation with Ca the activity was .000055, at 70% it was .000111, while at 100% it was .000365 (9% Putnam clay). The fraction of the added calcium which is dissociated from the clay is very minute over this range—about 0.5%. Since the Putnam type clay is characteristic of many Midwestern soils this fact has direct bearing upon liming. In the range from 30-70% saturation with calcium, addition of lime changes the environment of the plant root very little; above 70% saturation, the environment of the plant root changes much more rapidly with increasing lime. Thus the greater effectiveness of a given amount of lime when applied locally rather than mixed through the whole soil finds a clear explanation. The difference in liming practices between Midwestern and Southern soils is largely the result of the electrochemical differences between the predominant clay minerals. Kaolinite, characteristic of the Southern soils dissociates calcium much more extensively than does beidellite (Putnam).

In the study of the chemical assessment of the nutrient level in soils in terms of clay phenomena very good calcium and magnesium determinations were made with clay membrane electrodes of several types. Hydrogen ben-

tonite preheated to 300-400°C., calcium bentonite preheated to 400-600°C., and hydrogen Putnam clay preheated to 400-600°C., all give quantitative results in the range of 0.01 to 0.0001 molar. It has previously been shown that hydrogen bentonite membranes heated to 450-550°C. acquire the special property of being sensitive to potash but not to calcium. This gives adequate tools with which to handle potash and calcium simultaneously.

Testing Soils for Their Lime Need (Wm. A. Albrecht, E. R. Graham, A. W. Klemme and John Hubbard). During the year the Department of Soils tested 1487 samples of soils for 437 individuals. The Department also made 1932 sieve tests on limestone samples submitted.

The soil testing service is moving out into the counties and on to the farm in order to encourage the farmer to observe the crops as they register soil fertility conditions needing remedy or modifications via organic matter, limestone, and other fertilizer treatments. Testing the soils for their lime needs has shifted from being a single test performed to see the need of the soil for limestone to the use of several soil tests and several plant tissue tests to learn of need for other soil treatments that will make it more productive.

To date the test kits and reagents have been sent to individuals in more than one hundred counties. Twelve teachers of vocational agriculture have obtained them, with anticipation, according to requests, that about eighty students will be familiar with and begin testing of soils and plants before the end of the coming growing season. Veterans' classes are also using the various tests at an accelerated rate.

The Production and Distribution of Bacteria for Legumes (Wm. A. Albrecht and H. A. Henley). During the year sufficient cultures were distributed to supply nodule-producing bacteria for 5091 bushels of legume seeds. The amounts furnished as bushel units for the different legumes were as follows: Alfalfa 302; Korean lespedeza 866; Red clover 572; Sweet clover 1296; Soybeans 2036 and Misc. 19.

VETERINARY SCIENCE

A. J. Durant, *Chairman*

Blood Studies in Bang's Disease (Cecil Elder, D. E. Rodabaugh and O. S. Crisler). Much work has been done in Missouri in the control of Bang's disease. During the year seven different products (liquid phenothiazine, stilbestrol, penicillin, dextrose, sulfapyridine, neoprontosil, and streptomycin) have been used to determine their possible effect on the blood titre of experiment animals. Two unbred sows were injected with stilbestrol. Streptomycin was included because of recent reports regarding its effect upon blood titre. To date, 27 different products have been studied to determine any possible effect upon blood agglutination titre.

No effect on the blood agglutination reaction was observed in cattle with the seven products used during the past year. The only possible exception to this is the use of stilbestrol in cattle, and it, along with sulfapyridine, neoprontosil, and streptomycin, should be administered to additional animals before final conclusions regarding them are drawn. Stilbestrol had no effect upon two un-bred sows in which it was used.

This work proves rather conclusively that the common drugs used in treating cattle will have no effect upon the blood agglutination titre; therefore, their use in the treatment of certain diseases would not have any detrimental effect on any disease control progress based on the blood agglutination test.

Study of Cattle That Consistently Give Low Titre Reactions to the Bang's Agglutination Test (Cecil Elder, D. E. Rodabaugh and O. S. Crisler). One of the big problems confronting herd owners is the proper handling of animals that on repeated tests give low or suspicious reaction to the blood agglutination test. Many herds in Missouri are free of Bang's disease, but occasionally one or more of the cattle shows a low titre reaction, raising the question of the danger of sick animals to others in the herd.

Research this year confirmed former findings that low titre reactions are not dangerous in an otherwise negative herd. There seems to be no danger from running animals of this type with disease-free, susceptible individuals.

Investigations of the Pathology and Comparative Damage Done by Stomach, Nodular and Tape Worms in Sheep (Cecil Elder, D. E. Rodabaugh and O. S. Crisler). From an economic standpoint one of the most serious problems confronting Missouri sheep owners is the proper control of internal parasites. Much work has been done at this station in studying the different treatments to control these parasites and the work this year was confined largely to the use of phenothiazine-salt mixture (1-10). One hundred sheep were used on the experiment. A total of 35 sheep were autopsied during the year.

An outstanding fact observed was the difference in weight of lambs on December 1, 1946, as compared with weights of similar lambs on different treatments December 4, 1945. The average weight of 22 sheep in 1946 was 90.1# while it was only 55.2# on 25 sheep in 1945.

The high efficiency of phenothiazine-salt mixture proves it a very satisfactory product which will save farmers of this state many thousands of dollars. This mixture has a comparatively low cost, varying from 19¢ to 45¢ per head for the period May 1 to November 15. Since it is easy to administer, it should receive widespread use.

Fowl Paralysis or Neuritis of Fowls (A. J. Durant and H. C. McDougale). Investigations were continued on the transmission of fowl paralysis by blood transfusion in this study. The blood of visibly affected hens was injected to 241 day-old White Leghorn chicks. A total of 109 of the chicks were treated with four different drugs. These drugs were sulfamerazine, sulfathiazole, penicillin and streptomycin.

The data indicated sulfathiazole might be effective in preventing the occurrence of fowl paralysis in the chicks, since only 9.67% of the 31 inoculated with sulfathiazole developed fowl paralysis, and this is only 3% more than naturally occurred in the control birds.

Leukemia in Fowls (A. J. Durant and H. C. McDougale). Leukemia, a blood disease of fowls, was studied during the year in connection with the transmission of fowl paralysis by direct transfusion of blood. A total of 346 birds were under observation for eight months.

Only one case of true leukemia was found during the period and that was a case from a small farm flock.

Blackhead in Turkeys (A. J. Durant and H. C. McDougale). It has been claimed that emetine chloride was effective in curing birds affected with blackhead and this experiment was a continuation of research on this treatment. Eleven turkeys which varied in weight from $\frac{3}{4}$ pound to 9 pounds were treated with emetine hydrochloride. The dosage varying from $\frac{1}{256}$ grain to $\frac{1}{16}$ of a grain was given per orum and intravenously—approximately one-half receiving the drug intravenously and one-half by mouth. Only a single dose was given to each fowl and the birds were kept under observation until they recovered or died.

All eleven birds died from a severe case of blackhead disease—indicating that emetine chloride in the dosage used and in that stage of the disease was not effective in curing affected birds, though in the past it has been claimed that this drug was effective in curing birds affected with blackhead.

SERVICE PROJECTS

Tube Agglutination Blood Testing for Pullorum Disease in Chickens and Turkeys (H. C. McDougale). During this fiscal period 126,780 samples of blood were tested coming from chickens and turkeys. A total of 5399 or 4.2% were found to be affected with the disease and 82,891 of the total samples tested were chicken samples. The testing of turkey blood samples increased during the year, in keeping with the inauguration of the National Turkey Improvement Plan for this state.

Agglutination Blood Testing for Bang's Abortion Disease of Cattle and Swine (A. J. Durant and D. E. Rodabaugh). During this fiscal period a total of 63,636 tests were made by the tube agglutination method. Of this number 42,267 were federal samples and were tested in cooperation with the Bureau of Animal Industry, U. S. Department of Agriculture. The remaining 21,369 tests were state tests, of which approximately 10% were positive.

Diagnostic Service on Diseases of Animals and Poultry (A. J. Durant, H. C. McDougle, O. S. Crisler, R. F. Gentry and D. E. Rodabaugh). During this fiscal period a total of 1507 cases were treated and examined. Of this total approximately one-half of the specimens were examined or treated and the other half examined by autopsy. During this fiscal period 58 dogs and other animals were examined for rabies. Twenty-two or 38% of the 58 were found to be infected with the disease.

PUBLICATIONS

A. A. Jeffrey, *Editor*

The Experiment Station issued 50 publications during the year ending June 30, 1947, including 5 research bulletins, 25 popular bulletins, and 20 circulars. If single copies of all had been gathered and bound, they would have made a volume of 1230 pages. The total number of copies of the various publications printed was 314,200.

The actual distribution of free publications to the people of Missouri and to libraries and institutions in other states was even larger than the number of new copies printed. The number mailed or handed out in filling requests exceeded 454,894. This was made possible by reserve stocks of publications from earlier printings.

RESEARCH BULLETINS

| No. | Title, Series, Author, and Number of Illustrations | Pages | Copies |
|------|--|-------|--------|
| 403. | Thyroid Secretion Rate of Albino Rats During Growth, Pregnancy and Lactation, by R. A. Monroe and C. W. Turner, September, 1946; Figs. 10..... | 36 | 2,500 |
| 404. | Growth and Development LXI. Growth and Metabolism of Beef Cattle, by S. Brody, J. E. Comfort, H. H. Kibler, and D. M. Worstell, February, 1947; Figs. 8..... | 16 | 2,500 |
| 405. | The Relation of the Carotenoid Pigments of the Diet to the Growth of Young Chicks and to the Storage in Their Tissues, by Adelia E. Weis and Bertha Bisbey, April, 1947; Figs. 31..... | 56 | 2,000 |
| 406. | Trends in Contributions to Missouri and U. S. Cash Farm Income, 1924-1945, by R. L. Kohls, April, 1947; Figs. 17..... | 32 | 2,500 |

Reprints

| | | | |
|------|---|----|-------|
| 392. | The Determination of the Rate of Thyroxine Secretion by Certain Domestic Animals, by A. B. Schultze and C. W. Turner, August, 1945; Figs. 16..... | 92 | 2,000 |
|------|---|----|-------|

Bulletins

| | | |
|---|----|--------|
| 496. The Missouri Concrete Greenhouse Bench, by James E. Smith, Jr., July, 1946; Figs. 10..... | 16 | 6,000 |
| 497. Prospective Income From Average Size Farms on Grade 2 Missouri Land, by Ramey C. Whitney, July, 1946; Figs. 15 | 32 | 10,000 |
| 498. Trichomoniasis of Turkeys, by H. C. McDougale and A. J. Durant, August, 1946; Figs. 4..... | 12 | 10,000 |
| 499. The Missouri Soil Saving Dam, by J. C. Wooley, W. M. Clark, and R. P. Beasley, August, 1946; Figs. 11..... | 24 | 6,000 |
| 500. Fertilizer Inspection, Analysis and Use; 1945, by E. A. Trowbridge, L. D. Haigh, and E. W. Cowan, August, 1946; Figs. 7..... | 48 | 6,700 |
| 501. Growing Good Crops of Oats in Missouri, by J. M. Poehlman, January, 1947; Figs. 11..... | 20 | 10,000 |
| 502. The Missouri Queen Watermelon, by Aubrey D. Hibbard, March, 1947; Figs. 4..... | 8 | 3,000 |
| 503. Preparing Frying Chickens for Locker Storage, by E. M. Funk and Ferne Bowman, May, 1947; Figs. 9..... | 8 | 10,000 |
| 504. Farm Youth in Missouri, by Margaret L. Bright and C. E. Lively, June, 1947; Figs. 4..... | 20 | 10,000 |

Reprints

| | | |
|--|-----|--------|
| 391. Controlling Insect Pests of Melons, Cucumbers, and Related Crops, by Leonard Haseman, July, 1946; Figs. 6..... | 16 | 5,000 |
| 425. Fattening Early and Late Lambs, by A. J. Dyer and L. A. Weaver, August, 1946; Figs. 2..... | 16 | 10,000 |
| 433. Representative Missouri Weeds and Their Control, by W. B. Drew and C. A. Helm, August, 1946; Figs. 88..... | 216 | 3,000 |
| 442. Missouri Woods and Wood-Using Industries, by Wm. C. Sechrist and Ralph H. Peck, March, 1942; Figs. 4..... | 20 | 3,000 |
| 409. Landlord-Tenant Relationships in Renting Missouri Farms, by John F. Timmons, October, 1946; Figs. 5..... | 44 | 6,000 |
| 314. Yearling Heifers and Steers for Beef Production, by E. A. Trowbridge and H. C. Moffett, July, 1932; Figs. 9..... | 24 | 6,000 |
| 468. Farm Tractors, by M. M. Jones and Lloyd E. Hightower, May, 1943; Figs. 23..... | 40 | 6,000 |
| 495. Producing and Marketing Capons, by M. R. Irwin, April, 1946; Figs. 6..... | 12 | 10,000 |
| 330. The Feeding of Livestock, by A. G. Hogan, January, 1947, Figs. 9..... | 44 | 6,000 |
| 461. Some Factors Influencing Efficient Production of Sows, by L. A. Weaver and Ralph Bogart, February, 1943; Figs. 5..... | 16 | 6,000 |
| 305. Beekeeping in Missouri, by Leonard Haseman, March, 1947; Figs. 12..... | 52 | 6,000 |
| 430. Controlling Bot and Warble Flies of Livestock in Missouri, by Leonard Haseman and W. E. Roland, July, 1941; Figs. 15 | 32 | 6,000 |
| 377. Raising the Dairy Calf, by H. A. Herman, May, 1947; Figs. 10..... | 28 | 10,000 |

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|---|----|--------|
| 324. Soil Fertility Losses Under Missouri Conditions, by Hans Jenny, May, 1933; Figs. 6..... | 12 | 6,000 |
| 473. Common Internal and External Parasites of Poultry, by H. C. McDougle and A. J. Durant, July, 1943; Figs. 25..... | 24 | 6,000 |
| 494. Artificial Insemination of Dairy Cattle, by H. A. Herman, and A. C. Ragsdale, January, 1946; Figs. 26..... | 32 | 10,000 |

Circulars

| | | |
|---|----|--------|
| 310. Soil Treatment to Improve Permanent Pastures, by A. W. Klemme, October, 1946; Figs. 3..... | 8 | 10,000 |
| 311. Growing Strawberries in Missouri, by T. J. Talbert and Aubrey Hibbard, January, 1947; Figs. 6..... | 20 | 6,000 |
| 312. New Oat Disease Increases Importance of Seed Treatment, by C. H. Kingsolver, January, 1947; Figs. 3..... | 4 | 6,000 |
| 313. The Correlation Between Some Characteristics of Dairy Bull Semen and Conception Rate, by E. W. Swanson and H. A. Herman, January, 1947; Figs. 1..... | 8 | 3,000 |
| 314. Newcastle Disease of Poultry, by H. C. McDougle, February, 1947; Figs. 0..... | 4 | 4,000 |
| 315. Pruning Suggestions for Apple and Pear Trees, by T. J. Talbert, May, 1947; Figs. 6..... | 12 | 7,500 |

Reprints

| | | |
|---|----|--------|
| 309. Insect Control with DDT, by Leonard Haseman, Curtis W. Wingo, and George D. Jones, May, 1946; Figs. 2..... | 8 | 6,000 |
| 243. Smooth Bromegrass in Missouri, by E. Marion Brown, September, 1942; Figs. 0..... | 2 | 2,000 |
| 244. Seeding Permanent Pastures, by E. Marion Brown, September, 1946; Figs. 0..... | 4 | 6,000 |
| 269. Producing Rabbits for Meat, by Ralph Bogart, May, 1943; Figs. 10..... | 12 | 3,000 |
| 193. An All-Year Pasture System for Missouri, by W. C. Etheridge, C. A. Helm, and E. Marion Brown, October, 1946; Figs. 3..... | 12 | 6,000 |
| 215. Management of Sweet Clover in a Pasture System, by C. A. Helm, October, 1946; Figs. 2..... | 12 | 6,000 |
| 232. Plow Adjustment and Operation, by M. M. Jones and L. Hightower, May, 1942; Figs. 29..... | 24 | 6,000 |
| 203. Controlling the Fruit Tree Leaf Roller, by Leonard Haseman and Harry E. Brown, December, 1946; Figs. 1..... | 4 | 6,000 |
| 285. Improve Permanent Pastures with Lespedeza, Phosphate, Lime and Supplementary Grazing, by E. Marion Brown, February, 1944; Figs. 4..... | 8 | 6,000 |
| 284. Building a Sweep Rake, by M. M. Jones, February, 1944; Figs. 10..... | 16 | 6,000 |
| 210. Management of Korean Lespedeza, by C. A. Helm, December, 1940; Figs. 7..... | 8 | 6,000 |
| 309. Insect Control with DDT, by Leonard Haseman, George D. Jones, and Curtis W. Wingo, May, 1946; Figs. 2..... | 8 | 15,000 |

243. Smooth Bromegrass in Missouri, by E. Marion Brown, September, 1942; Figs. 0..... 2 6,000

CONTRIBUTIONS TO SCIENTIFIC JOURNALS

1008. Diet of Mother and Hydrocephalus in Infant Rats, by L. R. Richardson and A. G. Hogan, submitted July, 1946 to The Journal of Nutrition.
1009. The Male Hormone Content of Ruminant Manure, by C. W. Turner, submitted August, 1946 for publication.
1010. Vegetable Crops in Relation to Soil Fertility. V. Some interrelations of calcium, nitrogen, and phosphorus, by Sylvan H. Wittwer, submitted August, 1946 to Plant Physiology.
1011. Growth and Aging Problems in Agriculture, by Samuel Brody, submitted August, 1946 for presentation at The 1946 (Kingston, R. I.) Symposium of the Society for the Study of Development and Growth.
1012. Vegetable Crops in Relation to Soil Fertility. VI. Calcium Contents of Green Leafy Vegetables, by S. H. Wittwer, submitted August, 1946 to Food Research.
1013. The Value of a State Federation of Dairy Cattle Artificial Breeding Organizations, by H. A. Herman, A. C. Ragsdale, M. J. Regan and E. T. Itschner, submitted September, 1946 for publication.
1014. The Influence of Quantity and Quality of Nutrients on the Growth of Dairy Heifers by H. A. Herman and A. C. Ragsdale, submitted September, 1946 for publication.
1015. Dried Lactating Cow Manure in the Ration of Growing Chickens, by C. W. Turner, submitted September, 1946 to The Journal of Poultry Science.
1016. Irregularities in a Hybrid Between *Triticum Dorum* and *T. Persicum*, by Luther Smith, submitted September, 1946 to The Journal of Agricultural Research.
1017. Agricultural Problems in Growth and Aging, by Samuel Brody, submitted September, 1946 to Science.
1018. A Haplo-Viable Deficiency-Duplication from an Interchange in *Triticum Monococcum*, and its use in Linkage Studies, by Luther Smith, submitted September, 1946 for publication.
1019. Physiological Background for Psychoenergetic Studies, by Samuel Brody, submitted October, 1946 for publication.
1020. Clay Membrane Electrodes for Determining Calcium Activities, by C. E. Marshall and Alvin D. Ayers, submitted October, 1946, to Soil Science.
1021. The Cytology and Genetics of the Wheats and Their Relatives, by E. R. Sears, submitted October, 1946 to Advances in Genetics.
1022. The Nutritional Significance of Milk with Special Reference to Milk Sugar, by Samuel Brody and Dulal Pada Sadhu, submitted October, 1946 to The Scientific Monthly.
1023. Interrelations Between Excess Vitamin A Ingestion, Thyroid Size and Basal Metabolism, by Dulal Pada Sadhu and Samuel Brody, submitted November, 1946 to The Journal of Nutrition.
1024. Surface Area In Metabolism of Growing Guinea Pigs, by H. H. Kibler, S. Brody, and D. Worstell, submitted November, 1946 to The Journal of Nutrition.
1025. Subsoil Shattering and Subsoil Liming for Crop Production on Clay Pan Soils, by C. M. Woodruff and D. D. Smith, submitted November, 1946 to The Proceedings Soil Science Society of America.

1026. Vitamin C—Nitrogen Relations in Peaches as Influenced by Fertilizer Treatment, by S. H. Wittwer and Aubrey D. Hibbard, submitted November, 1946 to The Proceedings of the American Society of Horticultural Science.
1027. The Effect of Crop Sequence on Erosion Under Individual Crops, by D. D. Smith, submitted November, 1946 for publication.
1028. Building a Soil Deeper, by D. D. Smith, C. M. Woodruff, and D. M. Whitt, submitted December, 1946 to The Agricultural Engineering Journal.
1029. Effect of Mild Hypertthyroidism on Seasonal Yearly Egg Production of Fowls with Advancing Age, by C. W. Turner and H. L. Kempster, submitted January, 1947 for publication.
1030. Fertilizing the Orchard, by A. E. Murneek, submitted January, 1947 to The Iowa State Horticultural Society.
1031. Sprays to Thin Flowers and to Hold Fruit on Trees, by A. E. Murneek, submitted January, 1947 to The Proceedings of The Iowa State Horticultural Society.
1032. Brown Stem Rot of Soybean in Missouri, by James M. Crall, submitted January, 1947 to Plant Disease Reporter.
1033. Nutrition and Metabolism as Related to Photoperiodism, by A. E. Murneek, submitted February, 1947 to Vernalization and Photoperiodism in Plants.
1034. History of Research on Photoperiodism, by A. E. Murneek, submitted February, 1947 to Vernalization and Photoperiodism in Plants.
1035. Cleaning Soiled Shell Eggs, by E. M. Funk, submitted February, 1947 to The U. S. Eggs and Poultry Magazine.
1036. Sources of Resistance to Loose Smut, *Ustilago Nuda*, in Winter Barleys, by J. M. Poehlman, submitted February, 1947 to The Journal of American Society of Agronomy.
1037. Relative Occurrence of the Barley Loose Smuts in Missouri in 1946, by J. M. Poehlman and C. K. Cloninger, submitted February, 1947 to Plant Disease Reporter.
1038. The Proteins of Mammalian Spermatozoa, by Dennis T. Mayer, Lloyd E. Thomas, submitted February, 1947 for publication.
1039. A Fragmented Chromosome in *Triticum Monococcum* and Its Use In Studies of Inheritance, by Luther Smith, submitted February, 1947 to Genetics.
1040. Effect of Sex Hormones on Pituitary Lactogen and Crop Glands of Common Pigeons, by Joseph Meites and C. W. Turner, submitted March, 1947 to The Proceedings of Society of Experimental Biology and Medicine.
1041. Long-range Forecasting of Agricultural Prices, by Erwin T. Hadorn, submitted March, 1947 to Farm Economics.
1042. Effect of Thiouracil and Estrogen on the Lactogenic Hormone and Weight of the Pituitaries of Rats, by Joseph Meites and C. W. Turner, submitted March, 1947 to The Proceedings of Society of Experimental Biology and Medicine.
1043. Results of Further Investigations on the Use of "Hormone" Sprays in Tomato Culture, by A. E. Murneek, submitted May, 1947 to The American Society for Horticultural Science.
1044. Investigations on Thinning of Peaches by Means of Caustic and "Hormone" Sprays, by A. E. Murneek and A. D. Hibbard, submitted May, 1947 to The Proceedings of the American Society for Horticultural Science.
1045. The Induction of Lactation During Pregnancy in Rabbits and the Specificity of the Lactogenic Hormone, by Joseph Meites and C. W. Turner, submitted May, 1947 to The American Journal of Physiology.

1046. Effect of Adrenalectomy on the Mammary Gland of the Castrate and Estrogen Treated Castrate Male Rat, by J. J. Trentin and C. W. Turner, submitted May, 1947 to *Endocrinology*.
1047. The Effect of Intramammary Treatment for Mastitis Upon Milk Production, by Eric W. Swanson and H. A. Herman, submitted May, 1947 to *The Journal of Dairy Science*.
1048. Progress Report in the Study of Certain Goitrogens, by G. W. Pipes and C. W. Turner, submitted May, 1947 to *The Journal of Dairy Science*.
1049. Factors Influencing the Male Hormone Content of Cow Manure, by C. W. Turner, submitted May, 1947 to *The Journal of Dairy Science*.
1050. The Digestibility of Coarsely Ground and Finely Ground Alfalfa for Dairy Heifers, by Eric W. Swanson and A. C. Ragsdale, submitted May, 1947 to *The Journal of Dairy Science*.
1051. A Study of Factors Affecting the Length of Gestation in Dairy Cattle, by H. A. Herman and R. W. Spalding, submitted May, 1947 to *The Journal of Dairy Science*.
1052. Dairy Cattle Improvement Work on the Indian Agricultural Research Institute-India, by J. D. S. Kumaran, submitted May, 1947 to *The Journal of Dairy Science*.
1053. Thiouracil and Its Effects in the Feeding and Breeding of Livestock, by Ralph Bogart and Dennis T. Mayer, submitted May, 1947 to *The Journal of Animal Science*.
1054. Pyridoxine, Ketonic Acids, Glucose, and Specific Dynamic Action, by Dulal Pada Sadhu and S. Brody, submitted June, 1947 to *The American Journal of Physiology*.
1055. The Effect of Feeding Thiouracil on Basal Metabolism and on Specific Dynamic Action, by Dulal Pada Sadhu and S. Brody, submitted June, 1947 to *The Journal of Nutrition*, or *The American Journal of Physiology*.

INVESTIGATIONS UNDER COOPERATIVE PROJECTS

During the years 1946-47, the Agricultural Experiment Station has cooperated with the United States Department of Agriculture in the following projects:

Utilization of Farm Products.

Agricultural Land Use Planning.

Early vs. Late Lamb Production.

Marketing of Slaughter Livestock.

The Relation of Land Income to Land Values in Northern and Western Missouri.

Factors Influencing Quality and Palatability of Meat.

The Improvement of Viability in Poultry.

The Improvement of Swine Through Breeding.

R.M. Climatic Laboratories.

Determination and Evaluation of Work Capabilities of Horses and Mules and Related Factors.

Physiology of Reproduction in Farm Animals.

The Improvement of Pastures in the Corn Belt.

Maintenance and Development of the Hatch Dairy Experiment Farm at Hannibal, Missouri—Breeding, Feeding, and Management of Dairy Cattle.

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.

Transportation of Livestock, Other Farm Products and Supplies Between Farm and Market.

Current Land Market Activity in Missouri.

Control to Protect Crops from Grasshopper and Chinch Bug Damage.

Food Processing, Preservation, and Utilization.

Regional Land Tenure.

Dairy and Poultry Production Marketing.

Missouri Basin Flood Control Study.

Production Adjustment Studies.

Farm Equipment Studies.

Landlord Tenant Relationship.

Cotton Marketing.

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 hemophilia-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 "psycho-energetic laboratory studies", to establish certain fundamental data relating to the housing and production of dairy animals.

American Chemical Paint Company

For furthering research work on plant hormones or weed killers.

Quaker Oats Company

For research in the breeding of white hybrid corn.

Scott County Milling Company

For experimental studies with crops and pastures in Southeast Missouri.

American Dairy Association

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

Missouri Butter Insitute

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.

De-Raef Corporation

For research relating to the manufacture of cheddar cheese.

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."

Middle West Soil Improvement Committee

To further extension projects in soils improvement.

International Minerals and Chemicals Corporation

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

American Potash Institute

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

Ruhm Phosphate Company

For research in connection with phosphate absorption from the soil.

Missouri Portland Cement Company

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

Missouri Conservation Commission

For farm forestry research.

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."

Cerophyl Laboratories

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

CHANGES IN STATION STAFF FOR THE YEAR ENDING
JUNE 30, 1947

Appointments

Wm. L. Alley, Assistant Instructor in Field Crops
Gerald C. Anderson, Research Assistant in Animal Husbandry
Harold V. Biellier, Instructor in Poultry Husbandry
Calvin M. Bowen, Assistant Professor of Forestry
John R. Breuer, Assistant Instructor in Agricultural Chemistry
R. C. A. Costello, Instructor in Veterinary Science
James E. Crosby, Assistant Director of the Agricultural Experiment Station
Cecil L. Gregory, Instructor in Rural Sociology
James H. Gholson, Instructor in Dairy Husbandry
L. J. Gundy, Fellowship in Field Crops
Erwin T. Hadorn, Instructor in Agricultural Economics
Otis H. Horton, Assistant Instructor in Dairy Husbandry
W. B. House, Research Assistant in Agricultural Chemistry
John D. Hubbard, Research Assistant in Soils
Margaret S. Kanapaux, Research Assistant in Home Economics
John M. Kays, Instructor in Animal Husbandry
Richard L. Kohls, Instructor in Agricultural Economics
Victor N. Lambeth, Instructor in Horticulture
Louis C. Lamison, Research Assistant in Soils
James H. Lee, Research Assistant in Horticulture
Robert B. Livingston, Instructor in Botany
Sarah Frances Madden, Research Assistant in Home Economics
James E. Marr, Research Assistant in Animal Husbandry
Henry J. Meenen, Instructor in Agricultural Economics
P. W. McDaniel, Instructor in Animal Husbandry
James W. McKenzie, Assistant Instructor in Agricultural Economics
James S. McKibben, Instructor in Agricultural Engineering
Stanley McLane, Research Assistant in Horticulture
Wade R. McMillen, Instructor in Agricultural Economics
Boyd L. O'Dell, Assistant Professor of Agricultural Chemistry
Robert Roth, Instructor in Agricultural Engineering
Marybelle Sapp, Research Assistant in Home Economics
Clarence L. Scrivner, Assistant in Soils
Richard C. Smith, Assistant Professor of Forestry
Odie T. Stallcup, Assistant Instructor in Dairy Husbandry
Rachel Thomas, Instructor in Home Economics
Rebecca C. Wall, Assistant Instructor in Home Economics
Donald R. Warner, Research Assistant in Animal Husbandry
J. E. Weinman, Professor of Veterinary Science
D. M. Whitt, Research Associate in Field Crops

Resignations and Withdrawals

Royal J. Briggs, Instructor in Agricultural Economics
 Marialice Cunningham, Research Assistant in Home Economics
 George A. Harrison, Instructor in Animal Husbandry
 John D. Hubbard, Research Assistant in Soils
 Richard Irwin, Assistant Professor of Poultry Husbandry
 Bascom M. King, Associate Professor of Field Crops
 Sarah Frances Madden, Research Assistant in Home Economics
 F. Bessie McNiell, Assistant Professor of Home Economics
 Ralph H. Peck, Associate Professor of Forestry
 William O. Regan, Instructor in Agricultural Chemistry
 Marybelle Sapp, Research Assistant in Home Economics
 B. E. Stickrod, Instructor in Veterinary Science
 Ramey C. Whitney, Associate Professor of Agricultural Economics
 Clarence F. Winchester, Assistant Professor of Agricultural Chemistry
 Sylvan H. Wittwer, Instructor in Horticulture

FINANCIAL STATEMENT

 UNIVERSITY OF MISSOURI
 AGRICULTURAL EXPERIMENT STATION
 in account with

THE UNITED STATES APPROPRIATION, 1947

| | Hatch Fund | Adams Fund | Purnell Fund | Bankhead- Jones Fund |
|--|---------------|---------------|-----------------|-------------------------|
| Dr. | | | | |
| To balance from 1945-46..... | | | | |
| Receipts from the Treasury of the United States as per appropriations for fiscal year ended June 30, 1947..... | \$15,000.00 | \$15,000.00 | \$60,000.00 | \$83,175.72 |
| Total | 15,000.00 | 15,000.00 | 60,000.00 | 83,175.72 |
| Cr. | | | | |
| Personal Services | 14,644.70 | 9,692.25 | 46,041.38 | 56,054.70 |
| Travel | | 60.00 | 544.16 | 1,010.00 |
| Transportation of Things | | 119.04 | 239.69 | 194.29 |
| Communication Service | | 18.00 | 20.87 | 294.94 |
| Rents and Utility Services | | 49.29 | 148.54 | 790.23 |
| Printing and Binding | | 1.10 | 634.64 | 991.29 |
| Other Contractual Services | | 27.06 | 438.01 | 952.59 |
| Supplies and Materials | | 3,870.61 | 9,244.13 | 18,452.13 |
| Equipment | | 1,001.65 | 1,907.23 | 3,609.39 |
| Land and Structures | | | 62.88 | 118.30 |
| Contributions to Retirement | 355.30 | 161.00 | 718.47 | 752.86 |
| Balance | | | | |
| Total | \$15,000.00 | \$15,000.00 | \$60,000.00 | \$83,175.72 |