

# Missouri's Sixtieth Year of Agricultural Research

Annual Report of the  
Missouri Experiment Station  
1947-1948

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



**UNIVERSITY OF MISSOURI**

**COLLEGE OF AGRICULTURE**

**AGRICULTURAL EXPERIMENT STATION**

J. H. LONGWELL, *Director*

**BULLETIN 528**

**SEPTEMBER, 1949**

## LETTER OF TRANSMITTAL

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

Sir:

I am submitting herewith the report of the Agricultural Experiment Station for the year ending June 30, 1948. This report is submitted in accordance with the Federal law requiring such a report, a copy of which is to be submitted to the Governor of the State and to the Secretary of the Treasury of the United States.

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

### TABLE OF CONTENTS

	Page
Introduction .....	3
Agricultural Chemistry .....	6
Agricultural Economics .....	9
Agricultural Engineering .....	10
Animal Husbandry .....	12
Botany, Plant Pathology .....	18
Dairy Husbandry .....	20
Entomology .....	27
Field Crops .....	30
Home Economics .....	34
Horticulture .....	36
Poultry Husbandry .....	42
Rural Sociology .....	44
Soils .....	46
Veterinary Science .....	56
Service Projects .....	59
Publications .....	60
Investigations Under Cooperative Projects .....	66
Research Grants .....	67
Changes in Station Staff .....	69
Financial Report .....	71

Front cover: This is a view of Sanborn Field showing many of the plots which have become famous since they were established 60 years ago for fertilizer and crop rotation experiments.

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

# Missouri's Sixtieth Year of Agricultural Research

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

## INTRODUCTION

Sixty years ago, in 1888—the year the experiment station was founded—a research worker at the Missouri Experiment Station wrote:

“Scientific investigation and the world's common experience have shown beyond a doubt that tillage crops are wasteful of soil fertility, while the grasses are nature's great soil conservators and should have and do have, in all high agriculture, a prominent place in crop rotation. In western agriculture they are used to a minimum extent, with the results shown by statistics that our crops have declined with a rapidity phenomenal in the world's agriculture. Machinery gave us the opportunity for the wide tillage we pursue.”

Thus wrote Dr. J. W. Sanborn, director of the Missouri Experiment Station in 1888, in Station Bulletin No. 2 entitled *Grasses for Pastures and for Meadows*.

So it has been from the very beginning—60 years ago—that the research workers at the Missouri Experiment Station have served the farmers of the state in an endless effort to find ways to conserve the soil, improve and maintain its fertility, select more productive crop rotations, use more economical livestock feeding practices and rations, to develop and improve new varieties of trees and plants and indirectly to help raise the standard of living of all rural Missouri.

Professor Sanborn, who started the celebrated soils experiments 60 years ago on the field later named after him, had accomplished a remarkable amount of experimental work before the station was established in 1888 despite political opposition and a critical lack of financial assistance. Nineteen agricultural bulletins or experimental reports were published by the University before the formal bulletin series began.

The first bulletin printed by the University was one telling of the experimental work done with “four lots of year-old shoats” put on feed with rations of (1) whole corn and grass (2) whole corn (3) clear corn meal and (4) cob and corn ground together. Lot one was allowed to run at large and graze in a four-acre lot while the other lots were confined to pens. Another early report told of results when feeding hogs for lean meat.

Early experiments covered a wide range of subject matter including extensive research on Texas Fever, spaying heifers, livestock feeding, testing tillage implements, field crops, fertilization, seed germination, storing fodder, horticulture, blackleg, diseases and insects of fruit, and testing varieties of corn and wheat.

\*E. A. Trowbridge, Dean and Director, died June 7, 1948.

However, as pointed out by Déan Emeritus M. F. Miller, the first years of the Missouri Experiment Station experienced opposition and even ridicule. The people did not understand its real purpose and they had no conception of its possibilities. As time went on, however, the attitude of skepticism gradually changed to one of confidence and understanding. The two directors who were largely responsible for this change of attitude and for the outstanding development of the College and Experiment Station during the last half century were H. J. Waters (1895-1909) and F. B. Mumford (1909-1938).

A report written 60 years ago by the Missouri Board of Agriculture describes the College Farm of 640 acres as being in a rather dilapidated condition. The crop yields were low, the pastures grown up in "buck brush" and unproductive, the buildings crude and wholly inadequate. There were listed 44 head of livestock "including four Shorthorns of unfashionable families, one blind horse, one mule with fistula, and three more mules with harness that was invoiced at \$6.00." The reason for this discouraging condition was the policy of the Board of Curators that the College Farm must be not only self-supporting but a source of income for the whole agricultural program. And the farm, after all, was rocky, part timbered and of very moderate fertility.

It was not until after the turn of the century that the Board of Curators changed their policy so that more and more funds became available for improving the farm, building new buildings and classrooms.

Since 1931 additional land has been purchased to satisfy the research needs of the various departments. The College now operates 1245 acres in University South Farms, 240 acres in horticultural plantings, 90 acres for experiments in animal pathology, and approximately 400 acres, chiefly pasture, in the original farm. Total land area now used is approximately 2000 acres near Columbia. In addition, research work is supervised and carried on at many outlying experimental fields in the state including thousands of acres of forest land.

From this humble beginning the Missouri Experiment Station has grown to its present position as one of the leading agricultural research centers in the nation. Over 100 purebred beef cows representing the Aberdeen-Angus, Hereford and Shorthorn breeds, 150 purebred ewes representing five breeds and 70 sows representing three breeds are used by the college and experiment station. Two hundred head of purebred dairy cattle are available for research. Field crops, horticulture, and soils investigators have adequate acreages at their disposal. Forestry workers have 17,000 acres of forest land in the state where they may conduct research and the home economics and other departments have the latest in up-to-date laboratory equipment.

During the years this station has established itself: as an authority in vitamin research; as a leader in the study of hog cholera and Texas Fever; as a top dairy research station; as the introducer of new crops such as lespedeza and S-100 soybean and new cropping systems; as the virtual savior of the bee-

keeping industry with the introduction of sulfathiazole for the control of American Foul Brood in honey bees; as a leader in the animal husbandry, animal nutrition, and horticulture fields; as the originator of the open front Missouri Poultry House; as a pioneer in the use of X-rays and ultraviolet radiation to induce mutation in plants; as one of the first reliable sources of information about soil erosion and water runoff; and as a research center in the home economics field since 1909.

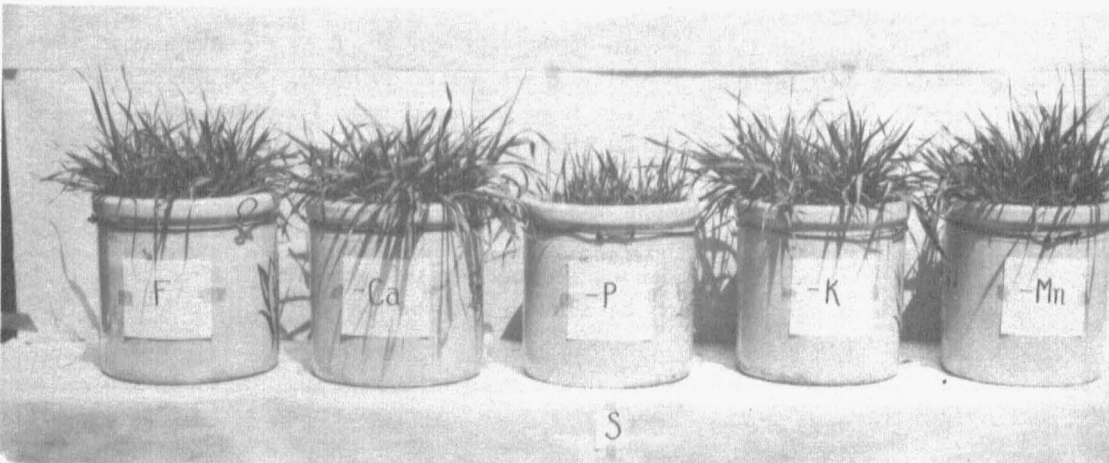
The Missouri Station was the first institution in America to produce and make available to the cattle raisers a preventive vaccine against blackleg in calves in conformity with newly discovered French methods. The Missouri Station produced and distributed to the medical profession the first smallpox vaccine made west of Boston and was among the first state experiment stations to establish a laboratory to put to extensive scientific and practical tests anti-hog-cholera serum, and to demonstrate its effectiveness in the field in protecting swine against hog cholera.

One of the major contributing factors in the successful growth and acceptance of the Missouri Experiment Station has been the rigid adherence to the policy of PRACTICALITY. It does not matter if you check the term of any director, J. W. Sanborn, E. E. Porter, H. J. Waters, F. B. Mumford, M. F. Miller or E. A. Trowbridge, each will reveal that the first purpose of experimentation was to discover or develop a plant, animal, method or practice that could be applied in a practical way to Missouri agriculture.

MISSOURI FARMERS have eagerly accepted these practical applications recommended by the experiment station the past 60 years. And that is as it should be for as Director Mumford said in his history of the Missouri Station, "If rural improvement is to be permanent it must be accomplished by the farmer's voluntary effort. He must believe in what he is doing."

With this report for 1948 Missouri is submitting data on many and varied research projects. Many of these projects, because of the very nature of experimentation, are continuous and will be completed in the years ahead. Because research workers at Missouri also believe in what they are doing!

Research continues on required nutrients for plants.



**AGRICULTURAL CHEMISTRY**A. G. Hogan, *Chairman*

The Effects of Different Storage Temperatures and Different Storage Periods Upon the Vitamin Content of Frozen Foods (Laura M. Flynn, Victor B. Williams, and A. G. Hogan). This research is a continuation of extensive study at Missouri on the effects of different storage temperatures and the length of storage on the vitamin content of frozen foods.

Paired roasts were assayed for thiamine, riboflavin, and niacin, one roast tested at once, and the other tested after frozen storage. Twelve pairs were tested. Neither beef nor pork showed any change in vitamin content after 30 months frozen storage. Storage at  $-18^{\circ}$  C. preserves vitamins as well as storage at  $-24^{\circ}$  C. Vitamin losses increase at  $-12^{\circ}$  C. Vitamin loss parallels deterioration in frozen food as judged by palatability and consumer preference tests.

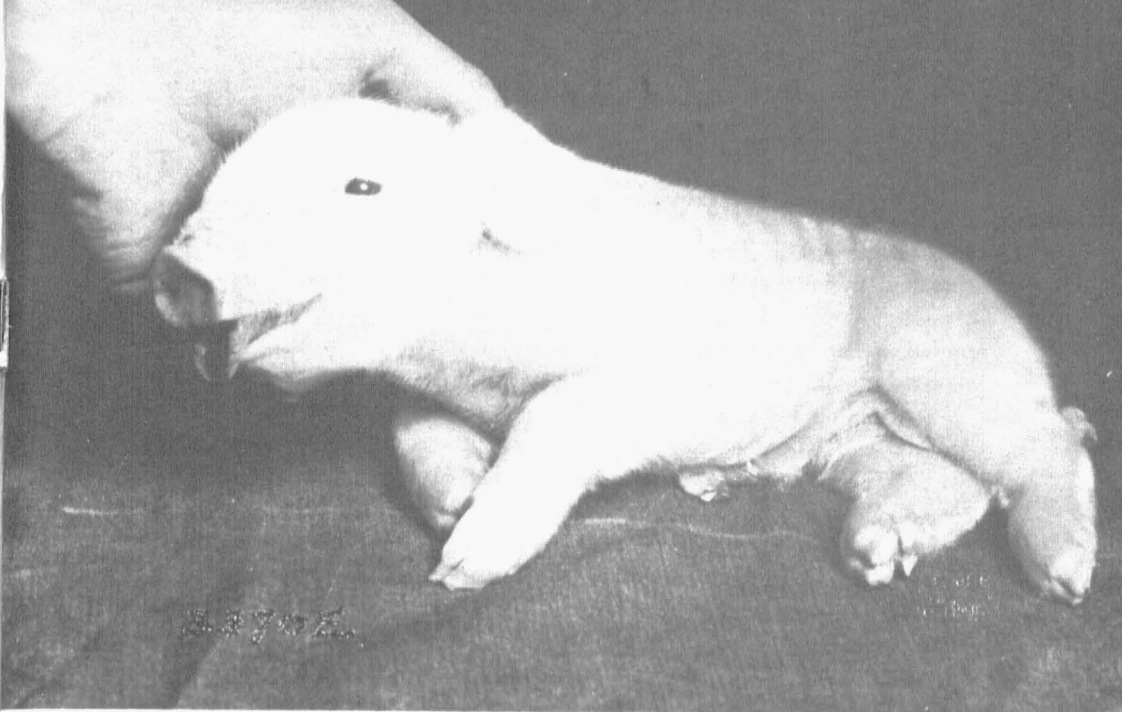
Mixtures of ascorbic and citric acids added to apples and peaches to prevent darkening or thawing retain at least 90% of the added vitamin after 11 months at  $-12^{\circ}$  C. Strawberries retained 85-95% of their ascorbic acid (61 mg./100 gm.), 75% of the carotene in cherries was retained at  $-18^{\circ}$  C. In contrast only 64% of the carotene in the fresh fruit (475 mcg./100 gm.) was retained at  $-12^{\circ}$  C. Frozen snap beans stored 9 months at  $-16^{\circ}$  C. retained 79% of their ascorbic acid (35 mg./100 gm.) and 70% of their carotene (400 mcg./100 gm.).

This specific information concerning losses of vitamins frequently decreasing with storage enables choice of the best temperature for storage of frozen foods. These data also aid in determination of desirable storage periods avoiding loss with excessively long storage.

**Vitamins Required by Swine** (A. G. Hogan and G. C. Anderson). One serious problem in swine production is a high mortality rate in pigs before they are 10 days old. Another important loss is caused by the slow growth rate frequently observed in weanling pigs. It looks now as if these difficulties could be largely eliminated when it is determined what vitamin deficiencies are responsible.

During the year three separate trials were carried out on the adequacy of synthetic diets for pigs, beginning at the age of 48 hours. The average weights in pounds of the pigs in these trials at 8 weeks were: First, 36; second, 24; third, 30. Pigs on wire floors, which reduced the opportunity for coprophagy, grew as rapidly as did those on cement floors with shavings for bedding. The only definite symptom of a nutritional deficiency was intermittent diarrhea, graded severe but not serious.

One gilt from the first trial was continued on the synthetic diet after the 8th week, in an attempt to carry her through a reproductive period. She bore



This newly born pig has a short undeveloped jaw and no control of its hindquarters due to the vitamin deficient ration of its mother. It died in 50 hours.

a normal litter but became anemic and died. There were marked pathological changes in the bone marrow, liver, kidneys, and spleen. Five pigs of the eleven in this sow's litter were reared on a synthetic diet. A synthetic diet supports a fairly rapid growth rate, but it is inadequate for the optimum nutritional state.

**The Study of Folic Acid (B Complex Content in Human Food)** (Laura M. Flynn, Victor B. Williams, Boyd L. O'Dell, J. E. Savage, and A. G. Hogan). Since reliable published data on the B complex content of human foods are scarce, microbiological assays for B complex were studied critically during the year.

Addition of "Tween 80" and glutathione, substitution of cysteine for cystine, and increased Mn content improved the basal medium, stimulated growth and resulted in greater precision in assays. Microbiological (M.B.) assays for Bc were made on soy meal (6 mcg./gm.), soy flour (5 mcg./gm.), dried non-fat milk solids (under 0.1 mcg./gm.), dehydrated spinach (17 mcg./gm.), dehydrated mustard greens (12 mcg./gm.). Chick assays on soy flour and spinach checked M. B. results. Chick assays on milk gave results much higher than M. B. assays. This may indicate poor extraction, or interference with M. B. assays by some constituent in milk. Present methodology seems more satisfactory with green leafy materials (high in Bc) than with foods high in protein. Soy products seem to be assayed reliably.

Storage of vitamin in the liver increases with increased Bc intake. Levels of Bc in leg and breast (0.05 mcg./gm.) are very low as contrasted with the amount in the liver (1.0-3.5 mcg./gm.).

**Nutritional Requirements of Poultry** (A. G. Hogan, Betty Gomez Lance, and J. E. Savage). This research on the nutritional requirements of poultry is continuous here at Missouri and if the knowledge of the vitamin required by poultry that has been gained from this year's work and previous work were applied, it has been estimated the production of poultry in Missouri could be increased by 20 per cent with no increase in the amount of feed required.

It was found that a synthetic diet must contain not less than 25 per cent of casein and 10 per cent of gelatin in order to sustain the maximum rate of growth in chicks. It must contain no less than 30 per cent of casein and 5 per cent of gelatin to sustain the maximum rate of growth in turkey poults. Approximately 10 per cent of the second generation of chicks reared on a synthetic diet became paralyzed, indicating nutritional deficiency.

When a synthetic diet, either for chicks or poults, was supplemented with a water extract of liver, or with the residue from water extraction, there was a definite acceleration in the rate of growth. When both the extract and residue were included in the diet there was a tremendous acceleration in the growth rate, exceeding anything that had been published at the time of this experiment.

Apparently an unrecognized nutrient is required for optimum nutrition of either chicks or poults. Chicks and poults grow more slowly on practical rations, with soybean oil meal as the only protein supplement, than they do on synthetic diets. The rate of acceleration in chicks was less marked.

**Abnormal Bleeding in Farm Animals and the Use of Methyl-Thiouracil in Rations for Swine** (M. E. Muhrer, D. R. Warner, Zane Palmer, and A. G. Hogan). Further tests were made on the characterization of the Hemophilia-like disease in swine. It was found that large whole blood transfusions would reduce the saline bleeding time as well as the coagulation time. The prolonged saline bleeding time has previously been considered a measure of a capillary defect and not a blood defect.

Hyaluronidase, a naturally occurring enzyme, is hemolytic and lowers the coagulation time of bleeder blood *in vivo* and *in vitro* but does not make the bleeder swine normal. A fat soluble fraction of normal blood has been prepared which also lowers the coagulation time of bleeder blood. It was found that methyl-thiouracil is about as effective as thiouracil in influencing the rate and economy of gain in swine.

**Unrecognized Vitamins Required by Livestock** (A. G. Hogan and W. B. House). Research was continued on unrecognized vitamins and the synthetic diet that does not contain folic acid again proved grossly deficient for guinea pigs. An attempt was made to find sources of the missing nutrient and whole wheat seemed to be active. The white flour fraction of wheat is devoid of activity. Wheat bran has low activity, wheat middlings are better, and wheat germ has a high level of activity.



## AGRICULTURAL ECONOMICS

O. R. Johnson, *Chairman*

**Transferring the Farm to the Next Generation** (O. R. Johnson, C. R. Klingner, and H. J. Meenen). This study took into consideration the handicap under which present day beginning farmers are working in undertaking to finance their beginning in farming and the increasing complexity of transferring farms from one generation to the next. Few farms are large enough to be sub-divided among the heirs to the estate without reducing the size of the unit below a minimum necessary to provide each of the children with a unit large enough to be operated profitably. Also there are other problems, such as living with relatives or building new homesteads, tenant houses for the hired labor and other improvement or modernization costs.

Since it is necessary to satisfy the claims of other heirs without requiring a sub-division of the farming unit and, if possible, without burdening the operating heir with an impractical debt burden, it has been suggested that the farm be passed on to a succeeding operator by making him liable for the rent value of the property plus an additional sum. This sum, within a reasonable period of years, would amortize the capital value of the property.

Such a program would reduce the operating heirs' problem to one of paying for the farm on a commodity basis or by payment in kind.

The main objectives of this plan are to enable young and well adapted men and women to succeed the preceding generation in occupancy and operation of adequate farm units and to avoid burdening them with a fixed charged debt which they may be unable to carry because of too heavy an initial down payment. It is designed also to protect the interests of all parties having a claim to a share in estates thus transferred.

**Poor Land and Minimum Living Levels** (O. R. Johnson, Wade McMillen, and H. J. Meenan). This analysis of the returns from sales and the use of farm products of the different soils in the counties studied showed that a surprising percentage of the farms of the poor land areas of the state produce an inadequate physical output to provide even a minimum living level for the farm operator. This percentage will be as high as 70 to 75 per cent in some areas, and shows a state average of 50 per cent or more.

This study shows that many operators and would-be purchasers of Missouri farm units should first determine if it is physically capable of making a family living in addition to paying the necessary operating cost. Also it is one thing for a farm to provide an exceptional living level for an owner operator while it is an entirely different one if the products of that farm must be shared with a landlord.

## AGRICULTURAL ENGINEERING

J. C. Wooley, *Chairman*

**Barn Hay Drying System** (C. L. Day, G. W. Steinbruegge, and M. M. Jones). The research on barn hay drying was continued and observations were made on 15 installations ranging in size from 20 to 200 tons, and drying alfalfa, soy beans, cow peas, clover, and lespedeza.

The types of driers included were central duct with laterals, side duct with laterals, side duct with slatted floor, and also the silo type. One laboratory experiment on design of air ducts for barn hay drying systems indicates much less resistance to flow of air when the duct opening along the barn floor is increased from one to two or three inches.

Operating costs range from \$0.50 to \$1.50 a ton. Installation costs for barn type driers ranged from about \$12 to \$30 per ton of capacity.

Farmers using the barn hay drying system reported saving from a few tons to an entire hay crop annually, which would otherwise have been badly damaged or completely lost. Hay was reported to be of better quality than when field cured.

**Use of Farm Labor and Materials for Low Cost Home Construction** (J. C. Wooley). This project with a quonset type dwelling 26'x40' was planned to give maximum use of farm labor during slack seasons of the year in building a farm home and also the maximum use of native materials. It also included cost study of the various phases of construction and heat distribution system.

It was found that quonset type buildings are better adapted to storage buildings than dwellings and cost studies indicate that there is a distinctive saving in construction of this type of house so far as the outside enclosure is concerned. However, this saving was lost in the irregular work required in covering the curved side walls, fitting partitions to them and in finishing around the dormer windows in the curved side walls. This high cost or irregular interior work overcame the advantages of low cost frame construction.

A comparison of building costs at the time this quonset type building was constructed with 1940 costs show that the dwelling would have cost \$3691 in 1940 as compared to \$6758 at the time it was constructed.

**Seed Bed Preparation for Small Grain Following Lespedeza** (M. M. Jones and C. W. Steinbruegge). Lespedeza-small grain rotations are extremely important in Missouri and trials for different methods of preparing seed beds for wheat and lespedeza were continued. Some plots were plowed, some were field cultivated twice, and some were field cultivated once, followed by tandem discing. The ground was too hard to be prepared by tandem discing alone.

The plowed plots gave best yields, averaging 25.3 bushels per acre. There was only little difference between the yields on plots field cultivated twice, and

those field cultivated once and disced once, the former being 21.5 and the latter 20.5 bushels per acre.

Although the yields of the plowed plots were higher, the cost of seedbed preparation was also higher. Furthermore, the time required for seedbed preparation was considerably more. Therefore, it appears that the use of the field cultivator is a practical solution of the problem of seedbed preparation for wheat following lespedeza on many farms.

Plowed plots were barer in the winter and early spring, making the soil more subject to erosion than the other plots.



## ANIMAL HUSBANDRY

L. A. Weaver, *Chairman*

**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 and Mrs. Fred Madden reported on the meat work.

The committee working on this food preservation project consisted of the following: Miss Laura Flynn, Kenneth Huff, J. E. Comfort, W. H. E. Reid, Miss Florence Harrison, A. E. Murneek, E. M. Funk, and S. B. Shirky.

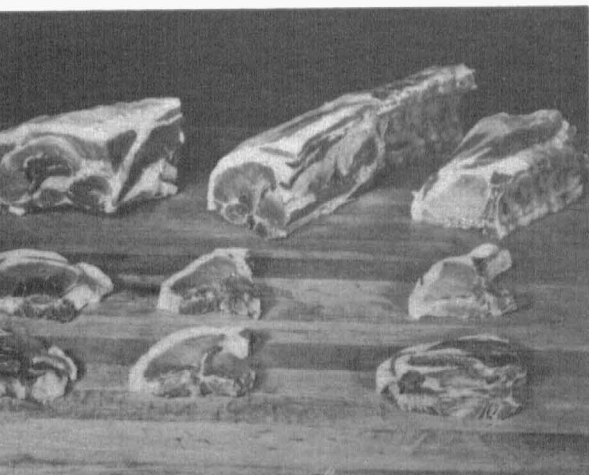
It was found that sausage, hamburger, and pork chops became less palatable when stored longer than 6 to 8 months at low temperatures. Beef steaks one inch in thickness and pork loin roasts can be stored satisfactorily 10 to 12 months but probably become less palatable if stored longer than one year.

The hamburger used in the second year of the experiment was fresh, lean trimmings from beef that had not been ripened in storage and the palatability of the hamburger remained more desirable for two to three months longer than in the first year of the experiment when the hamburger was from lean trimmings from beef that had been aged 10 days.

There was a noticeable difference in juiciness and color or appearance of 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 is very noticeable even on the sample that has been frozen only 48 hours. All of the pork chops that were frozen tended to be dry when cooked.

The one-inch porterhouse steaks scored about as well as the two-inch steaks used in the previous year's experiment. Scoring of tenderness and juiciness and flavor of lean remained relatively high during the first 12 months of

Pork chops became less palatable when stored longer than 6 to 8 months while steaks one inch in thickness and pork loin roasts can be stored satisfactorily 10 to 12 months.



storage at all three temperatures. There was a noticeable change in flavor of fat to a slightly rancid or "old" flavor after 9 months storage and a decline in palatability in all the steaks between the twelfth and fourteenth months of storage.

There was no significant difference in cooking losses on meats stored at the three temperatures in this experiment.

Pork chops and porterhouse steaks double wrapped in a cellophane-craft laminated paper, a glassine lined paper, and a waxed locker paper and in a waterproof meat wrapping paper showed the following shrinkage over a 12 months' storage period:

	<i>Pork Chops</i>	<i>Porterhouse Steaks</i>
Cellophane-craft laminated.....	3.62%	2.40%
Glassine-lined paper.....	3.25%	2.40%
Waxed locker paper.....	3.89%	4.18%
Waterproof butcher paper.....	3.25%	6.68%

From the palatability standpoint and the appearance of the frozen meat, the cellophane-craft laminated paper and the glassine lined locker paper both were more satisfactory than the waxed locker paper or the waterproof paper. The meat stored in the waterproof paper was noticeably dehydrated or freezer-burned after 9 months of storage at  $-18^{\circ}\text{C}$ .

**Producing Beef by the Maximum Use of Pasture and Other Roughage and a Minimum Use of Grain** (A. J. Dyer and L. A. Weaver). Experimental work at Missouri continued to show a large advantage for the system using the maximum amount of pasture and roughage in meat production. Choice feeder steer calves weighing 438 pounds in December, 1946, were developed into fat yearlings weighing 1023 pounds with about 20 bushels of corn.

They were sold in January, 1948, yielded carcasses that graded "good" and a dressing percentage of 58.8%, cold weight. Of the total increase in weight, 585 pounds, 70 per cent was made from roughage in winter and pasture in summer; grain was full fed in dry lot for only 30% of the entire gain. Roughage fed in winter consisted of legume hay, alfalfa and clover, supplemented with a small amount of grain, shelled corn 10 parts by weight and protein supplement, soybean meal 1 part by weight. To produce these fat yearling cattle, the following total amounts of feed were required per head:

- (1)  $1\frac{1}{2}$  tons legume hay,
- (2) 725 pounds corn silage—fed only during the second winter,
- (3)  $20\frac{1}{2}$  bushels shelled corn with about 115 pounds soybean meal,
- (4) Wheat-lespedeza pasture from May 3, 1947 to October 31, 1947.

If the cattle had been fattened in dry lot primarily by grain feeding, from 45 to 55 bushels of shelled corn would have been consumed and little or no profit would have been secured. By making extensive use of roughage and pasture and time, the cattle in this test yielded a good profit.



These ewes were wintered on pasture.

**Early Lamb Production** (C. V. Ross and A. J. Dyer). This study is the first of the series of experiments of early lamb production. The wintering phase emphasizes the value of good winter pasture and that is important in this state where small grain and pastures are on the increase.

The 52 head of two-year-old northwestern ewes in this project were bred to two purebred Hampshire rams and one lot was wintered in dry lot until parturition on legume hay and oat straw while the other lot was wintered solely on bluegrass pasture except on days when weather conditions made it impossible for them to graze. When snow or sleet covered the pasture, the second lot was fed legume hay plus oat straw.

After lambing both lots of ewes were fed the same ration which consisted of corn 6 parts, wheat bran 3 parts, and soybean oil meal 1 part. They were fed legume hay in addition. Commencing March 13, 1947, one group from each lot of lambs was creep fed. The ewes and lambs of the group from each lot which were to be creep fed were grouped together for the creep feeding phase of this experiment.

The average winter gain was approximately the same for both lots of ewes. Larger and stronger lambs were weaned by ewes wintered on pasture than those wintered in dry lot. Average weights of lambs dropped by ewes wintered on pasture were as follows: Singles 10.6 pounds, twins 8.0 pounds, average for all lambs 9.2 pounds. Lambs out of ewes wintered in dry lot averaged 8.6 pounds for singles, 7.2 pounds for twins and the total average for all lambs was 7.0 pounds. Fleece weights were approximately the same for both lots of ewes. Ewes wintered in dry lot consumed 320 pounds legume hay and 10 pounds oat straw per ewe from November 16 until the first lambs were

dropped, which was February 8. Ewes wintered on pasture consumed 40 pounds legume hay and 1 pound oat straw per ewe for the same period.

On June 19, the creep fed lambs averaged 73 pounds in weight. Those receiving no grain averaged 66 pounds. On June 24, eleven creep fed lambs weighing 863 pounds and 9 lambs, weighing 670 pounds, which had received no grain were shipped to St. Louis. These were all the lambs from each group which were considered large enough and fat enough to be marketed. The grain fed lambs sold for 50¢ more per hundred than did those receiving no grain. The lamb carcasses were graded by a U. S. D. A. grader. The grain fed lambs graded 5 choice, 3 good, 2 commercial and 1 utility. The lambs which had received no grain had 2 carcasses which graded choice, 4 which graded good and 3 which graded commercial.

The 11 grain fed lambs weighed a total of 860 pounds at St. Louis for a shrink of 3 pounds. The 9 other lambs weighed 650 pounds for a shrink of 20 pounds for the lot. The carcasses from the grain fed lambs were firmer, plumper, and more uniformly covered with white fat.

The creep feeding data suggests that there may be several conditions under which creep feeding may be profitable, such as during a late spring when pastures are not over productive, or at any other time when the ewes are not producing a maximum flow of milk.

**Inbred Swine Breeding Project** (L. A. Weaver, D. R. Warner, and G. E. Dickerson). The Missouri station is a cooperator with the regional swine laboratories and continued during the past year with two Poland China lines (II and VI) and one Hampshire line (V). The present level of inbreeding in Line II is slightly over 40% while inbreeding averages 20% for line VI and 22% for line V.

Three sublimes were started with the 1948 spring line V pigs. Sublining is being practiced in an effort to facilitate the use of inbreeding as a tool to increase effectiveness of selection.

The sow performance in Line II has been noticeably declining as inbreeding has advanced. The size and vigor of pigs at birth has continued to hold up; in fact Line II is superior from this standpoint to the less highly inbred Lines (V and VI). Prolificacy is expected to decline somewhat with increased inbreeding, but the more striking decline in Line II has been the suckling ability of the sows. After the pigs are three or four weeks old, many of the sows begin going dry, one udder section at a time. Consequently, even though the litters are small the pigs have low weaning weights and are severely stunted unless they are advanced enough to begin eating grain before the sow goes dry. More rigid selection is now being undertaken in an attempt to improve this situation.

In the fall of 1947, crosses between the three inbred strains were compared with each other and with the inbreds. The limited data (19 litters) indicate

that the linecross pigs, particularly of the IIxV cross, compare favorably with the best dry lot performance records from weaning to market weight. Average daily gain per pig varied from 1.6 to 1.7 pounds and feed required per 100 pounds gain ranged from 332 to 362 pounds.

After the 1948 potential breeding stock was selected from the 1947 spring group of weanling pigs, one hundred of the remaining pigs were started on a sub-project to secure information on the value or effect of supplying the hormone drugs "Protamone" and "Thiouracil" in the growing and fattening ration. In addition to observing how the three different inbred lines responded to the treatment, a comparison was made of limited and self-feeding during the growing period. The feed intake of the limited-fed pigs was controlled until the lots reached an average of approximately 160 pounds, then they were self-fed until a market weight of near 225 pounds was reached.

The .2% of thiouracil in the ration seriously stunted the young growing pigs regardless of pasture or controlling the feed level. After the thiouracil was removed from the ration, these pigs began to grow again and most of the pigs made good gains after a few weeks off of the treatment. Two of the pigs died after they were changed from thiouracil to the protamone treatment.

There was little or no advantage to feeding 2.8 grams of protamone per 100 pounds of feed to the pigs during the growing period. However, the mild hypothyroid condition developing when protamone was dropped from the ration during the finishing period offers encouragement for more experimental trials.

The change from protamone to the thiouracil treatment seemed to have a detrimental effect. The extreme hypothyroid condition was apparently hastened when the oral supply of thyroxine was discontinued and .2% thiouracil added to the ration.

The rate of gain for the protamone lots was much greater than the thiouracil lots and equaled that of the control group. In addition, the sluggishness, restricted breathing, myxoedema and general unthrifty appearance, noticed among many of the animals fed the thiouracil for only a few weeks, was not observed in the protamone groups.

The differences between lines on the various treatments was not great. However, the Hampshire pigs did seem to remain thriftier during this restricted feeding period and were observed to be foraging more often.

**Improved Techniques for Artificial Breeding** (D. T. Mayer, G. E. Dickerson, C. D. Squiers, James B. Marr, and Ralph Kampschmidt).

Chief results of work this year were set toward the discovery of techniques for the evaluating of the storage and fertilizing capacity of semen samples and the fertility of males.

Live-dead staining techniques for sperm cells were improved by the use of fast-green as a background stain. Also, it was found that fluorescein deriva-



tives act as the sperm-staining principle. Factors of a physical or chemical nature influencing staining results were ascertained.

Physical and chemical factors causing "settling out" of colloidal constituents of semen and diluters during storage are being studied. Apparently, the sodium ion concentration is a contributing factor but further study is needed before drawing definite conclusions. "Settling out" is a major problem in commercial use of artificial insemination, since "settled" samples are not usable and are a financial loss to the breeder or the organization.

**Comparison of Standard Cornbelt Rations with Complete Mixed Hog Feeds for Growing and Fattening Pigs** (L. A. Weaver and Zane Palmer). From time to time the Missouri station receives requests for information comparing the complete mixed hog feeds on the market with the standard cornbelt rations of corn and a protein mixture for growing or fattening swine.

Four lots of twelve hogs each were fed four different rations in a 77-day experiment in dry lot in this experiment. They were fed in a shed having concrete floors and opening to the south and all the pigs had access to a mixture of equal parts of ground limestone, bone meal, and salt.

Lot I was fed ground corn 80%, tankage 10%, soybean oil meal 5%, and alfalfa meal 5%; while Lot II was fed ground corn 58%, shorts 29%, tankage 6.5%, soybean oil meal 3.3% and alfalfa meal 3.2%. These two rations are considered standard cornbelt rations with Lot I containing 3.4% fiber and Lot II 4.2% fiber and each of them 16% protein.

In general, the complete mixed feeds on the market contain a minimum of 14 to 15% protein and a maximum of 6.5 to 8% fiber. Sufficient alfalfa meal (fiber 25%) was added to the feeds used for Lot I to bring the fiber content of ration fed Lot II up to approximately 6.5%. Likewise, oat mill feed (fiber 30%) was combined with corn, tankage, soybean oil meal, and alfalfa meal to bring the fiber content of the ration fed Lot IV up to 7.8%.

Combining the results secured with the 2 lots of hogs fed standard cornbelt rations (Lots I and II) for comparison with those secured by combining the two lots fed rations containing more fiber (Lots III and IV) it was found that hogs fed the standard rations gained almost 20% faster with a saving of more than 15% in feed required per unit of gain. This saving in feed amounted to more than a bushel of corn for each 100 pounds of gain produced.

The results of this trial indicate that when the fiber content in rations for growing-fattening pigs gets above 3.5% (approximate amount in a ration of corn 4 parts, trio mixture 1 part) the rate of gain will decrease and amount of feed required per unit gain will increase and that both of these effects become quite marked when the fiber content exceeds 5 per cent.

## BOTANY

C. M. Tucker, *Chairman*

**Mechanisms of Resistance on Immunity to Infection by the Wilt Fungus, *Fusarium Lycopersici*, and the Methods of Their Inheritance in Tomato Hybrids** (C. M. Tucker and A. M. Finley). Research was continued on the resistance of accessions of *Lycopersicon esculentum*, *L. Pimpinellifolium* and other species to races 1 and 2 of *Fusarium oxysporum* f. *lycopersici*. Among accessions of *L. esculentum* none was found as resistant to race 2 as several accessions of other species, including accession 160, *L. pimpinellifolium*, in use in the breeding program as a source of resistance to both races 1 and 2, although failing to provide the highest degree of resistance to race 2.

Studies on the 2 races of the wilt fungus indicate a fairly high degree of stability as to pathogenicity. Passages of the 2 races through susceptible and resistant hosts failed to reveal any adaptive changes which might indicate progressive increases or decreases in pathogenicity, providing additional evidence that the evolution of race 2 from race 1 is probably in the nature of a single mutation.

**Morphology and Physiology of Species of *Phytophthora*** (C. M. Tucker). Extensive isolation work was done on Cinchona material from Costa Rica and Guatemala. Information on the identity of the casual organisms has made possible the selection of control measures for use of growers of the affected crops.

Two species, *C. Ledgeriana* and *C. succirubra*, affected by top blight and sunken bark canker yielded isolates identified as *Phytophthora parasitica* and *P. cinnamomi*. Other studies on cultures or infected material yielded the following data:

*Erica regerminans*—California—*P. cinnamomi*; Tomato buckeye rot—Missouri—*P. parasitica*; Corn (greenhouse)—Indiana—*P. parasitica*; Potato (tubers)—Canada—*P. erythroseptica*; Spinach—Canada—*P. megasperma*; Avocado seedlings—Florida—*P. palmivora*; Grapefruit—California—*P. citrophthora*; and Elm (pit canker)—New England—*P. inflata* n. sp.

**Identification of Plant Diseases** (C. M. Tucker). During the year approximately 500 letters were written in regard to diagnoses of plant material and reply to requests for information on plant disease control by both county agents and growers.

Among the new plant diseases found in the state was plane tree canker stain disease near St. Louis. This is the first record of the disease in Missouri and identification provided the background for establishment of control measures. For example, the identification of the plane tree disease will enable the City of St. Louis to use proper pruning and trimming procedures which may save many thousands of street trees.



The development by the Missouri Station of varieties of tomatoes resistant to fusarium wilt is important to Missouri producers.

**Development of Tomato Varieties from Hybrids for Resistance to Fusarium Wilt** (C. M. Tucker, R. A. Schroeder, and A. D. Hibbard). Wilt is probably the most destructive tomato disease in Missouri, particularly in home gardens and market garden areas where long rotations are not feasible. New varieties with high resistance to fusarium wilt will replace the current variety rapidly.

The ten most promising hybrid progenies produced an average yield of 6.7 tons per acre, while 12 standard commercial varieties produced an average of 5.8 tons per acre. Seeds from 112 selected plants were tested for wilt resistance in the greenhouse during the winter. Most proved homozygous resistant, a few were segregated and none was homozygous susceptible. Under the same conditions the variety Ontario proved 100% susceptible.

**Virus Diseases of Stone Fruits** (C. M. Tucker and Daniel Millikan). Studies were begun this year on the feasibility of indexing stone fruits for virus content, with the purpose of establishing procedures permitting the certification of nursery stock as free from certain virus diseases. Budwood from source trees and scion blocks of three nurseries was secured and budded into various peach varieties and seedlings, and into ringspot free Montmorency cherries at Midway and Louisiana.

Duplicate material was sent to Wisconsin for a comparison of behavior under different climatic conditions. The ringspot virus proved readily identifiable on both peach and cherry under greenhouse and field conditions. The yellows virus has been identified only on peach. To date yellows symptoms have not been observed on cherry although indexing shows it present on trees in the nursery.

## DAIRY HUSBANDRY

A. C. Ragsdale, *Chairman*

**Nutritional Studies on Growth of Dairy Heifers and Milk Production** (H. A. Herman, O. T. Stallcup, J. W. Cobble, A. C. Ragsdale, J. E. Edmondson, and E. W. Swanson). Continuation of this research work confirmed the previous findings that heifers grown on a heavy grain ration while 5 to 30 per cent heavier and 5 to 10 per cent larger in skeletal growth than heifers fed minimum grain and abundant roughage rations, are costly to raise and produce no better as first calf heifers.

Normal Holstein heifers have been reared from birth to two years of age with an average feed consumption of whole milk 293 lbs., skim milk 1907 lbs., "calf starter" ration 27 lbs., grain mix 1389 lbs., hay 3719 lbs., silage 1436 lbs., and 317 days pasture. Similar feed consumption studies have been obtained for Jersey heifers.

This research shows that dairy heifers may be economically and adequately grown on rations utilizing limited amounts of whole milk, an 18% crude protein "calf starter" the first few weeks, and thereafter a grain mix containing approximately 14% crude protein and with liberal roughage feeding.

The blood plasma carotene of the dam, and also of the calf, was found to be highest on 6 cows receiving Korean lespedeza hay post-partum as compared to cows receiving alfalfa hay.

In a study of the effects of environmental temperatures in a controlled chamber, the solids-not-fat, the per cent of fat, and the chloride content of milk from 6 Holsteins and 4 Jerseys was not materially changed when the environmental temperature was raised from 50° F. to 60° F. Milk nitrogen values, however, appear to be variable.

**Dehydrated Culture in Ice Creams** (W. H. E. Reid, J. H. Gholson, and R. H. Thomas). The use of dehydrated cultures in ice creams offers the consuming public a new and distinctively flavored ice cream with improved physical properties. It also provides a new field for use of culture.

Special attention was given to the effect of variable amounts of culture upon the flavor, body, texture, color, and melt down of the ice creams. The studies thus far show that variable amounts of dehydrated culture are increased in order to maintain uniformity of overrun. Increased amounts of dehydrated culture have no apparent effect on the hardening of the ice creams. The distinctive desirable cultured flavor became more apparent with increased increments of the dehydrated culture.

As the amount of the culture in the mixtures was increased, the texture became proportionally closer, the body smoother and more mellow, and the resistance to melting greater. Three per cent of culture seemed to be most desirable.

**Mastitis Treatment of Dairy Cows** (H. A. Herman, C. P. Merilan, J. E. Edmondson, A. C. Ragsdale, and O. S. Crisler). Since the initiation of this study several years ago, periodic examination by means of diagnostic tests and bacteriological analyses of each quarter of every cow in the milking herd has been made. The infected quarters are treated with sulfanilamide infusions, penicillin, or other modern treatments.

This year 52 cows were treated (some of which are recurring cases); 28 cows, 53 quarters, were treated with amorphous penicillin (k), 18 cows, 32 quarters, were treated with penicillin (G) form, and 3 cows, 12 quarters, were treated with 4-4 diamino-diphenyl sulfone plus amorphous (k) penicillin in combination.

Iodized mineral oil (1 part iodine 2000) with 35% sulfanilamide used as an infusion cleared up about 75% of the infected quarters treated. Amorphous penicillin rendered 65 to 75% of the infected quarters free of *S. agalactiae*. Peni crystin (penicillin G) rendered only 59% of the quarters free of *S. agalactiae* in this year's trials. Sulfone and penicillin injected simultaneously were found to render 67% of the quarters free of mastitis organisms. Long standing cases of mastitis were found to give a poor response to any of the above treatments.

These treatments were found to only slightly reduce milk flow and pre-treatment levels were attained within a few days following treatment. It is believed that mastitis in dairy cattle may best be controlled by proper herd management and milking technique.

**Studies in Milk Secretion** (C. W. Turner, Joseph Meites, C. R. Blincoe, T. Y. Liu and Gene Kauffman). Research completed on this study concerned the influence of various factors on the lactogen content of the pituitary, the initiation of lactation at parturition, and the maintenance of pituitary lactogen and milk secretion. The results of present research suggest that the act of parturition results from the physiological over-balance of estrogen as related to progesteron. The estrogen stimulates the secretion of the lactogenic hormone of the pituitary and in turn milk secretion. The stimulus of milk removal then maintains the secretion and discharge of the lactogenic hormone.

In dairy goats, the administration of thyroprotein and estrogen caused an increase in milk production from about one to four pounds per day. When administration was stopped, milk secretion declined. This was repeated several times.

As a by-product of our research, dried cow manure has been shown to contain a vitamin-like substance which stimulates rapid growth of chicks on feeds containing no animal protein. It also is rich in male hormone which stimulates growth in pullets by conserving the protein fed. Dried cow manure can be substituted for the best alfalfa meal in the starter ration of chicks with favorable results upon the growth rate.

**Endocrinology of Milk Secretion** (C. W. Turner, Joseph Meites, John Trentin, and Victor Hurst). As a result of extensive study upon the factors influencing the thyroxine secretion of mice these research workers suggest that the growth of the mammary glands (udder) is stimulated by a hormone secreted by the anterior pituitary called mammogen.

In the study of the thyroxine secretion rate of male and female mice, it was observed that the rate per 100 gm. body weight decreased with advancing age and body weight. With increasing environmental temperature, the secretion rate declines. Pregnancy and lactation do not appear to markedly influence the thyroid gland. Mice were fed thyroprotein and injected with thyroxine during growth. Both preparations increased the rate of growth.

This research indicates that the factor which stimulates duct growth and the factors stimulating lobule-alveolar growth are identical. However, only when the mammogenic factor is isolated from other pituitary factors will the final story be told.

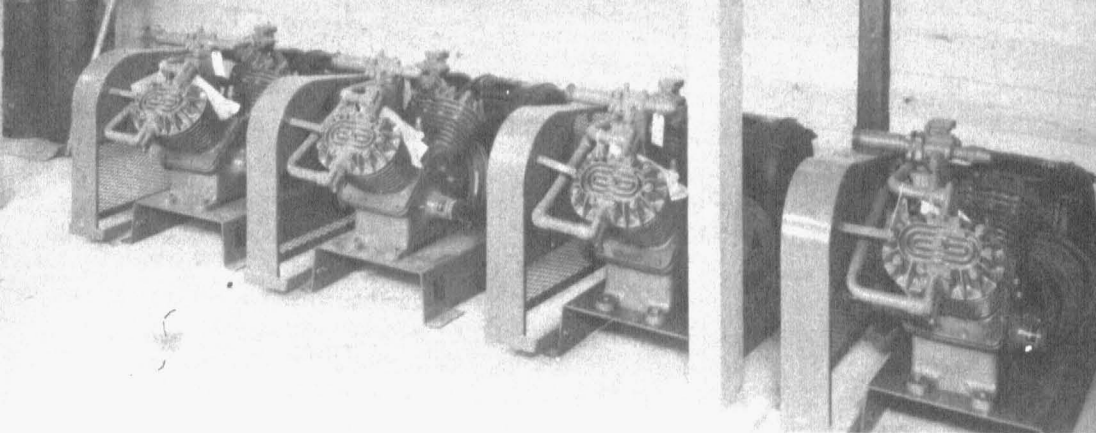
Thyroprotein is now undergoing extensive test over the country in experiment stations and the research laboratories of large feed companies and the fact that it will stimulate growth in certain animals and birds, will have quite factual application.

**Use of Spray Process Whey Solids in Ice Creams and Sherbets** (W. H. E. Reid, J. H. Gholson, and L. O. Shaffer). The use of spray processed whey solids in ice creams and sherbets is of particular economic importance to the cheese industry since it provides a new market for these nutritious food solids.

This research included a study of the use of spray process whey powder in the manufacture of different flavored ice creams and sherbets, with special attention directed to its effect upon processing, procedure, freezing, hardening and dipping of the ice creams.

It was found that dehydrated spray process whey solids could be used in different flavored ice creams and sherbets without altering the processing, freezing or hardening procedure commonly applied in commercial ice cream plants. As much as seventy per cent of the serum solids in chocolate and strawberry ice creams may consist of whey solids. Pineapple, orange and raspberry sherbets containing as much as ninety per cent whey solids were very desirable in every respect.

**New Climatic Laboratory** (S. Brody, H. H. Kibler, A. C. Ragsdale, C. R. Blincoe, Gloria Burge, J. C. Wooley, J. H. Thompson, and D. M. Worstell). The department of Agricultural Engineering, United States Department of Agriculture and the U. S. Navy Medical sciences research branch are cooperating with the University of Missouri Departments of Dairy Husbandry and Agricultural Engineering in this extensive study of the influence of climatic factors on productivity and physiological reactions of farm animals.



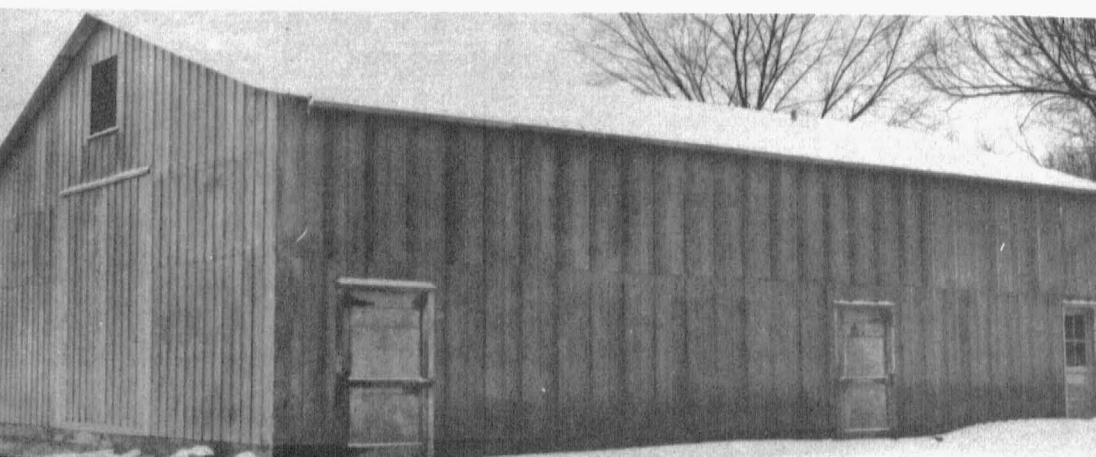
These compressors are a part of the equipment being used in the new climatic laboratory in the study of the influence of climactic factors on productivity and physiological reactions of farm animals.

This research is concerned with the influence of environmental temperature on physiological processes of animals, with special reference to milk production in dairy cattle, in a Psychroenergetic, or Bioclimatic Laboratory. Thus far, the work has consisted mostly in adapting or developing equipment and techniques for measuring metabolism, for gas analysis, for measuring surface and other temperatures, for blood analysis and for developing experimental designs and plans.

The Laboratory was opened officially March 11, 1948, and data on cardio-respiratory activities, body temperatures (surface and internal), blood and milk composition, feed and water consumption, body weights, and milk production have since been collected on 12 cows. Six of these cows were kept at 50° F. and approximately 60% humidity and the other 6 at temperatures which increased by 5° to 10° F. at about two-week intervals up to about 100° F.

The cardiorespiratory records referred to above are on pulse rate, respiratory rate, tidal air, pulmonary ventilation rate, oxygen consumption, carbon dioxide (and methane production), and heat production computed from the oxygen consumption. Much attention is also given to heat dissipation by vaporization, radiation, convection, and conduction.

Shown below is the new Psychroenergetic or Bioclimatic Laboratory where research is being conducted on the influence of environmental temperature on physiological processes of animals, with special reference to milk production.



**Factors Influencing the Energetic Efficiency of Growth and Related Transformations** (S. Brody, H. H. Kibler, and D. P. Sadhu). This research was a continuation of previous studies on growth metabolism.

Data on cardiorespiratory activities (heat production, pulse rate, ventilation rate, respiration rate, tidal air) of 16 Jersey heifers from age 10 months through gestation and lactation up to 5 years was analyzed. The average heat production between ages 10 and 25 months (middle of gestation period) was about 2000 calories per square meter per day. Heat production then increased to nearly 2800 calories just before calving and to nearly 4000 calories at the lactation peak. Equivalent results—that gestation increases the normal resting heat production by 40% and heavy lactation by 100% above the pregestation level—were also obtained on white rats. The other cardiorespiratory activities paralleled the resting heat production except that the tidal air tended to decline during the last third of the gestation period.

The following are some absolute values for the cardiorespiratory responses of the 16 Jersey cattle. Heat production: at 18 months (breeding time), 8000 calories per day; at the lactation peak, 13,000 calories per day; at 50 months (drying up), about 10,000 calories per day. Pulmonary ventilation: at 18 months, 60 liters (2.0 cu. ft.) per minute; at the lactation peak, 125 liters (4.4 cu. ft.) per minute; at 80 months, 90 liters (3.2 cu. ft.) per minute. Tidal air: 2.0 liters (0.09 cu. ft.); 20 to 50 months contrasted to 4.0 liters (0.14 cu. ft.) at the lactation peak. Pulse rate: 60 per minute at 20 to 80 months contrasted to 80 per minute during the lactation peak.

**Increasing the Effectiveness of Artificial Insemination as a Means of Improving Dairy Cattle** (H. A. Herman, A. C. Ragsdale, R. C. Laben, J. B. Peterson, D. B. Roark, D. S. Sanders, J. E. Edmondson, and K. L. Tallman). A study of the relationship between physical and chemical characteristics of dairy bull semen and conception rate under field conditions and of the factors affecting conception rate in some 40,000 cows enrolled in Missouri artificial breeding organizations was made.

Initial motility, survival time of spermatozoa in storage, initial per cent of live sperm, and other semen characteristics have been found to be significantly correlated with fertility of sires used in artificial insemination, the quality of semen, conditions of feeding and management of the cow herd, experience of the inseminator, health of the herd, and season of the year. In 1947, some 40,000 cows bred in Missouri artificial insemination organizations showed 60.8% non-returns per 100 first services.

The coefficient of correlation for survival time of semen in storage and conception rate for 3 breeding organizations and involving 65,885 services was found to be 0.215, 0.239, and 0.219 respectively. The best conception rate was attained in October and the poorest during April and May.



The mucus of the vagina and cervix seem most favorable to sperm survival during the first half and the middle of the heat period. This is strongly correlated with the most favorable time for insemination.

The percentage of live sperm found in semen is correlated with survival time of the sperm in storage and fertility of the sire. Results to date indicate a definite correlation between the hemolytic count and the length of storage. As the hemolytic count increased, the length of storage decreased. The non-hemolytic bacteria did not generally have a definite effect upon the length of storage, although certain non-hemolytic streptococcus were effective in increasing the storage time of semen. Some kept the sperm alive four days longer than the controls, while others killed the sperm in 1 to 2 days.

Over 5,000 Missouri dairymen owning some 70,000 cows have participated in the artificial insemination program. Studies on the evaluation of semen, dilution, storage, shipping and insemination technique have aided in increasing the efficiency of artificial insemination in the field. Conception rate is affected by level of nutrition, season of the year, health of the herd, quality of semen used, and experience of the inseminator. Cows should be inseminated during the heat period and up to 6 hours out of heat if optimum survival of sperm in the female tract is to be attained.

Bacteria, especially the hemolytic type, cause great damage to the sperm resulting in loss of man hours in artificial breeding. The application of clean sanitary methods of handling bulls and semen is of first importance in preventing the introduction of organisms in aiding higher conception rates.

**A Quantitative Study of the Precursors of the Constituents of Milk and the Energy Requirements of Milk Secretion** (C. W. Turner, R. A. Monroe, and G. W. Pipes). Thyroprotein, the synthetic thyroid hormone, is now being used in dairy rations under commercial conditions. If the results are as satisfactory as the experimental results indicate, its use in dairy rations may be expected to become widespread. Therefore, extensive work has been continued at this station on the influence of the presence and absence of the hormone of the thyroid gland on the precursors of the constituents of milk in the blood and on the rate of blood flow. Also, research has been continued on the site of losses of hormones in oral administration to ruminants and methods of prevention.

The metabolism of the goitrogenic chemicals is also being investigated. This involves the rate of absorption from the digestive tract, the level in the blood, the rate of disappearance from the blood, the amount in the tissues and the rate of disappearance following the discontinuation of goitrogen feeding.

In order to express results in terms of biological thyroxine activity, several thyroxine compounds, namely, crystalline thyroxine, mono- and di-sodium thyroxine were fed to chicks to determine their oral effectiveness. Crystalline thyroxine is less effective orally than the two sodium salts.

When chicks are fed thyroxine in excess of their secretion rates, their thyroid glands decrease in size. When the thyroxine is stopped and thiouracil is fed, the thyroids increase in size. How long the circulating thyroxine continues to depress the thyroid gland has been suggested as a measure of the rate of breakdown or elimination of the thyroxine. Contrary to expected results, vitamin A seems to prolong the effectiveness of thyroxine as measured by this technique. The synthetic estrogen, diethylstilbestrol, was found not to affect the duration of thyroxine activity.

**Hatch Dairy Experiment Station** (A. C. Ragsdale and Roy H. Wigginton). The production, utilization, and cost of alfalfa-brome grass mixtures for silage and pasture and of improved blue grass for pastures was continued at the Hatch Dairy Farm. These studies showed that there was a gross return of \$51.90 per acre from the alfalfa-brome grass pasture as compared to a gross return of \$29.33 from the blue grass. The hay was valued at \$35.00 a ton and the silage at \$11.50 a ton in these studies. The alfalfa-brome grass showed a net return of \$42.10 per acre and the blue grass showed a net return of \$33.82 per acre.

Thirty-two sires leased to cooperating farmers with 434 dam-daughter comparisons showed progeny performance as follows: daughters average 6439 lbs. milk, 347 lbs. fat, average test 5.39%; dams average 7607 lbs. milk, 404 lbs. fat, average test 5.31%. The decrease in milk was 1168 lbs., in fat 57 lbs., and the increase in test .08%. Eight sires increased production and 24 decreased production.

**Improvement of Dairy Cattle Through Breeding** (H. A. Herman, A. C. Ragsdale, R. C. Laben, D. B. Roark, and J. E. Edmondson). An investigation on the effects of inbreeding vs. outcrossing of family lines in the Holstein herd at the Missouri Station was initiated. The study covered breeding results from 1902 to 1947 and involved about 350 cows with over 1400 lactation records. A study was made of the length of time following parturition and the first estrus period on 350 cows involving 1025 gestations in the Missouri Experiment Station herd. The average length of time following parturition and first estrus was about 50 days for the 350 cows studied. The average length of gestation was found to be 279.47 plus or minus 5.6 days for 1957 pregnancies.

The "reproductive efficiency" for the station herd over a 45-year period is 81.5 per cent.

Linebreeding with a complete testing and type classification program with adequate disease control is indicated to be the best means of developing a uniformly high producing purebred herd.

## ENTOMOLOGY

Leonard Haseman, *Chairman*

**Missouri Ticks and Their Control** (Roland W. Portman, P. C. Stone, and Leonard Haseman). This study was a continuation of research on Missouri ticks and their control. The toxicity of four different formulations of benzene hexachloride (BHC) compared in stock dipping vats were found to be identical under field conditions. Dipped animals were protected for one week from tick attack. Hornflies, lice and fleas were also killed by this treatment.

Dipped cows with calves gained an average of fifty pounds more than the non-dipped cows and calves. Both groups grazed the same pasture. Comparative toxicity test showed that chlorinated camphene was slightly superior to chlordane and BHC, protecting the stock for nine days from ticks. The 250 head of stock belonging to the farmers cooperating in the dipping experiment gained about 10,000 pounds more beef than they would have, or a possible gross income of about two thousand dollars. This does not include the 100 to 150 head which were regularly treated in the other comparative toxicity tests.

**Sulfa Drugs for Controlling American Foulbrood of Bees** (Leonard Haseman). The sulfathiazole treatment developed at Missouri for American foulbrood is now rather universally accepted by practical beekeepers and by the larger commercial honey producers as an effective control for American foulbrood. It has from conservative estimate saved American beekeepers at least 100,000 colonies of bees during the last year worth \$1,000,000 and a crop of honey worth \$2,000,000. Also as savings in fruit and legume pollination the sulfa treatment has added further millions.

Further experiments were made with standard sulfathiazole and sodium sulfathiazole fed in sugar syrup and pollen substitute. When  $\frac{1}{2}$  gram sulfathiazole to one gallon of sugar syrup fed as such or combined in pollen substitute was fed to American foulbrood colonies, they promptly cleaned up combs and reared normal healthy brood.

One-half a level teaspoonful of sodium sulfathiazole to one gallon of sugar syrup gave similar results. When  $\frac{1}{2}$  gram of sulfathiazole dissolved in  $\frac{1}{2}$  pint of grain alcohol was repeatedly sprayed into diseased combs the bees failed to promptly clean up the combs. Also when a spray of alcohol struck adult bees and brood it caused some mortality.

Colonies in the experimental apiary have now remained free of all signs of American foulbrood infection since 1945 but these experimental colonies have continued to receive some sulfathiazole each summer.

**Codling Moth Investigation and Control** (Lee Jenkins, Curtis W. Wingo, Wilbur Enns, and Leonard Haseman). This study was a continuation of previous work and a number of new insecticides were tested and the results made available to the farmers and fruit growers of the state.

New insecticides including DDT, Toxaphene, Chlordane, Nonpariel, and proprietary combinations of fixed nicotine and DDT were tested for codling moth control used alone and in combination.

A program using 2 pounds of 50 per cent wettable DDT per 100 gallons sprayed on a seven-day schedule during the first brood of codling moths was tested in a small isolated orchard for codling moth control.

Of the new insecticides tested for codling moth control DDT was the best. Methoxy DDT appeared to be almost as good as DDT. There was a tendency for mite problems to develop where DDT was used. Combinations of oil and DDT caused injury to leaves and fruit.

Both 2 pounds of 50% wettable benzene hexachloride of 6% gamma isomer per 100 gallons and chlordane at 2 pounds of 50% wettable powder per 100 gallons gave curculio control on peaches and plums equal to lead arsenate.

Chlordane was more effective for grasshopper control than benzene hexachloride especially when used against mature grasshoppers.

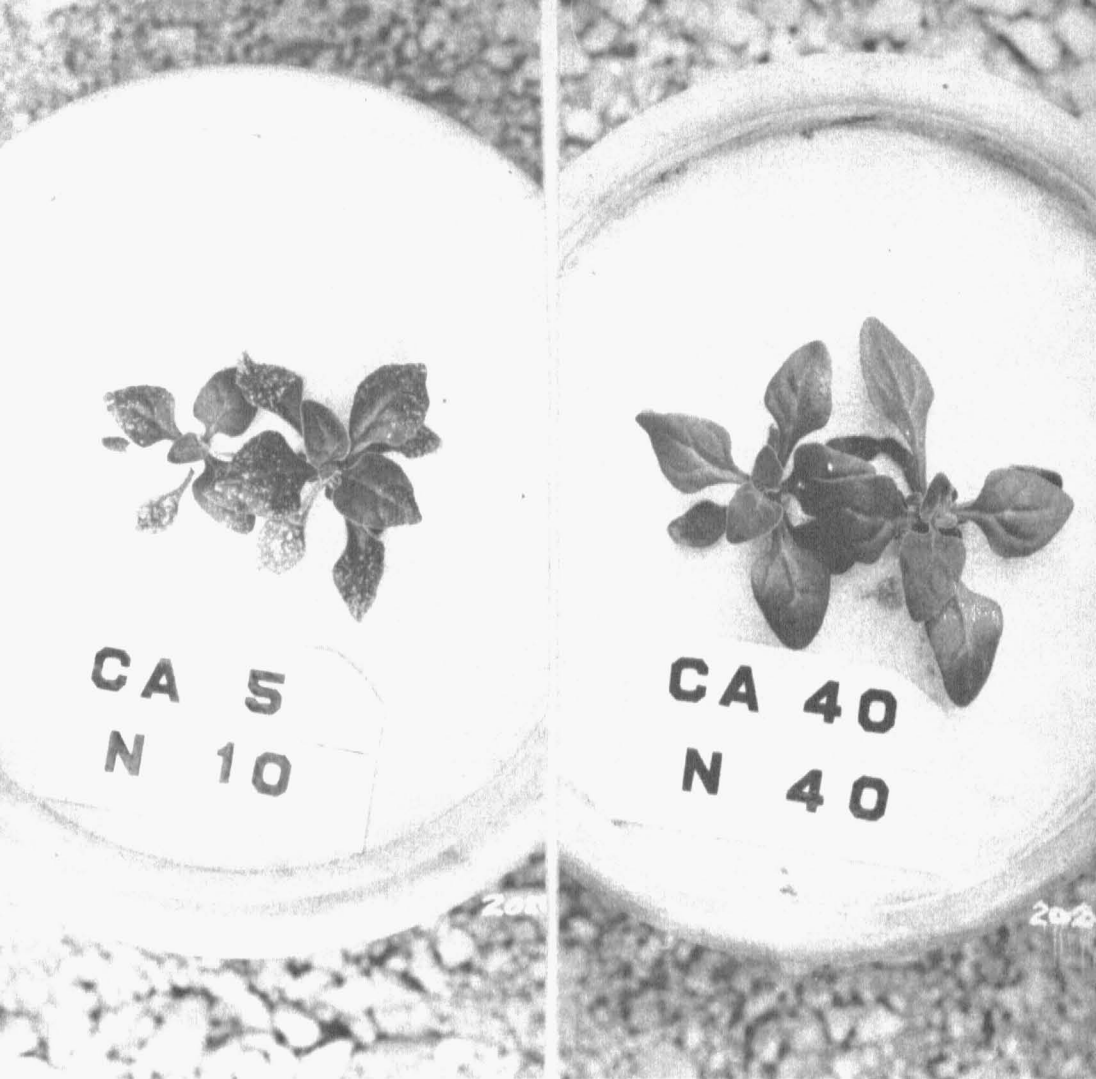
Chlordane at 1 quart of 50% emulsion to 100 gallons of water applied with a speed sprayer gave excellent control of cicadas in an apple orchard. D N 111 at 1¼ pounds per 100 gallons seemed the most promising material for summer control of the European red mite in Missouri.

**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). During the year the chinch bug, hessian fly, grasshoppers and European corn borer called for special attention and extensive state-wide surveys and scattered control programs were conducted. The horse fly problem continued over much of the state and previous extensive campaigns for control of bloodsucking flies and ticks were extended. Bot and warble fly control was also continued.

Of the orchard insects, codling moth continued to receive most attention and all growers in the state were contacted weekly with special instructions on timing the spray application. With the use of DDT to effectively hold codling moths in bounds we have created some other orchard problems, notably destructive abundance of red spiders and spider mites.

The household insect pests and those on foods and insect carriers of human diseases notably, mosquitoes, house flies, chiggers and ticks were also given more than the usual attention this year. The Missouri Station cooperated with the State Pest Control Association in promoting more perfect control of these groups of insect pests and also in reducing the menace and loss from rats.

**Influence of Soil Minerals on Insects** (Leonard Haseman, P. C. Stone, and H. E. Brown). This is a study to see if we can control insect pests by simply raising the general level of soil fertility.



These New Zealand spinach plants were grown on constant levels of fertility except for the variation in lime and nitrogen content. Green house thrips were given a choice of plants and much preferred the ones on the left low in calcium and nitrogen.

Some experiments were undertaken with potatoes and cole crops grown in the garden and receiving varying amounts of fertilizers for checking on possible influence of the varying levels of plant nutrients on insect pests breeding on them. The results from these observations on Colorado potato beetles and cabbage worms were inconclusive, though earlier studies on potato and the Colorado potato beetle in the insectary indicated that this beetle may be influenced by the soil minerals made available to the potato crop.

One generation of the fall web worm was reared on elm sprouts held in nutrient solutions containing all or all but one of each of the important plant nutrients. All larvae, however, pupated within ten hours of one another and no significant difference in the length of life cycle could be attributed to the amount of nutrients available.

## FIELD CROPS

W. C. Etheridge, *Chairman*

**Improvement of Soft Red Winter Wheat in Missouri** (J. M. Poehlman). Drill plot tests including standard varieties and improved new selections were conducted at Columbia, Lathrop and Sikeston. In these tests Clarkan continues to lead other soft wheat varieties with an average yield during the last eleven years of 27.5 bushels as compared to Fulcaster 25.4 bushels, and Early Premium 24.3 bushels.

Clarkan is now grown on 60-70 per cent of the total Missouri wheat acreage. Over a period of years it has produced 2.1 bushels per acre above Fulcaster, one of the better older varieties. Improved selections now being tested in the nursery point to the possibility of obtaining large increases over the Clarkan variety.

At Columbia seven yield nurseries were grown in which a total of 217 items were tested. Most of these were new selections in yield tests for the first time. In addition to yield, information was also obtained on test weight, date headed, height, leaf rust and loose smut infection, and pearling index.

Approximately 2000 head selections from crosses combining leaf rust and loose smut resistance with good soft wheat quality were grown.

Varieties from the drill plot tests were milled into flour and submitted to the Department of Home Economics for testing of baking qualities.

**The Improvement of Pastures** (E. Marion Brown and Robert B. Livingston). Research was continued at this station on the improvement of pasture with special emphasis on the managed grazing of Kentucky bluegrass and lespedeza.

A pasture at Lathrop, consisting mostly of bluegrass and lespedeza, was not grazed from June 29 to December 3, 1946. Three steers averaging 630 pounds in weight initially and 805 pounds finally were carried on this 5-acre pasture from December 3, 1946 to March 31, 1947. Some hay was fed during this period, but most of the feed was provided by grass reserved for winter grazing. Cattle gained 104 pounds an acre here during the winter, and 117 pounds from April to July, a total of 221 pounds, as compared with a total gain of 152 pounds an acre obtained April 26 to September 5, 1947, from the adjoining comparable pasture that had been pastured to capacity from March 28 to September 4 during 1946.

The grass breeding program included the improvement of Kentucky bluegrass by selection and by hybridization with Texas bluegrass; and the improvement of orchard grass and tall fescue by selection. A progeny test of 300 selected plants of orchard grass is in its third year.

The best introduced strain of Kentucky bluegrass (F.P.I. 119684) produced 15 and 20 per cent more than commercial bluegrass.

It was found that Kentucky bluegrass growing with either Ladino clover or birdsfoot trefoil maintained good stands if lawn-mowed but not if cut as hay. The effect of mowing on stands of brome grass growing with these legumes was directly opposite.

Sweet clover was more compatible with redbud than with any other grass. Alfalfa could not survive monthly mowings 2½ inches above the ground, but Ladino clover was best if lawn-mowed semi-monthly. Birdsfoot trefoil was influenced less by mowing and by the kind of grass with which it grew than any other legume in the test. Ladino-grass mixtures produced largest herbage yields under semi-monthly lawn-mowing and trefoil-grass mixtures ranked second.

In the work done with legumes on permanent pastures the data show that a permanent pasture at Lathrop renovated with lespedeza and phosphate fertilizer produced 197 pounds beef cattle gain per acre, and one renovated with sweet clover and phosphate fertilizer 187 pounds an acre, as compared with 253 pounds gain per acre from pasture treated annually with ammonium nitrate in addition to phosphate, and 152 pounds per acre produced by untreated pasture.

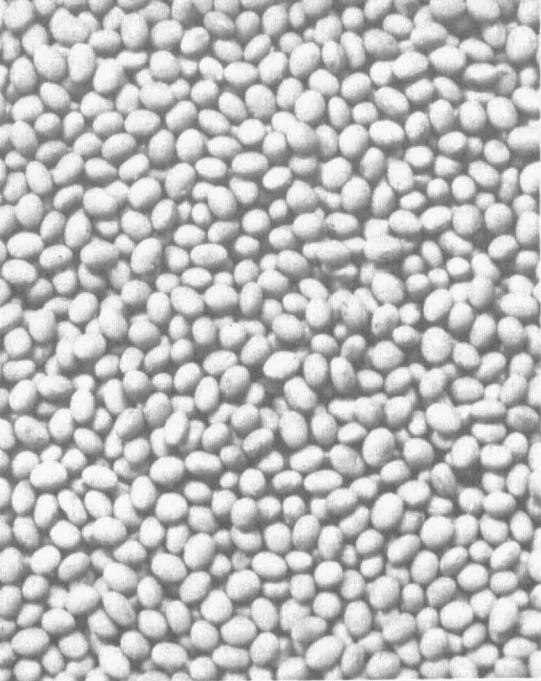
At Columbia, beef cattle gained only 167 pounds an acre on bluegrass renovated with sweet clover, phosphate fertilizer, and lime as compared with 223 pounds on pasture renovated with lespedeza without soil treatment. At both Columbia and Lathrop, deferred grazing required for survival of sweet clover seedlings materially reduced beef production.

Plowing grass sod increased 25 fold the early growth of sweet clover seedlings in an old bluegrass pasture and plowing was essential for the survival of birdsfoot trefoil seedlings in old grass sod.

A study of the adaptation of Alta and Kentucky 31 fescue, different strains and varieties of brome grass, Kentucky bluegrass, and orchard grass, Ladino clover, and birdsfoot trefoil was started in field plots.

**Breeding Winter Barley for Missouri** (J. M. Poehlman). This project is a continuation of study to find a variety or varieties of barley which would be safer and more productive for Missouri. Resistance to disease and winter hardiness are among the characteristics being sought in this research and testing work.

Barley variety tests were conducted at Columbia, Lathrop, Bethany and Perryville. These were nursery tests and included 36 varieties and selections. Three additional tests were conducted at Columbia in which a total of 170 items were tested. In addition to yield, information was obtained on winter survival, height, date headed, lodging, test weight, and resistance to the three forms of barley smut, mildew, and spot blotch. Yields of several new selections in these tests exceeded the yield of standard varieties by as much as 30 per cent.



The new variety S-100 soybean as shown above was developed at the Missouri Experiment Station from a single off-type plant found on a farm near Rutledge, Missouri. It is now one of the leading varieties in Southeast Missouri and stands remarkably well for combine harvesting. It has good resistance to shattering.

Clarkan continued to lead other soft wheat varieties with an average yield during the last 11 years of 27.5 bushels compared to Fulcaster 25.4 bushels, and Early Premium 24.3 bushels. Clarkan is now grown on two-thirds of the total Missouri wheat acreage.





**Improvement of the Missouri Soybean Crop** (W. C. Etheridge and staff). A new strain of soybean, S-100, was increased to approximately 1200 bushels and was distributed to farmers. S-100 is specially adapted to Southeast Missouri and will presently become the leading variety in this area, where soybeans have already become a major crop, approaching cotton in importance. This new variety, S-100, is a high yielding, medium early maturing soybean and it will permit earlier harvesting which will save many acres of grain from being lost in the field.

Seven uniform group tests were grown last year and one of these, C463, has been tested for the past four years and it is being increased for release to farmers. It is the best adapted to central Missouri.

The long range program consists of developing new varieties with high yield, high oil content, lodging resistance, disease resistance and other desirable characteristics. Emphasis is on the development of varieties with a higher oil content for the soybean processors. Many crosses of S-100 with high oil strains have been made for this purpose.

**Breeding Better Oats for Missouri** (J. M. Poehlman). In the oat research work, the Columbia x Bond-Iogold has proved to be the most promising line and compared with the Columbia variety in three seasons produced the following yield:

Variety	Yield in bushels per acre		
	1945	1946	1947
Columbia .....	45.2	64.5	39.1
O-200 (Col. x B-I) .....	67.7	72.3	55.7

A preliminary increase of this strain was made in 1947.

Use of disease resistant strains of oats has increased the safety and production of this crop. Resistant varieties are now being grown in northern Missouri. Development of earlier maturing strains will extend these benefits into southern Missouri. Also it would increase the overall safety in north Missouri by making it possible to mature the oat crop ahead of hot weather, which is not possible with the later maturing varieties now used in that section.

**Genetic Studies with Crop Plants** (J. G. O'Mara, E. R. Sears, L. J. Stadler, and M. S. Zuber). Genetic research consisted of studies of nature of gene mutation in corn (genes *A* and *E*) and of the genetic nature of X-ray induced mutations. Genetic studies concerned with methods of corn breeding, particularly as to the use of haploidy in economic breeding; use of nullisomic analysis in wheat and oats breeding; transfer of wheat chromosomes from *Aegilops*; and development of improved hybrids of corn.

The immediate practical applications of this project were in the development of new and improved methods of plant breeding. The work in this project has resulted in two major developments of plant breeding methods which are being used by practical plant breeders, the "nullisomic method" in wheat and oats breeding and the method of "gamete selection" in corn breeding.

## HOME ECONOMICS

Florence Harrison, *Chairman*

**Food Preservation Studies in Cooperation with the Horticulture Department** (A. E. Murneek, R. A. Schroeder, and Margaret Mangel). Experimental work was carried on in food preservation with lima beans and four fruits. The four fruits were grown on the Experiment Station grounds and were cherries, strawberries, apples, and peaches. Montmorency cherries were sorted and pitted. One series was processed with dry sugar (4:1 by weight) and one series with dry sugar + ACM (1 teaspoon Ascorbic Citric Mixture per 1 pound sugar). Samples were sharp frozen and stored at  $-12^{\circ}\text{C}$  and  $-18^{\circ}\text{C}$  and were scored fresh, at the end of three and six months by the panel of judges.

Thorogreen lima beans were rated by the judges as the most desirable.

Both temperatures,  $-12^{\circ}\text{C}$  and  $-18^{\circ}\text{C}$ , have proved satisfactory for storing peaches and apples although  $-18^{\circ}\text{C}$  produced products with slightly superior scores. In apples, the hard ripe stage rated a little higher than did the fully mature stage but in peaches, no difference seemed significant at the end of six months. For apples, soaking in brine solution and packing in ACM sugar ranked first with boiling water blanching and packing in ACM sugar second. Discoloration occurred with boiling water blanching particularly when there was no ACM present.

Storing peaches in ACM syrup produced better scoring products than did storing them in plain syrup; however, some judges objected to the tart flavor and softened texture of the ACM samples. Presoaking peaches in ACM  $\text{CaCl}_2$  water was slightly more desirable than were the other soaking methods.

There was no apparent difference between the two temperatures of the two treatments for cherries and strawberries at the end of the six months. All cherries were rated desirable but strawberries, while rated desirable at the end of three months, were not rated desirable in flavor and texture at the end of six months.

**Effect of the Method of Preparation on the Vitamin A, Thiamine, Riboflavin, and Niacin Content of Chicken** (Bertha Bisbey, Adelia E. Weis, Grace Richmond, and Vera Stone O'Dell). Since chicken is widely used in Missouri in both rural and urban communities and there are several methods in common practice of preparing it for the family table, it was felt that it was important to know which of these methods will best preserve the vitamins in question.

The chickens used were killed and dressed at the University Poultry Farm under the supervision of E. M. Funk, and records were kept of the live weight, weight after blood and feathers were removed, and weight when fully drawn.

Vitamin A and riboflavin assays are still in progress but completed results show that white meat has less riboflavin and more niacin than dark meat. The method of preparation does not seem to influence greatly the vitamins under

investigation at present. The vitamin A potency of these livers was significantly lower than that of livers of hens on a ration containing ample vitamin A as assayed in this laboratory (1939).

Results obtained by means of the fluorometric method showed that in comparison to the fresh raw sample the highest retention of thiamine was in the stewed meat followed by baked, fried, and canned meat. Dark meat contained more thiamine than light meat. Of the tissues assayed, liver was richest in thiamine and gizzard poorest.

**A Study of the Serviceability of Some Staple or Common Household Textiles as Measured by Laboratory Tests and Home Service** (Adella Eppel Ginter). This research of textiles was conducted on kitchen towelings and cotton curtain marquisettes.

Twenty-six fabrics, 4 linen, 8 cotton (3 of which had printed designs), 6 cotton and linen mixtures (3 of which were unbleached), and 8 rayon, linen and cotton mixtures were laboratory tested before use and towels made from them were used and laundered under various conditions, such as the Home Management House, the Home Economics Cooperative House, Home Economics Foods laboratories, and in various homes. After using and laundering fifty times, the towels were returned to the laboratory where tests were made to determine serviceability.

Most of the toweling improved in absorption. The 3 unbleached fabrics of cotton and linen absorbed the least when new, but were among the best after 50 usings. As a group, the towels of rayon, cotton, and linen mixtures absorbed very well as did the linen towels.

As to whiteness and freedom from stains: The towels of rayon mixtures and the all linen towelings were superior. The cotton towelings as well as the cotton and linen towelings were gray and badly stained; this was especially true in the towels of closer weave.

The 3 towelings with printed designs showed decided fading, which detracted from their appearance. The towelings with yarn dyed stripes showed little change in color.

Five cotton curtain marquisettes (3 with a permanent set and 2 without) were made up into curtains and were used in the Home Management House. Shrinkage was determined on the new fabrics and allowed for when the curtains were made.

This study is being continued but at the present time the following results have been noticed:

The initial shrinkage on the marquisettes given a permanent "set" was much less than those without the finish.

The time required to iron the curtains with a "set" has been less than that required to stretch the curtains without a "set."

The curtains with a "set" appear to be losing some of their crisp finish.

## HORTICULTURE

T. J. Talbert, *Chairman*

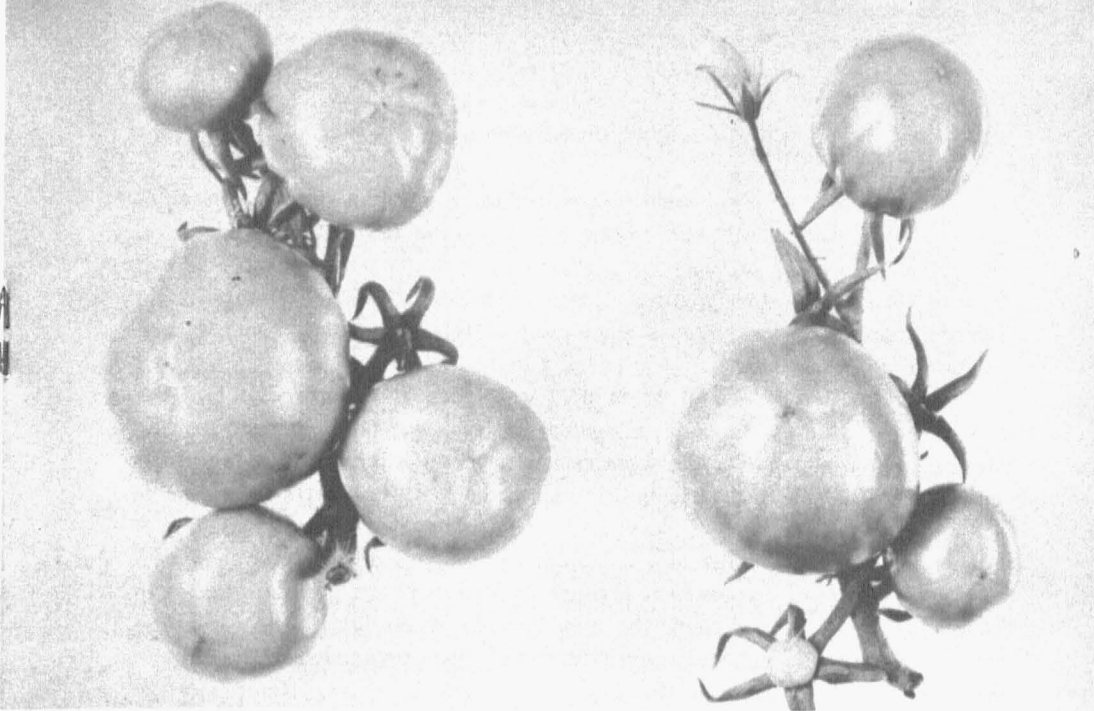
Physiology of Reproduction in Horticultural Plants — Development of "Hormone" Sprays (A. E. Murneek and assistants). The development at Missouri of Beta-naphthoxyacetic acid and p-chlorophenoxyacetic acid as "hormone" sprays to improve set and size of tomatoes has led to an increased use of the "hormone" treatment by growers of greenhouse tomatoes and also to some extent now when this plant is grown in the field. The "hormone" treatment, together with a new "Missouri method" of pruning staked tomatoes (developed as a "by-product" of this investigation) usually leads to an increase in yield of 15-50%. It is estimated that the benefit realized to tomato growers, as a result of studies and discoveries at Missouri, amounts, or will amount shortly, to the conservatively estimated value of \$200,000 per year.

The development of the use of a hormone-insecticidal dust to improve the set of string beans in hot weather is being tried and adopted by many growers. It is difficult to estimate, however, the present benefits from this relatively new treatment.

Extensive investigations were completed on the use and comparative value of synthetic growth substances ("hormones"), either as flower or whole plant sprays, in water or aerosol media, to improve the set and size of greenhouse-grown tomatoes. As a result it is now fully established that p-chlorophenoxyacetic acid and beta-naphthoxyacetic acids are the most potent "hormone" sprays for this purpose. They are used as water sprays either on flowers or on whole plants. An increase in yield of 20-50% may be expected during periods of cloudy weather. Because of complexity and cost, there is no advantage in using "hormones" in aerosol preparations.

The work on greenbeans showed that p-chlorophenoxyacetic acid at 5 parts per million (p.p.m.) in a water spray or at 25 p.p.m. in Cryolite dust, applied twice at 10-day intervals, increased the yield of the early-summer crop by 11% and 16% and the mid-summer crops by 30% and 49% respectively. Alpha-ortho-chlorophenoxypropionic acid at 10 p.p.m. in Cryolite dust increased yields by 14% and 50% respectively for the early- and mid-summer crops. In general, larger and more uniform and better quality pods were produced on plants treated with an insecticidal-hormone dust. The average seed number per pod was decreased slightly as a result of hormone applications.

A detailed histological investigation was made of the tomato flower bud inhibiting effects of p-chlorophenoxyacetic acid when applied in early and late stages of flower development, since in spraying flowers the buds may inadvertently receive the treatment also. When sprayed 3 days prior to opening into flower, the buds were markedly retarded in development. Both the male and female reproductive organs either were inhibited or aborted. A similar treatment of buds four days before opening resulted in a slight retardation of



The tomatoes on the left were sprayed once a week with naphthoxyacetic acid, 20 p.p.m., while the ones on the right are the control plants. Note more fruit per cluster and larger size.

flower development, stimulation of pollen grains (premature germination) and some inhibition in growth of the ovules. The same material, applied to open flowers, hastened fruit development with some inhibition of ovules; thus seedless tomatoes are produced. The conclusion was drawn that in hormone treatment of tomato flowers it is advisable to keep the spray away, as much as possible, from the buds, excepting when the number of open flowers per cluster is in excess of the requirement.

A preliminary study was made of the effects of naturally occurring "hormones" in young corn kernels and young apple seeds on fruit set and development of peppers and tomatoes. Neutral extracts of apple seeds, applied to flowers and whole plants, increased fruit set and seediness of peppers but basic and boiled extracts reduced fruit set. Injections of dilute plant hormone extracts into pepper plants by a cotton wick method proved unsatisfactory. Extracts of young corn kernels, partially purified, increased fruit set of tomatoes, but not of peppers, when applied in carbowax to petioles and main leaf veins of pepper. A chemical method for the estimation of 3-indoleacetic acid (heteroauxin) in concentrated seed extracts was devised.

**Nutrition of Vegetables and Their Dietary Value as Influenced by Soil Treatments** (R. A. Schroeder and V. N. Lambeth). Grower realization that the nutrient-element balance greatly influences the growth rate, total growth and dietary quality of vegetables has altered their fertilizer practices. The fact that a fertilizer application can be detrimental has made them discriminating in regard to fertilizers.

Particular emphasis this year was placed upon growing various vegetables upon colloidal clay-vermiculite substrate and making rapid tissue tests at various stages of growth in order that such tests might be correlated with the soil fertility yield and dietary quality of crop. The influence of nutrient-element balance upon tissue tests, rate of plant growth, total yield and chemical composition were again noted.

The sugar-starch ratio of green peas was markedly altered and previous results showing that the vitamin C content of leafy vegetables is decreased by nitrogen increments was further substantiated. Correlations between rapid tissue tests and balance of nutrients originally added to the substrate were made and bid fair to form an excellent basis of fertilizer recommendations.

**Nutrition of Fruit Plants** (A. E. Murneek). Soil mulching is at present an accepted orchard management practice in Missouri. Its popularity rises in relatively dry years, but particularly in periods of drought. The fertilizing value of mulches is not fully understood and appreciated, hence the present detailed study. It is believed that in drought years the vigor of fruit trees can be best maintained by a mulching practice and that yields of fruit can be increased as much as 20 per cent.

Mulching apple trees with 3 kinds of material (straw, hay and corn stover) was continued. Soil samples, collected from 5 horizons to a depth of 24 inches below the surface, showed the following total nitrogen content: sod, .143% to .078%; straw mulch, .160% to .082%; hay mulch, .163% to .098%. Leaf samples, collected at the same time had a total nitrogen content, for trees in sod, 1.687%; straw mulch, 1.759%; hay mulch, 1.865%. Thus straw mulch increased to some extent the nitrogen content of both the soil and the trees and hay mulch even more. The total potassium content of leaves from mulched trees was also significantly higher, but not of phosphorus. As a result of mulching there was a striking increase in soil moisture under the mulch and in exchangeable potassium, some increase in available phosphorus, but not in exchangeable calcium. This increase in K and P was greater for straw than hay mulch. Soil temperature records, taken continuously by thermographs, show markedly higher winter and lower summer temperatures (of the order of 10-20°F) under mulch than under bluegrass sod.

**New Sprays and Spraying Methods** (H. G. Swartwout). Some of the new fungicides offer fruit growers better or safer means of controlling diseases than some of the materials now being used. Over a period of three years Paratized has been one of the most effective fungicides for the control of apple scab and has caused less visible foliage injury than lime sulfur. Through the use of Fermate, grape growers can secure as good or better control of black rot than with Bordeaux without the risk of damage to the foliage and uneven ripening of the fruit that may result from Bordeaux sprays. Approximately 80 per cent of the commercial grape growers of Missouri have indicated their intention of using Fermate.

In addition to continued tests with Fermate ( $1\frac{1}{2}$ ), Phygon, Puratized plus Fermate, and Methasan plus Fermate were tested on grapes for the control of black rot with Bordeaux 5-7-100 for comparison. Fermate ( $1\frac{1}{2}$ ) and Fermate plus Methasan ( $\frac{3}{4}$  -  $\frac{3}{4}$ ) gave the best results with nearly perfect control of rot whereas 76 per cent of the fruit was affected on unsprayed vines. Bordeaux was somewhat less effective than Fermate. Phygon ( $\frac{3}{4}$ ) and Puratized plus Fermate were about the equal of Bordeaux. Bordeaux caused severe foliage injury that resulted in uneven and poor ripening of the fruit. The Puratized and Methasan combinations with Fermate caused some foliage injury and Phygon caused some russetting of the fruit. Fermate plus DDT gave the best foliage. In hand spraying, two pre-bloom and two after-bloom sprays gave better control of fruit rot than where the first pre-bloom spray was omitted. The above tests were on the Concord variety. On mildew susceptible varieties it was observed that Fermate was less effective than Bordeaux against downy mildew.

Fermate ( $1\frac{1}{2}$ ) gave nearly complete control of apple blotch on Duchess where sulfur checks showed 76.6 per cent of the fruit as culls. An early delayed dormant of 12-12-100 Bordeaux plus 2 quarts of Dendrol followed by Puratized ( $1\frac{1}{2}$  pints) in the pink and calyx sprays gave nearly as good control of blotch as the cover sprays of Fermate. Puratized without the delayed dormant of Bordeaux appreciably reduced blotch infection but did not give commercial control.

Fermate-DDT combinations in a hot dry summer caused no injury to apples.

Summer applications of BHC sprays to grapes and apples resulted in a decided off-flavor to the fruit.

DN-111, Xanthone, and sulfur as "niticides" caused appreciable injury to grape leaves. A 50% NETP preparation (Vapotone) removed much of the fruit bloom. A 100% NETP formulation had no ill effect.

DDT wettable powders in combination with summer oil caused considerable foliage injury to apples as in 1946. The addition of 4 pounds of bentonite reduced but did not eliminate injury.

**Factors Affecting Fruit Setting of the Apple** (A. E. Murneek). The chemical spray thinning of fruits is still largely in the experimental stage and only a few commercial growers are using it and those on a limited scale.

Elgetol, Goodrite No. 4, and naphthaleneacetic acid were used as sprays at various concentrations in the Agricultural Experiment Station orchard and in 3 commercial orchards in central Missouri for thinning the fruit crop on the following annual and biennial bearing varieties of apples: Jonathan, Wealthy, York, and Golden Delicious. The applications were made either at full bloom or up to 13 days after anthesis.

Goodrite No. 4 was found very erratic in results and largely ineffective at all of the 6 concentrations used. Elgetol at .5%, applied when petals were

shedding, thinned the fruit crop perfectly on vigorous Wealthy trees, but at this concentration and even when diluted to .25%, reduced the fruit set too much on somewhat weaker York, Jonathan and Golden Delicious trees. Naphthaleneacetic acid at 15, 20 and 25 p.p.m. thinned properly Wealthy apples in 2 orchards and at 30 and 40 p.p.m. Golden Delicious in 2 other orchards.

Results with experimental work on Alberta peaches showed that of all the materials tried Elgetol at .25%, applied at full bloom, was the best spray for chemical thinning of peaches. This is a slightly lower concentration than the one (.31%) found most effective in the preceding years and may be explained by the fact that the trees were considerably weakened by an attack of scale insects.

**Greenhouse and Nursery Management** (James E. Smith, Jr.). Research was continued on sub-irrigation and the use of the Missouri concrete greenhouse bench. This year it was remodeled with a bench bottom that has proved entirely satisfactory for sub-irrigation of both bench and potted plants.

This sub-irrigation of potted plants has proven equally as feasible for cut flower crops in soil. A tremendous saving in labor normally needed for watering is practically eliminated.

It was found that Vermiculite is far superior to sand as a propagating medium, and is finding favor among commercial flower growers.

Controlled propagation in a cellar, where all light, temperature, and humidity can be accurately controlled gave improved results, chief of which was earlier rooting of cuttings.

It was found that automatic ventilating equipment is highly satisfactory and should pay for itself within a reasonable length of time through a saving in labor and improved quality of plants produced in greenhouses thus equipped.

Commercial florists and nurserymen will benefit directly from these labor-saving methods and devices recommended by the Missouri Experiment Station and save time in production of quality stock.

Observations of the rose plantings indicate several species and hybrid species of roses that should be more widely planted in Missouri. They are: Hybrid Rugosa varieties, Grootendorst and Agnes in particular; Hybrid Sweetbriers; Moss Roses; Harrison's Yellow; Persian Yellow; Rosa mundi; and Hybrid Damask roses. Roses which have not proven satisfactory without extra protection are: The Hybrid Teas; Hybrid Perpetuals; Hybrid Centifolia; Austrian Copper; and Hybrid Bourbon varieties.

**Missouri Queen Watermelon** (A. D. Hibbard). The popularity of the new wilt-resistant variety of watermelon, "Missouri Queen," developed at this Station continued to spread and this variety is now under extensive trials in eighteen states outside Missouri. Reports indicate that the variety is adapted wherever an early midseason, wilt-resistant watermelon of this type is grown commercially.



The "Missouri Queen" watermelon has been put into commercial production by two of the largest seed growing companies in the country. Several watermelon breeders are making use of the highly homozygous inbred lines of this variety for use in the production of hybrid watermelon seed.

**Horticulture Experiment Fields at Campbell and Monett, Missouri** (A. D. Hibbard and assistants). At the Campbell Field work was continued with projects on peach growing, fertilization, pruning, thinning, spraying, soil management, erosion control, and variety adaptation. Soil management and spraying of apples was studied and spraying, fertilization, and variety appraisal was made on grapes. Variety data were secured on sweet cherries, plums, muscadine grapes and figs.

The value of terracing and contouring a young peach orchard was demonstrated by the superior growth and less erosion encountered in the orchard under a water-management system. Cotton hulls are valuable mulch material in the older orchard; if used in sufficient quantity they may eliminate the need for extra nitrogen. The use of a complete fertilizer in the peach orchards of this area is a profitable practice. Light pruning is indicated for producing trees at least until they are 10 years old.

Yield records and observations were made on some 80 varieties of peaches. Fifteen new kinds were added while a similar number were removed from the orchard. The varieties Pacemaker and New Day produced a superior product when processed for frozen storage.

Fermate and DDT are apparently efficient and safe materials for use on grapes. They should be supplemented with copper when downy mildew is a problem.

Most combinations of sulphur and Fermate are effective in apple scab control. Some of the miticides are apparently of doubtful value when their effect on the efficiency of other insecticides is considered. Sod culture with a complete fertilizer is proving as desirable as any soil management practice in this orchard.

At Monett, preliminary results indicate that the physical condition of strawberry soils such as aggregation, moisture holding capacity and organic matter content are of more value in strawberry production than actual nutrient content. A summer mulch was effective in lowering the soil temperature and conserving moisture during the months of July and August. The use of additional amounts of plant nutrients was not effective in increasing plant growth and survival at this station. The varieties Missouri 164 and U. S. D. A. 321 continue to show the most promise as commercial varieties to replace Aroma.

The M 27 tomato was distributed to cooperators in all of the important tomato producing counties in Missouri through county extension agents. About 1,000 plants of Missouri 164 Strawberry were put out with cooperators for trial and plant increase. A number of growers are adopting the practices of summer mulching and fall setting, which were developed at the Monett field.

## POULTRY HUSBANDRY

H. L. Kempster, *Chairman*

**Thermo-Stabilization of Shell Eggs** (E. M. Funk and Harold Biellier). Storage experiments started in May 1947 were completed in December 1947, showing that the process of Thermo-stabilization was effective in reducing spoilage in shell eggs. Shell eggs stabilized commercially by Swift & Company at Beatrice, Nebraska have been observed over a period of 6 weeks at room temperature. The interior quality of these eggs held up remarkably well as compared to natural eggs but some mold contamination showed at the end of 6 weeks and the albumen of these stabilized eggs required considerably more time to whip. The process was modified somewhat to reduce the time required to whip the albumen.

About 300 cases per day of these eggs were stabilized by this process and placed in commercial channels in southern markets. The eggs retailed for as much as 10 cents per dozen above other eggs and gave excellent satisfaction. If these favorable results continue the mid-west will be able to place in the southern cities a high quality table egg throughout the year.

**The Use of Vegetable Protein Concentrates and Crystalline Riboflavin in Practical Rations for Growing Chicks** (H. L. Kempster and Q. B. Kinder). This study was a continuation of previous work and over 3000 chicks were raised to make the usual replacement and were fed rations of comparable protein content.

Practical chick starter rations were designed without using appreciable amounts of animal protein concentrates. Crystalline riboflavin is an adequate source of riboflavin and is a less expensive source of this vitamin than many of the feeds high in riboflavin that are generally used. It is possible to reduce the cost of a chick starter ration from \$10.00 to \$15.00 a ton by judicious use of ingredients in the ration. A ration of cereal grains using soybean oil meal as the sole source of supplementary protein and supplemented with crystalline riboflavin has proved satisfactory.

**Relation of Date of Hatch to Egg Production** (H. L. Kempster). Poultry profits are greatly influenced by the rate of lay during the fall months. The average rate of lay for Missouri poultry flocks for October, November and December is 27 per cent. The rate of lay for 65 record-keeping flocks in Greene County in 1946 for the fall months was 37 per cent. The income over feed cost per bird for the three months was 35 cents as compared to \$1.55 for the five highest producing flocks which averaged 70 per cent. Chicks must be hatched early if high fall egg production is to be obtained.

Production of February hatched White Leghorn pullets from September 21st to February 28th was 74 eggs as compared to 80 eggs for those hatched in March and 71 for those hatched in April. For the New Hampshires the pro-

duction per bird for the February, March and April hatched birds was 62, 63 and 60 eggs respectively. Many of the earlier hatched pullets started laying while on the range but because of extremely hot weather it was considered unwise to house the pullets at an earlier date. It is apparent that early maturing breeds such as New Hampshire's and White Leghorns may be hatched as late as April, and that the early hatched pullets are not handicapped so far as fall and winter egg production is concerned.

**The Use of Laying Concentrates for Egg Production** (H. L. Kempster and Q. B. Kinder). As a means of saving on labor and of using a greater proportion of home raised grains in poultry rations there is a trend toward a method of feeding in which a high protein concentrate supplemented with the free choice of grains is employed. The usual recommendation "to use not less than three different grains" does not appear justified from the following results.

Laying concentrates containing 32 per cent protein were hopper fed with free choice of various combinations of grain. A pen hand fed grain and a 20 per cent protein laying mash served as a check. One pen had free choice of corn, wheat and oats, a second pen corn and oats, and a third corn alone.

During a 7 months test, October to April inclusive, the following results were observed: corn, wheat and oats 122 eggs per hen, corn and oats 133, corn alone 120 and 108 for the check pen. Whole grain constitute 81, 79, 72 and 75 per cent of the ration, respectively. A second test for the same length of time resulted as follows: corn, oats and wheat 116 eggs per hen, corn and oats 105, corn alone 93. The check pen laid 120. There appears to be no advantage in using more than two grains when a 32 per cent protein concentrate is fed in combination with free choice of grain.

And in another test, better results occurred when a 20 per cent laying mash was accompanied with the hand feeding of grain.

**The Effect of Environment on Laying Hens** (H. L. Kempster and J. C. Wooley). This project was a study to determine the effect of environment on laying hens and three poultry houses were used in the work. (1) The 20 x 20 Missouri Poultry House characterized by having a straw loft and an open space which can be closed by use of a canvas curtain. The side walls are not insulated. (2) A 20 x 20 house with insulated walls and ceiling. This house also has an open front which is provided with a baffle which protects the front. (3) A 20 x 20 concrete block house with straw loft and an open front which is placed higher than in the other houses.

The egg production per bird for White Leghorn pullets from September 21 to February 28 for the three houses was 73, 79 and 78.6 eggs respectively. The birds in the uninsulated house laid at a slightly lower rate, especially during cold, windy weather. The average percentage production for this group for the period November 1 to February 28 was 51 per cent, as compared to 54 for the other 2 houses. Apparently under Missouri conditions the open front straw loft type of poultry house meets the necessary requirements.

## RURAL SOCIOLOGY

C. E. Lively, *Chairman*

**Rural Community Trends** (C. E. Lively, C. L. Gregory, and H. R. Long). The principal effort on this project centered upon a mass communications survey of Shelby County in a further attempt to understand the social situation and trends in that area. In a society such as ours where indirect communication plays such a large part in social functioning, it is interesting to find that, in this better than average rural county, things are run chiefly by direct contact.

The really important indirect medium in this county was found to be the country weekly, and it deals in personals and makes the whole county a group of neighborhoods. Probably 3/5 of the households don't see a daily paper.

The radio was found to be used mostly not as a tool but as a toy. From the listening habits, it is clear that any one station would reach very few families with an educational program. The country schools are doing a poor job teaching youth the use of the printed page. This is important, for 60 per cent of the adults have not gone to high schools.

Possession of a radio seems to be a fair criterion of family use of indirect communication media. Those having radios take daily newspapers and periodicals, go to movies, use mail order houses and have agricultural bulletins far more than those with no radios.

It is believed that this study should serve to improve the approach and techniques of the agencies of adult education functioning in this and similar counties.

**The Rural Population and Man Power of Missouri** (C. E. Lively, Zetta Bankert, and Lawrence Hepple). A detailed study was made of the fertility of 1451 farm women, aged 15 years or over, living in 5 Missouri counties in 1939-42. The record included all children ever born, together with background data.

The most significant finding was the difference in owner-renter fertility. Within each tenure group, fertility displayed the characteristics so often revealed in other studies; i. e., the number of children ever born per 1000 women increased with age and was inversely related to income and schooling. Schooling was apparently more effective in reducing fertility than income. But throughout all the categories analyzed, the renter group showed a significantly higher fertility rate than the owner group. Such behavior suggests that in these counties, at least, farm owners and renters may represent different social classes which may be distinguished by other factors in addition to fertility.

If it is found that owners and renters do represent more or less distinct social classes in Missouri, or in certain major areas, the finding will have important bearing upon the techniques of agricultural education, particularly Extension education. The finding links significantly with this station's project on low income farmers.

**The Rural Health Facilities of Missouri** (C. E. Lively, Zetta E. Bankert, and C. L. Gregory). This study of the rural health facilities of Missouri is a continuation of previous research and the results of this year's work and other data accumulated by this department was reported in Research Bulletin 410.

Tabulation and analysis of 900 cases of chronic illness enumerated in the survey of illness this year showed that 15 per cent of the 6017 persons had been ill 3 months or longer. They represented 35 per cent of the 1544 open country households in 5 counties. They were not concentrated in any income group, but were older than average and three-fourths were heads of households or homemakers.

Among specific diseases and defects, the following seem particularly worthy of note, since each of them occurred 50 or more times per 1000 persons examined in at least one of the race or sex groups: Syphilis, non-malignant neoplasms, secondary anemia, malnutrition, goitre, pterygium, defective vision, hemorrhoids, varicose veins, hypertension, defective tonsils, adenoids, nasal defects, hernia, diseases of the gums, phimosis, cervicitis, defects resulting from childbirth, and other diseases and defects of the uterus.

Particularly noteworthy is the evidence of poor nutrition as indicated by the incidence of secondary anemia, rickets and after effects of rickets, goitre, obesity, poor condition of the gums, and defective teeth. The frequency of physician recommendations for change in dietary habits is also highly significant. A total of 8595 corrective recommendations were made by examining physicians and dentists and 18 per cent of these recommendations were dietary.

The evidence shown by this study constitutes eloquent testimony for the need of improvement of rural medical and health facilities, and for the promotion of health education particularly with respect to nutrition and the formation of better dietary and health habits.

**Rural Youth** (C. E. Lively, Margaret Bright, and Lawrence Hepple). The study of Missouri's rural youth and their situation was a continued analysis of data. The need for more and better schooling for farm youth is revealed as a major problem. As late as 1900 few farm youth entered high school. Apparently more than half those who finished the 8th grade now enter high school, but in 1940, 56 per cent of all farm youth aged 20-24 had not gone beyond the 8th grade and 96 per cent were not in school.

The Ozark and Southeast Missouri areas are most backward educationally, but low income farmers in the better counties school their children as well as the average. It was concluded that variation in the schooling of farm youth is more of a cultural trait than an economically conditioned circumstance. As a result of data supplied from this and other sources, legislation calculated to improve the rural school situation is being enacted. The farmer should benefit in time.

## SOILS

W. A. Albrecht, *Chairman*

**The Maintenance and Improvement of the Fertility Level of Missouri Soils** (Wm. A. Albrecht, E. R. Graham, C. M. Woodruff, D. D. Smith, A. W. Klemme, D. A. Brown, and H. C. Turley). The series of plots on which the study of plant and root penetration according to chemical and physical conditions of the deeper soil layers is being pursued were reshattered in August 1947. Additional lime at the rate of 4 tons per acre and rock phosphate at a rate of 1000 pounds per acre were incorporated in the subsoil to a depth of 16 inches on those plots receiving treatments. The fertilizer program was modified to provide ample quantities of the fertility elements in the surface soil to produce high yielding crops.

The increased rate of fertilization introduced in the spring of 1947 raised the yields of corn on all plots from a level in the vicinity of 20 bushels per acre to 40 bushels per acre and eliminated any differences as a result of the early subsoil treatments. The question to be answered now is whether or not subsoil treatments will be effective under an adequate fertilizer program for the surface soil. One of two possibilities exist. Either the heavy treatments of the surface soil will overcome the deficiency associated with the subsoil and subsoil treatments will prove ineffective, or the improved subsoil will result in a safe effective utilization of the fertilizer applied to the surface soil. The results during the next 6-year period should answer these questions.

Some trials with nitrogen in the form of gaseous ammonia and of ammonium nitrate, some with magnesium sulfate, some with borax, and some with other trace nutrients as soil treatments for different crops have been put out in various parts of the state. These are possible through the help of the county agents and interested farmers. Results from these trials coupled with information accumulating from the soil tests collected by the county agents and made in the laboratory of the Department of Soils, are coming to serve as a reconnaissance survey of the fertility levels of the different soils in Missouri. Coupled with the results coming from the soils are the observations of deficiency symptoms in the crops during the growing season. Some of these are visible manifestations by the plants and others are revealed through chemical tests of the plant tissues at various stages of plant development.

The benefits from nitrogen applications have held the outstanding place and interest so far as crop improvement from soil treatments are concerned. Farmers have shown an increasing interest in the whole subject of soil fertility. Observations in terms of soil tests and crop responses suggest that it is high time to realize that the production pressure on the soil is too great for the fertility supply of nitrogen to hold up under support no greater than the additions of nitrogen to the soil through the present management methods concerning legumes.

The study of the relationship of the primary mineral reserve to the available nutrients and uptake by plants was a continuation of previous research. The apparent lack of transfer of the potassium from the stable mineral reserves to the available or exchangeable form on the clay colloid in one instance and the marked transfer of potassium in the other presents an important agronomic problem. The evaluation of this transfer in reference to specific minerals has been investigated. To gain this information samples of potash-bearing rocks were treated with electro-dialyzed colloidal clay, which had been extracted from Putnam subsoil. After a significant weathering interval the clay-rock mixtures were added to acid-leached quartz sand and soybean plants were grown on the mixtures. The plants were then analyzed chemically to check the uptake of potassium. To gain additional information about the levels of Ca, Mg, and K in relation to the petrology and management of Missouri soils, a large number of samples have been analyzed chemically for these items. Correlations will be made with the mineral reserve of the various soil areas.

The results of the potassium studies show that the potassium supply of soils containing only microcline feldspar as the reserve source of potash will decrease rapidly while soils containing other potassium-bearing minerals will tend to maintain a potassium level high enough for most common farm crops. This information is especially helpful in the use and distribution of our potash supplies. The fact that increased productivity through the use of lime and phosphate on soils of old geologic origin has resulted in low levels of potassium and magnesium, can be used in consideration of the management of these soil regions.

Studies of the mechanisms of nutrient uptake by plants of the soil showed that using an alkaline soil (6% free calcium carbonate) and diluting it with successively larger increments of acid clay (highly saturated with hydrogen), there resulted an increasing degree of calcium saturation of the colloid, up to a certain dilution, and then a decrease. Plant growth (soybeans) followed this phenomenon, though the growth in all cases was relatively poor. Were the soil reaction a factor in the mechanism of nutrient uptake, the growth of the plants should have been more and differently variable. The addition of a constant amount of nutrients gave almost uniform improvement throughout the series with this relation to soil reaction, namely, the application of nutrients was more effective as the calcium saturation was reduced. Chemical analysis of the crop pointed out that this naturally alkaline soil with free calcium carbonate was not supplying several other essential nutrients, and that growth was better as the calcium was reduced even though the total amount of nutrients was reduced.

Here is the suggestion that excessive calcium carbonate in the soil, or neutrality in reaction (excessive liming on once-acid soils) is disturbing to the nutrition of plants in the equivalent of deficiencies of elements other than calcium, or as an unbalance because of excessive calcium.

Studies are now underway using electro dialysis of the soil to determine the suite of nutrients and their respective concentrations moving out with successive time intervals of electro dialysis and increasing degrees of acidity brought about in the soil. So far there are the suggestions, (a) that nutrients other than calcium cannot be exchanged from the soil into the plant root by the root acidity in significant amounts and rates until large amounts of the calcium and calcium carbonate are removed, and (b) that any plant root system in this soil is obtaining mainly calcium, or conversely, so little of the other nutrients that the plant growth is limited by the shortages of these.

These studies are a warning against using lime to the extent of making a soil neutral in reaction, or nearly so, that is, by the use of lime only and in generous amounts.

**Experiments in Crop Rotations and Fertilizers on Sanborn Field (W. A. Albrecht).** The crop rotation and fertilizer experiments on Sanborn Field are now in their sixtieth year. This field has become a mecca to which pilgrimages are made each year by large numbers of farmers and others interested in agriculture.

The low levels of productivity where no soil treatments have been used are now most outstanding. The yields are at extremely low levels regardless of whether the crops are in three-year, four-year, or six-year rotations, or in the same crop continuously. Continuous wheat with no soil treatment is almost a complete crop failure now in alternate years going back fifteen years. The past year was a failure with a yield of less than a bushel per acre.

Continuous corn with no soil treatment is of very poor yield with extremely high ratio of cob to grain. Continuous timothy with no soil treatment scarcely holds up timothy more than a year after plowing and reseeding before it goes back to weeds. Last year broom sedge began taking over the plot, or during the second year since plowing and reseeding. The advent of this weed (*andropogon virginicus*) is an indicator of the declining fertility supply on this plot when this weed does not take over the adjoining timothy plot given manure, or the roadways in bluegrass.

In the three-year rotation, the four-year rotation, and the six-year rotation no clover can now be grown. Korean lespedeza seed put on along with the clover seeding has failed to establish this crop on the plots with no soil treatments. This newer legume demonstrates the need of soil treatments if it is to grow on these less fertile soils. Corn, wheat, and timothy in these rotations are now producing at a level almost no higher in the rotations than under their continuous cropping. Sixty years on this level prairie soil given no return of fertility are sufficient time to bring yields below economic returns.

Among the different chemical soil treatments, the applications of calcium, of phosphorus, and of potassium are showing their separate effects more pronouncedly.



Besides the differences in the yields of the planted crops there are differences (a) in the kinds of weeds, (b) in their incidence in the different parts of the growing season according to the different soil treatment and cropping history, (c) in the visible properties of the tilled soil after cultivation and successive rainfalls, and (d) in the chemical properties of these soils when studied in the various laboratory tests.

**Determination of the Best Systems of Soil Management for the Most Important Soil Types of Missouri** (Wm. A. Albrecht, A. W. Klemme, and N. C. Smith). Protein determinations of the alfalfa hay at Norborne pointed out the wide range in the concentration of this food constituent in the different cuttings and the error in judging the feed value of this crop in terms of tonnage of hay. The cutting of the smallest tonnage per acre gave the maximum yield of protein in 1947.

A public field meeting was held at Norborne at corn harvest time. The field was a very effective demonstration of the value of putting extra nitrogen into the soil, either as applied salts or as green manure in sweet clover turned under, for increasing the yields of corn. Some 200 persons attended and discussions were held on the field in cooperation with the county agent and other agencies in agricultural education. Spring and summer meetings were held at the different fields under the leadership of the agricultural extension service, the county agents, and other agencies.

**Soil Survey and Land Classification** (H. H. Krusekopf, M. E. Springer, Joe A. Frieze, and C. L. Scrivner). The soil survey of Boone and Livingston counties progressed favorably during the past year. It was made in cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering. The survey of Livingston County was of special significance because it was supplying definite information on the benefits and damages resulting from frequent floods on the extensive bottomlands in northern Missouri. All of the soil survey personnel was assigned to special flood control studies in the Osage river basin for a large part of the summer in 1947.

These studies include soil classification, land classification, sedimentation determinations, flood damages, land use potentials, etc. In addition to this, special surveys were made for the U. S. Army Engineers, of levee districts. The state soil survey cooperates with the Soil Conservation Service in developing soil and land classifications for all the soil district counties.

**The Investigation of Nitrogen Fixation and of the Nitrogen and Carbon Behaviors Under Different Soil Treatments** (W. A. Albrecht, V. L. Sheldon, and Wm. G. Blue). During the year the carbon-nitrogen ratios of two legumes were studied for (a) different soils, (b) different soil treatments, and (c) soil treatments with trace minerals less commonly used. Lespedeza grown on five outlying fields of different soil types, both with and without soil treatments, representing the major soil areas in Missouri, served to test the first two fac-

tors. Alfalfa grown on the University South Farms served to test the third factor, namely the trace elements as additions to those common as fertilizer.

Carbon-nitrogen ratios of lespedeza according to the five different soil types and different fertilizer treatments in the five major soil areas of Missouri were as follows:

<i>Soil</i> *	<i>% Carbon</i>	<i>% Nitrogen</i>	<i>Ratio C/N</i>	<i>% Lignin</i>
Eldon—untreated .....	44.85	1.917	23.40	20.44
Eldon—treated .....	44.74	2.417	18.56	22.19
Lintonia—untreated .....	45.39	2.045	22.19	23.71
Lintonia—treated .....	45.01	2.325	19.36	22.22
Putnam—untreated .....	45.94	2.430	18.90	22.38
Putnam—treated .....	45.23	2.625	17.23	19.80
Grundy—untreated .....	44.98	2.265	19.86	51.57
Grundy—treated .....	44.25	2.437	18.16	20.43
Clarksville—untreated .....	45.81	1.925	23.79	22.01
Clarksville—treated .....	45.27	2.190	20.67	20.25

\*These soil types included silt loams, sandy loams and gravelly loam.

Carbon-nitrogen ratios of young alfalfa according to the soil treatments with trace elements as supplements to the more common ones were as follows: (Soil type—Putnam silt loam).

<i>Soil treatments</i>	<i>Carbon %</i>	<i>Nitrogen %</i>	<i>Ratio C/N</i>
Ca* .....	45.36	4.809	9.43
Ca, Mn .....	45.57	4.893	9.31
Ca, Bo .....	45.67	4.950	9.23
Ca, Mix .....	45.93	4.673	9.83
Ca, P .....	46.00	4.876	9.43
Ca, P, Mn .....	46.36	4.912	9.44
Ca, P, Bo .....	45.40	4.752	9.55
Ca, P, Mix .....	46.20	4.866	9.50
Ca, K .....	45.38	4.822	9.41
Ca, K, Mn .....	45.37	4.812	9.43
Ca, K, Bo .....	46.00	4.742	9.70
Ca, K, Mix .....	46.76	4.886	9.51
Ca, P, K .....	46.02	4.773	9.64
Ca, P, K, Mn .....	46.38	4.694	9.88
Ca, P, K, Bo .....	46.66	4.754	9.81
Ca, P, K, Mix .....	45.50	4.700	9.68

\*These abbreviations represent Ca—calcium; Mn—manganese; Bo—boron; Mix—a mixture of these plus cobalt, copper and zinc, and P—superphosphate; K—muriate of potash.

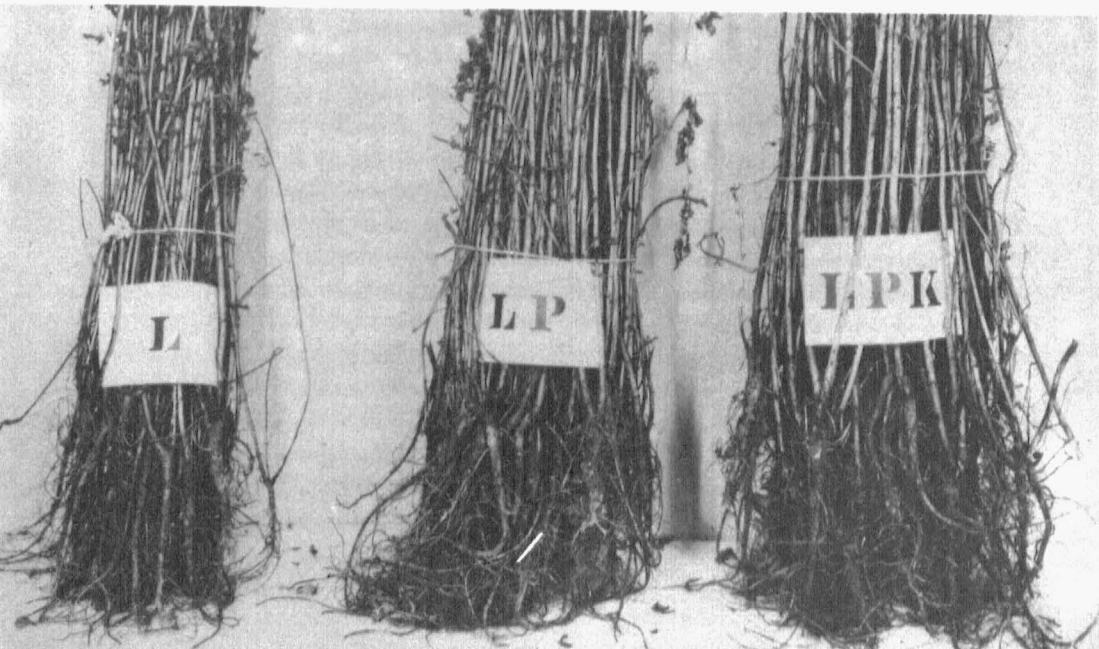
It is important that the soil treatment is responsible for variation in the carbon-nitrogen ratio. This variation is brought about more through variations in the nitrogen than those of carbon, yet both varied with the soil treatments.

This suggests the need to separate the carbon compounds (sugars, starches, celluloses, etc.) and the nitrogenous compounds into those that are amino forms, cyclic forms, etc., to say nothing of the need to determine the specific amino acids, if these ratios are to differentiate the plant's synthetic performances more accurately.

**Crop Rotations and Fertilizer Experiments on South Farms** (W. A. Albrecht and N. C. Smith). Results at the South Farms indicate that crop rotation enters into the seasonal labor distribution and other management factors, but plays little role as a factor in maintaining the fertility of the soil. Soil fertility is not maintained by the particular crop sequence, but according to the efforts toward putting fertility back into the soil as green manures, farm manures and other fertilizers. Crop removal in any rotation represents soil depletion. All crop rotations on the South Farms are demonstrating this inescapable fact. The plots with no soil treatments are declining in their productivity with time.

The nitrogen shortage was not solved without special attention going much beyond the mere putting of a legume crop into the rotation. The nitrogen in the soil under some rotations is now so low that the microbial activity, encouraged there, for example, when lespedeza crop residues carried over the winter are disced in for oat seeding, is such a serious competitor for the available soil nitrogen supply that a poor oat crop results. Merely liming the soil (fertilizing it with calcium) and introducing a legume crop into the rotation is not the solution of the soil nitrogen problem.

Where there was a deficiency of potassium (on the left) the sweet clover plants could be pulled out easily but the treatment of potassium on the soil (on the right) caused them to root firmly and avoided the so-called "root rot."



Potassium deficiency was serious enough to encourage the so-called "root-rot" disease of sweet clovers. Plants growing on plots given lime and phosphate could be pulled out readily to show the rotting roots, but where potassium was also applied, one could not demonstrate either of these troubles.

Phosphorus was found to be deficient under many degrees of cropping pressure, or under high demands on the soil for fertility. Delayed fruiting or heading by wheat and barley demonstrates the deficiency of this nutrient element in this soil very clearly. Barley is reflecting the shortages of potassium and nitrogen also.

Deficiencies of both phosphorus and potassium in addition to that of lime for red clover growth also have been demonstrated. Red clover given more fertility attention than only liming is demonstrating that it can be grown well by the help of soil treatments on even Putnam silt loam.

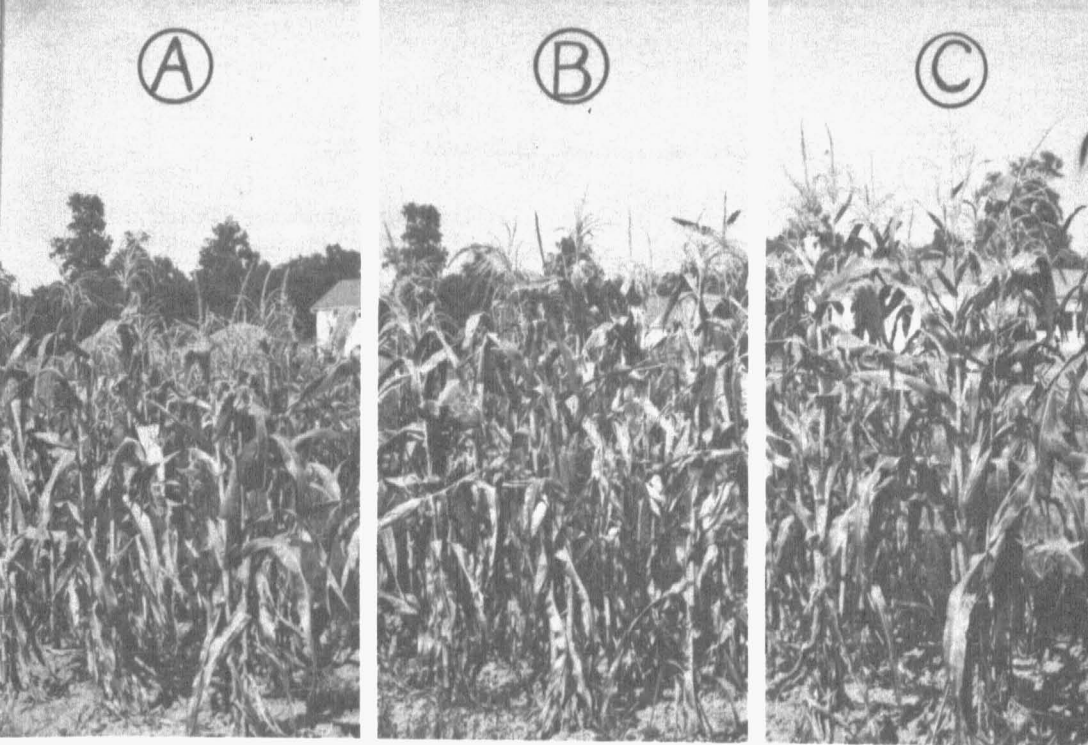
The soybean crop indicated a deficiency of magnesium and manganese in this soil. Boron applied to alfalfa demonstrated visible improvements in the crop as a larger growth, and suggests also its effects on changed chemical composition. Other trace minerals applied for this crop have not shown such readily recognizable effects, but show effects on the chemical composition.

The depth of the surface soil via its fertility as the major factor in the so-called "drought damage" was effectively demonstrated in 1947, a year that was classified as a "drought year" for corn. In one test on the South Farms there are three plots in a 3-year rotation where (a) there is no surface soil or only subsoil on the first plot, (b) there is normal depth (about 8 inches) of surface soil on the second plot, and (c) there is a double depth of surface soil made by moving such from the first plot to this third plot. All three plots have been treated alike including the lime and other fertilizers.

During the dry summer these plots exhibited varying degrees of what is commonly called "firing" of the corn. But when harvested the yields of corn were 30, 45, and 70 bushels per acre, respectively for them in the order given above. Such yields of grain demonstrate that supposedly water shortage or a "drought" that was the same for all three plots cannot be the responsible factor for such variation in yields. Sufficient water was present in the soil provided there was enough fertility in the soil. But as the fertile soil layer was shallower to be dried out more quickly, it represented a shortage of plant nourishment.

Three plots were plowed and fertilizers put down deeply as streaks in the upper subsoil by means of a TNT (Oliver) plow. On the first plot the fertilizer was 0-8-8; on the second 8-8-0; and on the third 8-8-8. Here there was less "firing" but differences in "drought" damage. The yields of corn in 1947 for these three plots in the above order were 61.6, 60.5, and 72.5 bushels per acre, respectively.

Since all these plots had the same normal depth of surface soil, one might expect a yield the same as in the normal depth of soil in the other series, namely 45 bushels. But since fertility was put into the subsoil, or below the zone



The summer of 1947 was considered by some as a season of drought. Corn grown on deeper surface soil (A—exposed subsoil; B—surface soil 8 inches deep; C—surface soil 16 inches deep) with constant fertilizer treatments had less “firing” with resulting yields of (A) 35 bushels; (B) 40 bushels; and (C) 70 bushels per acre.

of dried soil, there is evidence that it is the fertility factor in the more nearly perpetually moist zone, especially the nitrogen, which is responsible as a deficiency for what is commonly attributed to shortage of rainfall. The low crop yield or productivity in this case was due not to a shortage of water in the soil but to a shortage, in the deeper moist soil layers, of fertility with nitrogen as the foremost nutrient element in question.

**The Characteristics and Development of Heavy Clays in the Soils of Missouri** (C. E. Marshall, E. O. McLean, B. Chatterjee, S. A. Barber, B. C. Matthews, Yi Hseung, A. H. Beavers, and A. J. Metson). In the study of the mineralogical and physico-chemical characteristics of the clays, detailed studies of the ionization of mono- and divalent cations from clay minerals and also from actual soils have been made. (a) The ionization of magnesium, calcium, and barium has been followed over the whole titration curves. (b) The effect of soil-water ratio, of clay concentration and of previous drying has been determined for the two cations calcium and potassium. (c) The influence of potassium upon the ionization of calcium and of calcium upon the ionization of potassium has been determined for montmorillonite. (d) A plant nutrition experiment is under way in which a series of nutrient solutions are compared with clay cultures at the same activity levels of potassium and calcium. (e) The simultaneous uptake of phosphate and of cations such as calcium and potassium is being studied by cationic activity determinations in order to throw light on possible phosphate-cation-clay linkages.

Principal results to date show that: (a) Divalent cations are ionized to a much smaller extent than monovalent and the individual clay minerals differ greatly in this respect. (b) The clay membrane electrodes have been shown to give good results over the range of soil moisture made. The fixation of potassium upon drying shows itself by reduced potassium activities. (c) Calcium has a very great effect in increasing the ionization of potassium where the latter is present in small amount. Conversely large amounts of potassium decrease the calcium activity.

The study of the Grundy silt loam profile, reported on by Haseman and Marshall (Mo. Ag. Exp. Sta. Res. Bull. 387, 1945), has been resumed. Complete chemical analyses of the original samples have been made, the following being determined:  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{LiO}_2$ ,  $\text{P}_2\text{O}_5$ ,  $\text{ZrO}_2$ ,  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{K}_2\text{O}$ ,  $\text{Na}_2\text{O}$ , H and C. The results have been evaluated on the basis of the Haseman & Marshall work using zircon as the immobile indicator of gains or losses in different horizons, and in the profile as a whole.

Results may be interpreted in two possible ways: (a) If the profile is regarded as uniform originally, as assumed from earlier data then a movement upwards into the B horizon and into the profile as a whole of considerable amounts of  $\text{SiO}_2$  and sesquioxides must have occurred. (b) The chemical evidence shows some heterogeneity in the lower layers where the mechanical analyses indicated uniformity. Such heterogeneity would throw doubt on the earlier quantitative calculations.

Clay membrane electrodes are now being used for the simultaneous determination of K and Ca activities in colloidal clays. This method is of crucial importance in plant nutrition study.

**Testings Soils** (W. A. Albrecht, E. R. Graham, A. W. Klemme, O. T. Coleman, and student assistants). The work of testing soils has shifted from its original objective of "testing soils for their lime need" to that of testing soils for their deficiencies in general. As a consequence, soil testing has become a seemingly complicated and refined chemical manipulation in the laboratory and field. It now involves measurements of (a) the degree of soil acidity, on pH, (b) the supply of readily oxidizable organic matter, and (c) the extractable and exchangeable supplies of Ca, P, K, Mg, Mn. As soon as more refined methods become usable for other elements, tests of the soil for these will, in all probability, be included in the array of nutrient elements measured. Possibly before too long the ionic activities of each of the elements may be measured as we now measure that of the hydrogen ion when we speak of the pH of the soil.

In addition to shifting in its objective, the testing of soils has also shifted in its location of major activities. It is now being carried on extensively out in the laboratories in the different counties of the state by some trained personnel under the direction and responsibility of the county agent. The training

of the personnel, and the supervision of the accuracy in the chemicals and equipment has been sponsored by the Department of Soils. To date 35 counties have established their laboratories for testing soils. Fifteen counties are pending with laboratories in prospect. With that total number finally established almost one-half of the counties will be testing soils for a nominal fee, and may be able to serve a part of the farmers in other counties not so equipped. Even though much testing of soils is being done by individual counties, the Department of Soils tested 2254 soil samples for 555 persons during the past year.

The interest in knowing more about the fertility needs of the soil has increased so much that the public is not only much more interested in testing soils, but is also ready to pay the costs when charges of one dollar per sample are made for this service by the soils department. With the testing of the soil, with the testing of the plant tissues, both for nutrient deficiencies, and with the plant's visible symptoms suggesting such, all closely observed, and their results integrated, we are moving closer toward correctly diagnosing the troubles in the soil that are preventing the growing of better crops. We are also going into better position to give prescriptions for those soil treatments that will make bigger and better crops to make healthier animals that must feed on them.

The farmer himself must become familiar with the crop symptoms suggesting deficiencies in the fertility of the soil. By moving the service of testing soils into the counties and on the farm, the farmer can do more toward making the diagnoses and carrying out the prescriptions himself. Many farmers are reporting their results in better crops and more economical purchase of effective fertilizers as a result of testing their soils.

**Fineness of Grinding Limestone** (Wm. A. Albrecht and N. C. Smith). This research on fineness of grinding limestone has been continuous and this year the field work assisted in using "mill-run," ten-mesh limestone in comparison with pulverized or 100-mesh limestone in a rotation of corn, oats, and sweet clover with these stones both drilled and broadcast. These plots have been demonstrating the service by limestone as a provider of calcium as a plant nutrient more than of the carbonate as a neutralizer of the acidity of the soil. They demonstrate also that one need not remove the acidity of the soil to grow a legume crop like sweet clover.

Results of this study on the fineness of grinding limestone show that one need not use amounts of limestone large enough to remove all the soil acidity, a fact that reduces decidedly the costs of meeting the lime needs of the soils of Missouri.

**The Production and Distribution of Bacteria for Legumes** (Wm. A. Albrecht). On July 1, 1947, the distribution to Missouri farmers of nodule bacteria for legumes was discontinued. It was evident that now with the many commercial concerns producing bacteria for inoculation of legumes there was no advantage in educational service, adequate source, or satisfactory price of the bacteria cultures by producing and distributing them from the Department of Soils.

**VETERINARY SCIENCE**A. J. Durant, *Chairman*

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). This research has been continuous and has shown that nodular worm infestation can be materially reduced if not almost entirely eliminated by continued use of Phenothiazine and salt mixture for 2 or 3 years and is of inestimable value. Death losses from stomach worms have been greatly reduced by this treatment. The reduction of parasites by a practical simple method has saved Missouri sheep owners hundreds of thousands of dollars.

A total of 110 sheep have been on the experiment the past year and 1888 egg counts were made during the year. Five sheep have died and 29 have been killed. All were carefully examined for parasites and material collected for histopathological study; 56 histopathological specimens have been studied during the past year.

In order to get dependable results on parasite investigations it was found that sheep must be posted within one hour after death. It has been found that the best specimens for histopathological study were those which were fixed without washing. It was found that such factors as washing, the presence of two or more species of parasites made it difficult to interpret results on histopathological studies. Because of these factors we decided to work with parasite free lambs and have them available for dosing with pure cultures of parasites.

During the year 5 parasite free lambs raised by special technique have been under study and it has been possible to maintain them parasite free for as long as 12 months. Two parasite free lambs were dosed with nematodirus larvae. Lamb No. 621 received 18,354 nematodirus larvae with apparently no ill effects to the lamb. This lamb was killed and tissues examined. The only gross pathology was seen in the duodenum. The mucous membrane showed hyperemia and slight hemorrhage but this was not extensive. A total of 3822 nematodirus worms were recovered from the small intestine. Of this number 2576 were found in the first three feet of the intestine.

This study will be continued with younger lambs. Two of the lambs that were raised parasite free in 1947 have been placed on a specially prepared plot of ground at the Veterinary Research Farm in order to study the effect of freezing and other climatic factors on larvae and eggs deposited on the pasture the previous Fall. The 5th parasite free lamb was slaughtered May 4 and material collected to establish normals for histopathological studies.

Phenothiazine salt mixture was found to hold down *haemonchus contortus* infestation but did not materially affect infestations with *trichostrongyles*. We have rather conclusive evidence that the continued use of phenothiazine in the salt in previous years has materially lowered the nodular worm infestation in all of our sheep. Heavy infestations with tapeworms were observed in the



spring months last year but later in the season the tapeworms disappeared without any treatment being administered. The explanation for this is not known and further work should be done to determine whether it is an age immunity or some other factor. The consumption of phenothiazine was compared in two lots of sheep, one on poor pasture and one on good pasture. The sheep on poor pasture consumed 0.286 gms. phenothiazine per day, on the good pasture 0.472 gms. per day. Sheep on poor pasture but receiving treatment did not do materially better than control sheep not treated which were run upon a much better pasture, proving the value of good feed in the control of parasites.

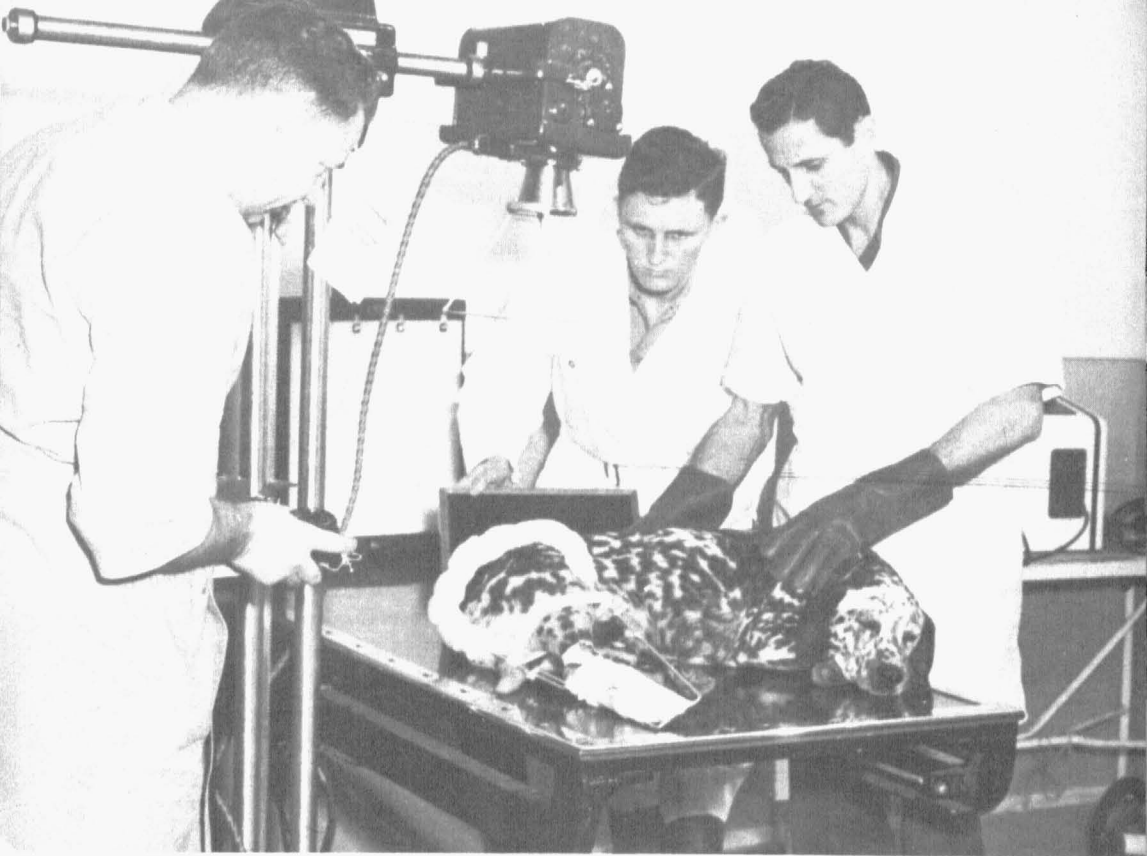
**Bang's Disease Vaccination Experiment** (Cecil Elder, D. E. Rodabaugh, and James E. Comfort). A total of 143 head of cattle belonging to the University of Missouri Beef Herd have been used in this experiment. An attempt has been made to control Bang's Disease infection in this herd by means of periodic blood tests coupled with calfhood vaccination using Strain 19 Brucella Abortus vaccine to work out the quickest practical method to rid a herd of infection. The calves have all been vaccinated as near as possible at the age of 6 months:

The principal results were:

Number of tests made during period ending March 31, 1948.....	953
Total number of calves vaccinated with Strain 19.....	33
Number of calves returning to negative status.....	13
Average number of months it took the 13 calves to become negative after vaccination.....	5.4
Number of calves still showing titre (1 to 50 or above) after reaching 18 months of age.....	4
Calves still showing some titre but not yet 18 months old.....	14
Calves sold on which blood test records are not available.....	2
Total number of abortions in the positive herd.....	34
Number of cows that aborted before showing a blood titre.....	8
Cows that reacted and later aborted.....	26
All 4 calves that remained positive at 18 months of age were over six months of age at time of vaccination (7 to 10 months).	

A complete study will be made of all calves that failed to return to negative status at the age of 18 months.

**Fowl Paralysis or Neuritis of Fowls** (A. J. Durant and H. C. McDougle). For the past fifteen or twenty years much research has been done on fowl paralysis of chickens and, although much information has been obtained concerning the nature and course of this disease, a solution for this perplexing poultry malady still remains to be found. The Missouri Experiment Station for the past fifteen years has spent considerable time investigating certain phases of fowl paralysis, particular attention being given to the transmission by means of the blood of affected fowl.



The new veterinary clinic was opened to Missouri farmers during the year. The broken leg of a dog is being X-rayed in the top picture and a purebred Hereford bull with a severe case of foot rot is being treated in the bottom picture.



During this period of research, Missouri has reported two new symptoms of fowl paralysis artificially produced by blood transfusion. One of these symptoms is referred to as soiled front and was observed in a number of experimental birds. These changes consisted in the feathers just under the mandible, along the throat, and in the cervical and crop regions appearing damp, darkened, and permanently discolored. The second new symptom observed was a wilted comb. Although demonstration of nerve involvement which might indicate the cause of the changes in the comb is still lacking, there appears to be little doubt that this is a new symptom of fowl paralysis not heretofore observed or at least not reported.

Infected birds apparently vary in their ability to transmit the disease using artificial methods. Of 233 birds inoculated, 104 or 44.63% developed a form of fowl paralysis. However, the minimum transmission was 21.73% and the maximum transmission was 77.27%. Of 111 uninoculated controls, 11 or 9.90% developed the disease.

**Blood Studies in Bang's Disease** (Cecil Elder and D. E. Rodabaugh). This research has been continuous and the aim has been to determine the effect of different treatments upon blood titres and the significance of this in the control of Bang's Disease by the use of a blood test.

The following products have been tested the past year: Streptomycin hydrochloride, neoprontosil, stilbestrol, wart vaccine and sulfapyridine sodium. It was found that none of these products made any appreciable change in the blood titre of the cattle. In all 28 drugs, vaccine, serums, etc., commonly used in the treatment of disease, have been tried and in no instance has any product been found to produce any appreciable change in blood titres. It is believed that some minerals and trace elements should be included, but suitable cows were not available for this purpose this past year.

**Newcastle Disease Investigations** (A. J. Durant and H. C. McDougle). Investigations on Newcastle disease in Missouri have been directed toward epidemiology by means of field investigations and subsequent testing of blood samples secured from suspected flocks. These investigations indicate that Newcastle disease is widespread in Missouri. Thirty-seven counties gave H. I. tests, indicating the presence of the disease, while fourteen counties showed no indication of the disease. Samples from 51 counties were examined. Eighty-nine flocks were found positive and 173 were negative, giving a total of 262 flocks examined. Virus was isolated in four of the counties.

**Blackhead in Turkeys** (A. J. Durant and H. C. McDougle). Investigations were made on improved methods of technic on ablation of the ceca for the prevention of blackhead. In addition, drugs were injected into the ablated ceca in an attempt to prevent the growth of these organs after they are ablated, which is one of the drawbacks to the practical success of this operation.

Sodium morrhuate appears to show some promise as a means of destroying or preventing the growth of the ceca after they are abligated. Preliminary experiments with the drug indicate that it completely destroys or prevents the growth of these organs.

**Tube Agglutination Blood Testing for Pullorum Disease in Chickens** (H. C. McDougle). During this fiscal period 30,235 tests were made on chickens for the detection of carriers of pullorum disease. This is a great reduction from last year's blood testing report. Due to the reconstruction of Connaway Hall it was necessary to temporarily discontinue blood testing to a large extent, and 30,000 birds represent only a small fraction of those usually tested for the disease.

**Agglutination Blood Testing for Bang's Abortion Disease of Cattle and Swine** (D. E. Rodabaugh and Cecil Elder). A total of 1,659 tests were made by the tube agglutination method for Bang's disease in cattle. The reduction in the number of annual tests is due to the fact that the Bureau of Animal Industry, during this fiscal period, moved the laboratory from the department of veterinary science to Jefferson City, Missouri. In addition to the Bang's disease tests, 240 tests for mastitis were conducted in the laboratory, as well as 80 fecal examinations for parasites of farm animals.

**Diagnostic Service on Diseases of Animals and Poultry** (A. J. Durant, Cecil Elder, H. C. McDougle, O. S. Crisler, A. A. Case, and D. E. Rodabaugh). During this fiscal period a total of 4,606 cases were treated or examined. Of this total, approximately one-half of the animals were examined or treated and the other half examined by postmortem.

**Rabies Diagnostic Service** (H. C. McDougle and D. A. Hill). During this fiscal period 44 animal heads were examined for rabies. Of this number 11 were found to be infected with the disease.

## PUBLICATIONS

A. A. Jeffrey, *Editor*

The Experiment Station issued 36 new publications during the year ending June 30, 1948, including 12 research bulletins, 10 popular bulletins, and 14 circulars. If single copies of all had been gathered and bound, they would have made a volume of 975 pages. The total number of copies of the various new publications printed was 229,500.

In addition to these publications, the *Farm News* and the *Announcer* were published in cooperation with the Extension Service. The *Farm News* was printed weekly and mailed to newspapers, farm papers, county agents, vocational agricultural instructors and other farm leaders. It had a circulation of 1550 a week. The *Announcer* went to 22,000 farmers and others requesting it once a month.

**Research Bulletins****No. Title, Series, Author, and Number of Pages and Copies.**

407. The Relationship Between Percentage of Live Spermatozoa and Motility, Longevity, and Fertility of Semen of Dairy Bulls, by F. W. Madden, H. A. Herman, and E. R. Berousek, July, 1947; 16 pages, 2000 copies.
408. Growth and Development LXII. The Specific Dynamic Action of Nutrients with Special Reference to the Effects of Vitamins and Hormones, by Dulal Pada Sadhu, August, 1947; 64 pages, 2000 copies.
409. Studies in Soil Nitrogen and Organic Matter Maintenance, by M. F. Miller, August, 1947; 30 pages, 3000 copies.
410. The Health of Low-Income Farm Families in Southeast Missouri, by C. L. Gregory, Zetta E. Bankert, Aleta McDowell, and C. E. Lively, August, 1947; 33 pages, 2000 copies.
411. Oral Effectiveness of the Dimethyl Ether of Diethylstilbestrol and of Various Steroid Hormones on the Mammary Glands of Mice and Rabbits, by J. T. Trentin and C. W. Turner, March, 1948; 48 pages, 2500 copies.
412. Growth and Development LXIII. Heat Production and Cardiorespiratory Activities During Gestation and Lactation in Jersey Cattle, by S. Brody, D. M. Worstell, A. C. Ragsdale, and H. H. Kibler, March, 1948; 24 pages, 2500 copies.
413. Low-Income Farmers in Missouri: Situation and Characteristics of 459 Farm Operators in Four Social Area B Counties, by H. F. Lionberger, April, 1948; 32 pages, 2500 copies.
414. Rural Social Areas in Missouri as Determined by Statistical Analysis of County Data, 1940, by C. E. Lively and C. L. Gregory, April, 1948; 28 pages, 2500 copies.
415. Studies Concerning the Induction and Maintenance of Lactation I. The Mechanism Controlling the Initiation of Lactation at Parturition, by Joseph Meites and C. W. Turner, May, 1948; 68 pages, 2500 copies.
416. Studies Concerning the Induction and Maintenance of Lactation II. The Normal Maintenance and Experimental Inhibition and Augmentation of Lactation, by Joseph Meites and C. W. Turner, May, 1948; 36 pages, 2500 copies.
417. The Thyroid Secretion Rate in the Mouse and Its Relation to Various Physiological Processes, by Victor Hurst and C. W. Turner, May, 1948; 64 pages, 3000 copies.
418. The Experimental Development of the Mammary Gland with Special Reference to the Interaction of the Pituitary and Ovarian Hormones, by J. J. Trentin and C. W. Turner, May, 1948; 48 pages, 2500 copies.

**Reprints**

284. Types of Farming in Missouri, Hammar, Roth and Johnson; 100 pages, 10,000 copies.
326. Variations in Dairy Bull Semen, Herman and Swanson; 84 pages, 2500 copies.
382. Effects of Temperature and Humidity on Keeping Quality of Shell Eggs, E. M. Funk; 28 pages, 2000 copies.

**Bulletins**

505. Manufacture of Cottage Cheese From Nonfat Dry Milk Solids, by W. H. E. Reid and Merrill O. Maughan, July, 1947; 8 pages, 10,000 copies.
506. Soybean Production in Missouri, by B. M. King, July, 1947; 28 pages, 10,000 copies.
507. Terracing for Erosion Control, by M. Clark and J. C. Wooley, July, 1947; 48 pages, 10,000 copies.
508. Winter Barley in Missouri, by J. M. Poehlman and C. A. Helm, September, 1947; 20 pages, 10,000 copies.
509. Missouri Peach Culture, by T. J. Talbert, October, 1947; 36 pages, 10,000 copies.
510. Teamwork of Science and Agriculture, by E. A. Trowbridge and J. E. Crosby, Jr. October, 1947; 72 pages, 3500 copies.

511. Fertilizer Inspection Analysis and Use; 1946, by L. D. Haigh, E. W. Cowan, and John R. Breuer, October, 1947; 48 pages, 7000 copies.
512. Coccidiosis in Chickens and Other Birds, by A. J. Durant and H. C. McDougale, March, 1948; 12 pages, 10,000 copies.
513. Fertilizer Inspection and Analysis; Spring 1947, by H. J. L'Hote and J. R. Breuer, March, 1948; 40 pages, 6500 copies.
514. Effect of Planting Time on Maturity, Yield and Quality of Soybeans in Southeast Missouri, by C. V. Feaster, May, 1948; 8 pages, 8000 copies.

#### Reprints

450. Growing Raspberries and Blackberries, H. G. Swartwout and W. R. Martin, Jr.; 32 pages, 8000 copies.
379. Pollination and Fruit Setting, A. E. Murneek; 28 pages, 5000 copies.
482. Controlling American Foulbrood with Sulfa Drugs, L. Haseman and L. F. Childers; 16 pages, 4000 copies.
443. Measuring the Productive Value of Pastures, Homer J. L'Hote; 34 pages, 5000 copies.
464. Growing Potatoes in Missouri, A. D. Hibbard; 24 pages, 10,000 copies.
437. Selecting Fruit Varieties, T. J. Talbert and A. D. Hibbard; 52 pages, 5000 copies.
247. Pastures for Hogs, L. A. Weaver; 40 pages, 8000 copies.
305. Beekeeping in Missouri, Leonard Haseman; 52 pages, 6000 copies.
341. Factors Influencing Hatchability in the Domestic Fowl, E. M. Funk; 24 pages, 5000 copies.
350. The Cooling of Eggs, E. M. Funk; 16 pages, 5000 copies.
364. Tuberculosis of Poultry, A. J. Durant; 24 pages, 8000 copies.
376. Rations for Weanling Pigs, L. A. Weaver; 8 pages, 6000 copies.
384. Factors Influencing Production of Clean Eggs, E. M. Funk; 12 pages, 5000 copies.
423. The Normal Growth of Chickens, H. L. Kempster; 20 pages, 4000 copies.
465. Hog Cholera, Cecil Elder and O. S. Crisler; 8 pages, 8000 copies.
471. Protein Content of Concentrates for Turkeys, E. M. Funk; 16 pages, 3000 copies.
478. Control of Termites, Leonard Haseman; 16 pages, 10,000 copies.
492. Alfalfa in Missouri, W. C. Etheridge and C. A. Helm; 16 pages, 10,000 copies.
501. Growing Good Crops of Oats in Missouri, J. M. Poehlman; 20 pages, 15,000 copies.
502. The Missouri Queen Watermelon, A Wilt Resistant Variety for Southeastern Missouri, A. D. Hibbard; 8 pages, 4000 copies.
503. Preparing Frying Chickens for Locker Storage, E. M. Funk and Ferne Bowman; 8 pages, 5000 copies.
506. Soybean Production in Missouri, B. M. King; 28 pages, 15,000 copies.
468. Farm Tractors, M. M. Jones and L. E. Hightower; 40 pages, 10,000 copies.
398. Wheat in Missouri, W. C. Etheridge, C. A. Helm and J. M. Poehlman; 44 pages, 6000 copies.

#### Circulars

316. Grape Culture—Planting, Handling and Later Care, by T. J. Talbert, July, 1947; 24 pages, 10,000 copies.
317. Protect Your Poultry Flock From Newcastle Disease, by H. C. McDougale, September, 1947; 4 pages, 10,000 copies.
318. Good Varieties of Cotton for Missouri, by J. R. Paulling, November, 1947; 8 pages, 10,000 copies.
319. Rations for Livestock and Poultry, by A. C. Ragsdale, November, 1947; 12 pages, 10,000 copies.
320. Top and Double Working, and Bridge Grafting of Fruit Trees, by T. J. Talbert, January, 1948; 16 pages, 6000 copies.
321. Rodent Control in Orchards, by T. J. Talbert, April, 1948; 24 pages, 10,000 copies.

- 322. Lawn Culture in Missouri, by T. J. Talbert and E. M. Brown, February, 1948; 12 pages, 10,000 copies.
- 323. Sweet Clover Management in a Pasture System, by C. A. Helm, March, 1948; 8 pages, 10,000 copies.
- 324. Spray Programs for Grapes, by H. G. Swartwout, March, 1938; 4 pages, 2000 copies.
- 325. Saving Gasoline on the Farm, by M. M. Jones, March, 1948; 4 pages, 8000 copies.
- 326. Spraying Home Fruit Plantings, by H. G. Swartwout, W. R. Martin, Jr., and Lee Jenkins, April, 1948; 8 pages, 5000 copies.
- 327. Growing Gooseberries and Currants, by H. G. Swartwout, April, 1948; 12 pages, 6000 copies.
- 328. Control of Household Insects, by Leonard Haseman, May, 1948; 20 pages, 8000 copies.
- 329. Controlling Plant Diseases in the Home Garden, by C. M. Tucker, June, 1948; 8 pages, 10,000 copies.

#### Reprints

- 329. Controlling Plant Diseases in the Home Garden, C. M. Tucker; 8 pages, 10,000 copies.
- 321. Rodent Control in Orchards, T. J. Talbert; 24 pages, 10,000 copies.
- 328. Control of Household Insects, Leonard Haseman; 20 pages, 8000 copies.
- 327. Growing Gooseberries and Currants, H. G. Swartwout; 12 pages, 6000 copies.
- 324. Spray Programs for Grapes, H. G. Swartwout; 4 pages, 2000 copies.
- 326. Spraying Home Fruit Plantings, H. G. Swartwout, W. R. Martin, Jr., and Lee Jenkins; 8 pages, 5000 copies.
- 325. Saving Gasoline on the Farm, Mack Jones; 4 pages, 8000 copies.
- 323. Sweet Clover Management in a Pasture System, C. A. Helm; 8 pages, 10,000 copies.
- 322. Lawn Culture in Missouri, T. J. Talbert and E. M. Brown; 12 pages, 10,000 copies.
- 320. Top and Double Working, and Bridge Grafting of Fruit Trees, T. J. Talbert; 16 pages, 6000 copies.
- 319. Rations for Livestock and Poultry, A. C. Ragsdale; 12 pages, 10,000 copies.
- 318. Good Varieties of Cotton for Missouri, J. R. Paulling; 8 pages, 10,000 copies.
- 317. Protect Your Poultry Flock from Newcastle Disease, H. C. McDougle; 4 pages, 10,000 copies.
- 316. Grape Culture; Planting, Handling and Later Care, T. J. Talbert; 24 pages, 10,000 copies.

#### CONTRIBUTIONS TO SCIENTIFIC JOURNALS

- 1056. The Thyroid Secretion Rate of Growing and Mature Mice, by Victor Hurst and C. W. Turner, submitted July 9, 1947 to American Journal of Physiology.
- 1057. Minimizing Storage Losses by Thermo-stabilizing Shell Eggs, by E. M. Funk, submitted July 16, 1947 for use at the annual Poultry Science Association Meeting at Clemson College on August 28.
- 1058. The Determination of Soil Organic Matter by Means of a Photo-electric Colorimeter, by E. R. Graham, submitted July 16, 1947 to Soil Science.
- 1059. The Genome Approach in Radical Wheat Breeding, by E. S. McFadden and E. R. Sears, submitted July 22, 1947 to Journal of American Society of Agronomy.
- 1060. Effect of Thyroprotein-Feeding on the Gland and Weights of Two-year-old White Leghorn Hens, by C. W. Turner, submitted August 20, 1947 to the Journal of Poultry Science.
- 1061. Effect of Age and Season on the Thyroxine Secretion Rate of White Leghorn Hens, by C. W. Turner, submitted August 20, 1947 to the Journal of Poultry Science.
- 1062. The Electrochemical Properties of Mineral Membranes VIII. The theory of selective membrane behavior, by C. E. Marshall, submitted August 29, 1947 to the Journal of Physical Chemistry.

1063. The Ionization of Calcium From Soil Colloids and Its Bearing on Soil-Plant Relationships, by C. E. Marshall, submitted August 29, 1947 to Soil Science.
1064. The Electrochemical Properties of Mineral Membranes VI. Clay Membranes for the Determination of Calcium, by C. E. Marshall and A. D. Ayers, submitted August 29, 1947 to the Journal of the American Chemical Society.
1065. The Electrochemical Properties of Mineral Membranes VII. Clay Membranes for the Determination of Magnesium, by C. E. Marshall and L. O. Eime, submitted August 29, 1947 to the Journal of the American Chemical Society.
1066. Changes in the Sugar Content of Raw Green Beans During Storage, by A. G. Hogan, submitted September 12, 1947 to the Food Research Journal.
1067. Climate and Efficiency of Productive Processes, by Samuel Brody, submitted October 1, 1947 to the American Council of Education.
1068. Effect of Rape Seed Oil Meal on the Thyroid of the Chick, by C. W. Turner, submitted October 15, 1947 to Poultry Science.
1069. A Fast Green-Eosin Stain for the Differentiation of Live From Dead Spermatozoa, by Dale Squiers, Mohammed M. Oloufa, Dennis T. Mayer and Ralph Bogart, submitted October 17, 1947 to the American Journal of Physiology.
1070. The Activities of Calcium and Potassium ions as Related to Concentration and Drying in Clay Suspensions, by C. E. Marshall and E. O. McLean, submitted October 31, 1947 to Soil Science Society of America.
1071. Time-Saving Apparatus for Respiratory Exchange Measurements, by H. H. Kibler, submitted November 3, 1947 to Science or Review of Scientific Instruments.
1072. Soil Development and Plant Nutrition III. The Transfer of Potassium from the non-available to the available form as Reflected by the Growth and Composition of Soybeans, by C. E. Marshall, submitted November 4, 1947 to Proceedings of Soil Science of America.
1073. Plant Nutrition and the Hydrogenion VI. Calcium Carbonate a Disburging Fertility Factor in Soil, by D. A. Brown and Wm. A. Albrecht, submitted November 6, 1947 to Proceedings of Soil Science Society of America.
1074. Erosion and Production Under Missouri Grazing Systems, by D. M. Whitt and D. D. Smith, submitted November 12, 1947 to Proceedings of Soil Science Society of America.
1075. Estimating Soil Losses From Field Areas of Claypan Soil, by D. D. Smith and D. M. Whitt, submitted November 13, 1947 to Proceedings of Soil Science of America.
1076. Effect of DDT on Dairy Cattle and Milk, by Curtis W. Wingo and O. S. Crisler, submitted November 13, 1947 to Journal of Economic Entomology.
1077. Determination of the Exchangeable Hydrogen and Lime Requirement of the Soil by Means of the Glass Electrode and a Buffered Solution, by C. M. Woodruff, submitted November 14, 1947 to Proceedings of Soil Science Society of America.
1078. Erosion in Relation to Rainfall, Crop Cover, and Slope on a Greenhouse Plot, by C. M. Woodruff, submitted November 14, 1947 to Proceedings of Soil Science of America.
1079. Thermo-stabilization of Quality in Shell Eggs, by E. M. Funk, submitted November 22, 1947 for the 8th World's Poultry Congress to be held in Copenhagen, August 1948.
1080. Mild Hyperthyroidism Maintains Egg Production with Advancing Age, by C. W. Turner and H. L. Kempster, submitted November 25, 1947 to Journal of Poultry Science.
1081. Design of a Terrace System From Hydrologic Data, by Dwight D. Smith, submitted December 8, 1947 to Agricultural Engineering.
1082. Canker Stain of London Plane in St. Louis, Missouri, by T. W. Bretz and C. M. Tucker, submitted December 9, 1947 to Plant Disease Reporter.
1083. The Effect of X-rays Upon Mutation of the Gene *A* in Maize, by L. J. Stadler and Herschel Roman, submitted December 13, 1947 to Genetics.



1084. Gumbolil—Its Formation and Relation to Overlying Soils with Claypan Subsoils, by H. H. Krusekopf, submitted December 16, 1947 to Proceedings of Soil Science Society of America.
1085. Nutrient-Element Balance and Growth of Leaf Lettuce, by R. A. Schroeder, submitted December 23, 1947 to American Society of Horticulture Society Proceedings.
1086. Nutrient-Element Balance and Time of Anthesis in Tomato Flowers, by Victor N. Lambeth, submitted January 7, 1948 to the American Society for Horticultural Science.
1087. Some Factors Affecting Ascorbic Acid Content of Apples, by A. E. Murneek and S. H. Wittwer, submitted January 8, 1948 to the Proceedings of the American Society for Horticultural Science.
1088. A Preliminary Study of the Effect of Axillary Foliage on Yield of Tomatoes, by D. D. Hemphill and A. E. Murneek, submitted January 8, 1948 to Proceedings of the American Society for Horticultural Science.
1089. Vitamin A, Iodide and Thyrotropic Hormone Content of the Anterior Pituitary, by D. P. Sadhu, submitted January 12, 1948 to American Journal of Physiology.
1090. Physiological Mechanism of Experimental Goitrogenesis, by D. P. Sadhu, submitted January 12, 1948 to American Journal of Physiology.
1091. Correlation Between the Lactose Content of Milk and the Cerebroside and Choline Content of Brain, by D. P. Sadhu, submitted January 12, 1948 to Journal of Dairy Science.
1092. Electrocardiograms of Mules, Horses, Cattle, Sheep, Swine and Goats, by Wesley S. Platner, Hudson H. Kibler, and Samuel Brody, submitted January 21, 1948 to American Heart Journal.
1093. The Effect of Severity of Pruning on the Performance of Young Elberta Peach Trees, by A. D. Hibbard, submitted January 23, 1948 to the Proceedings of the American Society of Horticultural Science.
1094. Influence of Season on Comb Development of Chicks Following Oral Administration of Methyl Testosterone, by C. W. Turner, submitted January 28, 1948 to Poultry Science.
1095. The Relation of the Yolk Index Determined in Natural Position to the Yolk Index as Determined After Separating the Yolk from the Albumen, by E. M. Funk, submitted February 13, 1948 to Poultry Science.
1096. Feeding Estrogen (Dianisylhexene) to Laying Hens, by C. W. Turner, submitted February 25, 1948 to Poultry Science.
1097. Thiouracil and Mammary Growth, by J. J. Trentin, V. Hurst, and C. W. Turner, submitted February 26, 1948 to Society for Experimental Biology and Medicine.
1098. Defoliation of Soybeans in Southeast Missouri Caused by *Phyllosticta Glycineum*, by James M. Crall, submitted February 26, 1948 to Plant Disease Reporter.
1099. Feeding Thyroprotein and Sex Hormones to Laying Hens, by C. W. Turner, submitted March 8, 1948 to Poultry Science.
1100. Testing Soils for Lime Requirement by Means of a Buffered Solution and the Glass Electrode, by C. M. Woodruff, submitted March 12, 1948 to Soil Science.
1101. Spontaneous Mutation at the *R* Locus in Maize. II. Race Differences in Mutation Rate, by L. J. Stadler, submitted March 26, 1948 to American Naturalist.
1102. Nutritional Requirements of Turkeys, by Betty Gomez Lance and Albert G. Hogan, submitted March 31, 1948 to Journal of Nutrition.
1103. Effect of Ultraviolet Irradiation on Biological Activity of Estradiol Benzoate, by J. J. Trentin and C. W. Turner, submitted March 31, 1948 to Endocrinology.
1104. Vitamins Required by Swine for a Complete Life Cycle, by A. G. Hogan and Gerald C. Anderson, submitted April 9, 1948 to The Journal of Nutrition.
1105. Evaluating Soil Losses From Field Areas, by D. D. Smith and D. M. Whitt, submitted April 21, 1948 to Agricultural Engineering.

1106. A Study of the Types of Bacteria in Bovine Semen and Their Effect Upon Motility, by J. E. Edmondson, K. L. Tallman, H. A. Herman, submitted May 6, 1948 to Journal of Dairy Science.
1107. The Role of Certain Hormones on Spermatogenesis, by J. D. Sampath Kumaran, submitted May 6, 1948 to Journal of Dairy Science.
1108. Thyroid Secretion Rate and Its Relation to Various Physiological Processes, by Victor Hurst and C. W. Turner, submitted May 6, 1948 to Journal of Dairy Science.
1109. Spermatozoa Behavior in Bovine Cervical Mucus at Varying Stages of Estrus, by H. A. Herman and Otis H. Horton, submitted May 6, 1948 to Journal of Dairy Science.
1110. Measurement of the Rate of Endocrine Gland Secretion as a Tool in the Genetic Selection of Dairy Cattle, by C. W. Turner, submitted May 6, 1948 to Journal of Dairy Science.
1111. The Effect of Lactation and Gestation on Heat Production and Cardiorespiratory Activities of Dairy Cattle and Rats, by Samuel Brody, D. M. Worstell, A. C. Ragsdale, and H. H. Kibler, submitted May 6, 1948 to Journal of Dairy Science.
1112. The Growth of Dairy Heifers Reared on Maximum Roughage with Varying Amounts of Grain, by O. T. Stallcup, H. A. Herman and A. C. Ragsdale, submitted May 6, 1948 to Journal of Dairy Science.
1113. Histological Effect of Thiouracil on Fetal Thyroids, by G. Kauffman, V. Hurst, and C. W. Turner, submitted May 6, 1948 to Endocrinology.
1114. Oral Effectiveness of Androgens in Fowls, by C. W. Turner, submitted May 6, 1948 to the Journal of Poultry Science.
1115. The Metabolism of Thyroxine in the Goat, by R. A. Monroe and C. W. Turner, submitted May 27, 1948 to American Journal of Physiology.
1116. Changes in the Sugar Content of Raw Green Beans During Storage, by V. B. Williams, Laura M. Flynn, and A. G. Hogan, submitted April, 1948 to Press Food Research.
1117. Interfering Factors in the Assay of Vitamins, by V. B. Williams, Laura M. Flynn, and A. G. Hogan, submitted June 2, 1948 to Journal of Bacteriology.
1118. Gene Mutation (Synopsis of paper to be presented at the VIII International Genetics Congress at Stockholm, July 1948), by L. J. Stadler, submitted June 17, 1948.

### INVESTIGATIONS UNDER COOPERATIVE PROJECTS

During the years 1947-48, 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.

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

#### Office of Naval Research

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

#### American Cancer Society

For support of research on the genetic nature of X-ray induced mutations.

#### Quaker Oats Company

For research in the breeding of white hybrid corn.

**American Dairy Association**

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

**Cerophyl Laboratories**

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

**De-Raef Corporation**

For research relating to the manufacture of cheddar cheese.

**International Baby Chick Association**

For research in connection with hatchability studies.

**Spencer Chemical Company**

For research in connection with pasture studies.

**American Potash Institute**

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

**International Minerals and Chemical Corporation**

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

**Swift and Company**

For research on the project dealing with "The Influence of Soil Composition and Treatment on the Composition of Forages and the Resulting Development of Animals."

**Middle West Soil Improvement Committee**

To further extension projects in soils improvement.

**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 fertilizing material.

**Missouri Conservation Commission**

For farm forestry research.

**Missouri Butter Institute**

For the study of mold mycelia in cream and butter.

**Corn Products Sales Company**

For research in the field of dairy products.

**Kraft Cheese Company**

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

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

**Ortho Research Foundation****Midwest Breeding Farms, Trenton, Missouri**

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

CHANGES IN STATION STAFF FOR THE YEAR ENDING  
JUNE 30, 1948

Appointments

- Harry Atkinson, Research Associate in Soils.  
Clifton R. Blincoe, Research Assistant in Dairy Husbandry.  
Lillian E. Brehn, Assistant Professor of Home Economics.  
Donald B. Brooker, Research Assistant in Agricultural Engineering.  
Ernest E. Burgess, Technician in Department of Veterinary Science.  
Arthur A. Case, Assistant Professor of Medicine and Surgery in Department of Veterinary Science.  
Lloyd E. Cavanah, Assistant Instructor in Field Crops.  
James W. Cobble, Assistant Instructor in Dairy Husbandry.  
Kenneth C. Compton, Assistant Professor of Forestry.  
Gordon E. Dickerson, Associate Professor of Animal Husbandry.  
Joe Wheeler Duck, Assistant Professor of Agricultural Education.  
Justus H. Edmondson, Graduate Assistant in Dairy Husbandry.  
George F. Ekstrom, Professor of Agricultural Education.  
Carl F. Feaster, Research Associate in Field Crops.  
O. Hale Fletchall, Assistant Instructor in Field Crops.  
James F. Forward, Instructor in Poultry Husbandry.  
Gerald D. Goetsch, Assistant Professor of Veterinary Physiology.  
Edward R. Hauser, Research Assistant in Animal Husbandry.  
Lawrence M. Hepple, Assistant Professor of Rural Sociology.  
D. A. Hill, Assistant Professor of Veterinary Bacteriology.  
Ralph Fred Kampschmidt, Research Assistant in Animal Husbandry.  
Eugene Kauffman, Graduate Assistant in Dairy Husbandry.  
Richard L. Kohls, Instructor in Agricultural Economics.  
Robert C. Laben, Graduate Assistant in Dairy Husbandry.  
Buel Lanpher, Research Assistant in Agricultural Economics.  
Walter R. Langford, Assistant Instructor in Field Crops.  
Homer J. L'Hote, Supervisor of Photo Service and Supervisor of Fertilizer Inspection.  
Robert E. McDermott, Instructor in Forestry.  
Charles P. Merilan, Graduate Assistant in Dairy Husbandry.  
Marion E. Midforth, Instructor in Home Economics.  
Daniel F. Millikan, Jr., Research Assistant in Botany.  
Robert A. Monroe, Graduate Assistant in Dairy Husbandry.  
J. Milford Nichols, Instructor in Forestry (Field Forester).  
Myron G. Nuffer, Technical Assistant in Genetics.  
Joseph G. O'Mara, Research Associate in Field Crops.  
Zane Palmer, Assistant Instructor in Animal Husbandry.  
John R. Paulling, Professor of Agricultural Economics.

Alvah L. Perry, Instructor in Agricultural Economics.  
Duane R. Peterson, Assistant Professor of Veterinary Physiology.  
Edward E. Pickett, Assistant Professor of Agricultural Chemistry.  
Mary E. Plumb, Technical Assistant in Genetics.  
Grace Virginia Richmond, Research Assistant in Home Economics.  
Donald B. Roark, Graduate Assistant in Dairy Husbandry.  
W. P. Sappenfield, Assistant Instructor in Field Crops.  
John R. Schabinger, Graduate Assistant in Dairy Husbandry.  
Loren O. Shaffer, Graduate Assistant in Dairy Husbandry.  
Victor L. Sheldon, Research Assistant in Soils.  
Willard S. Summers, Instructor in Landscape Architecture.  
Harold J. Thompson, Research Associate in Agricultural Engineering.  
John J. Trentin, Graduate Assistant in Dairy Husbandry.  
Donald McLean Trotter, Instructor in Veterinary Pathology.  
James R. Whitley, Assistant Instructor in Agricultural Chemistry.  
Chase C. Wilson, Assistant Instructor in Dairy Husbandry.  
R. H. Westveld, Professor of Forestry.

#### Resignations and Withdrawals

Harry Atkinson, Research Associate in Soils.  
Helen E. Beresford, Associate Professor of Home Economics.  
Ralph Bogart, Assistant Professor of Animal Husbandry.  
Calvin M. Bowen, Assistant Professor of Forestry.  
Robert F. Gentry, Instructor in Veterinary Science.  
Conrad H. Hammar, Professor of Agricultural Economics.  
Otis H. Horton, Assistant Instructor in Dairy Husbandry.  
Richard L. Kohls, Instructor in Agricultural Economics.  
R. E. Leighton, Superintendent Hatch Dairy Experiment Farm.  
Preston W. McDaniel, Instructor in Animal Husbandry.  
Maxine McDivitt, Assistant Professor of Home Economics.  
Duane R. Peterson, Assistant Professor in Veterinary Physiology.  
John R. Schabinger, Graduate Assistant in Dairy Husbandry.  
Kenneth L. Tallman, Graduate Assistant in Dairy Husbandry.  
Donald M. Trotter, Assistant Professor in Veterinary Physiology.  
Edwin A. Trowbridge, Dean of the College of Agriculture, Director of the  
Agricultural Experiment Station, Professor of Animal Husbandry. (Died  
June 7, 1948.)

## FINANCIAL STATEMENT

UNIVERSITY OF MISSOURI  
AGRICULTURAL EXPERIMENT STATIONin account with  
THE UNITED STATES APPROPRIATION, 1948

	Hatch Fund	Adams Fund	Purnell Fund	Bankhead- Jones Fund	Research & Marketing Fund
Dr.					
To Balance from 1947-48.....					
Receipts from the Treasury of the United States as per appropriation for fiscal year ended June 30, 1948	\$15,000.00	\$15,000.00	\$60,000.00	\$83,175.73	\$53,019.62
Total .....	15,000.00	15,000.00	60,000.00	83,175.73	53,019.62
Cr.					
Personal Services .....	12,266.89	11,243.16	44,791.26	56,015.66	24,060.84
Travel .....	4.40		1,178.96	906.20	1,098.94
Transportation of things.....		94.24	244.91	310.81	97.48
Communication Service .....	90.00		18.08	298.45	272.70
Rents and Utility Services .....	5.00	26.80	96.00	692.63	323.71
Printing and Binding .....			773.95	1,718.95	75.75
Other Contractual Services .....	19.05	149.89	832.89	833.75	556.41
Supplies and Materials .....	525.86	2,429.01	9,567.12	18,727.36	5,219.62
Equipment .....	1,790.93	859.21	1,806.88	2,511.02	5,314.35
Land and Structures .....				454.32	137.50
Contributions to Retirement .....	297.87	197.69	689.95	706.58	254.57
TOTAL EXPENDITURES .....	\$15,000.00	\$15,000.00	\$60,000.00	\$83,175.73	\$37,411.87
Unexpended Bal. June 30, 1948 .....					15,607.75