Investigations of Agricultural Problems

Work of the Agricultural Experiment Station During the Year Ending June 30, 1938

F. B. Mumford and S. B. Shirky

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*In cooperative service with the U. S. Department of Agriculture.
President F. A. Middlebush,
University of Missouri,
Columbia, Missouri

Sir:

I am submitting herewith the report of Former Director F. B. Mumford of the Agricultural Experiment Station for the year ending June 30, 1938. This report is submitted in accordance with the Federal law requiring such 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,

M. F. Miller, Director,
Missouri Agricultural Experiment Station.

October, 1941.
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Investigations of Agricultural Problems

Work of the Agricultural Experiment Station During the Year Ending June 30, 1938

F. B. Mumford, Director

S. B. Shirky, Assistant to the Director

The function of the agricultural experiment station in every state is to attempt to solve those problems which the farmer cannot readily solve for himself. Before the establishment of these stations, farmers were entirely on their own initiative in solving their farm problems and in developing improved practices. It is true that there were those among them who were far-seeing and who made great progress in their methods, but in the main the advancement was slow. Naturally, the conditions in those early days were greatly different from those of the present. Land was abundant, the population was small and every farmer was really a pioneer. As lands became settled and population increased agricultural problems multiplied, and agricultural colleges were founded during the Lincoln administration the purpose of which was to bring better information to the people on the land. It was soon discovered, however, that colleges had little available information to teach, excepting the accumulated experience of farmers and members of the college staff. Then came the demand for experiment stations, which were established through the passage of the Hatch Act in 1887 and which have now been in operation for over half a century.

The founding of agricultural experiment stations represented one of the great forward steps in the development of American agriculture. As their work has progressed during the past fifty years its basic importance has become generally recognized. It is on this fact-finding work of the experiment stations that the progress of agriculture is dependent. Without it, agriculture would be reduced to a rule-of-thumb system without power to combat insect pests or animal and plant diseases, with few improved varieties of field crops, fruits or vegetables, with little knowledge of the principles of soil conservation, and with meager information about the many improved agricultural practices which are now so widely used. It is this information regarding the great multiplicity of agricultural problems that the experiment stations have been able to supply and that the extension services have made available to the farm people of the country.

It is the purpose of this report of the Missouri Agricultural Experiment Station to summarize in very brief form the more recent findings in connection with the various experiment station projects under way.
Experiments in Progress During the Year Ending June 30, 1938.

AGRICULTURAL CHEMISTRY

A. G. HOGAN, Chairman

Simplified Rations for Rabbits and Guinea Pigs During the Reproductive Stage (A. G. Hogan, J. W. Schroeder).—Earlier work has shown that it is possible to rear rabbits and guinea pigs on simplified rations, but that these rations were grossly inadequate during the reproductive stage. The young were hemorrhagic, and were dead at birth, or soon succumbed after birth. Fresh extract of cereal grasses added to this diet, enabled the animals to bear normal young, and rear them successfully. During the past year, the stability of the cereal grass extract and methods of storage of these extracts have been studied. The basal ration commonly used was made up of parts by weight as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casein</td>
<td>20</td>
</tr>
<tr>
<td>Starch</td>
<td>43</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>8</td>
</tr>
<tr>
<td>Wheat germ oil</td>
<td>2</td>
</tr>
<tr>
<td>Cellufour</td>
<td>6</td>
</tr>
<tr>
<td>Salts</td>
<td>4</td>
</tr>
<tr>
<td>CaCO₃</td>
<td>1</td>
</tr>
<tr>
<td>Yeast</td>
<td>15</td>
</tr>
<tr>
<td>Vitamins A and D mixture</td>
<td>1</td>
</tr>
</tbody>
</table>

The active agent in the grass extract was very labile. The fresh juice has been sealed in cans and frozen as promptly as possible. It was removed from storage when needed and supplied to rabbits. Three females that received this frozen whole juice gave birth to a total of seven litters, but the mortality was exceedingly high. Only one litter, a total of four, was reared. Three litters were dropped by females that received fresh whole juice, and at least three in each litter were reared. It was thought that the active agent in the fresh whole juice was destroyed by enzyme action. Thus, when the fresh grass was blanched with live steam, and the juice expressed and frozen, the results were fairly satisfactory. A sample of dehydrated oat grass showed only a moderate degree of promise.

Nutrition of Poultry (A. G. Hogan, E. M. Parrott).—In devising suitable vitamin carriers to be used with simplified diets for poultry, it became evident that the real problem was the preparation of effective liver extracts. It was noted that some of the birds became anemic, and in time it became evident that the anemia was due to a vitamin deficiency. It is believed that this vitamin is not identical with any which are now recognized. The ration producing anemia to the greatest extent was as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casein</td>
<td>35</td>
</tr>
<tr>
<td>Cornstarch</td>
<td>35</td>
</tr>
<tr>
<td>Salts (O &amp; M)</td>
<td>4</td>
</tr>
<tr>
<td>Cellophane</td>
<td>3</td>
</tr>
<tr>
<td>Lard</td>
<td>8</td>
</tr>
<tr>
<td>Cod Liver oil</td>
<td>2</td>
</tr>
<tr>
<td>Wheat germ oil</td>
<td>4</td>
</tr>
<tr>
<td>Ether Extract of Egg Yolk</td>
<td>2</td>
</tr>
<tr>
<td>Tikitiki</td>
<td>1</td>
</tr>
<tr>
<td>95% Alcoholic extract of Pork Liver</td>
<td>2</td>
</tr>
</tbody>
</table>
Up to the present time one hundred and seventy-five anemic chicks have been produced on all rations studied.

The anemia described can be healed by water extracts of yeast or of liver. These have been fractionated in an attempt to learn more of the nature of the active agent, and to obtain it in greater concentration.

**Vitamin B Complex Members that are Required by the Rat (L. R. Richardson, A. G. Hogan).**—After producing the antidermatitis vitamin H (B₆) free from any other known vitamin, an attempt was made to determine whether or not there were others which had not been recognized. Rats were placed on rations which contained only B₁, B₁₂, and flavin as sources of the water soluble vitamins. The rats failed to grow. Therefore, there is at least one more member of the B complex necessary, and this has been designated as the "Fourth Rat Factor."

Yeast, a water extract of yeast, and an 80 per cent alcoholic extract of dried beef were the best sources of the Fourth Rat Factor. Tikitiki was only a fair source and yeast residue and liver residue were almost completely inactive.

The active agent was not adsorbed on fuller's earth in neutral or slightly acid medium, but preliminary data did indicate that it may be adsorbed at a low pH value. Norite adsorbate of yeast extract, liver extract, and tikitiki possessed some slight activity but not enough to be of any advantage as a step in the concentration of the factor.

Preliminary data indicated that the activity was precipitated from aqueous solutions by barium hydroxide and by lead acetate. Fair growth was obtained on 10 mg. dry matter of the decomposed barium hydroxide precipitate of tikitiki, but this procedure was unreliable. The activity was found in the filtrate when precipitations were carried out with phosphotungstic and picric acids.

Extraction of yeast at pH 1.0 and at pH 7.0 with 95 per cent ethyl alcohol and with a chloroform and ethyl alcohol mixture has not given any concentration of the factor. More activity was obtained in the extracts made at a pH of 1.0 than when made at a pH of 7.0. There was more dry matter in equivalent quantities of the extracts made at pH of 1.0 than in those made at a pH of 7.0.

**Vitamin B₃, Intermediates (A. G. Hogan, L. R. Richardson).**—Thiazole and pyrimidine nuclei (split products) of vitamin B₃ were fed separately and together to pigeons and to rats as the sole source of vitamin B₃. Polyneuritis was prevented or cured in both pigeons and rats when thiazole and pyrimidine were given together, but when separately neither was effective. The same results were obtained with both pigeons and rats by injection of thiazole and pyrimidine subcutaneously. Intravenous injection of polyneuritic pigeons seemed to cure the polyneuritis but death resulted in every case 48 to 72 hours after the injection was initiated.
The Antidermatitis Vitamin (A. G. Hogan, L. R. Richardson).—In previous work, a method was developed by which a ration could be made free of the antidermatitis vitamin, and the symptoms of this deficiency could be produced regularly and consistently. An effort has been made to concentrate this ration. The first step was adsorption on fuller's earth from a water extract of rice polishings. The adsorbate was eluted with an aqueous pyridine methyl alcohol mixture, and the eluate was concentrated to remove the pyridine and methyl alcohol. The aqueous solution then was treated with lead acetate, and after removal of excess lead from the filtrate, the greater portion of the activity remained in the filtrate in both precipitation reactions. The final filtrate, after removal of the excess phosphotungstic acid, was concentrated to dryness and then extracted with acetone. The acetone extract contained most of the activity.

It has been demonstrated by others that nicotinic acid is the anti-blacktongue principle. From one to five mg. of nicotinic acid have been fed to six rats suffering from mild cases of dermatitis without any healing activity. Also, it has been reported that isoleucine was the active substance in healing the dermatitis in rats suffering from vitamin B₆ deficiency. Three rats with dermatitis were not healed when given 20 mg. of isoleucine daily.

Cataract in Rats on Flavin Deficient Diets (A. G. Hogan, L. R. Richardson).—Other workers have reported an incidence of almost 100 per cent of cataract in rats which received a flavin deficient diet. The addition of flavin prevented the occurrence of cataract or arrested it if added to the diet after cataract had started to develop. At this Station, cataract has been observed in rats on flavin deficient diets, but the incidence of cataract was small.

The difference in the technique used was in the carbohydrate and fat content of the basal rations. Where a high incidence of cataract was observed, the ration was composed of cornstarch and fat. Where the incidence was much lower, the ration contained sucrose.

In earlier work on the vitamin B complex, a ration was used which contained cornstarch and lard. It was observed that the incidence of cataract in the earlier work was greater than when the sucrose and no fat ration was used. Three groups of 10 rats each were given a ration which differed only in the carbohydrate and fat content as indicated below:

Group I received a sucrose ration which contained no fat.
Group II received Day's ration which contained cornstarch, lard, and butter fat.
Group III received a ration similar to that used by Day but contained a larger percentage of lard and no butter fat.

Twenty per cent of the rats in group I developed doubtful cases of cataract. In the other two groups the incidence of cataract was 40.0 and 55.5 per cent respectively. The average time required for the cataract to develop was 10.8 weeks for each group. Apparently starch contributed to the development of cataract.
Pigeon Anemia due to a Vitamin Deficiency (A. G. Hogan, J. G. Lee).—Since there are striking differences in the nutritional requirements of different species, an attempt has been made to compare the vitamin requirements of the pigeon and of the rat. A ration that has been used in rat studies was supplied to pigeons, along with those members of the Vitamin B complex that thus far have been recognized. With this procedure almost every experimental pigeon developed anemia of a peculiar type. It was very similar to the sickle cell anemia of negroes.

The first curative agent studied was an alcoholic extract of rice polishings (tikitiki). This material invariably healed the anemia, but was not reliable in restoring body weight. It was assumed that the weight maintenance factor was labile, since some materials both healed anemia and restored weight and other materials, prepared at another date, healed anemia but would not restore weight.

Flavin and nicotinic acid may be required by pigeons, but they did not heal the anemia.

Adsorption has been a useful method of separating and concentrating some of the vitamins, and this procedure has been applied to this antianemic vitamin. The weight maintenance factor but not the antianemic factor may be adsorbed on Lloyd's reagent. At a pH of 1, both the antianemic and weight maintenance factors were adsorbed on fuller's earth, and neither was adsorbed at a pH of 7.

Various precipitating agents have been investigated but none has been entirely satisfactory.

Attempts have been made to obtain the active agents by the use of solvents. A mixture of chloroform and ethyl alcohol gave some promise, though the restoration of weight was not permanent.

Deaminized Casein Anemia (A. G. Hogan, R. E. Guerrant).—Rats which received deaminized casein soon died. If the deaminized casein was supplemented with lactalbumin, they survived much longer, but finally became anemic and died. If the deaminized casein was supplemented with casein they did not become anemic, and they survived indefinitely.

Difficulty in the use of lactalbumin in these rations has been encountered. In the first place it was expensive, and in the second place, some preparations were less suitable in that they may themselves heal the anemia. For these reasons, other sources of protein have been tested. Wheat gluten may be useful as a substitute for lactalbumin, since it did not interfere with the development of anemia. When the deaminized casein-wheat gluten ration was supplemented with a daily dose of 25 mg. lysine and 30 mg. methionine daily there was no improvement either in red cell count or in weight.

One of the fractions of hydrolyzed casein prepared by the copper salt method was effective in healing deaminized casein anemia, when supplied at a level of 5 per cent. The increase in red cell counts and in weight was steady though not rapid.
If the copper salt fraction was active, the untreated hydrolyzed casein should be effective. This was found to be the case if hydrolyzed casein was supplied at a level of 20 per cent, but 10 per cent was not enough.

In the rations just described, the hydrolyzed casein was added to a deaminized casein-wheat gluten ration. It was decided to omit the wheat gluten from the combination. When the deaminized casein was combined with 20 per cent of the hydrolyzed casein, the animals recovered slowly from anemia, and there was a gradual gain in weight. When this amount was reduced to 10 per cent, the number of red cells continued to decline and there was no gain in weight. The addition of 15 per cent lactalbumin to the ration of deaminized casein 10 plus hydrolyzed casein 10, was followed by prompt increases in red cell counts and in weight. If lactalbumin alone was added to deaminized casein, it was not effective at a level of either 15 or 25 per cent.

Fig. 1.—Rats on the basal ration make slight gains in weight, but become anemic and die.

In previous reports, autoclaved casein did not make good the deficiencies of deaminized casein, but recent evidence showed that the re-
duction of the nutritional value of the autoclaved casein depended on the pH at which the casein was heated. At a pH of 7 the activity was reduced markedly, and at a pH of 5 and 6 there was a slight reduction. At a pH of 9-10, the activity of the casein was lost almost entirely.

Including liver which had been extracted with water in an anemia producing ration increased the red cell count very slowly, but it made the gains in weight rapid. This contrasted to the results obtained by combining deaminized casein 10 and hydrolyzed casein 20. This caused rapid gains in red cell count, but no gains in weight.

This suggests that at least two amino acids were involved in the deaminized casein syndrome. One prevented the anemia, and possibly one more was required to permit gains in weight.

Anemic rats were observed to have enlarged spleens.

**Simplified Rations for Chicks (A. G. Hogan, L. R. Richardson).**

One of the most successful rations was made up as follows:

- Casein ................... 35
- Corn Starch .............. 27
- Lard .................... 7
- Cellophane .............. 3
- Salts ................... 4
- Cod Liver oil ........... 2
- Wheat germ oil ......... 4
- Soybean oil ............ 4
- Hexane extract of wheat bran 2
The vitamin carriers important in this connection were:
Fuller's earth adsorbate of alcoholic extract of pork liver ........ 4
Filtrate from fuller's earth adsorbate ................................. 4
Water extract of alcohol extracted pork liver ....................... 4
Vitamin B1 crystals, daily .............................. 40 gamma
Flavin crystals, daily .................................. 20 gamma

All of these carriers are solutions, which makes them subject to manipulation for the separation and concentration of the active agents. One group of chicks on such a ration had an average weight of 348 grams at 6 weeks, as compared to an average of 388 grams for the control group which received a practical chick ration.

Liver residue, after it has been extracted thoroughly with water and with alcohol, still had unique nutritional properties. Thus 10 per cent of this residue was substituted for an equal amount of corn starch in the experimental ration, and the chicks which received it grew with unusual rapidity. An attempt to obtain the active portion of this liver residue in soluble form has met with some degree of success.

AGRICULTURAL ECONOMICS
O. R. JOHNSON, Chairman

A Classification of Farms and an Inventory of Land Resources in Callaway County, Missouri (Conrad H. Hammar, Alva M. Meyers).—A classification of farms and an inventory of land resources in Callaway County, Missouri, has been made during the year. This classification included not only the farms, but all roads and public utility services such as telephone and power lines. By use of these data and airplane photographs, a total of 31 areas with a reasonable physical and economic homogeneity were designated for the County as a whole. Analyses were made of the changes in school child enumeration. Also, some tabulation of tax delinquency assessments were made.

In some of the poorer areas of Callaway County, as many as forty per cent of the farms existing two decades ago had been abandoned by 1938. The school child enumeration showed that the school child population in these areas had decreased by similar percentages.

The early indications of the study were: (1) the data developed has a very direct and important application to land use planning and (2) a reorganization of the system of land use was needed in Callaway County.

Forest Restoration in Missouri (Conrad H. Hammar, R. H. Westveld).—A report on this work was published as Missouri Agricultural Experiment Station Research Bulletin 392. A number of people in various universities and in government service contributed to this bulletin. The data presented showed that while Missouri has made a very good beginning in forest restoration, the greater part of the work remained to be done. Approximately 15,500,000 acres of land in Missouri should be in forest. Of this number only 3,500,000 acres were being satisfactorily managed for forest production. The remain-
ing 12,000,000 acres, constituting more than one-fourth of the total area of the state showed no satisfactory progress toward forest rejuvenation. This huge acreage is producing little of value. The report pointed out the economic benefits that would arise directly or indirectly from forest restoration in the State.

**Types of Farming in Missouri** (O. R. Johnson, Conrad H. Hammar, W. J. Roth).—Results of this study have been published in Missouri Agricultural Experiment Station Research Bulletin 284.

There are seven major types of farming areas in Missouri. These include: (1) Northern and Western Meat Production; (2) Ozark Meat Production; (3) Cash Grain, Truck, and Fruit; (4) Ozark Border Dairy and Wheat; (5) Ozark Plateau Dairy and Poultry; (6) Southwest Fruit, Dairy, and Poultry; and (7) Southeast Lowlands Cash Crops. Within these major types of farming districts there are innumerable smaller districts representing minor variations of the major combinations of farm enterprises.

The farming of Missouri is unusually diversified. There are few states that have within their borders parts of the corn and cotton belts together with important fruit, dairy, and cash grain producing areas.

**Missouri Farm Land as an Investment** (Conrad H. Hammar, E. S. Troelston).—Two field parties have obtained data from some twenty counties of the State. These data have been tabulated and much of it relates to the farm mortgage foreclosure problem. A detailed analysis was made of foreclosed farms in a dozen townships located in as many counties and representing a great variety of land and farming types.

The movements of land values since 1932 have been determined.

**Adjustments in Farming from the Standpoint of Production Planning and Soil Conservation** (O. R. Johnson, Homer L'Hote, Darryl Francis).—Detailed records on 75 farms in the South Missouri area and 67 farms in the North Missouri area have been summarized and the summaries returned to the cooperators. All records were continued on 63 farms in South Missouri and 61 farms in North Missouri. Field workers have made preliminary records and contacts on 60 additional farms in South Missouri and 62 additional farms in North Missouri. Efforts have been made to secure or retain those farms where only first class pasture farming practices were followed.

The work of tabulation and analysis of the first two years records has been started.

**The Legal Aspects of Farm Leases** (O. R. Johnson, John H. Dickerson).—A report on this project has been published in Missouri Agricultural Experiment Station Research Bulletin 270. The diverse nature of the types of farming practiced in Missouri indicated that special adaptations of leases were needed in different localities. The following possibilities for improvement were suggested:
(1) Written leases have many advantages.
(2) The principle of compensation for improvement should be studied.
(3) The principle of the landlord's compensating the tenant for disturbance when the tenant was required to move from the premises has several undesirable implications.
(4) The length of time prior to March 1 required for legal notice of termination of tenancy should be increased substantially.
(5) Present laws governing waste committed by tenants are stringent.
(6) Some arbitrative authority, more easily and cheaply available than court jurisdiction, should be established.
(7) Limitation of the landlord's lien for rent owed by the tenant would weaken the position of all landlords as parties to lease contracts.
(8) Minimum standards of housing and sanitary conditions should be recognized.
(9) Technical knowledge on tenure problems should be extended by extensive investigation.
(10) Regulation of private land use in order to protect public interest repeatedly has been sustained as a proper exercise of governmental power. Taxing speculative profits from short-term ownership would discourage frequent transfers of farms.
(11) Tax exemption for homesteads, except in special cases and on the basis of need, seemed inadvisable. The primary effect of tax exemption is to increase the value of the property. Tax exemption for one class means higher taxes or new taxes for others.

—An analysis of landlord-tenant relationships on 427 tenant-operated farms has been made. These farms were distributed throughout the state of Missouri, and were selected because they were tenant farms on which both tenant and landlord were well satisfied.

All tenants averaged 8.7 years on the same farm. Fifty-six per cent of the leases studied were crop share, forty per cent were stock share, and four per cent were cash. Seventy-seven per cent of the leases studied were written. Most leases were brief, complete, and written in simple language. Most cooperators believed that an annual lease, automatically renewed, terminated by notification six months prior to March 1, was best. The average size of all farms studied was 295 acres. Stock share leased farms contained 349 acres; crop share leased farms, 262 acres; and cash leased farms, 211 acres. According to the 1935 census, the average size of all Missouri rented farms was 119 acres.

Of the total tillable acres over 15 per cent was in legumes.

Over 95 per cent of the tenants reported that their farms were average or above average in fertility, compared with all farms in their respective communities.

For each 100 crop acres, there were 2.5 horses, 2.6 milk cows, 4 beef cows, 2 sows, 6 ewes, and 59 hens.
Thirty-three per cent of the tenants had descended the "Agricultural ladder".

Sixty-one per cent of the stockshare landlords, 50 per cent of the cash landlords, and 43 per cent of the crop-share landlords bought their farms at voluntary sale.

Of the stock share landlords fifty-six per cent was composed of either professional men or merchants.

Tenants and landlords were related in 8 per cent of the cases.

Seventy-nine per cent of the tenants and 85 per cent of the landlords kept records.

The average age of tenants was 44 years, while that of the landlords was 58 years.

In 89 per cent of the cases the tenants planned on owning a farm eventually.

There apparently was no one best type of lease. Each type of farming and each individual called for special consideration relative to type of lease. Factors other than lease provision, such as mutual good-will and careful selection of landlord and tenant, were conducive to satisfactory landlord-tenant relationships. Family relationship did not play an important part in making landlord-tenant relationships successful. The general acceptance of the annual lease by the cooperators was important.

Effects of Better Selection of Crop for Pastures on Missouri Farm Income (O. R. Johnson, George W. Collier).—A report on this project has been published as Missouri Agricultural Experiment Station Research Bulletin 282. This project is in cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture. The report shows that the acreage and yield per acre of corn in Northern Missouri have declined markedly since 1910. This was true even before the unfavorable seasons of 1934-'35-'36. Increased erosion promises a continued decrease in crop and livestock production. If systems of land use emphasizing the conservation of soil resources are not followed. On Grundy silt loam the rotated hay and pasture should consist of legumes rather than timothy. From a soil fertility standpoint, it was not important that there should be a decrease in the percentage of farm lands in grain. An increased application of limestone and phosphate to make possible the growth of red clover, sweet clover, and alfalfa was advisable. The use of Korean lespedeza sown in small grain should be encouraged.

On Putnam silt loam a much heavier lime application is necessary to make possible the growth of most legumes, and the use of Korean lespedeza, double cropped with small grain, should receive even greater emphasis than now is the case.

The use of winter barley following soybean hay provided a cover crop during the winter, increased the quantity of fall pasturage, and compared favorably in yield of grain with corn in many parts of Missouri. The size of many farms located on Lindley loam should be
increased greatly. Beef cattle and sheep probably should be the principal enterprises. Only on the small area of bottom land and on the broader ridges should any general farming be practiced.

On the small general farms on Summit silt loam, the farm organization should be intensified by the growing of higher yielding legumes and by increasing per acre yields of crops and milk production per cow.

On the Crawford gravelly loam, in Southwestern Missouri, the greater use of Korean lespedeza during the summer, and winter barley for pasturage during the fall, probably would increase milk production per cow, decrease the quantity of winter roughage required, and lessen the quantity of purchased concentrates.

On the dairy farms on Union silt loam, the double cropping of Korean lespedeza following small grain and of winter barley following soybeans for hay also was suggested. The increase in total pasturage available, a better seasonal distribution of grazing, and a slight increase in grain fed per cow, would make it possible to increase the number of cows, as well as the milk production per cow.

If some of these practices are not put into effect, crop and livestock production will decline still further; soil resources will be still further diminished by depletion and erosion; and future incomes will be reduced.

Farmers' Cooperative Organizations in Missouri (Herman M. Haag).—Missouri Agricultural Experiment Station Research Bulletin 389 is a report on this project. A statement of the farmers' cooperative marketing and purchasing situation in Missouri is given in this publication.

It includes the number of associations, volume of business, year of organization, and other pertinent data.

Additional work has been done dealing with the cost of operating exchanges and elevators. Cooperative associations in Missouri operated at an average of only 6 cents per dollar of sale in 1935. This is as low as any reported for cooperative associations in any state. A study also has been made showing the cost to the exchanges and elevators of extending credit to patrons.

Analysis of Commodity Prices (Herman M. Haag).—During the past year, the work on this project has been almost exclusively the revision of the Missouri Farm price index. It was found that the previously published Missouri Farm prices had been revised considerably so that it would be necessary to recalculate many of the figures necessary for the index. Revision of the index included substitution of a base period from July, 1924, through June, 1929, for the 1910-14 base previously used. Eleven additional commodities were included in the index. Also, a change in the weighting was used.
Farm Cost Accounting and Cost of Family Living on Farms (B. H. Frame).—A fairly complete study has been made on one hundred and two farms located in the Big Creek watershed in Harrison county, Missouri, and in Decatur and Ringold counties, Iowa. This study is in cooperation with Soil Conservation Service of the United States Department of Agriculture.

About one-third of the area lies in Iowa, and two-thirds in Missouri. The Big Creek watershed is predominantly a livestock farming region. Most of the livestock sold from the region was produced on the farm from which it was sold. Very few stockers or feeders were brought into the area. Financial returns on these farms varied widely, the 25 high farms earning $777.28, as compared to a loss of $702.16 on the 25 low farms. The 25 high farms had a few more crop acres and a slightly higher percentage of their total area in crop than the 25 low farms. The high farms had more livestock per acre than the low farms. Crop yields were higher on the high farms than on the low, having an average feed unit value of 25.0 per crop acre as compared to an average of 21.3 for the low group. Although the 25 high farms had more livestock per crop acre, they purchased less feed. This was not accounted for by higher crop yields. They either had better livestock or were better feeders. The high farms used man labor, power, and equipment more efficiently than the low farms. All these farms have improved soil erosion control, while maintaining their average financial incomes.

Utilization of Labor on Farms (B. H. Frame).—The per acre time required to perform specific field operations in certain Missouri counties and using specified types of equipment has been determined. The counties from which the records were secured were: Atchison, Bates, Carroll, Linn, Saline, and Vernon. There were a few records from Cass and St. Clair counties. In no case was a sample of less than five records used.

Table 1 shows the operation, the power unit, and the average acres per ten hour day per man and per horse.
TABLE 1.—UTILIZATION OF LABOR ON MISSOURI FARMS

<table>
<thead>
<tr>
<th>Farm Operation</th>
<th>Power Used</th>
<th>Average Acres Per 10 Hour Day Per Man</th>
<th>Per Horse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breaking Corn Stalks</td>
<td>2 horses</td>
<td>20.00</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>4 horses</td>
<td>25.00</td>
<td>6.25</td>
</tr>
<tr>
<td></td>
<td>4 horses</td>
<td>30.50</td>
<td>7.63</td>
</tr>
<tr>
<td></td>
<td>(2 men)</td>
<td>66.67</td>
<td></td>
</tr>
<tr>
<td>Raking and Burning Corn Stalks</td>
<td>2 horses</td>
<td>22.2</td>
<td>11.1</td>
</tr>
<tr>
<td>Cutting Corn Stalks with Stalk Cutter</td>
<td>2 horses</td>
<td>11.63</td>
<td>5.81</td>
</tr>
<tr>
<td></td>
<td>3 horses</td>
<td>18.18</td>
<td>6.06</td>
</tr>
<tr>
<td></td>
<td>4 horses</td>
<td>27.78</td>
<td>6.94</td>
</tr>
<tr>
<td></td>
<td>Tractor</td>
<td>55.82</td>
<td></td>
</tr>
<tr>
<td>Plowing land</td>
<td>2 horses</td>
<td>1.79</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>3 horses</td>
<td>2.87</td>
<td>0.96</td>
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<tr>
<td></td>
<td>4 horses</td>
<td>4.03</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td>5 horses</td>
<td>5.21</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>6 horses</td>
<td>6.47</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>10-20 tractor</td>
<td>8.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15-30 &quot;</td>
<td>10.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-30 &quot;</td>
<td>11.79</td>
<td></td>
</tr>
<tr>
<td>Harrowing land</td>
<td>2 horses</td>
<td>16.67</td>
<td>8.33</td>
</tr>
<tr>
<td></td>
<td>3 horses</td>
<td>17.84</td>
<td>5.75</td>
</tr>
<tr>
<td></td>
<td>4 horses</td>
<td>23.26</td>
<td>5.81</td>
</tr>
<tr>
<td></td>
<td>5 horses</td>
<td>28.57</td>
<td>5.71</td>
</tr>
<tr>
<td></td>
<td>10-20 tractor</td>
<td>32.26</td>
<td></td>
</tr>
<tr>
<td>Discing land</td>
<td>3 horses</td>
<td>12.99</td>
<td>4.33</td>
</tr>
<tr>
<td></td>
<td>4 horses</td>
<td>13.51</td>
<td>3.38</td>
</tr>
<tr>
<td></td>
<td>6 horses</td>
<td>20.41</td>
<td>3.40</td>
</tr>
<tr>
<td></td>
<td>6 horses</td>
<td>15.87</td>
<td>2.65</td>
</tr>
<tr>
<td></td>
<td>(Tandem Disc)</td>
<td>10.20</td>
<td></td>
</tr>
<tr>
<td>Sowing Small Grain</td>
<td>Broadcasting by hand</td>
<td>12.66</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 horses and 2 men,</td>
<td>17.86</td>
<td>17.86</td>
</tr>
<tr>
<td></td>
<td>end gate seeder</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 horses and 1 man,</td>
<td>40.00</td>
<td>20.00</td>
</tr>
<tr>
<td></td>
<td>end gate seeder</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 horses, drill</td>
<td>12.66</td>
<td>6.33</td>
</tr>
<tr>
<td></td>
<td>3 horses, drill</td>
<td>12.50</td>
<td>4.17</td>
</tr>
<tr>
<td></td>
<td>4 horses, drill</td>
<td>14.93</td>
<td>3.75</td>
</tr>
<tr>
<td></td>
<td>10-20 tractor drill</td>
<td>31.25</td>
<td></td>
</tr>
<tr>
<td>Planting corn, 2-row planter</td>
<td>2 horses</td>
<td>13.89</td>
<td>6.94</td>
</tr>
<tr>
<td>Planting soybeans, 2-row planter</td>
<td>2 horses</td>
<td>12.50</td>
<td>6.25</td>
</tr>
<tr>
<td>Go-Devilling Corn</td>
<td>2 horses</td>
<td>9.09</td>
<td>4.55</td>
</tr>
<tr>
<td></td>
<td>4 horses</td>
<td>14.29</td>
<td>3.57</td>
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<tr>
<td>Cultivating Corn</td>
<td>2 horses</td>
<td>7.09</td>
<td>3.55</td>
</tr>
<tr>
<td></td>
<td>3 horses</td>
<td>13.61</td>
<td>4.50</td>
</tr>
<tr>
<td></td>
<td>4 horses</td>
<td>12.66</td>
<td>3.16</td>
</tr>
<tr>
<td></td>
<td>10-20 tractor</td>
<td>19.23</td>
<td></td>
</tr>
<tr>
<td>Shocking Oats, 27.5 bu. per man</td>
<td></td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>Shocking Wheat, 13.2 bu. per man</td>
<td></td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>Husking Corn, 33.7 bu. per man</td>
<td></td>
<td>1.9</td>
<td></td>
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Investments in Crop Equipment (B. H. Frame).—An analysis of the crop equipment on 63 Nodawary county, Missouri, farms has been made. The value of crop equipment per crop acre decreased as the crop acre per farm increased. Table 2 shows the investment in crop equipment in Nodawary county in 1936, on eleven farms averaging 146.18 acres.
TABLE 2.—INVESTMENT IN CROP EQUIPMENT IN NODAWAY COUNTY, 1936  
11 FARMS: AVERAGE CROP ACRES: 146.18.

<table>
<thead>
<tr>
<th>Article of Equipment</th>
<th>Average No. Pieces Per Farm</th>
<th>Average Value Per Piece</th>
<th>Average Crop Acres Per Piece</th>
<th>Average Value Per Crop Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sets of Harness</td>
<td>2.41</td>
<td>$28.57</td>
<td>61</td>
<td>$0.47</td>
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<tr>
<td>Wagons</td>
<td>2.73</td>
<td>28.50</td>
<td>54</td>
<td>.53</td>
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<tr>
<td>Miscellaneous Small Tools</td>
<td></td>
<td>28.06</td>
<td>101</td>
<td>.28</td>
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<tr>
<td>Disk Harrows</td>
<td>1.45</td>
<td>13.20</td>
<td>161</td>
<td>.08</td>
</tr>
<tr>
<td>Spike Harrows</td>
<td>.91</td>
<td>45.54</td>
<td>124</td>
<td>.37</td>
</tr>
<tr>
<td>Mowers</td>
<td>1.18</td>
<td>14.05</td>
<td>73</td>
<td>.19</td>
</tr>
<tr>
<td>Cultivators, 1-row</td>
<td>2.00</td>
<td>24.75</td>
<td>200</td>
<td>.12</td>
</tr>
<tr>
<td>Corn planter</td>
<td>.73</td>
<td>26.82</td>
<td>146</td>
<td>.18</td>
</tr>
<tr>
<td>Hay Rakes</td>
<td>1.00</td>
<td>3.80</td>
<td>161</td>
<td>.02</td>
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<tr>
<td>Walking Plows</td>
<td>.91</td>
<td>43.55</td>
<td>178</td>
<td>.24</td>
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<td>Gang Plows</td>
<td>.82</td>
<td>76.60</td>
<td>200</td>
<td>.38</td>
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<tr>
<td>Grain Binders</td>
<td>.73</td>
<td>43.25</td>
<td>200</td>
<td>.21</td>
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<tr>
<td>Manure Spreaders</td>
<td>.73</td>
<td>13.78</td>
<td>178</td>
<td>.08</td>
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<td>Sulky Plows</td>
<td>.55</td>
<td>18.20</td>
<td>325</td>
<td>.06</td>
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<tr>
<td>Listers</td>
<td>.45</td>
<td>44.60</td>
<td>161</td>
<td>.28</td>
</tr>
<tr>
<td>Grain Drills</td>
<td>.91</td>
<td>35.00</td>
<td>325</td>
<td>.11</td>
</tr>
<tr>
<td>Cultivators, 2-rows</td>
<td>.46</td>
<td>13.86</td>
<td>228</td>
<td>.05</td>
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<td>End gate Seeders</td>
<td>.04</td>
<td>38.40</td>
<td>1827</td>
<td>.02</td>
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<td>Rollers</td>
<td>.08</td>
<td>39.25</td>
<td>406</td>
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<td>Corn Binders</td>
<td>.36</td>
<td>86.00</td>
<td>636</td>
<td>.13</td>
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<td>Hay Loaders</td>
<td>.23</td>
<td>21.53</td>
<td>541</td>
<td>.04</td>
</tr>
<tr>
<td>Go-Devils</td>
<td>.27</td>
<td>10.50</td>
<td>812</td>
<td>.01</td>
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<td>Hay Stackers</td>
<td>1.18</td>
<td>50.00</td>
<td>1624</td>
<td>.08</td>
</tr>
<tr>
<td>Trucks</td>
<td>.09</td>
<td>778.33</td>
<td>2924</td>
<td>.29</td>
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<td>Threshing Machines</td>
<td>.05</td>
<td>10.00</td>
<td>1624</td>
<td>.01</td>
</tr>
<tr>
<td>Alfalfa Cultivators</td>
<td>.09</td>
<td>50.00</td>
<td>2924</td>
<td>.02</td>
</tr>
</tbody>
</table>

All Crop Equipment          | 20.63                      | 41.03                   | 7.09                       | 5.79                        |

AGRICULTURAL ENGINEERING  
J. C. Wooley, Chairman

Poultry Housing Studies.—Poultry houses providing three different degrees of protection have been used in this experiment. The data on production, growth, and mortality indicated that two different environments were desirable for poultry. (1) A reasonably warm place without draft where the hens can roost, and (2) a place where fresh air and sunshine are plentiful. Air movement in the second environment need not be controlled under ordinary conditions. Feed, water, and scratching litter were supplied in this second environment.

Efficiency of Tillage Methods in Growing Corn (M. M. Jones, R. P. Beasley, Lloyd Hightower).—Two sets of experiments were conducted, one on a Putnam silt loam and the other on a Grundy silt loam. On Putnam silt loam the method of seed bed preparation that gave the largest yield was also the method that required the least work and consisted of (1) spring plowing, (2) bedding (ridging with disk hillers on the tractor cultivator) and (3) leveling and planting. The leveling and planting operation was delayed somewhat in order to permit weed seeds to sprout and then be killed before planting. The leveling was done with disk hillers and sweeps on the tractor cultivator, the planter being pulled behind the tractor at the same time and the whole
operation accomplished at once. The seedbed method which gave the lowest yield consisted of fall plowing, tandem disking, harrowing, and planting.

The soil was firmly packed by the winter and spring rains and by the middle of late spring was in much the same condition as ground which had not been plowed the preceding fall.

The use of a tractor cultivator equipped with eight-inch sweeps so spaced as to cut all the ground was compared to the tandem disk for working down the seed bed after plowing. The cultivator equipped with sweeps gave somewhat better results.

The various methods of cultivation used gave similar yields except in the plots receiving only two shovel cultivations. On these plots the yield was lower than on the others. The results of this year's cultivation trials indicated that the rotary hoe, spring-tooth weeder, or spike-tooth harrow could be used just as well as the regular shovel or sweep cultivator for the first cultivation.

Different methods of seed bed preparation and different amounts of cultivation on corn were tried on Grundy silt loam near Hamilton, Missouri. Double disking twice in the spring gave better yields than either spring plowing or fall plowing. The disking required considerably less work. The section of the field where listing was located was damaged severely by grasshoppers and could not be compared with the other methods of seed bed preparation. Also, a heavy rain just as the corn was coming up damaged the stand on the listed plot. Yields were not increased significantly by cultivating more than three times. It should be remembered that the weather affects the effectiveness of different methods of seed bed preparation and different cultivation methods.

**Fertilizer Placement Studies on Corn (M. M. Jones, R. P. Beasley, Lloyd Hightower).**—The 1937 fertilizer placement tests were inconsistent and the fertilizer did not produce the usual increase in yield. A rather dry period near the end of the growing season probably was responsible for these results. Tests were made with 4-12-4 fertilizer on Knox silt loam and Wabash silt loam at three different rates of application and at different depths. Twenty-seven days after planting the stalks on the fertilized plots were 5 to 10 inches higher than on the unfertilized plots, but there was no difference in the height of the corn planted caused by variations in the depth of the fertilizer. There was no significant difference in the yield of the plot planted with the different depths of fertilizer, nor were the yields from the fertilized plots significantly different from those of the unfertilized plots. When drilling and hilling fertilizer were compared, there were no significant differences in yield although the fertilized plots produced stalks of much greater height at the end of 37 days than did the unfertilized plots. The final yield showed little difference.
A Portable Sheep Dipping Tank (J. C. Wooley, M. M. Jones).—A portable sheep dipping tank has been designed and built to enable farmers to dip their sheep economically. Blue print plans, bills of materials, and directions for building the tank have been developed and made available. Dipping has been neglected because of the inconvenience and expense connected with this operation. It is believed that a single portable tank cooperatively owned and used by a group of farmers will reduce the trouble and inconvenience of dipping so that it will be more generally practiced. The portable tank is a standard galvanized sheet metal tank mounted on an old automobile chassis with the mountable chutes leading to and from the tank. A special trip platform facilitates lowering the sheep into the tank. The illustration shows the tank in operation.

Small Combines (M. M. Jones).—Cost data have been obtained on 51 small combine harvesters used in Central Missouri. Machines of 5, 6, and 8 foot cuts have been included in the study. A few gave mechanical difficulties, but the majority were satisfactory.

The average acreage harvested per machine was 238 acres. Of the 51 machines, 32 did some custom work. The cost per acre of harvesting small grain varied from 75 cents to about $1.60 and averaged $1.24. These costs included depreciation, interest, housing, repairs, overhead cost on the tractors pulling the machines, fuel, oil, and labor.

Erosion Control by Thin Section Overfall Structure (J. C. Wooley).—A thin-section overfall structure for controlling erosion has been developed. Forms are not necessary and this reduces the cost to
from one-fifth to one-eighth of that of the straight wall type. This type of structure has been used by large numbers of farmers throughout the State. About 50 structures have been built as demonstrations and the use of this type has spread from these. Structures with a notch 4 feet wide and 1½ feet deep with an overfall of 5 feet are being constructed with about $10 to $12 worth of materials. This project not only saves on cost of structures planned, but increases the utilization of overfall structures in Missouri.

**Contour Furrowing of Permanent Pastures (J. C. Wooley).—**Contour furrowing of permanent pastures has been done in some sections with the regular walking plow. This results in a heavy loss of sod and exposes a large amount of subsoil. Securing a stand of grass on these furrows is difficult. A furrowing machine has been designed and built that lifts two strips of sod and plows a furrow in the subsoil under them. The sod strips are then returned to cover the subsoil furrow. No sod is lost and the top productive soil is left on top. Furrows placed from 15 to 20 feet apart work well and such coverage costs about 40 cents an acre.

**ANIMAL HUSBANDRY**

**E. A. TROWBRIDGE, Chairman**

**Nutritional Requirements of Brood Sows (A. G. Hogan, E. G. Gahley).—**Investigators who have studied the nutritional requirements of brood sows have concluded that the concentrates commonly used in swine feeding were not adequate during the lactation stage. In order for the pigs to attain a satisfactory weaning weight, the sows should have access to forage.

Over a period of several years sows that received the basal rations produced pigs that were decidedly unthrifty. In the spring of 1936 the results were very surprising, the pigs being 35 per cent heavier than had been obtained before. A survey of the literature did not disclose a single instance of comparable weights under comparable conditions.

During the fall season of 1936, the sows did not do as well as they had the previous spring, but their pigs were superior in most respects to those of former years.

Again, in the spring of 1937, the pigs did well. Rations supplemented with small amounts of manganese sulfate were slightly superior to the basal ration, and rations containing corn of the 1936 crop excelled the ration containing corn of the 1935 crop.

In contrast to the excellent results of the spring season of 1937, the fall crop of pigs was practically a complete failure.

The composition of the rations was essentially the same. Evidence was secured that the factor causing the great number of fetal deaths had no effect upon the lactation period.
In the spring of 1938 it was decided to repeat the comparison of old and new corn and of the rations with and without manganese. The results thus far have not been decisive.

Studies on the rearing of orphan pigs have been continued. When the new born pigs were removed from their dams immediately after birth and received no colostrum, the mortality was very high. Therefore, it is believed that colostrum, or some acceptable substitute, is necessary if orphan pigs are to be reared.

**Beef Cattle Breeding** (E. A. Trowbridge, J. E. Comfort, M. W. Hazen).—This project is in cooperation with Sni-A-Bar farms and the United States Department of Agriculture. It has been designed to test the ability of purebred Shorthorn bulls to sire offspring of uniform type, capable of excellent feed utilization, and production of superior quality carcasses, and to perpetuate the heredity of these lines.

Seventy-five high grade Shorthorn cows and heifers of breeding age were divided into three groups. To each of the groups two purebred Shorthorn heifers were added. Three unrelated purebred Shorthorn bulls have been mated to each of the three groups of breeding females. The bulls were rotated among the herds annually, so that at the end of three years, each bull will have sired calves from each cow herd.

The first crop of calves arrived in the spring of 1938.

**Comparison of Systems of Grazing Bluegrass Pastures** (J. E. Comfort, J. M. Poehlman, M. W. Hazen).—This project is in cooperation with Sni-A-Bar Farms, the United States Department of Agriculture, and the departments of field crops and soils of the Missouri Experiment Station.

Three systems of grazing (continuous, rotation, and supplemented) have been compared at Sni-A-Bar Farms for six years. The method of grazing on the supplemented grazing pasture has been a combination of rotation and supplemented grazing for two years. The 25-acre bluegrass pasture was divided in three divisions and grazing in each division was rotated. In mid-summer the cattle were transferred to a field of Korean lespedeza and left on this field until September 1. They were returned then to the bluegrass pasture for the remainder of the season.

Eighty range-bred Shorthorn yearling steers averaging 465 pounds were used in 1937. On the twenty-fifth of April 21 steers were placed on the continuous pasture, 23 on the rotation pasture, and 26 on the supplemented pasture. Twenty-eight days later the number on the continuous and rotation pasture was increased to 25 head each, and on the supplemented pasture to 30. The 30 steers on the supplemented pasture were moved to 10 acres of Korean lespedeza on July 13 and continued grazing the lespedeza until September 7. All the cattle were taken from the experimental pastures on September 25 on account of a shortage of moisture in the early fall of 1937.
Steers on the supplemented grazing pasture gained 107.9 pounds per acre on the 35 acres of bluegrass and Korean lespedeza. The cattle on the continuous pasture gained 64.2 pounds per acre, and the steers on the rotation grazing pasture gained 71.8 pounds per acre (on 25 acres of bluegrass). The addition of 10 acres of lespedeza to the 25 acres of bluegrass increased the total live weight gain to 122 per cent over the average gains made on the continuous and rotation bluegrass pastures.

This increase was not entirely a result of gains made on lespedeza since the cattle on the supplemented pasture made 62 per cent greater gains on bluegrass than the cattle grazed under the other two systems.

**Beef Produced with Minimum Grain and Maximum Roughage.**—Two lots of yearling steers and two lots of 2-year-old steers were fed to determine the efficiency of various methods of producing beef with the minimum of grain and the maximum use of roughage. One lot of 2-year-olds and one lot of yearlings were fed half a grain ration with corn silage and alfalfa hay *ad libitum* for 140 days. The other lots were fed corn silage and alfalfa hay *ad libitum* for 160 days with a full feed of corn 10 parts and cottonseed meal 1 part during the last 76 days. The two-year-olds fed half grain ration throughout a 140 day period gained 1\(\frac{1}{2}\) pounds daily and the yearlings fed in the same manner gained 1\(\frac{3}{4}\) pounds daily. In each case these cattle made higher daily gains than the cattle fed roughage only for 84 days and then full fed grain for 76 days.

All four lots of cattle graded “good” on foot and in the carcass and dressed out about 57%. Physical analyses of ribs showed that the carcasses of the yearling steers fed half grain ration with roughage the entire period contained the smallest amount of fat. There was little difference in the other three lots. Maximum use of roughage on yearling steers occurred in the lot fed half a grain ration for the entire period, while with the 2-year-olds it occurred in the lot fed roughage alone 84 days and then full fed for 76 days.

The grain consumption was higher in the group fed roughage 84 days and then full fed. Palatability scores and cooking losses on cooked rib roasts from these cattle were about the same for all lots.

Both yearling and 2-year-old cattle had been put in such a condition that their carcasses would grade “medium” to “good” with the use of 15 to 25 bushels of corn, about 100 pounds of cottonseed cake, 2\(\frac{1}{4}\) tons silage, and \(\frac{1}{2}\) ton good legume hay.

**Barley for Fattening Cattle** (E. A. Trowbridge, H. C. Moffett).—Missouri Early Beardless barley fall sown was fed to fattening steers with satisfactory results. It was compared with shelled corn and fed as a part ration with shelled corn to fattening cattle: one trial in summer; and another in the winter.

“Good” to “choice” white-faced yearling steers were full fed in dry lot 140 days. One lot had shelled corn, another coarsely ground barley, and a third lot half shelled corn and half coarsely ground
barley. Cottonseed meal (41-43% protein) was fed 1 part to 10 parts of grain, and alfalfa hay was fed to each lot.

Average daily gains were 2.23 pounds for the cattle fed shelled corn; 2.35 pounds for those fed barley; and 2.44 pounds for those fed corn and barley.

To produce each 100 pounds of gain, 615 pounds of corn and cottonseed meal and 213 pounds of hay were required. The other two rations varied but little from this requirement.

The corn fed cattle brought $9.00 per hundred on the St. Louis Market, graded "low choice" on foot and in the carcass and dressed 60.6 per cent. The cattle fed corn and barley brought $8.50 per hundred, graded and dressed out the same as the corn fed steers. The cattle fed barley sold for $8.00 per hundred and graded and dressed just slightly below the other two lots.

For the winter feeding trials, corn silage was added to each of the rations which were otherwise the same as those fed in the summer. "Good" to "choice" native yearling steers, mostly white-faced, were fed 140 days.

The cattle getting barley gained 1.96 pounds daily, while the other two lots gained 1.9 pounds. The cattle getting barley ate 1 pound more grain and 3 pounds less silage than the corn fed cattle, while the cattle fed the mixture showed grain consumption between the other two lots. The cattle fed corn graded "high good" on foot and in the carcass, and the other lots were slightly less. All showed dressing percentages of about 60%.

The cattle were sold on the St. Louis market, the barley fed cattle bringing $7.85 per hundred and the other lots $8.00 per hundred.

No hogs followed the cattle fed in the summer but in the winter the pork produced behind the cattle was highest when corn was fed and lowest when barley was the grain ration.

Missouri Early beardless barley with a protein supplement and roughness has been used successfully as a substitute for, or supplement to, corn in fattening cattle.

Cross Breeding in Swine (L. A. Weaver.)—The crossbred (Duroc Jersey on Poland China and Poland China on Duroc Jersey) sows were back-crossed, three being mated to the Poland China boar and three to the Duroc Jersey boar. In addition, purebred Duroc Jersey and Poland China sows were double mated so that both purebred and crossbred pigs were produced. This made possible comparison of purebred, crossbred, and backcrossed pigs.

The purebred Durocs had an average birth weight of 2.5 pounds for an average of 11 pigs per sow and an average weaning weight (8 weeks) of 24.5 pounds, for an average of 5 pigs per sow. The purebred Polands had an average birth weight of 2.9 pounds for an average of 7 pigs per sow and a weaning weight of 19 pounds for an average of 4 pigs per sow. The average birth weight for the backcross (F, sow X PC boar) was 2.8 for an average of 11 pigs per
sow and the reciprocal cross was 2.6 for an average of 10 pigs per sow. The weaning weights were respectively 26 and 22 pounds for an average of 4 and 5 pigs per sow. The first cross pigs averaged 2.9 pounds at birth and 22 pounds at weaning.

The purebred Duroc pigs made the most rapid gains in the fattening pen. There was little difference among the other groups. The Durocs also produced their gains with slightly less feed than any group while the backcross pigs required the most feed per unit of gain.

These results differ from those of the previous year when crossbred pigs made the most rapid gains.

Forage Crops for Swine (L. A. Weaver).—Pigs having an initial weight of 43 pounds gained nine times as fast when fed corn and a simple mineral mixture on rape and oat pasture than did similar pigs fed corn and minerals in a dry lot. Twenty-five bushels of corn was used for each 100 pounds gain made by the pigs fed in dry lot, as compared with 6½ bushels used by those fed on pasture.

When a protein supplement of equal parts tankage and soybean oil meal was added to the corn plus mineral ration the pigs on pasture made slightly more rapid gains than those fed a similar ration in dry lot, weighing on the average 7 pounds more at the end of the 126-day feeding period. The pasture in this case saved 1½ bushels of corn, 18 pounds of tankage and 18 pounds of soybean oil meal in producing each 100 pounds of pork.

When a ration of corn, supplemented with a mixture of equal parts tankage and soybean oil meal plus minerals, was compared with corn alone plus minerals (both rations being fed on rape and oat pasture), pigs fed the former ration gained 20 per cent more rapidly and consumed 20 per cent less concentrate for each 100 pounds of pork produced. The pigs receiving the protein supplement reached a marketable weight 30 days prior to the others. In this experiment 35 pounds of protein supplement replaced 104 pounds of corn.

Rations for Pigs at Weaning Time (L. A. Weaver).—Pigs weighing 43 pounds at the beginning of the experiment made less than 20 pounds gain in 126 days and required more than 1450 pounds of feed for 100 pounds gain when fed all the shelled corn and a mineral mixture of equal parts ground limestone, bone meal, and salt they would eat. When either tankage; a mixture of equal parts tankage and soybean oil meal; or tankage, soybean oil meal, and alfalfa hay were added to the corn and mineral ration the gains were satisfactory and the amount of feed consumed per 100 pounds gain was relatively low, varying from 362 pounds to 380 pounds.

Improvement of Swine Through Breeding Methods (L. A. Weaver, Ralph Bogart).—The United States Department of Agriculture and several mid-western states are cooperating in developing meritorious strains of hogs through breeding methods. Moderate inbreeding with rigid selection is the system of breeding employed at this Station.
The foundation animals for three inbred lines have been obtained. Line I consists of sows bred by the College and a boar, Valley King, bred by Sunshine Valley Farm. These animals are large but are easy feeding hogs. Line II sows were secured from Welborn and Sons' herd and a boar was selected from the University of Minnesota herd. The sows in this line are thick and fatten early in life but the boar is moderately rangy. Line III sows and a boar were purchased from the herd of N. L. Farmer. They are of Messenger and Mischief Mixer breeding. These animals are of the larger type and have the reputation for farrowing and raising large litters of good pigs.

Farrowing records for the spring 1938 were satisfactory except that some of the sows in Line II failed to produce litters.

The 1933 Farrowing Record

<table>
<thead>
<tr>
<th>Line</th>
<th>No. Sows Farrowed</th>
<th>Pigs Farrowed</th>
<th>Average Birth Wt. of Pigs 3 Weeks</th>
<th>No. Pigs Alive 8 Weeks</th>
<th>Average Wt. Pigs 3 Weeks</th>
<th>No. Pigs Alive 8 Wks. Weaning</th>
<th>Weaning Weight of Pigs</th>
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<td>7.5</td>
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<td>2*</td>
<td>7.5</td>
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<td>7.0</td>
<td>11.9</td>
<td>7.0</td>
<td>38.5</td>
</tr>
<tr>
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<td>3</td>
<td>8.8</td>
<td>3.1</td>
<td>8.3</td>
<td>11.7</td>
<td>8.3</td>
<td>34.4</td>
</tr>
</tbody>
</table>

*Two sows failed to produce litters.

A special farm of 120 acres has been secured for handling these hogs. Considerable effort is being concentrated on getting this farm properly improved and fenced.

A three year rotation is being practiced in such a manner that hogs will be pastured on clean ground each year. This will permit the demonstration of sanitary swine practices for successful production of hogs.

Genetic Studies of Swine (Ralph Bogart).—Hair samples from Duroc Jersey hogs were examined microscopically in a study of shade of red. The shade of red was influenced by the amount and distribution of black pigment as well as the shade of the red pigment in the hair. Duroc Jersey and Hampshire hogs have been crossed in studying the belt character. Records have been kept on the markings in purebred Hampshire herds.

Chemical Test for Pregnancy in the Mare (D. T. Mayer, F. N. Andrews).—On account of the time and number of test animals required it is desirable to develop a more rapid test than the customary biological test for pregnancy in the mare. Several chemical tests have been tried, including the Cuboni and Kober tests. A modification of the Kober reaction has provided a test which has proved reliable, easy to perform and read. The modified Kober test gave excellent results but was less sensitive than the biological, and more sensitive than the Cuboni test.

A Method for Concentrating the Gonadotropic Hormone from Pregnant Mare Serum (D. T. Mayer, F. N. Andrews).—A simple method for the production from pregnant mare's serum of a product
completely soluble in water and very active biologically has been developed. The active fraction from 50cc. of pregnant mare’s serum, when dissolved in 50cc. of water, gave a very positive response in the rat with dosages as small as 0.025cc. One mg. of the active fraction was equivalent to 17 rat units.

**The Effects of Reduced Summer Temperature on the Breeding Capacity of Rams** (Fred F. McKenzie, D. W. Colvard).—Concentration of sperm in semen was lower from rams kept in quarters of normal summer temperatures (85-100°F.) than when kept in quarters of 80°F. or below. A larger percentage of abnormal sperm was produced by the rams kept at normal temperatures than by the rams kept at reduced temperatures. The volume of semen was not affected significantly by the temperatures.

When used for intensive breeding, rams maintained in quarters where the maximum temperature was 80°F. showed considerably more sexual drive.

**Intensive Sexual Activity of Rams** (Fred F. McKenzie, D. W. Colvard).—Intensive sexual activity of rams resulted in a sperm concentration decline, slight increase in percentage of abnormal sperm, and the volume of the semen followed an exponential decline.

**Artificial Insemination in Sheep** (Fred F. McKenzie, V. Berliner, D. W. Colvard, R. Steensma, E. Gahley, M. Heck, John Lasley).—Semen from three rams was used to inseminate artificially 46 ewes. Eliminating those ewes which did not become pregnant after natural breeding, the percentage of impregnations from each of the three rams were 83.3, 87.5, and 27.3. The sperm concentrations of the three rams used were, respectively, 1,897,000, 2,231,500, and 249,300 per cubic mm. The ram with the low sperm concentration was also the ram with the low percentage of ewes impregnated. All three ewes inseminated by the capsule method became pregnant.

**Artificial Insemination Equipment** (Fred F. McKenzie).—The laboratory now has satisfactory equipment for the collection of semen from the four classes of farm livestock: horses, cattle, sheep, and swine; and for artificial insemination.

**Preliminary Attempts in Storing Semen** (Fred F. McKenzie, D. T. Mayer, R. Steensma).—A search has been made for adequate means for evaluating semen quality. Motility of sperm, sperm morphology, semen volume and color, the pH and sperm concentration are aids in judging semen quality. An additional criterion is found with the use of the respirometer whereby the oxygen consumption of the semen sample is measured. It is believed that this new measuring method offers possibilities. It is a physiological technique. Refinement in respirometer construction must be developed.

Sodium chloride was found to be a favorable diluter for bull semen in concentrations of 0.9%; a mixture of sodium chloride 0.8% and inactivated sheep blood serum was satisfactory for ram semen. Strych-
nine solution reactivated certain samples of stored semen. The addition of gonadotropic hormone to semen prior to storage improved the quality of the product. A diluter should be added to semen slowly rather than rapidly, and not semen added to the diluter.

**The Ovaries of Ewes (V. Warbritton).—**The mechanisms of ovulation; the nature of the anestrual ovary; the nature of maturation in oocytes; the activity of the germinal epithelium; ovarian changes correlated with estrus; and the nature of atresia and cyst formation have been studied in 125 ovaries from about 70 ewes.

Some of the mechanisms involved in ovulation have been described. Observation on the anestrual ovary has shown that it varied with individual animals, and that these variations probably were responsible for the difficulties experienced in attempts to induce estrus and ovulation during the anestrual season.

Maturation in follicles has been observed and described as well as changes in the germinal epithelium. Ovarian changes during estrus that were correlated with estrus have been noted. Atresia and cyst formation were studied.

**Spermatogenesis in the Ram (V. Warbritton).—**Spermatogenesis has been studied in the testes of 14 rams, (see Fig. 4). The essential features of spermatogenesis occurred in the ram as they have been described in most other species in text accounts. During spermatogenesis, the nucleus flattened more than it did in most species and the acrosome became smaller than in most other species.
Chromosome Counts in Cattle, Swine, and Sheep (V. Warbritton).—Chromosome counts have been made on smear preparations of spermatocytes of a bull, two boars, and a ram. The haploid number was $23 + 1$ and counts of diploid chromosomes or superimposed anaphases have shown 46 as a probable diploid number. The chromosomes were relatively small in all the species. No dimorphic pair has been observed. "Lampbrush" chromosomes numbered 23 in an oocyte from a ewe.

Sperm Morphology in the Ram (V. Warbritton).—Normal spermatozoa varied in several ways, and many defective types occurred. (See Fig. 5) Some of the abnormalities found were described by

the following terms: pinheads, tapering, pyriform, damaged, enlarged, beaded, tailless, broken tail, coiled tail, filiform, fixed tails, spermatids, cytoplasm retained, vesicular nucleus, and large acrosome. There was a marked tendency for the tails of the sperm to be lost in the female tract.
BULLETIN 438—ANNUAL REPORT

BOTANY
C. M. TUCKER, Chairman

Apple Scab Investigation (M. A. Smith).—In cooperation with the Bureau of Plant Industry, United States Department of Agriculture.

Observations on the epidemiology of apple scab fungus *Venturia inaequalis* have been made. The fungicidal efficiency of various soluble and insoluble coppers have been tested. Liquid lime sulphur at one gallon to 50 of water was used as the standard spray. In addition, a spray composed of liquid lime sulphur ¾ gallon to 50 gallons and a wettable sulphur 2 pounds to 50 gallons were used.

The more soluble coppers with the exception of bordeaux mixture produced much more spray injury in the form of fruit russet on Ben Davis than did the more insoluble forms of copper. Satisfactory control of apple scab was obtained with liquid lime sulphur 1 to 50 and with the combination spray-liquid lime sulphur and wettable sulphur listed above. Copper phosphate mixture and copper oxychloride gave satisfactory scab control, but the copper oxychloride resulted in considerable spray injury.

Apple Blotch Investigations (M. A. Smith).—This project is in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture.

The apple varieties Duchess and Colton were used to compare the efficiency of copper phosphate mixture and copper oxychloride with bordeaux mixture in the control of the apple blotch fungus *Phyllosticta solitaria*. Two spray applications were made—June 1 and June 15.

Copper phosphate mixture and copper oxychloride gave satisfactory control of blotch on the Duchess variety. Bordeaux mixture and copper phosphate mixture gave superior fungicidal action to copper oxychloride in the control of the disease on the Colton variety. No spray injury resulted from the use of any of the materials.

Seed Treatment of Barley (C. M. Tucker, J. E. Livingston).—The effects of seed treatment with Ceresan on smut control and yields have been studied, using farm-grown seed samples obtained from various sections of the State. Plantings have been made at Sikeston, Grain Valley, Elsberry, and Columbia at various dates. The plantings at Columbia were badly damaged by army worms and yield data were secured from only one planting. Differences between varieties were not significant and probably were due to location and variation in soil fertility, moisture conditions, or other factors. The only significant difference between treated and untreated plots occurred in the variety Missouri Early Beardless planted at Columbia, where treatment caused an increase in yield of 1.2 bu. per acre. The consistent increases due to treatment noted in previous years did not appear in the 1937 crop.

There was a trace of brown loose smut in all varieties, both treated and untreated. Black loose smut was rare in 1937 in these plots.
Covered smut was present in traces in the untreated plots, but did not appear in treated plots.

Rhynchosporium leaf spot appeared at Columbia in November on plantings made September 22. In May, 1937, plantings of September 22 and October 14 were attacked more severely than those of September 7. Missouri Early Beardless and Tennessee No. 5 were about equally susceptible. The Kentucky varieties were more resistant.

**The Inheritance of Resistance to Ustilago Nuda in Barley** (C. M. Tucker, J. E. Livingston).—An effort is being made to develop a variety of winter barley with high resistance to *Ustilago nuda*. Missouri Early Beardless, Trebi, Pannier, and No. 506 have been used as parents, along with the species *Hordeum deficiens* and *H. Intermedium*. Preliminary results indicated that resistance was dominant. Since inoculation was successful in only 75 to 80 per cent of susceptible varieties it has proved difficult to determine the F<sub>2</sub> segregation ratio definitely. A study of the behavior of F<sub>3</sub> progenies is now in progress. In one instance a single factor appeared to govern resistance.

A study of vernalization of barley varieties has been undertaken to facilitate the breeding work. Varieties varied widely in the exposure required to permit heading without the development of a rosette; Missouri Early Beardless usually headed after an exposure of 15 days, while Purdue 21 required an exposure of 36 days. Vernalization for 14 days of seeds from crosses between Trebi and Missouri Early Beardless permitted the identification of winter and spring type plants. The winter plants were distinguished by a larger number of tillers and a slight clustering of leaves at the base, indicating a tendency toward the rosette stage. The winter type plants headed a few days later than the spring type.

The character for winter hardiness of barley varieties and their vernalization period requirements were not interrelated. Missouri Early Beardless requiring 15 days exposure showed a field survival percentage of 39.34; three varieties which required exposures of at least 30 days had the following survival percentages: Esaw-15.43; Nakano Wase Selection 33-5.48; Nakano Wase Selection 68-23.44.

**Fusarium Wilt of Tomato** (C. M. Tucker, G. W. Bohn).—A strain of *Lycopersicon pimpinellifolium* possessing a very high resistance to infection by *Fusarium lycopersici* has been used to incorporate the character into a tomato variety of commercial value. Previous work indicated that the character was governed by a single, dominant factor. Further pollinations have resulted in securing various back-crosses and out-crosses which have been tested for wilt resistance in the greenhouse. The progenies of 9 second back-crosses to commercial varieties involving 43 to 253 plants of each, showed a segregation of resistant and susceptible plants which approached closely a 1:1 ratio. Under the same conditions the resistant parent remained free from infection, while Louisiana Pink, Bonny Best, and Ponderosa were infected to the extent of 97 to 100 per cent.
Field experiments in 1937 were complicated by swarms of blister beetles and other factors which caused the loss of many plants before data on resistance were secured.

The plants were grown in the greenhouse in inoculated soil; the roots were dipped in a suspension of spores and mycelium of the fungus at transplanting; and planted in a field heavily infected from previous crops. Some of the more susceptible varieties were grown on steamed, non-inoculated soil until transplanting, when they were inoculated and transplanted as checks.

In general, Bonny Best, Louisiana Pink, and Break O'Day showed little resistance. A few plants of the resistant L. pimpinellifolium showed brown streaks in the vascular tissue from which Fusarium was isolated; the plants exhibited no symptoms of wilt in general appearance. The strain of John Baer selected at Michigan State College was more resistant than Break O'Day or Louisiana Pink. A collection received as L. Humboldtii appeared identical with L. pimpinellifolium but had little resistance.

A few F₁ hybrids of L. pimpinellifolium with various commercial varieties showed browning of the vascular tissues, but none exhibited external signs of infection. In previous years F₁ hybrids remained free from infection.

The F₁ hybrids back-crossed to Bonny Best yielded progenies which segregated approximately in the expected 1:1 ratio.

The F₁ hybrids selfed yielded progenies which segregated near the expected 3:1 ratio with an excess of resistant plants.

Three progenies resulting from open pollination of the plants of the backcross of F₁ hybrids to the resistant parent were of special interest. They showed wilt symptoms in the field in 1936. Since they were back-crosses to the resistant parent, they should have been either heterozygous or homozygous for the dominant factor for resistance. However, they became infected and were classified as homozygous susceptible. In 1937 their progenies segregated, indicating that they were actually heterozygous; this suggests the possibility that the factor for resistance may not be completely dominant.

The F₂ progenies were variable in their resistance.

The progenies from open pollination of the out-cross of the F₁ hybrid between Earliana and L. pimpinellifolium to Break O'Day, varied considerably in their reaction to Fusarium. Many of them yielded very few wilted plants. The reverse cross left to open pollination yielded progenies segregating rather close to the expected 3:1 ratio.

Progenies of the second back-crosses and out-crosses segregated fairly close to the expected 1:1 ratio.

Genus Pythium (C. M. Tucker, John T. Middleton).—A disease of fibrous-rooted Begonia plants occurring in California and Missouri affects roots, crowns, stems and basal leaves. *Pythium ultimum* was obtained from infected tissue in both states; the Missouri material
yielded *P. de Baryanum* and *P. Splendens*, also. All 3 species were capable of causing the disease.

A soft rot of Zucchini and Mammoth Summer Crookneck pumpkins and watermelons was studied in cooperation with the California Station. Diseased fruits had slightly sunken, soft, water-soaked spots of irregular size and shape. Infections occurred most frequently at the stem or blossom end. The causal fungus was identified as *P. ultimum*.

A study of the isolates revealed that certain of them failed to produce oospores in culture, but otherwise were indistinguishable from normal cultures. All isolates exhibited identical temperature—growth relations: optimum 25-28° C., maximum 40° C. All caused damping-off of pumpkin, watermelon, and tomato seedlings during the pre-emergence and small seedling stages of growth. Older plants were resistant.

**Genus Phytophthora** (C. M. Tucker).—In cooperation with the California Station a paper has been published on the root rot of China aster, annual stock and Transvaal daisy caused by *Phytophthora cryptogea*.

In cooperation with the United States Department of Agriculture, studies have been made on a rot of Winter Queen watermelon caused by *Phytophthora capsici*. In cooperation with the New Jersey Station a disease of rhododendron caused by a new species of the genus is being studied.

**Effects of Seed Treatment on Oat Yields** (C. M. Tucker, J. E. Livingston).—Various seed treatments were made on Columbia oats on April 13, 1937. The oats were planted on April 22, and harvested July 6.

Rod row plantings were made at the rates of 6 to 10 pecks per acre.

Soaking the seed in a formaldehyde solution caused a significant reduction in yield although the germination test did not reveal seed injury.

The formaldehyde spray treatment did not affect the yield significantly.

Ceresan treatment caused a marked increase in yield over that of the dry check plots.

When the plants were 22 days old, the Ceresan and check plots showed a better stand of plants, somewhat darker green in color and larger in size than those of the other plots.

Plot differences due to seed treatment could be observed from the time the plants were 2 inches high.
Precursors of the Constituents of Milk (C. W. Turner, W. R. Graham, Jr., E. P. Reineke, V. E. Peterson).—The mammary gland as a unit is dependent upon the blood stream for the transport of the nutrients required in the production of milk and the maintenance of glandular tissue. Milk precursors are taken up from the blood in its passage through the active mammary gland, and waste products are removed by the venous blood. By chemical transformation, as yet poorly understood, the constituents removed from the blood are converted into milk.

Accurate information as to the changes taking place in the constituents of the blood in its passage through the lactating mammary gland should be of fundamental value in determining more efficient methods of feeding for the production of milk and butterfat. Identification of the major precursors of milk should permit quantitative studies on the specific effect of the lactation stimulating hormones. This would be of prime importance in the breeding of more profitable dairy cattle.

Studies on the nutrition of the mammary gland by means of comparisons of the level of constituents of arterial and mammary venous blood together with measurements of the volume of blood flow through the gland has been continued. Particular attention has been given to the carbohydrate balance of the lactating mammary gland, the energy cost of milk secretion, studies on fat secretion, and the precursors of milk protein.

Precursors of Lactose (C. W. Turner, W. R. Graham, Jr., E. P. Reineke, V. E. Peterson).—For many years it has been assumed that the glucose of the blood was the sole precursor of milk sugar. Experiments to obtain the carbohydrate balance of the mammary gland showed that the glucose taken up would account for only about 50 per cent of the lactose secreted. Further experiments showed that in addition to the uptake of glucose, the mammary gland removed from 10 to 30 mg. of lactic acid per 100cc. of blood passing through it. The level of urea in mammary venous blood was higher than that in arterial blood, indicating that certain of the amino acids may be deaminized, their residues remaining as possible precursors of lactose. By calculating the uptake of glucose and lactic acid and amino acids as precursors of lactose it was possible to strike a carbohydrate balance for the lactating mammary gland.

The respiratory quotient of the mammary gland was usually above 1.0, indicating that fat was being formed from carbohydrate.

The Precursors of Milk Protein (C. W. Turner, W. R. Graham, Jr., E. P. Reineke, V. E. Peterson).—The absorption of amino acids by the lactating mammary gland was sufficient to account for not more
than 40 per cent of the milk nitrogen, even though all the amino acids were utilized for protein synthesis. The amount of urea nitrogen formed often exceeded the uptake of amino acid nitrogen. Thus, contrary to the previously accepted belief, the free amino acids of the blood cannot enter into milk protein synthesis to any considerable extent. This has directed attention to the plasma proteins as possible precursors of milk protein.

Arterio-venous measurements of total globulins and albumen show considerable shifting in the albumen-globulin ratios of the proteins due to changes brought about in their passage through the mammary gland. Early work suggested the breakdown of certain blood globulins with the return of portions not needed for milk protein synthesis in the albumen fraction of the venous blood.

A method has been developed for further partitioning the plasma globulins of goat blood into euglobulin, pseudoglobulin I and pseudoglobulin II. Solubility curves showed evidence of the partial separation of additional globulin fractions. Measurements showed considerable shifting of portions of globulin from one fraction to another, but the uptake of globulin was not confined to any specific fraction.

During early lactations there was a consistent uptake of fibrinogen by the mammary gland. After the seventieth day of lactation, fibrinogen in excess was returned rather consistently to the venous blood. There was an uptake of non-protein nitrogen by the mammary gland in excess of that which may be accounted for by either the amino acid or urea nitrogen. This suggests that unidentified portions of this fraction may be concerned in milk protein synthesis.

The Energy Cost of Milk Secretion (C. W. Turner, W. R. Graham, Jr., E. P. Reineke, V. E. Peterson).—If the volume of blood flow through the mammary gland were known it should be possible to ascertain the efficiency of the mammary gland as a separate unit, by determining the level of oxygen, carbon dioxide, and urea in arterial and mammary venous blood. These constituents were determined in a series of 27 experiments, and the gross efficiency was calculated according to the formula:

\[
Ef = \frac{\text{EM} \times (\text{CO}_2 - \text{O}_2) + 5.01 \text{O}_2 + \text{EM}}{K \times (1.09 \times 100 + 5.01 \times \text{O}_2 + \text{EM})} \quad \times 100
\]

Where

\[
\begin{align*}
\text{Ef} &= \text{Gross efficiency in per cent} \\
\text{EM} &= \text{milk energy per cubic centimeter} \\
K &= \text{ratio of blood flow to milk yield} + 100 \\
\text{CO}_2 &= \text{carbon dioxide in volumes per cent} \\
\text{O}_2 &= \text{oxygen in volumes per cent}
\end{align*}
\]

As determined by this technique, the gross efficiency of the mammary gland in the production of milk was slightly more than 90 per cent. This included the maintenance of the mammary gland tissue in addition to the cost of milk production itself. The cost of milk synthesis was slightly less than 10 per cent of the total energy transfer.
Artificial Breeding of Dairy Cows (A. C. Ragsdale, H. A. Herman).—Artificial insemination has been practiced in the Station dairy herd since July, 1937. This method has been found to be equal to and in some cases more effective than natural service. Artificial insemination has proved especially valuable in the use of one bull in the Station Herd. This bull had suffered a hip dislocation and could not be used by other methods. The fertility of each sire in the Station Herd is being studied with reference to sperm concentration, motility, pH, and general morphology. It is hoped that it will be possible to index bulls on the basis of fertility as indicated by the characteristics of the spermatozoa.

Good Dairy Sires in Missouri Herds (H. A. Herman, M. J. Regan).—Through the cooperation of the Agricultural Extension Service pedigrees and production records have been assembled on dairy sires in use throughout the state. Over 100 sires have been checked and recorded. Superior sires have been detected and their service is being utilized better by having such information available.

Breeding Studies in the Station Herd (A. C. Ragsdale, H. A. Herman).—Complete records on the Station Herd are available since its establishment in 1887. A line breeding project of a long-time nature has been developed in an effort to produce useful, long-lived, high producing animals of desirable type.

Most of the sires used in the Holstein herd have been of Ormsby blood lines. Brood cows of outstanding merit are being used to perpetuate the herd. Attention has been given to the development of cows of greater size and stronger attached udders than were found on many of the older animals in the herd.

The Jersey herd descended largely from cows of St. Lambert breeding. An effort has been made to develop cattle above average in production and size.

Proved sires have been used as much as possible in this work.

The Development of a High Production Strain of Jersey Cattle (A. C. Ragsdale, C. W. McIntyre).—This project is in cooperation with the Bureau of Dairy Industry, United States Department of Agriculture.

The use of proved sires, selection, production testing of all females, and the proving of bulls dropped in the herd through use in the herds of dairy farmers under lease agreements, have been continued. Eighteen bulls bred in the herd were in service under such agreements at the end of the year. The Jersey herd averaged 6,926 pounds of milk containing 378 pounds fat for 22 cows in milk.

Crop Records on the Hatch Farm (A. C. Ragsdale, C. W. McIntyre).—Alfalfa, seeded in August, 1935, on virgin sod, was cut three times in 1937 with yields of 2.14, 1.96, and 1.36 tons per acre respectively. The total costs of harvesting and storing, including all man and team labor were $1.60 per ton of hay. Hay of like quality could be
purchased at a cost of $14.00 per ton. Valuing the hay at this price a return for the crop for the preceding year was $23.98 per acre making a total of $91.58 for the two years. The total seeding cost was $30.55 per acre, resulting in a return of $61.03 per acre for the use of the land from July 1, 1935, to January 1, 1938.

The alfalfa seeded in September, 1936, yielded hay of varying quality and some volunteer barley which was used for ensilage. The return over all harvesting costs for this field was $42.81 per acre, leaving $18.55 for the use of the land from July 1, 1936, to January 1, 1938.

The alfalfa and timothy seeded in August, 1937, cost $26.95 per acre for all man, tractor, and team labor, and seed, lime, and fertilizer. There have been no returns from this field to date.

Twenty-two acres of blue-grass pasture, 10 acres of which were limed and seeded with alfalfa in 1936, produced 0.8 ton of hay and 478 cow days of pasture which replaced 8.44 tons of alfalfa hay and 9.56 tons of corn silage. The gross return from this field was $7.82 per acre. There was a like return of $5.23 per acre from the wooded pasture and $19.24 per acre from the third pasture.

Rye purchased in the field at $1.75 per ton along with volunteer barley from one alfalfa field was put into the silo. These crops were cut with a mowing machine, partially cured, and raked. The cost of mowing, raking, and hauling was $2.44 per ton for the rye with a five-mile haul and $1.20 for the barley with a quarter-mile haul. The cutting and filling cost was $1.37 and $0.98 per ton respectively. Total cost for rye in the silo was $3.81 per ton exclusive of the purchase cost and $2.19 per ton for the barley. No molasses or other preservatives were used. A fairly satisfactory silage resulted. Corn which produced 10 tons of silage per acre was purchased at $2.75 per ton in the field. The cost of cutting was 20.5 cents, loading 26.4 cents, hauling two miles with trucks 53 cents and putting in the silo 43.3 cents per ton; making a total cost, including purchase of the corn, $4.18 per ton.

The Influence of Certain Rations and Management Practices on the Rate of Growth and Milk Production of Dairy Heifers (A. C. Ragsdale, H. A. Herman, R. G. McCarty).—Three groups of Holstein heifers have been grown on different planes of nutrition, and on complex and simple rations. The rate of growth has been measured by the increase in weight and body dimensions.

One group was reared on wholeskimilk, skim milk, and chopped alfalfa hay. These heifers nursed their dams for three days, were changed to bucket feeding on the fourth day, and thereafter received mixed herd milk containing 3.8 per cent fat until three weeks of age when fresh skim milk was substituted gradually. Skimmilk was fed at the rate of one pound daily for each 10 pounds of live weight with a maximum of 20 pounds of skim milk. Alfalfa hay feeding began at two weeks of age or as soon thereafter as the calves would eat it. It was supplied ad libitum. Heifers in this group averaged 17.3 per
cent below normal in weight and 4.1 per cent below normal in height at withers at six months of age. At 12 months of age the corresponding percentages below normal were 22.1 and 5.0 per cent; at 18 months, 11.8 and 3.27 per cent; and at 24 months, 13.8 and 3.8 per cent respectively. They were thrifty in appearance and possessed good appetites. The heifers were bred at the usual age and freshened at 28 1/2 months of age. During the first lactation they averaged 338 days, with a production of 6710.5 pounds of milk and 261.19 pounds of butterfat per cow. This is about 70 per cent as much milk and fat per cow as was produced by a check group of 2 year old heifers of similar breeding, grown normally in the Station herd.

A second group of three Holstein heifers was fed and managed in the usual manner the first few weeks of age, but with increasing age the roughage and grain were supplied ad libitum in the form of a special ration containing 35 per cent finely chopped alfalfa hay and 65 per cent concentrates of growth promoting nature. It was termed the “super growth ration.” In addition to this special ration, whole-milk was fed at the rate of 10 to 20 pounds daily until freshening time.

A third group of three heifers was fed and managed the same as group 2 except the solid portion of their diet consisted of 90 per cent super ration and 10 per cent dehydrated green grass (oats cut at joint stage).

There were no significant differences in the rate of growth of the heifers in these two groups. Both groups at six months of age averaged 21.8 per cent above normal weight and 6.2 per cent above normal height at withers. At nine months of age, corresponding percentages were: weight, 29.7 per cent; height at withers, 4.7 per cent. At eighteen months of age the average weight was 30.6 per cent and the average height at withers 5.3 per cent above normal.

The digestible nutrient requirements for a pound of gain for the different groups were as follows: normal, 4.05 pounds; alfalfa-roughage, 5.00 pounds; “rapid growth,” 3.34 pounds. Thus the “rapid growth” groups showed the greatest efficiency in the use of nutrients.

The heifers have all been bred and are reproducing normally. The heifers fed only roughage were first observed in heat at 15 to 18 months of age. The “rapid growth” group showed evidence of estrus at 9 to 10 months.

Growth, Blood Picture, and Related Physiological Phenomena in Calves Fed Chiefly on Milk Diets (H. A. Herman, R. G. McCarty).—Two calves have been fed on a diet of milk only, except that 10 per cent of the total dry matter of the ration was supplied by dehydrated grass (oats cut at the joint stage). It was thought that the minerals, vitamins, and the added protein factors introduced by the grass would supplement the milk very much in the same manner as fresh green grass supplements milk in the case of calves nursed and fed under natural conditions. This did not prove to be the case. Both calves made
above normal growth to six months of age. However, one of the calves died at less than one year of age, showing hemorrhages, but not nearly as many lesions as the calves heretofore raised on milk and mineralized milk. The second calf is declining in growth and apparently will not survive.

Factors Affecting the Solids-not-fat Content of Milk (A. C. Ragsdale, H. A. Herman).—Since some laws and ordinances require certain percentages of solids-not-fat content of milk, and since many factors such as breed, stage of lactation, age, physical condition, and feed of the cow, as well as temperature and season of the year affect the solids-not-fat and the fat content of the milk, many controversies arise between producers, distributors, dairy manufacturing plants, and law enforcement agencies.

The milk from a group of 25 cows has been sampled every fourteen days and analyzed for total nitrogen, lactose, and chlorides. The solids-not-fat was determined by the drying method and also from the specific gravity by empirical methods.

The mixed herd milk varied from 8.2 to 9.04 per cent throughout the year, with the months of July, August, and September lowest and November, December and January highest. During the summer months nearly half the Holstein samples and about 10 per cent of the Jersey samples were below the legal standards.

Turning the cows on fresh succulent pasture has resulted in an increase in the solids-not-fat content of the milk. A cow at the height of milk production universally produced milk of lowered solids-not-fat content.

The physiological explanation for variation in the solids-not-fat content of milk is somewhat obscure, however, the data indicates that the isotonicity of the milk is maintained by an increase in chlorides at the expense of the lactose and that the production of low solids milk is comparable to the secretion occurring under disturbed physiological conditions, such as freshening, irregular milking and drying off.

The Effect of Thyroxine on Milk Production (C. W. Turner, H. A. Herman, W. R. Graham, Jr.).—A study has been made of the effects of thyroxine injected subcutaneously, and desiccated thyroid administered orally, on the milk and butterfat yield of cows in various stages of lactation.

Desiccated thyroid, fed at the rate of 2 ounces daily throughout an eight weeks period was observed to bring about an average increase in milk yield of 18.2 per cent. The butterfat yield for the same period was raised 35 per cent above the base level. Cows at the peak of production and those nearing the end of the lactation period, failed to increase in milk yield when desiccated thyroid was fed. There was, however, a slight increase in fat yield, probably as a result of metabolic disturbances.

The injection of thyroxine, in alkaline solution, at the rate of 5 mg. daily for three weeks was observed to bring about an increase of
11 per cent in milk and 22 per cent in butterfat yield where the cows were in the declining phase of lactation. Increasing the daily dosage of cows in the last half of lactation to 10 mg. of thyroxine for two weeks resulted in an average increase of 23 per cent in milk production and 37 per cent in butterfat yield.

The injection of thyroxine in cows at the peak of production resulted in a diminution of both milk and fat yield. Period of lactation, as well as the individuality of the cow, seemed to be an important factor in affecting the results of thyroid substance on milk secretion.

The solids-not-fat content of the milk produced by cows undergoing both types of thyroxine administration was increased slightly. There was a general lowering of the daily solids-not-fat output when treatment was discontinued.

Thyroxine, injected subcutaneously, was more effective from the standpoint of dosage required. The lowered efficiency of desiccated thyroid may be explained by the possibility: (a) that the thyroid substance is partially inactivated in the rumen, reticulum, and omasum before it reaches the abomasum of the bovine; (b) the activity of desiccated thyroid may not be proportional to its iodine content, but only to a fraction of the iodine which accounts for most of the calorigenic effect.

The Carbohydrate Metabolism Hormone (C. W. Turner, A. J. Bergman).—In addition to the hormones of the pituitary which influence the growth and secretion of the mammary gland, there are

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ASSAY OF THE CARBOHYDRATE METABOLISM HORMONE

**STIMULATES CARBOHYDRATE METABOLISM OF BODY**

THE GUINEA PIG IS VERY SENSITIVE TO THIS HORMONE

ASSAY ANIMAL

WELL NOURISHED MALE

GUINEA PIG WEIGHING 180-220 GMS. ARE USED.

ONE ITRAPERITONEAL INJECTION, ANIMAL SACRIFICED AFTER 8 HOURS AND THE BLOOD SUGAR DETERMINED, BY THE SHAFFER-SOMOGYI METHOD.

GUINEA PIG UNIT—THE MINIMUM AMOUNT OF EXTRACT WHICH WILL CAUSE AFTER 8 HOURS AN INCREASE OF 50% (TO ABOUT 165 MG. PER CENT) IN THE BLOOD SUGAR OF FIVE OR MORE ANIMALS.

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Fig. 6.—Assay of carbohydrate metabolism hormone.

other hormones which may influence the rate of milk secretion through their action on the precursors of milk in the blood. One of these factors influences the amount of sugar in the blood. A method of assay of this factor has been studied. The injection of a pituitary preparation caused a rise in the blood sugar of the normal male
guinea pig. The tentative guinea pig unit of the hormone was described as follows: the minimum amount of extract injected intraperitoneally into well nourished male guinea pigs weighing from 180 to 220 gm., which caused after 8 hours an average increase of 50 per cent in the blood sugar of five or more animals.

Certain investigators have claimed that the lactogenic hormone caused a rise in the blood sugar. The purest lactogenic extracts developed at this station contained very little carbohydrate metabolism hormone, and the carbohydrate factor contains very little lactogenic hormone. This apparently shows that the lactogenic hormone was not directly concerned with changes in blood sugar.

The Composition of Rabbit Milk Stimulated by the Lactogenic Hormone (C. W. Turner, A. J. Bergman).—A comparison was made between the composition of milk secreted by rabbits after parturition with the milk experimentally initiated in pseudopregnant rabbits by the lactogenic hormone. The lactose and total solids were similar; the fat, however, was higher and the ash content lower in the “experimental” milk. Apparently the milk stimulated by the hormone was essentially similar to normal milk.

Studies on Fat Secretion (C. W. Turner, W. R. Graham, Jr.).—The feeding of small amounts of fish liver oils to lactating cows was followed by a decline in the fat content of the milk. The factor responsible was contained in the saponifiable fraction of the oil. Hydrogenation of the oil before feeding eliminated the fat depressing effect. It was concluded that the factor responsible for the reaction was in the unsaturated bonds of the fish oils. Since simple unsaturated fats produced no deleterious effects, it was believed that the fat depressing effect of the natural fish liver oils was concerned with some particular grouping of unsaturated bonds in the fatty acids.

Methane, Hydrogen, and Carbon Dioxide Production in the Digestive Tract of Ruminants in Relation to the Respiratory Exchange (Samuel Brody, L. E. Washburn).—A method has been developed for securing from cattle directly expired air for analysis. Time curves after feeding were mapped for expired CO₂, CH₄, and consumed O₂. These time curves on expired air were paralleled by time curves after feeding on the composition of rumen gas of living animals. The total CO₂ expired was corrected for the fermentation CO₂ thus enabling the computation of “true” R. Q.s (respiratory quotient) as contrasted to the “apparent” R. Q.s formerly published. These data also made possible corrections for CH₄ accumulated in spirometers during “metabolism tests” and computation of feed energy losses in fermentation gasses from the digestive tract, which on maintenance feed intake approximate 25 per cent of the maintenance energy requirement. The absolute fermentation losses were not constant, but declined rapidly with time after feeding. The ratio of rumen CO₂ to CH₄ also declined with time after feeding, due largely to the percentage decline in the CO₂.
Diurnal Metabolic and Activity Rhythms (Samuel Brody, L. E. Washburn).—In some species vision is best in day light, in others in night light. These differences result in conditioned diurnal sleep and activity rhythms which are reflected in diurnal metabolic rhythms. In the rat the metabolic peak has been found to be at night (usually before midnight) and the trough in day (usually before noon). The metabolic difference between peak and trough is approximately 25 to 30 per cent. This is at least the equal to the metabolic difference between fast and feeding. The diurnal metabolic rhythm in the rat was not extinguished by a month of continuous light, or by continuous feeding, or by a combination of continuous light and fast; but it was extinguished by a week of continuous light and continuous feeding.

Energetic Efficiency of Egg Production (Samuel Brody, E. M. Funk, H. L. Kempster).—This project is in cooperation with the department of poultry husbandry.

Fowls produce most eggs at a characteristic body weight which is about 4 pounds in Leghorns and about 5¾ pounds in Rhode Island Reds and Barred Rocks. Preceding these body weights of maximum production, gross energetic efficiency of egg production tended to be independent of body weight. Following these body weights, gross energetic efficiency decreases.

The ratio of egg energy produced to total digestible nutrients energy consumed was about 11 per cent in 100-egg producers, 14 per cent in 150-egg producers, 17 per cent in 200-egg producers, 20 per cent in 250-egg producers, 27 per cent in 360-egg producers. These are rough estimates depending upon the size of egg, size of fowl, nature of feed, and other factors. Apparently the gross energetic efficiency of egg production in “good” layers was about ¾ that of the efficiency of milk production in “good” milkers, and about the same as the efficiency of early postnatal growth.

The distribution of the consumed feed between its uses for egg production, maintenance, and weight gain (or loss) showed that the net efficiency was about 60 per cent. This was about the same order as of milk production.

The difference in gross efficiency of egg and milk production was attributed to four factors: (1) The greater structural complexity in an egg than in milk; (2) More “biologic time” was taken to produce unit egg energy than unit milk energy, with greater expenditure of overhead maintenance; (3) Egg contains relatively more fat than milk with consequently greater energy expense for production; and (4) Evolution apparently favored increasing milk production to a greater extent than egg production, with corresponding greater digestive and metabolic powers in cows than fowls.

The gross energetic efficiency of egg production was less than of early postnatal growth and very much less than of prenatal growth in the chick.
Energy Metabolism Level During Gestation, Lactation, and Post-Lactation Rest (Samuel Brody, Virgil Herring).—In the rat, milk production and respiratory quotient have been found to fall and rise together with fast and refeeding. Twelve hours after the food was taken away from the lactating rat, the respiratory quotient declined from the initial level of 1 or over, to 0.73, and the milk production declined from the initial level of about 3 grams to zero. On refeeding after a 2-day fast, respiratory quotient and milk production promptly raised to the pre-fast level. This would indicate that in the rat it is not possible to determine the basal metabolism during normal lactation because normal lactation appears to be incompatible with the post-absorptive state. The heat production of normally lactating rats (not in post-absorptive condition) was nearly double that of non-lactating of the same weight.

In the rat, the resting energy metabolism during gestation was practically the same as during sex rest of animals of the same size. In growing cows, the metabolism during gestation tended to increase more rapidly; therefore, the body increased during gestation without an apparent food-energy cost was accounted for not by lowering of resting metabolism but by: (1) a reduction of spontaneous physical activity with a resultant saving of energy; (2) saving of heat increment of feeding; (3) gestation gains were of a rather watery nature; (4) the maintenance cost of the pregnant uterus may be relatively inappreciable because of the thermo-neutrality of its environment, and its low tonicity and physical activity. While the absolute energy cost of growth may be considerable, it is probably relatively insignificant, as compared to resting metabolism of the mother.

Relation Between Heat Increment of Gestation and Birth Weight (S. Brody).—The amount of extra heat produced, Q, during gestation above the non-gestation level (at rest) was related to the birth weight, M, of the offspring (of different species from rats to horses) by the equation \( Q = aM^n \). The numerical value of \( n \) is of the order of 1.2, and of \( a \), is 4400; this means that the formation of a fetus of 1 Kg. at birth was associated with a heat increment of gestation of 4400 Calories, and when the birth weight was not 1 Kg., the heat increment appeared to vary with the 1.2 power of birth weight. This heat increment of gestation of 4400 Calories of a 1-Kg. offspring at birth differed by less than 10 per cent from the Rubner constant of 4808 Calories, “the amount of energy which was necessary to double the weight of the newborn.” The surface law was not applicable to prenatal growth.

A Comparison of the Amounts and Energetic Efficiencies of Milk Production in the Rat and Dairy Cow (Samuel Brody, Ruth Nisbet, Hudson Kibler).—In comparison of respective body weights of the rat and dairy cows, rats produce very much more milk energy than cows. In comparison to basal metabolism, the production was the same in rats and cows. Milk energy production tended to be direct-
ly proportional, not to body weight, but to any one of: (1) basal energy metabolism; (2) weight; and (3) food consumption. In other words, gross energetic efficiency of milk production tended to be independent of body weight. It tended to be the same not only in large and small animals of the same species but also in different species.

**Fermentation Energy Losses in Dairy Cattle (L. E. Washburn).**—Rumen and expired gases of a dairy cow were measured simultaneously at different times after feeding. The results indicated that, contrary to the accepted opinion, the ratio between fermentation carbon dioxide and combustible gases is subject to a considerable but characteristic variation. Expired fermentation carbon dioxide computed from the above ratio and uncorrected for salivary carbon dioxide not only necessitated a reduction in the respiratory quotient, but also represented a carbon loss equivalent to 835 to 1749 calories in a 24-hour period. Total energy losses in fermentation carbon dioxide and combustible gases were calculated to be about 12 to 16 per cent of the feed energy intake, or 25 to 40 per cent of the maintenance requirement. Rumen oxygen and nitrogen values showed that aerobic influence was undoubtedly present, though not appreciable. As digestion proceeded, the rumen gases approached values comparable to intestinal gases.

**Fasting Energy Metabolism During Lactation (S. Brody, L. E. Washburn).**—Data obtained by an open-circuit-mask respiration method indicated that the total heat production of a lactating cow during fasting was about 10 per cent higher than that of a dry cow. Up to 60 hours of fast the heat production curves of both animals were essentially parallel, reaching a level at about 36 to 48 hours after feed. After 60 hours the heat production of the lactating animal further declined about 20 per cent. It was indicated that the higher level of total energy metabolism in the lactating cow was in a large measure due to heat increment of nutriment.

During 72 hours of fast, the lactating cow continued to produce a relatively constant amount of milk fat, although her milk yield declined about 50 per cent; therefore, it was believed that within the limits of these experiments, lactation as a mechanism was unchanged by fasting.

**Estimating Live Weight from Chest Girth of Dairy Cattle of Unknown Age (A. C. Ragsdale, S. Brody).**—It has been shown that the interrelations between practically every one of the 21 measurements and body weights made at this station over a series of years followed a constant pattern or design, which may be expressed by a mathematical equation.

This equation has been applied to the prediction of weight from linear size in work at this Station. Later it has been embodied in a formal prediction table, estimating live weight of dairy cattle.
A standard has been developed for estimating live weight from chest girth based upon 15,610 sets of chest girth-weight measurements.

Relation Between Physiological and Gravitational Weight (Samuel Brody).—Extensive data have been prepared showing that physiological weight was proportional not to simple gravitational weight, but to gravitational weight raised to the 0.72 or 0.73 power.

The Course of Fasting Energy Production Curves in the Lactating and Dry Dairy Cows Under Similar Environmental Conditions (A. C. Ragsdale, S. Brody, L. E. Washburn).—The fasting energy production of a lactating dairy cow was 10 per cent higher than that of the dry cow. This difference was constant until 60 hours after feeding. The heat production of both cows declined 47 per cent, and reached a level at 36-48 hours after feed. While this level was maintained by the dry animal, the heat production of the lactating animal further declined about 16 per cent after 60 hours. Milk yield decreased about 50 per cent during 72 hours of inanition, but the fat production remained at a remarkably constant level.

These studies indicated (1) lactation as a function was maintained within certain limits of inanition, (2) the higher energy metabolism of the lactating animal was due in a large measure to specific dynamic effect of the food. It is believed that lactation stimulus, endocrine or otherwise, acts to a considerable degree upon the alimentary system of the animal.

The Effect of Fasting and Refeeding on Milk Secretion in the Cow and Goat (A. C. Ragsdale, S. Brody, L. E. Washburn).—There was a remarkable persistency in maintaining lactation during fasting in the cow and goat. There were certain indications that fasting may have a beneficial effect on later milk secretion. While levels of fasting energy metabolism were approached at the same rate, declines in milk secretion proceeded at different rates. At 72 hours after feeding in the cow, milk yield had declined 50 per cent and fat percentage had increased 100 per cent; in the goat milk yield had declined 80 per cent and fat percentage had increased about 400 per cent. Milk yield and percentages of constituents returned rapidly to original prefast values upon refeeding.

The Mammogenic Hormone (C. W. Turner, E. T. Gomez, A. A. Lewis).—Indications have been found that estrogen and progestin of the ovary and corpus luteum stimulated the secretion of a pituitary factor. This factor has been named mammogen.

Its presence in the pituitaries of pregnant cattle has been shown by a series of experiments on rabbits and rats. Extensive growth of their mammary glands has been stimulated by the daily injection of cattle pituitary tissue. Also, it has been shown that the lactogenic and the mammogenic hormones were not identical since non-pregnant cattle pituitaries containing considerable amounts of lactogen did not stimulate gland growth.
In animals injected with estrogen, there soon was stimulated extensive growth of the duct system. The pituitaries of such animals contained the mammogenic hormone, and its presence was not observed in comparable animals not so stimulated. A rather simple chemical called anol (p-hydroxy-prophenyl-benzene) was observed to have estrogenic properties and to stimulate the growth of the rabbit gland. Pituitaries from these animals contained considerable amounts of mammogenic hormone.

**ASSAY OF MAMMOGENIC DUCT GROWTH FACTOR**

The assay method involves the following steps:

- **Assay Animal**: Male mice weighing 10-25 gms are used.
- **Control Gland**: Very rudimentary mammary glands.
- **Stimulated Gland**: Very rudimentary growth of ducts with enlarged end buds.
- **Injection**: Subcutaneously once daily for 6 days.
- **Removal**: On the 7th day, fixed, stained, and examined for evidence of growth of ducts.
- **Mouse Unit**: Amount of tissue or extract necessary to secure 1 or more glands showing growth stimulation in 50±10% of 10 or more male mice.

**Fig. 7.—Assay of mammogenic duct growth factor.**

A method of assay for the mammogenic hormone has been discovered. Male albino mice have very rudimentary mammary glands throughout their life. The injection of mammogen stimulated the growth of these rudimentary ducts. A mouse assay unit of mammogen was described as follows: the amount of tissue or extract required to produce definite signs of development in one or more glands of 50 ± 10 per cent of 10 or more male albino mice weighing 10 to 25 gm. Injection was made once daily, subcutaneously, for six successive days, sacrificing on the seventh. Successive groups of mice administered the same extract showed that the reproducibility of the method was satisfactory.

A study of the chemical properties of mammogen indicated that it differed considerably from the other pituitary hormones. It was extracted in lipid solvents and was recovered as an oily residue upon the vacuum distillation of the extracting solutions. A concentration of 25 to 30 times has been effected by these means, resulting in preparations 2 to 3 mg. of which contain one mouse unit.

**The Lactogenic Hormone of the Pituitary** (C. W. Turner, R. P. Reece).—The hormone of the pituitary which stimulates milk secretion—called the lactogenic hormone—has been traced in all stages of growth, reproduction, and lactation in the albino rat. In the male, the hormone was present at a low level and continued so with in-
creasing body weight. In the female there was a gradual increase with increasing body weight and sexual maturity. In rather old fat rats there was a definite decline representing senescence.

ASSAY OF LACTOGENIC HORMONE
LOCALIZED STIMULATION OF PIGEON CROP GLAND

PIGEONS WEIGHING 300-400GMS ARE USED. CROP GLAND.
NORMAL PIGEON EXPERIMENTAL PIGEON
DAILY INTRADERMAL INJECTIONS OVER THE CROP GLAND OF
MATURE PIGEONS FOR FOUR DAYS.
PIGEON UNIT—THE MINIMUM AMOUNT OF EXTRACT WHICH
WILL CAUSE THE PROLIFERATION OF AN AREA OF THE
CROP GLAND ABOUT THE SIZE OF A NICKEL.

Fig. 8.—Assay of lactogenic hormone.

During the estrus cycle there was a maximum during estrum and a minimum during metestrum. During pregnancy the amounts present remained within the range of the estrus cycle, but following parturition there was a marked increase in the hormones stimulating lactation.

The fetal pituitaries had the lowest lactogen content. There was an increase in lactogen content of pituitaries in calves and a further increase in heifers and young bulls. The bulls from one to two years old contained somewhat more than the younger group. Pituitaries from steers contained less than those from bulls. The heifer group increased greatly upon reaching sexual maturity.

Per unit weight of fresh anterior lobe tissue, pituitary glands from dry, open dairy cows contained 72 per cent more lactogen than pituitaries from dry, open beef cows; dry and pregnant dairy cows 37 per cent more than dry and pregnant beef cows; lactating and open dairy cows 69 per cent more than lactating and open beef cows; and lactating and pregnant dairy cows 73 per cent more lactogen than lactating and pregnant beef cows.

The consistently higher content of lactogenic hormone in dairy cattle was believed to be of considerable significance in relation to the variation in milk production of beef and dairy cattle.
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Fig. 9.—Change in amount of lactogenic hormone in the pituitary of the albino rat with increasing body weight.

Fig. 10.—Concentration of the lactogenic hormone in the pituitary of the albino rat during estrus cycles, pregnancy, and lactation.
The Effect of Temperature Upon Butter (W. H. E. Reid, W. S. Arbuckle).—Flavor is of ultimate importance in determining the value of butter. A temperature of 40 degrees Fahrenheit is used in the principal markets of the country for scoring butter. The body of butter becomes firm and resistant at relatively low temperatures, thus making the product more difficult to spread. At higher temperature the body is less firm and has more desirable spreading properties; at still higher temperatures the butter becomes oily, sticky, or greasy. Apparently there is some relationship between the temperature and intensity of flavor of the butter.

Butter was scored at temperatures of 40, 50, 60, and 70 degrees Fahrenheit. The high score butter received a higher score at higher temperature, while the medium low score butter was given a lower score value at the higher temperatures. Flavor of butters at low temperatures was less distinct while pronounced, full flavors were observed at higher temperatures. The salt flavor was most pronounced at 50 degrees Fahrenheit or at higher temperatures.

The body of the butters was considered too resistant at 40 degrees Fahrenheit, medium resistant at 50 degrees Fahrenheit, and was undesirable at 70 degrees Fahrenheit being salvy, sticky, and greasy.

Spreading properties of the butter at 40 degrees Fahrenheit were not good, at 60 degrees the spreading qualities were very good, but at 70 degrees these qualities were rated only as fair.

The Effect of Composition and Serving Temperature Upon Consumer Acceptance and Dispensing Qualities of Ice Cream (W. H. E. Reid, R. J. Drew, W. S. Arbuckle).—All mixes were made from the same sources of ingredients. After the ice creams were frozen and hardened, they were properly tempered at 6, 10, 14, and 18 degrees Fahrenheit in commercial ice cream cabinets before they were judged.

The ice creams were observed with respect to flavor, body, and texture preference at the four temperatures. Stability, crystalline structure, and dipping studies were also made of each series of ice cream.

The ice cream containing 14 per cent fat was generally the most desirable, although the 16 per cent fat ice cream was preferred at the high serving temperature, and the 12 per cent fat ice cream at the low temperature. Ice cream containing 13 per cent serum solids had the highest rated consumer acceptance at the preferred serving temperatures.

As the sugar content was increased at the highest temperature, the ice cream was less desirable. However, at the preferred serving temperature, the ice cream containing 16 per cent sugar was rated as having the highest consumer preference.

High serum solids ice cream varying in sugar and gelatin content was most desirable when 14 per cent sugar and .4 per cent gelatin were used. The serving temperature of 10 degrees Fahrenheit was considered most desirable from the consumer's viewpoint.
As fat, serum solids, or sugar content was increased the ice crystals became smaller and were more abundantly surrounded by non-crystalline material. The composition and serving temperature definitely affected the resistance of the ice cream and had a direct relation to the number of dishes of ice cream obtained per gallon.

There was an optimum point between the water in a frozen and unfrozen form which produced the most stable ice cream when exposed to 85 degrees Fahrenheit temperature. It was affected materially by the serving temperature and composition of the ice creams.

As the fat or gelatin was increased the ice creams became more stable at 85 degrees Fahrenheit, with serving temperature affecting their stability very little, while the effect of variation in sugar and serum solids content on stability was influenced greatly by serving temperature.

The Use of Moving Pictures in Ice Cream Investigation (W. H. E. Reid, W. S. Arbuckle, R. J. Drew).—Motion pictures have been used in the study of the stability of ice cream. Ordinary colored film was utilized, and the ice creams and sherbets studied included those of common flavors, including fruit and nut ice creams. Data so recorded emphasized certain factors which otherwise might not be observed.

Studies on the stability of the ice cream were made by motion pictures taken at regular intervals. Direct comparison of the changes could be so recorded.

**ENTOMOLOGY**

L. HASEMAN, Chairman

Codling Moth Investigation (L. Haseman, Lee Jenkins, Curtis Wingo, Harry E. Brown, W. W. Smith).—Control investigations of codling moth were restricted mostly to four field stations: St. Joseph, Elsberry, Cape Girardeau, and Marionville. At each station a research assistant was in charge.

More normal rainfall and temperatures have resulted in less favorable conditions for increase in codling moth. The problem of controlling it, therefore, has been less serious this year. A severe freeze in the late spring of 1938 practically eliminated the set of fruit over the southern and central part of the State and reduced it greatly in other areas. This was a further severe setback for the codling moth. This year, a lighter schedule of sprays proved sufficient and worm control was the best in the past few years. The general codling moth situation has improved materially due to better control practices and to weather conditions.

Oriental Fruit Moth Investigations (L. Haseman, Curtis W. Wingo).—The new Oriental fruit moth has become a complicating factor in codling moth investigation. Some time, therefore, has been devoted to the study of the biology of this new moth and some progress
has been made toward its control. Primarily the pest is an enemy of
the peach, but it also attacks the apple, and since it is a close relative
of the codling moth, studies have been made along with the regular
codling moth investigation. Figure 11 shows the Oriental fruit moth
abundance in the orchards at Cape Girardeau throughout the season.

![Oriental Fruit Moth Bait Trap Records](image)

Fig. 11.—Oriental fruit moth bait trap records at Cape Girardeau, April 25 to
October 2, 1938.

Three methods of worm control in peaches were tried: (1) four
applications of a special oil-sulfur dust were applied at 5-day intervals,
beginning one month before picking time; (2) four applications of
a summer oil-nicotine sulphate spray were applied under like condi­
tions; and (3) three applications of an oil-sulfur dust were applied
at from 5 to 7-day intervals.

The pest was very difficult to control especially on late varieties of
peaches, but results seem to be encouraging. Treatments No. 1 and
No. 2 resulted in 97 to 98 per cent perfect peaches, and treatment No.
3 resulted in 92 per cent perfect peaches. The check plot with no
treatment had 81 per cent perfect peaches.

The introduction of parasites in the peach orchards in Missouri
showed this year, for the first time, very encouraging results.

**Striped and Spotted Cucumber Beetles** (Leonard Haseman, Curtis
W. Wingo).—The ever-increasing injury by the striped and spotted
beetles on cucurbits in home gardens and in the commercial melon
fields in Missouri has resulted in a thorough investigation of these
pests. In Columbia the beetles appeared later in the spring than
usual and in the fall they were exceptionally abundant on late squash.

On the farm of R. L. Galemore at Blodgett, Missouri, a detailed
beetle control project was undertaken. Four different insecticides
were used in four replications: Fixed nicotine, lead arsenate-lime,
cryolite, and calcium arsenate-gypsum. In all, six applications were made on May 11, May 18, May 25, June 6, June 13, and June 28. Abundant rainfall made it difficult to keep the plants properly covered with the insecticides.

In evaluating the relative effectiveness of the four treatments, the total yields of muskmelons were taken as the measure of control.

**Effect of Treatments**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryolite</td>
<td>316 pounds</td>
</tr>
<tr>
<td>Lead Arsenate-Lime</td>
<td>314 pounds</td>
</tr>
<tr>
<td>Fixed Nicotine</td>
<td>277 pounds</td>
</tr>
<tr>
<td>Calcium Arsenate-Gypsum</td>
<td>225 pounds</td>
</tr>
<tr>
<td>Untreated</td>
<td>232 pounds</td>
</tr>
</tbody>
</table>

The cryolite and the lead arsenate-lime plats were quite definitely the higher yielding plats.

**Strawberry Insects and Their Control** (Leonard Haseman, W. W. Smith).—Strawberry leaf roller was serious in the commercial fields near Marionville and a series of spray controls were undertaken. Arsenate of lead applied the last of April after the leaves were folded failed to control the pest. A spray containing 4 pounds of fixed nicotine to 100 gallons of water, applied on May 20, gave only 10 per cent kill of the caterpillars. A small test made June 23, including 4 teaspoonfuls of fixed nicotine to 2 gallon gave only 10% kill. After the leaves were folded, this pest was very difficult to reach and kill.

Some observations also were made on the strawberry rootworm (*Graphops*) and also on a millipede which fed on the ripe fruit. During the middle of April adults of the rootworms were abundant, and in one field millipedes destroyed 10 per cent of the ripe fruit.

**A Study of Insecticides** (L. Haseman, Harry Brown, Curtis Wingo, W. W. Smith, Lee Jenkins).—For the control of codling moth, phenothiazine, fixed nicotine, and cryolite were studied as possible substitutes for arsenate of lead. In the codling moth tolerance studies a number of the barium compounds were given special attention and some of them showed some promise as stomach poisons. Tartar emetic also appeared promising.

Fruit tree leaf rollers have built up to dangerous numbers and several commercial miscible oils and engine oil emulsions have been investigated as dormant sprays to kill the winter eggs, which appear in packets on limbs and twigs.

The oriental fruit moth has been a very difficult caterpillar to control, especially on peach. Nicotine sulphate and summer oil sprays and an oil-sulfur dust have been used in orchard control experiments with very good results. Four applications at 5-day intervals, beginning four weeks before peaches began to ripen, materially reduced injury by this pest on peach.

For controlling ox warble, derris and rotenone in a heavy oil and derris-soap powder have been used as a wash on the backs of cattle in
four dairy herds. These products gave 100 per cent kill of all warbles with no injury to the animals. This proves an effective and safe way to destroy the warbles on the backs of cattle.

A number of new commercial sprays and dusts have been placed on the market and several of these have been checked for value; also, a number of spreaders and stickers or deposit-builders have been used in the codling moth spray investigation.

Tolerance of the Codling Moth to the Toxic Action of Insecticides (Allan G. Peterson).—The toxicity of various chemicals on codling moth larvae has been tested by dissolving or suspending the chemical in water and injecting it through the mouth of the mature larva by means of a hypodermic syringe. A dosage of 1/100 of a cubic centimeter per mature larva was used in each case. The toxicity of the chemicals tested may be summarized as follows: Barium carbonate, barium thiosulphate, copper ferricyanide, copper oxalate, cadmium sulphide, and p-toluene-sulphonyl-amide gave mortalities of 60 to 80 per cent at dilutions of 1:200.

A saturated solution of barium ferricyanide gave a mortality of 60 per cent, and a 1:300 solution of barium ferrocyanide gave a mortality of 20 per cent. Antimony oxide, 1:200, resulted in a mortality of 50 per cent. Cream of tartar, 1:200, gave no mortality.

Barium bromate, barium permanganate, barium thiocyanate, diphenyl sulphone, diphenyl sulphide, derrisine, copper sulphate, copper acetate, potassium metabisulphite, antimony tartrate, tartar emetic, potassium metabisulphite, and potassium permanganate resulted in 100 per cent mortalities at dilutions of 1:100 or higher.

The most promising chemicals tested appeared to be: barium bromate, diphenyl sulphone, and diphenyl sulphide, each of which gave a mortality of 100 per cent at 1:200; copper sulfate, which gave a mortality of 90 per cent at 1:500; copper acetate, which gave a mortality of 100 per cent at 1:400; and tartar emetic, which gave a mortality of 100 per cent at 1:1500.

In addition to the injection method, a number of chemicals were tested by spraying on apples in order to observe their toxicity against newly hatched codling moth larvae. The toxicity of these chemicals may be summarized as follows:

Calcium thiosulphate sprayed at a dilution of 1:50 allowed four entries from 10 newly hatched larvae introduced on the apple.

Barium phosphate, diphenyl sulphone, and barium citrate at 1:50 allowed three entries per 10 newly hatched larvae.

Potassium metabisulphite, tartar emetic, potassium thiocyanate, barium ferrocyanide, ethylene thiocyanate, zinc benzoate, potassium silicate, barium carbonate, lead thiocyanate, and a saturated solution of paraffin in benzene allowed two entries per 10 newly hatched larvae.

Lead thiosulfate at 1:50 allowed one entry per 10 larvae in one test and two entries per 10 larvae in another test. Copper thiocyanate at
1:50 allowed eight entries from 24 larvae, but only one larvae was found inside the apple. Potassium permanganate at 1:200 allowed three entries from 23 larvae. Mercury thiocyanate at 1:50 produced spray injury on the apple and allowed two entries from 23 larvae.

Antimony tartrate, barium oxalate, and barium tartrate at 1:50 allowed one entry per 10 larvae. Barium permanganate at 1:100 allowed one entry per 10 larvae.

Diphenylene oxide, barium thiosulfate, and phenothiazine were the only chemicals tested which allowed neither stings nor entries at dilutions of 1:50.

**Mosquitoes in Missouri** (L. Haseman).—Rather intensive studies and collections have been made to determine what mosquitoes were most abundant on farms where horses were suffering from sleeping sickness. Collections made in central Missouri showed *Aedes vexans* to be the most abundant species on farms where the disease was present. A few specimens of the common malarial mosquito, *Anopheles punctipennis*, were also taken along with the other more common species.

There is a general tendency for malaria to increase, and the importance of mosquito investigations in connection with malaria cannot be stressed too much.

**Periodical Recurrence of Insect Pests** (L. Haseman).—Most serious insect scourges vary in intensity from year to year. They will rise to scourge proportions when they find conditions favorable and then usually drop to the point of no economic importance with unfavorable conditions.

The recent grasshopper outbreak rose in importance with the heat and drouth conditions of 1933-36, until the prolonged heat and drouth of 1936 which was unfavorable for normal maturity and egg deposition that fall. In 1937, the grasshopper scourge had decreased some in importance. In the spring of 1938, at egg-hatching time, the weather was cool, and well-timed cool rains definitely proved unfavorable to young hoppers. In some areas where alarming numbers of young hoppers had hatched, the weather so reduced their numbers that later in those areas little or no baiting was necessary. Later in the summer of 1938 there was a definite increase in fungus disease and in mite, fly maggot, and thread-worm parasitism among the maturing hoppers.

During 1938, in some parts of northwest and west central Missouri, chinch bugs showed definite increase. Local weather and cropping conditions seemed favorable so that in these areas a definite increase in this pest was faced again.
FIELD CROPS

W. C. ETHERIDGE, Chairman

Rotation Pastures Compared with Cultivated Crop in the Production of Feed for Cattle (C. A. Helm).—The feed output of a farm, particularly that part which is grazed, may be enlarged at low cost by dependable rotations adapted partly or wholly to grazing uses. Good examples of such rotations for Missouri are:

1. Fall-sown or spring-sown grain crops, grazed in the fall and spring, or in the spring only, together with their companion crop, Korean lespedeza, which follows the grain pasture in early summer and is grazed from then until fall.

2. Fall-sown or spring-sown grain crops which are harvested for grain, after more or less seasonal grazing in fall or spring, and are followed by their companion crop of lespedeza for summer pasture.

3. Fall-sown grain crops, composed of extremely early varieties of barley or wheat, harvested for grain after light seasonal grazing, and followed by a quick maturing crop of soybean hay.

These examples may be varied in many ways to adapt them to seasonal conditions and to farm needs. For example, the grain crop may be grazed out completely, may be harvested for grain or silage, or may be partly grazed and later harvested. In any case it would be followed by volunteer lespedeza pasture or hay, or by soybean hay. Red clover or sweet clover may be substituted for lespedeza in continuous rotation with the grain crop, making a two year rotation rather than a one year rotation.

The 1937 records of some of these short rotations of grain and legumes as compared with certain staple crops showed the following:

1. At Columbia, bluegrass yielded 128 lbs. gain in live weight of cattle per acre; wheat-lespedeza yielded 287 lbs.; and rye-lespedeza yielded 238 lbs.

2. At Columbia a rotation of barley for pasture and soybeans for hay produced per acre 68 pounds of live weight gains in grazing cattle and 3860 pounds of soybean hay. Corn on an adjacent field made an average yield of 35.7 bushels. Obviously the total product of the barley-soybean rotation substantially exceeded the corn crop.

3. At Green Ridge on Gerald silt loam, a poor soil, the barley and soybean rotation furnished 24 cattle days of barley pasture per acre in the fall, 18 bushels of barley per acre in the spring, and 1600 pounds of soybean hay per acre in the summer.

Corn on an adjacent field yielded only 14.2 bushels per acre.

Physiological Study with Soybeans (W. C. Etheridge, Denver I. Allen, Paul R. Burkholder).—This project is in cooperation with the department of botany.

A study of the effect of variations in the concentration of essential mineral elements on the growth of Morse and Virginia varieties of soybeans has been started.
The concentrations of three salts, \( \text{KH}_2\text{PO}_4 \), \( \text{Ca(NO}_3\text{)}_2 \), and \( \text{MgSO}_4 \) have been varied while keeping the total concentration constant. Salts were varied in increments of \( \frac{1}{8} \). Sand was used as culture media in glazed, 3-gal. stoneware jars.

Three plants of each variety were grown per culture for seven weeks, harvested, and dry weights recorded. The cultures which produced the highest yields of Virginia were characterized by low concentration of \( \text{KH}_2\text{PO}_4 \) and included the entire range of \( \text{Ca(NO}_3\text{)}_2 \) and \( \text{MgSO}_4 \) concentrations. Those producing the highest Morse yields were not so well defined, but were more in the region of high concentrations of \( \text{MgSO}_4 \) and low \( \text{Ca(NO}_3\text{)}_2 \) with variable concentrations of \( \text{KH}_2\text{PO}_4 \). The difference in the varietal response to salt concentrations was indicated. The Virginia responded to low \( \text{KH}_2\text{PO}_4 \), with other salts having little effect, while Morse was variable in response to \( \text{KH}_2\text{PO}_4 \) but generally responding best to high \( \text{MgSO}_4 \) and low \( \text{Ca(NO}_3\text{)}_2 \) proportions.

Cotton Varieties in the Southeast Missouri Lowlands (B. M. King).—The testing of cotton varieties in the southeast Missouri lowlands has been continued. Fifteen varieties were grown on Lintonia fine sandy loam of medium fertility at Sikeston, and on a highly productive phase of Sarpy silt loam at Steele. Hibred led in acre yield of lint at Sikeston. It ranked eighth in money value per acre, being exceeded by Coker 100-2, Delfos 719, Deltapine, and the Stoneville strains 2B, 4B, 5 and 5A. Hibred also led in acre yield of lint at Steele, but there too the returns of this variety in terms of money value per acre fell below that of the Stoneville strains and Deltapine. The superiority of these cottons was discovered several years ago and they now are grown almost to the exclusion of other varieties in Missouri.

Selections from Stoneville strains, Delta Pine Land No. 10 and No. 11, made in 1936, were grown in plant-to-row plots in an effort to isolate strains superior to the parent varieties. Stoneville 4A and Deltapine have been crossed, and each of these in turn crossed with four other varieties, in the hope of producing superior parent stock for future selections.

Breeding Barley in Missouri for Feed (W. C. Etheridge, B. M. King).—A complete realization of the sound theoretical advantages of winter barley in Missouri agriculture is problematical, because of serious limitations placed on the crop by certain defects of the barley varieties themselves. All of those now in general use in the State show one or more undesirable characters, including lack of winter hardiness, tendency to lodge and shatter, susceptibility to disease, and the presence of a heavy growth of barbed awns. The correction of all or even some of these faults would add substantially to the value and general usefulness of barley throughout the whole State. An attempt is therefore being made to discover better varieties among those now in existence and to develop superior new kinds by plant breeding.
Forty varieties and strains were compared in a nursery yield test at Columbia in 1936-37. Acre yields ranged from 4.6 bushels for Abyssinia, C. I. 1220, to 59.1 bushels for Kentucky No. 5. Acre yields in bushels of the seven highest producing varieties were as follows:

- Kentucky No. 5 ........................................... 59.1
- B 313 ........................................... 51.7
- Kentucky No. 2 ........................................... 50.5
- Arabel ........................................... 50.3
- Kentucky No. 1 ........................................... 49.1
- B 296 ........................................... 48.4
- B 202 ........................................... 48.1

These varieties have rather consistently shown good yields, but they are heavily awned. The highest yielding hooded varieties and their respective yields in the 1937 test were: Missouri Early Beardless, 33.1; Hooded Winter-B210, 27.7; Tennessee 5, 26.5; and Tennessee 6, 24.3.

Missouri Early Beardless, the leading variety in the State, was developed by mass selection, and is known to be a mixture of pure lines. Proceeding on the assumption that these lines are variable in capacity to yield, resistance to cold, lodging, shattering, and diseases, a large number of them have been isolated by selection. In the 1937 trials, 35 lines selected in 1934 were grown in single plots of three rod-rows, and 39 selected a year later were grown in single rod-rows. The most promising of these lines were saved for growing in the 1938 nursery yield tests.

A further step toward the development of better barley varieties was undertaken in the spring of 1937. Ten of the pure lines from Missouri Early Beardless were crossed with an equal number of the best awned varieties. The \( F_1 \) was grown in the greenhouse in the winter of 1937-38 and the \( F_2 \) grown in the field in the spring of 1938.

Improvement of the Missouri Soybean Crop (B. M. King).—This project is in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture.

For over a decade the Virginia variety of soybeans has been planted to more than 60 per cent of the entire soybean acreage of the State. The reason for this is the unusual capacity of this variety to produce relatively high yields on medium to poor land. It also is among the best varieties for fertile soil. The brown color of the seed, however, renders it unsuitable for the production of the best quality of beans for milling purposes; therefore, the development of a yellow-seeded variety possessing the good features of Virginia would meet the need for a dual purpose kind for the production of hay for feed and seed for industrial uses.

In 1929 Virginia was crossed with seven different yellow-seeded varieties. Selections were made from the \( F_n \) generation of each of the crosses. The most promising types appeared in the group of selections.
from the cross, Virginia x B.P.I. 37062. Two of these selections, No. 66 and 69, were reselected in 1934. In 1937 fifty of the selections from line No. 66 were grown in a nursery yield test with Virginia as a check, and in seed increase rows. Twenty-three of these produced higher yields of hay and seed than the check.

The progeny of two crosses, B.P.I. 37062 x Illini and Virginia x B.P.I. 54610-3 each were grown in mixed populations. Several hundred promising segregates were chosen for growing in plant-to-row plots the following season.

In 1937 a number of selections from hybrids and from introductions by the U.S. Department of Agriculture were grown in rod-rows for general observation on maturity, shattering, lodging, and yield. Crosses were made between standard varieties and these selections this year.

Two varieties, Manchu and Missouri Sel. 54563-3, were grown under various fertilizer treatments at several locations in the State, in an effort to determine the effect of variety, soil type, fertilizer treatment, and season on the chemical composition of the seed. Apparently, the season may have considerable effect on composition, especially on the iodine number and the protein content.

**Improvement of Permanent Pastures** (E. M. Brown, J. M. Poehlman).—Kentucky bluegrass, Canada bluegrass, orchard grass, and Bermuda grass have been grown for periods of two months in thermoregulated growth chambers at temperatures ranging by 10° intervals from 40° to 100° F. At the lowest temperature Kentucky bluegrass, Canada bluegrass, and orchard grass produced a small amount of herbage, but Bermuda grass not only failed to grow but was severely injured by the 40° temperature. The optimum temperatures for herbage production by Kentucky bluegrass, Canada bluegrass, and orchard grass, under the conditions of this experiment, were 90°, 90°, and 70° respectively, while Bermuda grass produced more herbage at 100° than at any lower temperature.

Roots and rhizomes of Kentucky bluegrass grew most rapidly at 60° while those of Canada bluegrass made their most rapid growth at 50°. At higher temperatures root and rhizome production by the two bluegrasses declined, root growth being checked completely in the lower soil levels by a temperature of 80° F. The best root development in the case of orchard grass occurred at 70°. Apparently the sharp decline in herbage production by the Kentucky and Canada bluegrass under natural conditions which occur when average air and soil temperatures go up to 80° F. was due to the depressing effect of this temperature on root growth rather than any direct influence on foliage production. The ability of orchard grass to continue top growth at temperatures above 80° F. seems due to the continued development of new roots by this species at the higher temperatures.

Kentucky and Canada bluegrass and orchard grass were severely injured by exposure for 8 weeks to a continuous temperature of 100°
F. The relative resistance of Kentucky bluegrass to heat is illustrated by the fact that 90% of the plants survived, while only 45% of the Canada bluegrass, and 4% of the orchard grass plants survived the high temperature. No injury to these three grasses resulted from an air temperature of 100°F as long as the temperature of the soil was held below 90°F; therefore, heat injury to grasses seems due to high soil temperatures rather than to excessive air temperatures.

Larger live weight cattle gains were produced on bluegrass pastures supplemented during midsummer with Korean lespedeza than on bluegrass alone at the Sni-A-Bar Farms in 1937. Three systems of grazing management were compared: (1) continuous grazing, (2) rotation grazing, and (3) rotation grazing supplemented with Korean lespedeza during mid-summer. In the third system the total live-weight cattle gains were increased by 122% over the average gains of systems one and two by the addition of lespedeza pasture which increased the total acreage by only 40%. Results from these pastures over a seven-year period indicated that for the most efficient use of bluegrass, it should be utilized fully while in an active growing stage; that cattle should be rotated while grazing; and that a supplementary pasture should be used in midsummer.

**Early Wheat for Missouri** (W. C. Etheridge, J. M. Poehlman).—Early maturity is a very desirable characteristic for wheat in Missouri. It escapes much weather damage, insect injury, and disease. It enables the farmer to get his wheat on an earlier market. It permits early growth of a legume following the wheat crop, and with the increased acreage of the wheat-lespedeza rotation in Missouri this is of importance.

Missouri Early Premium is an early maturing variety of wheat developed by pure line selection. It is highly productive, beardless, short-strawed, and early maturing. However, improvement is still desired in its yield, disease resistance, and fly resistance. An attempt has been made to produce such a variety by hybridization with varieties known to be superior in these qualities. Early maturing selections from these crosses were grown in a yield test for the first time in 1937-38. F₁ and F₂ hybrids of the new crosses also were grown. The three high yielding varieties for 1937-38 at each of the stations where wheat variety tests were made were as follows:

- Columbia.—Kawvale, Clarkan, Missouri Early Premium.
- Elsberry.—Kawvale, Michigan Wonder, Fulcaster.
- Green Ridge.—Clarkan, Missouri Early Premium, Kawvale.
- Maryville.—Kawvale, Cheyenne, Clarkan.
- Sni-A-Bar.—Clarkan, Kawvale, Missouri Early Premium.
- Sikeston.—Missouri Early Premium, Clarkan, Kawvale.
Breeding for Resistance to Loose Smut and to Covered Smut in Fulghum and Columbia Oat Varieties (W. C. Etheridge, B. M. King).—Fifty-seven varieties and strains of oats replicated six times were included in the 1937 nursery yield test. Among these were 31 selections from Fulghum crosses with Richland, a stem-rust resistant variety; Markton, a smut resistant variety; and Victoria, a crown-rust-and-smut resistant variety. Weather conditions were favorable for a normal development of smut and rust. Of the 31 selections, 16 produced a higher yield than Fulghum. Only three of them outyielded Columbia, and in no case was the acre yield in excess of two bushels over Columbia.

A large number of selections from the F₂ and F₄ generations of the cross Columbia x Navarro backcrossed to Columbia were grown in observation plots. Navarro was used because of its high resistance to smut. Otherwise, it is not a good variety for Missouri conditions. The selections showed a wide variation in plant type, kernel characters, time of maturity, and susceptibility to smut, indicating that the initial plants selected were heterozygous. In order to make available true breeding lines, panicle selections where made from 25 of the progenies of the initial F₂ and F₄ selections for growing in observation plots.

Smut long has been recognized as the most destructive oat disease in Missouri, but crown and stem rust also cause considerable loss. Occasionally, crown rust has been more destructive than smut in wet seasons. Therefore, in recent years efforts have been made to produce a smut and rust resistant strain similar to Columbia in adaptation and capacity to produce high yields. Columbia was crossed with C. I.1811, a smut and rust resistant strain selected from the cross, Victoria x Richland. The F₁ and F₂ generations of this cross were produced in the greenhouse during the winters of 1937 and 1938, and the F₃ generation was produced in the field in the spring of 1938.

In south Missouri a small acreage of winter oats, mostly of the Red Rustproof varieties, is planted annually. Sometimes good yields are produced, but as a rule the crop is damaged severely by cold weather. Successful winter oat culture, therefore, is dependent first on the discovery of a hardy variety that will survive winter injuries in this territory. The variety must also be capable of producing high yields if it is to compete successfully with barley as a fall sown feed grain and wheat as a cash crop.

Six varieties of winter oats were tested on the southeast Missouri experiment field in 1937, and the record of the results is as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Bushels per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culberson C.I.273</td>
<td>71.5</td>
</tr>
<tr>
<td>Coker 32-1 C.I.2026</td>
<td>60.7</td>
</tr>
<tr>
<td>Custis C.I.2041</td>
<td>69.9</td>
</tr>
<tr>
<td>Lee C.I.2042</td>
<td>71.9</td>
</tr>
<tr>
<td>Winter Fulghum C.I.2498</td>
<td>71.5</td>
</tr>
<tr>
<td>Winter Turf C.I.2506</td>
<td>66.0</td>
</tr>
</tbody>
</table>
Hybrid Corn Yield Test (L. J. Stadler, G. F. Sprague, J. G. O’Mara, E. R. Sears, Luther Smith).—Yield tests with hybrid seed were harvested near Maryville, Montgomery City, Grain Valley, Jefferson City, Sikeston, and Jasper. In general, hybrids exhibited a consistent and significant increase in yield over commercial open pollinated varieties. The two hybrids, Missouri No. 8 and No. 47 have given good average yields and have shown a rather wide range of adaptation. Table 3 is a summarization of these tests. The fall drought of 1937 reduced the yields of the later hybrids materially. This was a partial reason for the relatively poor showing of Missouri 8 in the Maryville and Montgomery City tests. Missouri No. 47 was better adapted to northern Missouri than No. 8.

Approximately 200 pounds of inbred seed involved in Missouri Nos. 8 and 47 were distributed to prospective hybrid corn producers.

Table 3.—Comparison of Double Cross Hybrids and Open Pollinated Varieties Included in the 1937 Yield Tests

<table>
<thead>
<tr>
<th></th>
<th>Average yield in bushels per acre near the following towns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maryville</td>
</tr>
<tr>
<td>Missouri No. 8</td>
<td>77.3</td>
</tr>
<tr>
<td>Missouri No. 47</td>
<td>92.1</td>
</tr>
<tr>
<td>All hybrids</td>
<td>94.8</td>
</tr>
<tr>
<td>All varieties</td>
<td>71.6</td>
</tr>
<tr>
<td>Percent increase hybrid over variety</td>
<td>32.6</td>
</tr>
<tr>
<td>Highest yielding hybrid</td>
<td>112.2</td>
</tr>
<tr>
<td>Highest yielding variety</td>
<td>92.7</td>
</tr>
<tr>
<td>Percent increase</td>
<td>35.7</td>
</tr>
</tbody>
</table>

Selection Among Selfed Lines and Convergent Improvement (L. J. Stadler, G. F. Sprague, J. G. O’Mara, E. R. Sears, Luther Smith).—Approximately six acres have been devoted to lines in various stages of inbreeding for further selection and for seed increase. In most cases adequate seed was obtained and reserves are now more plentiful than at any time during the past four years.

Back pollinations for the improvement of a number of the older tested lines has been completed.

A total of 168 selected selfed-top crossed ears have been obtained, representing new selfs in five varieties and one single cross.

Approximately 2700 top crossed ears (variety or hybrid x inbred) were obtained for a test of the relative efficiency of different female parents in the evaluation of inbreds.

A total of 200 pounds of selfed seed of four lines has been produced by hand pollination. A portion of this seed has been turned over to the Missouri Corn Growers Association for release to prospective hybrid corn producers.

A limited amount of top cross seed was obtained from the detasseling plot. A severe attack of army worms damaged the late planted pollen rows and resulted in poor seed sets for many strains.
Seed Treatment Experiments (L. J. Stadler, G. F. Sprague, J. G. O'Mara, E. R. Sears, Luther Smith, C. M. Tucker).—This project is in cooperation with the department of botany.

In general, states to the North and East of Missouri have reported favorable results with treatment of seed corn to control various seedling blight, and states to the South and West have been unable to find any consistent benefits from such treatments; therefore, perhaps differences in response to seed treatment might be expected in different portions of Missouri. Studies have been started to test this point. Two years' data are available for seedling stand and a single year's data for yield for stations other than Sikeston.

Samples of two hundred ears each of the varieties Reid's (obtained near St. Joseph) and Midland (obtained near Chaffee) were placed in a germinator and readings made on germination and prevalence of disease. Ears germinating less than 90 per cent were discarded. Of the remainder, Fusarium was the principal pathogene encountered. Each variety was divided into two lots, healthy and diseased. Tests were made on these lots with Semesan Jr. at Columbia, Maryville, Montgomery City, Grain Valley, Sikeston, and Jasper. Seedling counts and yield data were obtained at each station.

The most striking difference was the marked superiority of Midland over Reid's at every station except Sikeston. For all stations combined this superiority amounted to 14.7 per cent. The differences between healthy and diseased or treated and untreated seed were not great and probably of little significance.

The date-of-planting experiment in relation to seed treatment was conducted at Columbia. The planting dates in 1937 were May 13, May 20, May 27, and June 7. No important relationship between yield and date of planting, seed condition, or seed treatment has been noticed.

Corn Ear Worm Studies (L. J. Stadler, G. F. Sprague, Luther Smith, E. R. Sears, and J. G. O'Mara).—Ninety-one inbred lines of corn have been planted in ten-plant progenies on June 30 for this study. Germination was irregular and seedling growth poor due to dry weather. Individual plant notes were taken on date of silking, number of eggs deposited three days later, and ear worm damage grade at harvest time. Many of the plants had to be discarded due to grasshopper injury. Many plants were barren as a result of the poor soil conditions and drought. These factors made a satisfactory statistical analysis of the data difficult.

Certain tentative conclusions may be drawn: (1) probably a ten-plant sample was inadequate; (2) there was an apparent difference between strains in their attractiveness to the moth as indicated by the number of eggs laid; and (3) there appeared to be little or no correlation between the number of eggs laid three days after silking and the damage grade of the mature ear.
Genetic Effects of Ultra-Violet Radiation (L. J. Stadler, G. F. Sprague, Luther Smith, E. R. Sears, and J. G. O'Mara).—Genetic alterations induced by penetrating radiations of ultra-violet light included translocation, deficiencies, and point mutations. In addition, in maize, "germless seeds" were produced, resulting from alterations (induced by pollen treatment) which prevented the normal development of the embryo. These were designated "dominant lethals," though as in other postulated dominant lethals there was no assurance that the underlying alteration was genic or even chromosomal. Many attempts have been made to interrelate some or all of these effects, so as to derive from them some single basic change produced by the radiation. On the other hand, it often has been argued that some of the effects (that is, deficiencies and mutations) must be distinct in origin and nature. All of these effects, however, are found in all experiments suitable for their demonstration within the X-ray to gamma-ray range. Comparison of X-ray and ultra-violet effects in maize indicated that at least three of the four were spectrologically separable. Ultra-violet rays failed to affect translocation rate, while it greatly increased the frequency of germless seeds, deficiencies, and mutations. As previously shown, this contrast might have been incidental to dosage, but later studies of the X-ray dosage relation showed that this was not the case. The ultra-violet ray effects on germless seeds and deficiencies have distinctive spectral characteristics. The alterations resulting from translocation were separable from those resulting from the other three effects, and those producing germless seeds were separable from those producing deficiencies.

Polyploidy Studies with Wheat (L. H. Stadler, G. F. Sprague, Luther Smith, E. R. Sears, and J. G. O'Mara).—Five types of chromosomal variants have been encountered in *T. monococcum*: (1) haploids, (2) triploids, (3) trisomics, (4) chromosomal fragments, and (5) deficiency-duplication derivatives of meiotic ring. Some preliminary work has been done on the genetic analysis of *Ae. caudata, Ae. umbellulata, Ae. uniaristata*, and *T. durum*. Three sterile hybrids, *T. monococcum* x *Ae. caudata, Ae. speltoides* x *T. monococcum*, and *Ae. speltoides* x *Ae. caudata*, have been studied cytologically. Twenty-eight additional hybrids involving seven-chromosome species are being grown.

Heat treatment of seeds and seedlings failed in an extensive test to produce tetraploid sectors in flowering spikes. A light dose of X-ray on germinating seeds has apparently been effective in producing tetraploid sectors. The immediate effects of colchicine have been determined on *Triticum monococcum* and *Secale cereale* where tetraploid and octoploid sectors were produced in roots within 20 hours after treatment by a failure of the achromatic figure to appear when the chromosomes were in the doubled metaphase condition. Studies on the possibility of centrifuging seeds to produce polyploid sectors are being continued in *T. monococcum*. 
A haploid of *T. vulgare* pollinated by a diploid yielded 14 seeds. Eleven of the resulting 13 plants were monosomic for from 0-3 chromosomes, and two of these were also trisomic for one chromosome.

**HOME ECONOMICS**

**BERTHA BISBEY, Acting Chairman**

**Utilization of Cotton and Other Fabrics (Jessie V. Coles).**—Studies have been made concerning the kinds, quantities, and qualities of goods desired by consumers. Four articles of women's clothing: house dresses, afternoon dresses, slips, and hose; and four household textiles: window curtains, blankets, sheets, and towels were used in the study. By questionnaires, information was secured from home makers buying in cities and in small towns. The data were collected over a period of a year and a half. A total of 5,738 usable questionnaires were assembled from 54 of the 115 counties of the State.

**The Income of Columbia Families (Jessie V. Coles, Esther McGuire).**—The incomes of 564 Columbia families have been studied. The average size of incomes of all families was $2432.00, over three-fifths receiving less than $2500.00 annually, almost one-half had less than $2000.00 and 30% less than $1500.00. One-eighth of the families studied had less than $1000.00 per year income. About one-tenth had incomes between $3500.00 and $4500.00, and another tenth over $4500.00. One-fourth of the families studied were classified as salaried professional. In another one-fourth of the families, the main contributor was a wage-earner. About one-fourth of the families depended upon business occupation and the remaining one-fourth were clerical workers.

The study included a higher proportion of salaried professional and a lower proportion of wage earners than was typical of the city as a whole. Almost all of the families studied were largely dependent upon earnings of the different members of the family.

Only about 5 per cent of the total income of all families was money received from sources other than earnings. Wives contributed 4.3 per cent of the earning and other members of the family than the wife or husband contributed 2.4 per cent. Therefore, the husbands in the families constituted by far the most important contributors to the family income.

It was revealed that 96 per cent of the husbands had finished at least eighth grade school, 73 per cent had finished high school, 60 per cent had had further schooling, and 35 per cent had finished college.

In general, the income of the family was in proportion to the amount of education of the income earners. One-third of all families consisted of three members, between one-fourth and one-fifth consisted of two members only. More than one-fourth of the families
studied had over four members and the remaining one-sixth had five, six, or seven members. Of the members of the families other than husbands and wives 69 per cent were under 16 years of age. The average age of all husbands was 43 years, and that of wives was a little over 39 years.

The wage-earning families had the lower income and the greatest economic burden as indicated by size composition of family. The highest income groups had the smaller family.

**HORTICULTURE**

*T. J. Talbert, Chairman*

**Complete Fertilization of Apple Trees** (A. E. Murneek).—Wealthy and Jonathan trees, growing on loess soil under sod culture and receiving, in addition to nitrogen, normal and 2 x normal amounts of potassium and phosphorus, have not shown any significant effect in growth and fruit production after seven consecutive years of fertilization. Around half of the trees, the fertilizer had been spaded in each year to a depth of 12-15 inches.

Twigs and fruit spurs 1 to 3 years old were collected from all of the trees in the fertilizer experiment and analyzed chemically for the relative concentration of potassium and phosphorus. Those trees receiving the potassium fertilizer showed a very marked increase of potassium in the spurs and in the twigs. Concentration of potassium was noticeably higher in the plant material from trees around which the fertilizer was broadcast. Apparently the spading in of the potash was of no particular value to the tree.

Whether broadcast or spaded in, there was no significant difference in the relative amount of phosphorus in the spurs and twigs of trees receiving superphosphate.

**Virus Diseases of Plants** (C. G. Vinson).—A definite crystalline active fraction of the virus of tobacco mosaic has been obtained by salting the virus out of acidified aqueous solutions using solid anhydrous sodium sulfate or by the addition of a small amount of a saturated aqueous solution of aluminum sulfate. The crystalline fraction contains about 1 per cent ash and about 16 per cent nitrogen. The product was highly infectious.

All visible pigment was removed from the fraction by dispersing the M crystals in neutral phosphate solution then adding a volume of ether equal to about thirty per cent of the volume of the dispersion. On shaking vigorously, the pigment concentrated on the surface of the ether droplets, and was carried to the top as the ether rose. The ether and pigment were then easily drawn off.
Improvement in Determination of Total Nitrogen (A. E. Murneek, P. H. Heinze).—Speed and accuracy are important features in nitrogen determination. A modified Kjeldahl procedure for the determination of total N was perfected and satisfactorily used on a variety of soils and plant material. It consists in the use of .1 gram of selenium + .25 grams copper sulphate + .7 grams of mercuric oxide as catalysts in the total nitrogen determination by the Kjeldahl-Gunning-Arnold method.

The new procedure is very accurate and hastens the digestion time.

Control of Biennial Bearing of Apples (A. E. Murneek).—Wealthy trees which have acquired a decidedly biennial bearing habit, have been subjected to a drastic experimental treatment in order to break their fruiting in alternate years. Heavy fruit thinning in the bearing year has been followed by severe pruning and application of nitrogen fertilizers in the fall of the “on” years and the spring of the “off” years.

The drought in 1936 and a heavy late frost in the spring of 1938, both have affected adversely this investigation. No decided effect has been observed which may be attributed to the experimental treatment. The trees continue to alternate in their manner of fruiting. A block of Golden Delicious trees which are also biennial bearers, have been included in this investigation.

Grape Nutrition (H. G. Swartwout).—Concord grapes have been fertilized by pumping 1½ pounds of sulfate of ammonia per vine into the soil with a watering rod attached to a large orchard sprayer. Analyses of the various parts of the vines, roots, trunks, sections of the canes, and leaves have been made on the plants so treated. The analyses showed identical percentages of nitrogen in corresponding parts of plants. This corresponded with previous trials with fertilizers in a bearing vineyard in which the nitrogen showed no measurable effect on growth and no percentage increase of nitrogen in the vine parts. When young Concord vines were grown in the tubs until it was evident there was an acute shortage of nitrogen, there was a considerable increase in the percentage of nitrogen in all parts of the vines when nitrogen was applied.

Cabbage Variety Trials for Disease Resistance and Fertilizer Requirements (R. A. Schroeder).—Date of maturity and yield records were obtained on twenty-one varieties of cabbage on soil which was free from cabbage yellows. The yellows-resistant varieties were compared with susceptible varieties having approximately the same dates of maturity. The resistant varieties were quite as satisfactory as the more commonly planted susceptible varieties.

Plantings on yellows-infected soil demonstrated the resistant properties of such varieties as Jersey Queen, Marion Market, and Globe, and the lack of satisfactory resistance in such varieties as Golden Acre, Copenhagen Market, Glory of Enkhuizen, and Resistant Detroit.
Varieties of Melons (R. A. Schroeder).—Increased plantings of Fusarium-wilt-resistant varieties of watermelons, Improved Kleckley Sweet No. 6, and Improved Stone Mountain No. 5, substantiated previous results that these varieties had sufficient quality to meet market demands, along with their wilt resistant characteristics.

The Japanese varieties, Honey Cream, Japanese Honey, and Sweet Japanese, were the better home garden melons.

Greenhouse Crops (R. A. Schroeder).—The effect of root temperature upon the growth of cucumbers in greenhouses has been studied by growing the crop at several different root temperatures. Cucumbers will not make a satisfactory growth at a soil temperature of 60° F.

Temperatures of 70° F. and 85° F. produced as good a growth as occurred under good commercial production conditions.

The occurrence of the leaf and fruit injury which caused severe commercial losses was induced by lowering the temperature to 60° F. and prevented by maintaining a soil temperature of 70° F. or above.

The amounts of water absorbed by the plant were significantly higher at the higher temperatures.

In connection with greenhouse tomatoes, one of the principal problems concerns the poor set of tomatoes under normal fall conditions. Growth promoting substances have been applied to the tomato flowers. The set of tomato flowers which occurred under the treatment in which indoleacetic acid in lanum paste was spread over the ovary and cut style in two applications compared favorably with the set of flowers obtained under normal and hand pollination.

Tomato Variety Tests (R. A. Schroeder).—Two new varieties that demonstrated good possibilities for use in Missouri are Stokesdale and Brown's Special.

Fertilizer results on tomatoes showed that complete fertilizer was of much greater value than any of the elements individually applied. Preliminary tests have been made on the importance of calcium in the growing of tomatoes.

Tomato wilt tests again demonstrated that Break O'Day, Pritchard, and Marglobe were the leading wilt-resistant varieties for Missouri. A new selection from New South Wales, 38470 No. 114, showed considerable resistance.

Cultural Experiments with Irish Potatoes (R. A. Schroeder).—The effects of nitrogen, phosphorus, potassium, and calcium individually and in combination on the growth of Irish potatoes have been studied.

The results this year were affected seriously by the flooding of the field which occurred the day following the planting.

Observations suggested that a complete fertilizer was better than the elements used individually.

Seed which received the greensprouting treatments had a considerably earlier date of emergence, and apparently a small resultant increase in total yield.
Vitamin Content of Plants as Influenced by Cultural Treatment (C. G. Vinson).—Apples, pears, peaches, plums, and grapes are much lower in vitamin C content than the strawberry.

Sweet corn had about the same content of vitamin C as tomatoes. Some of the crossed sweet corn varieties such as Golden Cross and Bloom Cross were higher in vitamin C than Golden Bantam, Country Gentleman and Stowell’s Evergreen. Ripe fruit of tomato was higher in vitamin C than the green fruit.

Young tender pods of snap beans were lower in vitamin C content than older pods. Green seeds of Henderson’s bush lima bean were not quite as high in vitamin C content as the seeds of snap beans.

Varieties of the garden pepper such as Harris’ Early Giant and Ruby King had a high content of vitamin C, especially toward maturity. A marked increase was associated with changing of the color of the fruit from green to red. The ripe fruit of the garden pepper was much higher in vitamin C than citrus fruits.

Well developed but green fruit of many varieties of the persimmon was fully as high in vitamin C content as ripe fruit of the garden pepper. The ripe fruit of the persimmon was not quite so high in vitamin C. Green, fully developed leaves of the persimmon were five to ten times higher in vitamin C than the green fruit, and hence five to ten times higher than mature fruit of the garden pepper. Mature leaves of the persimmon were apparently much higher in vitamin C than any other product yet reported.

Substitutes for Arsenical Sprays (H. G. Swartwout).—Pheno-thiazine and bentonite fixed nicotine has been used as arsenical substitutes for the control of codling moth on apples. Zinc arsenate has been used as a non-lead arsenical.

Lead arsenate 1-50 was used in the calyx application and followed by phenothiazine and the nicotine combination respectively in all subsequent sprays. No fungicide was used in the phenothiazine and fixed nicotine sprays. Tests were made in two orchards. Codling moth entries were greatly reduced as compared with an untreated check, but the material was less efficient than lead arsenate. The fruit of Jonathan to which phenothiazine was applied were apparently reduced in size and somewhat off color. Golden Delicious fruit receiving this spray was much smaller than that from adjoining trees, but there was no noticeable effect on color.

Zinc arsenate was used after the calyx spray which was lead arsenate 1-50. The zinc arsenate was used at 3-100 in the first and second cover sprays and at 2-100 in subsequent sprays. It was used with a 2-2-100 zinc sulphate-lime mixture to reduce burning. There was a high percentage of worms and stings with the zinc arsenate used in this way. The zinc lime mixture seemed to greatly reduce the efficiency of the zinc arsenate.

The bentonite-nicotine combination treatment showed a low worm infestation, but the codling moth population was so low in this plot that results were not conclusive.
Sweet Cherries in Missouri (T. J. Talbert).—Investigations at Columbia have shown that early blooming in sweet cherries was the cause for unfruitfulness. Tests of sweet cherries have been started in peach growing districts.

Relation of Age to Performance of Apple Branches (A. E. Murneek, D. G. White).—An effort has been made to measure the difference in size and color of apples produced on inside and outside portions of an apple tree. Observations were made on King David, Winesap Jonathan, and Rome trees, and showed that: (1) more commercially desirable fruit was produced on middle-height limbs than on low limbs; (2) pruning increased the number of apples borne on both low and middle limbs; (3) tipping of twigs markedly reduced the set of fruit. The largest number of flowers bore fruit when located on wood five to seven years old.

On the inside portion of the tree, a larger leaf area produced smaller fruit than a smaller leaf area at the periphery. Differences in thickness of the leaves and wide variations in light intensity were associated with size of apples in relation to their location on the tree.

Branch Ringing as a Means of Affecting Fruit Set in Apples (A. E. Murneek).—A number of large branches from Minkler and Arkansas varieties of apples, were ringed at the time of full bloom by removal of a strip of bark $\frac{1}{4}$ inch wide. The wound was covered at once with grafting wax.

There was an immediate increase in set of fruit in both varieties, which persisted until the time of harvest. The increase in yield of the ringed branches of the Arkansas variety was more than doubled, which was not only unexpected but extraordinary in scope. The ringing did not change significantly the seed number, and it evidently influenced the fruit directly. Branch ringing seemingly stimulated vegetative growth also. More recent investigations on ringing of the large limbs of the Rome and other varieties of apples have shown that it not only increased the set, but also the size of the fruit. It was quite evident that there is a favorable effect from ringing even when executed quite late in the season.

Photoperiodism and Enzyme Activity in the Soybean Plant (A. E. Murneek, A. D. Hibbard).—Changes in activity of the enzymes, catalase, peroxidase, invertase, amylase, and reducase, were studied in soybean plants when grown under a 7-hour day and a 14-hour day from germination until the plants under the shorter light period had produced flowers.

The activities of most of the enzymes studied were depressed in the beginning under the short-day treatment. Later, there was an increase under this treatment which continued as long as the plants were exposed to day-light periods of different lengths.

Invertase and peroxidase began to increase in activity as soon as five days after the treatments were started. Catalase was depressed
for 15 to 20 days, and then became more active in the leaves of the reproductive plants. The depression of catalase was greatest in the tip of the stem. Changes in enzyme activity in the tip of the stem were similar to those observed in the leaves but occurred several days later.

Amylase and reducase did not seem to be affected by the length of the daily light period.

**Tests for the Possible Presence and Effects of Catalysts (Hormones) in Sexual Reproduction** (A. E. Murneek).—Previous investigations have shown that there is a relationship between the concentration of carotinoid pigments (carotene and xanthophyll) and the development of floral organs in the soybean plant. Since carotene is considered to be a precursor of vitamin A, which has been shown to be connected with sexual reproduction, attempts have been made to introduce both carotene and vitamin A in various concentrations into vegetative plants. Applications of these substances were made to the underside of scarified and non-scarified leaves and to stems, at close intervals over a prolonged period in the form of a lanolin emulsion. Freshly prepared and frozen extracts of sap of plants in various stages of reproduction also were used for a similar purpose and in the same manner, since there is some evidence for the presence of a flower producing hormone ("florigen").

The results were negative. Neither long-day soybean plants, nor short-day *Rudbeckia* were made to produce flowers as a result of this treatment.

**The Relation of Photoperiodic Induction to Photoperiodic Inhibition** (A. E. Murneek).—Earlier experiments showed that when *Rudbeckia bicolor* plants, after a preliminary exposure to a long day, were exposed to a short day growth was inhibited, but sexual reproduction took place. Short days do not permit either vegetative development or reproduction in this species. It is possible through photoperiodic induction to obtain flowering plants of various heights, forms, and types of flower development.

A relatively high temperature (90-100° F.) had a morphological effect on *R. bicolor*. It induced flowering of short-day rosette plants, which, under normal temperatures, (70-80° F.) remained vegetative almost indefinitely. Therefore, by growing under combinations of certain photoperiods and temperatures, it was possible to obtain still other forms of plants. In respect to sexual reproduction, *R. bicolor* was attuned in nature to both the photoperiod and the temperature.

**Christmas Trees as a Crop** (R. H. Westveld).—Experimental plantations of several desirable species of trees used for Christmas trees have been made in three different localities near Columbia. The species investigated include Douglas Fir, Balsam Fir, Southern Balsam Fir, White Spruce, Norway Spruce, Eastern Red Cedar, and Jack Pine.
Increasing the Durability of Fence Posts (R. H. Westveld).—The purpose of this study is to determine the species of trees that may be used effectively as fence post material when properly treated with wood preservative, and also to determine the technique of effective preservation which is most adaptable for use by farmers. Twelve common species have been selected, several of which occur in every woodlot, for the species adaptability test. Two of these, black oak and basswood, both notably nondurable, have been selected for a series of 15 different treatments involving seven common preservatives and varying lengths of time in treatment. With a total of 320 posts cut and seasoned for treatment, 10 posts of each of two species of wood have been given each of the preservative treatments. These treated posts have been set, and records of durability will be maintained.

Artificial Propagation of Forest Trees and Shrubs (R. H. Westveld).—Plantations of seedling trees have been planted on the University Wildlife Area east of Ashland. Shortleaf, Ponderosa, White, Red, Pitch, and Jack Pine, Southern Cypress, Black Locust, Green and White Ash, White Oak, Silver Maple and Shagbark Hickory have been established in both pure and mixed stands. Planted areas are permanently worked, and maps prepared for all plots. Growth data and survival counts are made each year.

In addition to plantations of seedling trees, direct seeding of black walnut has been made at depths varying from 1½ to 6½ inches, using both hulled and unhulled nuts, and using different seed treatments to repel rodents.
Normal Growth of Chickens (H. L. Kempster).—Records on the growth of New Hampshire pullets indicated that this breed possessed the ability to accumulate weight rapidly when young. The following table shows the weights at various ages as compared with Rhode Island Reds and White Leghorns.

<table>
<thead>
<tr>
<th>Age in Weeks</th>
<th>New Hampshires</th>
<th>R. I. Reds</th>
<th>White Leghorns</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>42 grams</td>
<td>41.5 grams</td>
<td>39.7 grams</td>
</tr>
<tr>
<td>4</td>
<td>238 &quot;</td>
<td>186 &quot;</td>
<td>154 &quot;</td>
</tr>
<tr>
<td>8</td>
<td>658 &quot;</td>
<td>425 &quot;</td>
<td>488 &quot;</td>
</tr>
<tr>
<td>12</td>
<td>1137 &quot;</td>
<td>859 &quot;</td>
<td>757 &quot;</td>
</tr>
<tr>
<td>16</td>
<td>1519 &quot;</td>
<td>1195 &quot;</td>
<td>955 &quot;</td>
</tr>
<tr>
<td>20</td>
<td>1873 &quot;</td>
<td>1449 &quot;</td>
<td>1162 &quot;</td>
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<td>24</td>
<td>2143 &quot;</td>
<td>1692 &quot;</td>
<td>1352 &quot;</td>
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<td>28</td>
<td>2305 &quot;</td>
<td>1964 &quot;</td>
<td>1478 &quot;</td>
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<td>32</td>
<td>2374 &quot;</td>
<td>2215 &quot;</td>
<td>1550 &quot;</td>
</tr>
<tr>
<td>36</td>
<td>2435 &quot;</td>
<td>2381 &quot;</td>
<td>1573 &quot;</td>
</tr>
<tr>
<td>40</td>
<td>2526 &quot;</td>
<td>2480 &quot;</td>
<td>1557 &quot;</td>
</tr>
</tbody>
</table>

At the age of 12 weeks, the New Hampshires weighed a half pound more than did the Reds. There was a pound difference in their weight at 24 weeks, but by the age of 40 weeks both breeds weighed practically the same.

For the production of market chickens, such as broilers, the use of a breed which grows rapidly at a young age is highly desirable.

The Rate of Growth of Rhode Island Red Pullets Infected with Paralysis or Leukemia (H. L. Kempster).—Rhode Island Red pullets that developed paralysis or leukemia grew at the same rate as did birds not affected by these diseases. This confirmed earlier observations with reference to White Leghorns. The study included all pullets which were diagnosed by the Veterinary Department for a six year period and the growth experienced by these birds indicated that they grew at a normal rate.

Nutritional Requirements of Turkeys (E. M. Funk).—The effect of ration on the occurrence of slipped tendons in turkeys is shown in Table 5.

<table>
<thead>
<tr>
<th>Protein Supplements</th>
<th>Number of Turkeys</th>
<th>Slipped Tendons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean oil meal</td>
<td>97</td>
<td>3</td>
</tr>
<tr>
<td>Soybean oil meal and 2% bone meal</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>Cottonseed meal</td>
<td>66</td>
<td>2</td>
</tr>
<tr>
<td>Corn gluten meal</td>
<td>69</td>
<td>9</td>
</tr>
</tbody>
</table>

These data indicated that the occurrence of slipped tendons in turkeys was greater when additional bone meal was added to the ration and when corn gluten meal was substituted for soybean oil meal.
Growth data also showed that soybean oil meal was superior to corn gluten meal or cottonseed meal as a protein supplement for turkeys when used in conjunction with meat scrap and dried milk.

Factors Influencing the Hatchability of Hen’s Eggs (E. M. Funk).—The shell breaking strength, percentage of thick white and the height of thick white, the yolk color and the percentage of yolk, have been studied in relation to the hatchability of hen’s eggs. Measurements made during the hatching season with fresh laid eggs indicated that these characters were not related to the hatchability of eggs.

Artificial Propagation of Game Birds (E. M. Funk).—Table 6 shows the number of eggs laid per month by each of twelve different quail.

Table 6.—Eggs Laid by Quail by Months

<table>
<thead>
<tr>
<th>HEN</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Died</td>
<td>2</td>
<td></td>
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<tr>
<td>May</td>
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<td></td>
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<tr>
<td>June</td>
<td>1</td>
<td>16</td>
<td>23</td>
<td>16</td>
<td>5</td>
<td>2</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>July</td>
<td>3</td>
<td>13</td>
<td>13</td>
<td>22</td>
<td>27</td>
<td>16</td>
<td>13</td>
<td>8</td>
<td></td>
<td>6</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>August</td>
<td>5</td>
<td>16</td>
<td>15</td>
<td>16</td>
<td>28</td>
<td>12</td>
<td>10</td>
<td>16</td>
<td></td>
<td>5</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>September</td>
<td></td>
<td>14</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>30</td>
<td>28</td>
<td>54</td>
<td>95</td>
<td>47</td>
<td>28</td>
<td>25</td>
<td></td>
<td>35</td>
<td>53</td>
<td>23</td>
</tr>
</tbody>
</table>

The wide variability in egg production indicated the possibility of breeding quail which possess the ability to lay a large number of eggs.

It also was found that the feed consumption of quail and chukar partridges varied with production, being approximately 50 per cent greater when the females were laying eggs.

The Effect of Feather Mites on Egg Production (H. L. Kempster).—A severe outbreak of feather mites in November in a 20 x 20 Missouri poultry house caused egg production to drop from 53 per cent to 2.3 per cent. The birds were treated by dusting with sulphur, and in February production averaged 54 per cent. In spite of this handicap, the birds laid 68 eggs between September 26 and April 10, as compared with 76 eggs in a two story house where the outbreak did not occur.

Nutritional Requirements of Poultry (H. L. Kempster).—White Leghorn pullets fed all mash rations varying in amounts and sources of vitamin A showed variation in egg production dependent upon the proportion of yellow corn, alfalfa leaf meal, and cod liver oil in the rations. The results are comparable to those reported for previous years. The basal ration containing 65 per cent yellow corn produced 73 eggs per hen from October 10 to July 4. The remainder of the ration consisted of dried skim milk, 2; meat scrap, 8; and ground wheat and shorts in various amounts to bring the total to 100%. A substitution of 30 pounds of white corn for an equal amount of yellow corn resulted in a slight decrease in egg production. The addition of 10 per cent alfalfa leaf meal resulted in a marked increase in production which may be attributed either to the increased vita-
min A or possibly vitamin G content of the ration. A similar increase in egg production was experienced when the changes involved the addition of 5 per cent alfalfa and 1 per cent cod liver oil. This would indicate that the increased egg production was due to some extent to the A content of the ration. The addition of 2 per cent cod liver oil to the 35 per cent yellow corn ration resulted in egg production slightly below the other groups receiving 10 per cent alfalfa leaf meal or 5 per cent alfalfa and 1 per cent cod liver oil.

The use of ground barley as a substitute for yellow corn meal resulted in slower growth and an excessive mortality among baby chicks. The regular Missouri all mash formula is as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow corn meal</td>
<td>54</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>10</td>
</tr>
<tr>
<td>Wheat shorts</td>
<td>15</td>
</tr>
<tr>
<td>Alfalfa Leaf Meal</td>
<td>5</td>
</tr>
<tr>
<td>Dried milk</td>
<td>5</td>
</tr>
<tr>
<td>Salt</td>
<td>1</td>
</tr>
</tbody>
</table>

In one pen ground wheat and in another ground barley was substituted for the yellow corn. New Hampshire chicks were used. At the age of 8 weeks the males weighed 785, 723, and 667 grams respectively for the corn, wheat, and barley fed chicks. The corresponding females weighed 723, 628, and 590 grams respectively. Mortality for the barley fed lot was 36 per cent as compared to 2 per cent for the other two groups. Mortality was exceedingly high especially during the first two weeks of the experiment. Apparently something was radically wrong with the barley fed lot. Post mortem examination showed that the hulls of the barley were causing compaction in the intestines.

The Feed Purchasing Power of Eggs Laid by a Hen (H. L. Kempster).—The year 1937 showed the most unfavorable relationship between egg and feed prices that has prevailed since 1910 and possibly for a much longer period. The eggs laid by a 122-egg hen would purchase 101 pounds of feed as compared to 142 pounds for the period 1910-1933. The egg-feed ratio was 9.78 which was slightly higher than for 1934 when feed was relatively high and eggs relatively low. While the average price of eggs per dozen for 1937 was 17.8 cents, a half cent lower than for 1936, the price of feed was 14 per cent higher. There was a marked decline in feed prices from the April peak so that by the end of the year the relationship between feed and egg prices was approaching normal. The following table shows a comparison with the preceding years:

<table>
<thead>
<tr>
<th>Year</th>
<th>Average farm price of feed per 100 pounds</th>
<th>Average farm price of eggs per dozen</th>
<th>Pounds of feed 122 eggs would purchase</th>
<th>Egg-Feed Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1931</td>
<td>.98</td>
<td>14.4</td>
<td>146</td>
<td>6.95</td>
</tr>
<tr>
<td>1932</td>
<td>.58</td>
<td>10.8</td>
<td>196</td>
<td>5.87</td>
</tr>
<tr>
<td>1933</td>
<td>.60</td>
<td>10.2</td>
<td>148</td>
<td>7.80</td>
</tr>
<tr>
<td>1934</td>
<td>1.27</td>
<td>18.6</td>
<td>116</td>
<td>9.34</td>
</tr>
<tr>
<td>1935</td>
<td>1.50</td>
<td>20.6</td>
<td>122</td>
<td>7.20</td>
</tr>
<tr>
<td>1936</td>
<td>1.52</td>
<td>18.3</td>
<td>122</td>
<td>8.20</td>
</tr>
<tr>
<td>1937</td>
<td>1.74</td>
<td>17.8</td>
<td>101</td>
<td>9.78</td>
</tr>
</tbody>
</table>
The Best Systems of Soil Management for the Most Important Soil Types in Missouri (M. F. Miller, H. H. Krusekopf, G. E. Smith).—
Results for the past ten years secured from the experiment field at Newtonia, Missouri, have been summarized and published as Missouri Agricultural Experiment Station Bulletin 395, "Soil Fertility Investigations on the Brown Limestone Land of Southwestern Missouri." The results showed that there was danger in turning under ordinary straw if it was not supplemented with other plant nutrients. Turning under three tons of straw had an injurious effect on succeeding crops. Management of this soil demanded the use of not only limestone and green manures, but also of fertilizers and improvement in the organic matter supply in the soil resulted in better yield. Straw alone was detrimental, but converted into manure and used in this form it was an effective help for wheat yields.

Data on the experiment field at Eldorado Springs have been published as Missouri Agricultural Experiment Station Bulletin 396, "Soil Fertility Investigations on Rolling Prairie Land of Southwestern Missouri." Needed changes in the cropping system used were suggested. These changes gave less emphasis to corn and more emphasis to the fall seeded grains such as wheat, barley, soy beans, lespedeza, timothy, and orchard grass. The harvesting of these crops by means of livestock was encouraged. Raising the level of organic matter in the soil through the use of sod crops and manures and with heavier applications of fertilizers on the winter cereals has made it possible to develop an improved type of farming on this soil.

The various outlying experimental fields are serving as demonstration fields, and meetings of farmers in the surrounding areas are being held at these fields from time to time.

The Improvement of Permanent Pastures (H. H. Krusekopf, G. E. Smith).—This project is in cooperation with the departments of animal husbandry and field crops.

Some of the original grass areas on the University South Farms have been tested for improvement in permanent pastures by the use of fertilizer. There has been a decided increase in clovers where both lime and phosphate have been used. The use of these materials, particularly phosphate, as surface dressings has not been as effective in establishing better grass as where these materials have been put directly into the soil. Nitrogen applications have not given significant yield increases, but have brought the blue grass into prominence in the flora, if lime and phosphate accompany them. Chemical analyses of the grasses have been made to determine whether or not there are effects other than tonnage increase from soil treatments. Animal assays are being made to determine the value of soil treatments on permanent pastures.
 Increasing the Productivity of Missouri Pastures (M. F. Miller, W. A. Albrecht, C. E. Marshall).—This project is in cooperation with the departments of agricultural chemistry, animal husbandry, dairy husbandry, and field crops.

There is a wide variation in the fertility of different Missouri soils as measured by the growth of sweet clover, lespedeza, bluegrass, and redtop. In order to test the response to two fertilizers, lime and phosphate, experiments have been started on the Putnam silt loam from the University South Farms. One experiment using the four crops, sweet clover, lespedeza, bluegrass, and redtop, has been started. In order to secure a direct comparison between field and green house results small replicated field plots using the same soil have been planted to bluegrass and redtop.

Studies with Nitrogen and Carbon in Soils Under Different Systems of Soil Treatment and Management (M. F. Miller, W. A. Albrecht).—The original plan for this project provided for two groups of plots, one on a rather level, uneroded upland, and the other on a similar but more sloping soil on which erosion was an important factor. The nitrogen content of the more level soil at the outset averaged 2740 pounds per acre 2,000,000 pounds. The cropping systems have included rotations as well as continuous sod and legumes.

A Standard corn, wheat, clover rotation failed to increase the nitrogen content materially even when manure was applied, while continuous sod, left on; continuous alfalfa, removed; and continuous clover, left on raised the nitrogen content of the more level plot an average of approximately 250 pounds per acre. Continuous rye grown and turned under annually permitted a nitrogen decline of approximately 700 pounds.

Apparently a nitrogen level of about 3000 pounds in the surface 2,000,000 pounds of an acre is about the maximum that can be expected of this soil in this climate, even when rather intensive systems of supplying nitrogen and organic matter are employed. Therefore, a large increase of nitrogen and organic matter cannot be anticipated with the usual rotation system. It seems more important to consider the nitrogen turnover than the matter of a high nitrogen maintenance. These results are based on observation covering a period of 20 years.

Effects of Different Soil Treatments, Long Continued, Upon Bacterial Activity in the Soil (W. A. Albrecht).—A study has been made of the so-called “degree of lignification” of organic matter residue from the soil. This study has been made from the differences in nitrogen and carbon in the soil before and after treatment with 80 per cent sulphuric acid. Previously sod had been compared with continuous wheat. During the first year, four continuous wheat plots and three wheat plots in a four year rotation were studied. If non-lignified organic matter were considered as the only part that was broken down to liberate its content for plant use, the lowest supplies of usable organic matter were present in the soil with continuous
wheat without manure, followed by that in wheat given complete fertilizer, and next by that with wheat given sodium nitrate. These three varied only within a ton per acre of total usable organic matter. In the soil of the plots under continuous wheat with manure, the four year rotation with no treatment, the four year rotation with commercial fertilizer and with fertilizer plus limestone, there was a higher level of this kind of organic matter by three tons than in the continuous wheat plots, and agree within a variation of less than a ton and a half. The limed soil was shown to be slightly lower in the supply of usable organic matter. The extensive chemical procedure involved in these studies has confined the work to about six plots annually.

Laboratory studies on the nitrification in the soil from various plots have been completed and they are now available in thirty-nine studies, involving twenty-eight individual plots. These summarized studies show that the kind of cultivated or tilled crop was of little influence on the nitrification level in the soil. Soil treatments, however, were important in determining this level. Liming, phosphate, and fertilizer additions were distinctly beneficial on the soil's capacity to handle green manure additions resulting in the productions of nitrates.

Crop Rotation and Fertilizer Experiments (M. F. Miller, H. H. Krusekopf, W. A. Albrecht, C. E. Marshall, G. E. Smith).—The year 1938 marked the close of a 50-year period of studies of different systems of cropping and soil treatments as they reflect themselves in the crop yields and the soil conditions. The soils were sampled for accurate chemical studies. The plan now has been completely revised so that additional information on these soils may be secured. For example, limestone has been withheld in many cases where we now know it should have been used long ago. In other cases phosphates have been withheld. These will be applied to the soil with additional modifications as results to date indicate.

The studies on Sanborn Field have given some striking results as follows:

1. Continuous use of heavy applications of commercial fertilizer for 50 years has not shown detrimental effects measurable in the soil's physical condition.
2. Continuous wheat without additions to the soil have given a decline in yield of about 10 bushels per acre during the 50-year period.
3. Continuous corn without soil treatment has given a decided decline in the yield and with it a reduction in the nitrogen content of the surface soil by about one-half.
4. Continuous timothy under similar conditions has shifted the flora to one consisting largely of weeds. Manuring the sod has maintained the timothy flora distinctly.
5. Oats without treatment have yielded less than 20 bushels per acre as an average for 50 years.
6. During the 50 years, the regular introduction of clover into the rotation of corn, oats, wheat, and clover has served to maintain the crop yields at the level of that where these separate crops were grown continuously with heavy annual applications of manure.

7. Nitrification processes now are at a low level under all continuous cropping without soil treatment, but are improved more as legumes occur more often in the rotation.

8. Microbiological transformations in the soil are enhanced by addition of lime and phosphate, so that these treatments mean the delivery of more nitrate nitrogen to the soil by the crop.

9. These fertilizer additions suggest more complete organic matter decay in the soil, since lignification of the organic matter in the soil is highest, or the organic matter consists mainly of this decay-resistant residue, lignin, as the microbial diet is balanced by soil treatments, including lime and phosphorus.

10. The manured plots have a higher exchange capacity by about 2 M.E. per 100 gms. of soil.

11. Depletion of the exchangeable calcium is distinctly evident on some plots.

12. The soils have become more acid.

Fertilizer Investigations on the South Farm (M. F. Miller, H. H. Krusekopf, W. A. Albrecht, C. E. Marshall, G. E. Smith).—A heavy infestation of rust and severe winds and rain caused the wheat to lodge and nullified any significant differences in yields. Those fertilizer ratios containing a large quantity of nitrogen retarded maturity and resulted in a smaller yield and poorer grain quality than those where nitrogen was omitted.

Superphosphate gave as satisfactory a yield as any of the ratios. Though corn in the fertilizer ratio studies was planted late, it made excellent yields. The superphosphate resulted in a four and one-half bushel increase while most of the complete fertilizer ratios brought increases from seven to ten bushels.

In the barley studies the crops made excellent growth in the fall and showed more effects of the fertilizer than did wheat.

An extensive investigation has been started on the use of different phosphates on small grain. Practically all available sources of phosphates were used in replicated plots in equivalent amounts on wheat, barley, on both limed and unlimed land. Wide variations have been evident during the winter and spring seasons.

A number of pasture fertilizer experiments have been started. Applications of phosphate ranging from 100 to 4,000 pounds have been made on bluegrass pasture both with and without nitrogen and potash. The only visible effect noticed was the increased growth and depth of color resulting from the applications of nitrogen. Another pasture fertilization study included various ratio applications applied in replica. One harvest has made on these plots with differences varying from 500 to 800 pounds of dry matter. Nitrogen alone or
nitrogen with phosphorus gave the largest increases. The return from potash was very small.

**Limestone as a Source of Calcium** (W. A. Albrecht).—Calcium has demonstrated its importance in nitrogen fixation in legumes not only through its direct role in the plant, but indirectly by its significance in making phosphorus and possibly potassium of more effective service. The use of phosphorus and potassium in the early life of the soybean plant has been found to be dependent on the calcium level.

The study of the activity of magnesium in connection with the constant calcium level has shown that higher magnesium levels were more effective than nitrogen fixation by soybeans. This suggested that magnesium may be more effective through its influence in bringing about more efficient calcium utilization.

**Land Classification in Missouri** (H. H. Krusekopf, E. M. Springer).—A method has been developed for classifying all land on the basis of physical factors. The application of the method in a survey of land in Linn and Chariton counties has been satisfactory. An accurate land classification must be based on a detailed soil classification.

The soil features that were most significant in determining land use were the criteria for the various land classes. Texture, structure, fertility, drainage, and erosion and relief were the principal soil features considered. These are permanent characteristics and give permanent value to the land classification.

Seven classes or categories were established for use in the land classification scheme. These have been found to be sufficient for a detailed grouping of the various land types. Each major class was further divided into subclasses on the basis of a soil factor that was significant in limiting the use of the land. For example, in land class III there may be subdivisions according to erosion, texture of the soil, or other soil factors affecting land use.

Under favorable conditions and with experienced personnel, an average of 10 square miles can be classified per man per day. The scale of the maps used was the same as that of the soil classification maps.

**Soil Erosion Studies** (H. H. Krusekopf, C. M. Woodruff).—Since the close of the original investigation covering the measurement of erosion losses under different systems of cropping and cultural practices, the seven original plots have been carried in fallow uncropped condition to determine the influence of the previous systems on erosion losses. The differences in content of organic matter, in granulation and in soil depth should have a direct influence on erosion losses. If these plots were maintained in a bare, cultivated condition, these differences could be accurately measured.

These measurements have been made and while in general the results were in accordance with expectation, there was one marked peculiarity. The plots formerly under crops have eroded to a greater extent under fallow than under the cropping systems and in about
the same relative order except that one formerly in rotation has eroded to a much greater extent than was anticipated. As a matter of fact it has lost soil in larger amounts than the plots previously in continuous corn or wheat and in very much larger amounts than the plot previously in continuous sod. No satisfactory reason has yet been discovered for this difference.

The length of slope and degree of slope erosion studies were concluded this year after ten years data had been secured. The length of slope studies showed that for continuous corn the runoff per unit area decreased as the length of slope increased, while the erosion losses increased with slope length. The degree of slope studies showed that under continuous corn, doubling the per cent grade, increased the runoff more than twice and the erosion about nine times.

A greenhouse installation has been made for standardized measurements. The apparatus provided for regulated applications of water as artificial rain and a plot of soil adjusted to various degrees of slope. With this apparatus it has been possible to establish certain definite principles regarding runoff and erosion, and the results of this investigation have been published as Missouri Agricultural Experiment Station Research Bulletin 280.

**Finely Ground Limestone for Agricultural Purposes (W. A. Albrecht).—**Different calcium salts and different amounts and degrees of fineness of limestone have been drilled with sweet clover seeding for comparison. Differences in crop stand and thriftiness were indicated by less reddish stems and were in favor of the heavier dosages of limestone whether drilled or broadcast.
The heavier, broadcast applications of two and three tons per acre were most successful in getting a stand and in carrying a good clover through the winter. The use of 600 pounds of finely pulverized stone drilled with the sweet clover produced a good crop. Drilling as little as 300 pounds of "Mill-run ten-mesh" limestone has been strikingly successful. Drilling limestone that is ordinarily available deserves more attention. The slower solubility of a portion of the stone may be advantageous in the second year.

Chemical studies have been made which indicate a similar nitrogen content where limestone was drilled as where heavy applications were used.

The Properties of Colloidal Material in Missouri Soils (C. E. Marshall).—The mechanical fractionation of different soils has continued along with mineralogical and physico-chemical investigations of the clay fraction. The colloidal properties of the clay were found to be closely related to their mineralogical structure.

On the physico-chemical side a new membrane electrode has been developed which is designed to give information regarding ionic calcium, potassium, sodium, and magnesium in their relationship to soil colloids.

Improving Heavy Clay Subsoil (C. E. Marshall, E. Whiteside, E. R. Graham, C. M. Woodruff).—The mechanical and mineralogical composition of different horizons in several claypan soils has been studied. The identification of the heavy accessory minerals offers promise as a means of deciding the origin of these soils. Various methods of carrying out the aggregate analyses of soils have been studied with the view to determining some of the fundamental factors in the erosion of these soils.

The Missouri Soil Survey (H. H. Krusekopf, W. D. Shrader, Ellsworth Springer).—The soil survey, discontinued in 1926, and re-established late in 1937, began new methods of soil survey procedure in 1938. Aerial photographs were used as base maps and permitted the mapping of soils with more detail than in former times. The classification of slopes and erosion also was made a part of the soil survey procedure. All soil survey work has been in cooperation with the Bureau of Plant Industry and the Soil Conservation Service.

Recently, with each area mapped, a land classification of the area also has been prepared. Classification of land has been based primarily on soil and other physical features that determine the use of the land.

The Nature of Soils Structure and its Influence Upon Soil Tillage (W. A. Albrecht, C. M. Woodruff).—Erosion measurements have shown that excessive amounts of runoff and erosion occur from slopes continuously planted to intertilled crops. These excessive losses seemed due in part to the deterioration of soil structure.

In test of this hypothesis soil of which the structure had been destroyed by excessive cultivation was exposed to beating drops of
artificial rain. The temporary soil structure produced by tillage disintegrated under the impact of the rain drops. The rate of water intake by the soil became negligible after 0.1 to 0.2 of an inch of rain had been absorbed by the dry soil.

Microscopic studies of the surface so exposed to the raindrops showed that the clay had been washed from the silt and the sand leaving the surface of the soil sealed by a layer of very fine silt. This layer was often less than 1 mm. in thickness. A desirable porous, aggregated structure remained intact beneath the dispersed surface. When the surface of the same soil was protected against the destruction of the soil structure by raindrop impacts, by a two weeks growth of barley, the soil continued to absorb water at a rate in excess of 1½ inches per hour until the soil profile was saturated to a depth of two feet.

Soil crumbs, with diameters of one to two millimeters were sieved from the soil on two plots of Sanborn Field. Both plots had been cropped continuously to corn: one without soil treatment; the other with annual applications of barnyard manure. When exposed to artificial rain the water intake by the manured soil was 50 per cent greater than that by the unmanured soil.

**VETERINARY SCIENCE**

A. J. Durant, Chairman

**Comparison of the Tube Agglutination and Rapid or Plate Tests on Low Reacting Sera in Bang's Disease Testing (Cecil Elder).**—Samples used for this work were selected from routine tests in the Bang’s disease testing laboratory. Samples which gave a suspicious reaction on the routine test were picked out and tested again by the tube test and the plate method. The results were compared.

In all, 4,401 samples have been tested by this comparative method. Checks identical or within one-half dilution were found on 3,954 samples or 96.41 per cent of all samples checked. Variations of one dilution or more were found in 147 samples.

If the plate test had been used as a routine method rather than the tube test, a greater number of reactors would have been reported than were reported by the tube test. If eight minute readings had been used greater variation in the results of the two tests would have resulted, since some of the samples were classified as slow reaction by the plate method.

**Retests on Cattle Giving Suspicious Reactions to Bang's Disease Tests (Cecil Elder).**—Records on 6,173 cattle which have given one or more suspicious reactions to the tube agglutination test for Bang's disease have been studied. The number of animals that gave a suspicious reaction and later became positive varied in relationship to the percentage of herd infection, as was determined by the initial
test. In herds in which there were no positive reactors on the first test the suspects, or animals with a suspicious reaction, that later changed to positive reactors on subsequent retests amounted to 8.68 per cent. From herds which on the first test showed 10 per cent or more infection, the number that changed from suspicious to positive varied from 17 to 20 per cent. Apparently an animal giving a suspicious reaction to the blood test was potentially more dangerous in a herd which had infection on the initial test than it was in a herd in which no positive reactors were found on the first test.

The Transmission of Bang's Abortion Infection from Swine to Cattle Under Pasture Conditions (Cecil Elder).—For several years, cattle free from Bang's disease have been permitted to run in the same pasture with hogs which have been artificially infected with Brucella suis.

Six cows have been carried on the experiment and have at all times been in close contact with the artificially infected hogs. During the year one cow aborted when 157 days of her gestation period had elapsed. Following this abortion the blood titre was 1-25 and later became negative. In this case, there appeared to be no relationship between the act of abortion and the blood titre. The gestation period of four of the other five cows on the experiment varied within the normal limits. During the year the blood titre of the six cows has varied from negative to positive in the 1-50 dilution. Colostral milk samples, have in some cases, run a little bit higher in titre. Attempts to isolate cultures of Brucella suis or Brucella abortus from these cows have all failed.

Although the titres on the colostral milk samples and the abortion in the one cow are highly significant, it is not believed that the danger from swine artificially infected with Brucella suis was very great in spreading infection to negative reacting cows in the same small pasture.

Toxemia in Sheep (Cecil Elder).—An effort has been made to develop a means of early diagnosis of toxemia in sheep and upon curative treatment. For the curative treatment, a buffered salt solution in combination with dextrose has been used. Attempts have been made to produce experimental cases of the disease. On the theory that the presence of acetone bodies in the urine is an early symptom of toxemia, 115 tests for acetone bodies have been conducted. It was found that 76 tests were negative, 32 were positive, and 7 were partial reactors. From the data available it appeared that the acetone tests may have some value in diagnosing the disease. Work has been done in the treatment of this disease on six field cases and one experimental case, using the buffered salt and dextrose solution. Apparently this treatment had some value. The solution tried was Hartman's solution and was used with both 5 and 10 per cent dextrose intravenously. The 10 per cent dextrose solution had the greatest value.
Study of Cattle that Consistently Give Low Titre Reactions to Bang's Agglutination Test (Cecil Elder, O. S. Crisler).—Sixteen cows have been on this experiment during the year, and two more were added from the dairy herd during the spring. Thirteen of the sixteen have calved normally, with an average gestation period of 278.84 days. One cow aborted, with a gestation period of 128 days. This cow never had gone higher in her blood titre than an incomplete reaction in the 1-50 dilution, while other cows in the herd varied from negative to an incomplete 1-100 dilution. Colostral milk samples have varied from negative to a positive reaction in the 1-200 dilution. In all cases, guinea pig inoculations and cultural examinations for Brucella abortus have given negative results.

Low Agglutination Reactions in Unbred Virgin Gilts (Cecil Elder).—Only three low titre animals have been available for study and they have been kept in isolation pens during the period. All have had normal gestation periods and normal farrowings. Attempts to obtain cultures of Brucella abortus or Brucella suis have given entirely negative results.

Apparently low agglutination titres in unbred virgin gilts are not of any great significance, and such animals do not seem to be dangerous.

The Pathology and Comparative Damage Done by Stomach, Nodular, and Tape Worms in Sheep (Cecil Elder, O. S. Crisler).—Lambs which were raised during the spring of 1937 have been added to the experimental group. A part have been added to the treated group, and another part to the control group. Microscope egg counts have been made on fecal samples collected at intervals of two weeks.

During the year, 24 sheep have died, nine of which were controls, seven were from the 14-day treatment group, and eight from the 28-day treatment group. Sixteen of the 24 sheep that died were lambs. Fifteen, twelve of which were lambs, have died from parasitism. This indicated that age was an important factor in parasite problems. Infestations were more serious when both nodular and stomach worms were present in the same individual. Good feed apparently played a very important part in the control of losses from parasitic invasions.

Heaviest losses from stomach worms and nodular worms occurred during August, September, and early October. Our records indicated that if sheep survived this period, even on heavily infested pasture, the chances for their living the rest of the year were increased greatly.

Tissues have been saved for histological study from all sheep that have died.

Fowl Paralysis (A. J. Durant, H. C. McDougle).—Previous work has shown that 50 per cent of the chicks hatched from visibly affected birds showing the eye form of fowl paralysis developed the disease in from 57 to 171 days, and further that 60 per cent of chicks from affected birds developed some form of paralysis in the third generation.
Attempts have been made to test the infectivity of the blood of chicks hatched from hens affected with visible clinical symptoms of fowl paralysis.

Fourteen White Leghorn pullets were selected for the experiment. Most of these birds showed varying degrees of eye lesions of fowl paralysis. These pullets were mated to healthy White Leghorn males. Thirty-two eggs were obtained for the first incubation, and 12 living chicks were hatched. From the second and third hatches, 30 living chicks were obtained, making the total number, 42. From this group, 22 chicks were selected to test the infectiousness of the blood. When the 22 chicks were two days old, one-half of a c.c. of blood was drawn from the brachial vein of each chick. Each sample of the blood before it had had time to clot was injected intravenously in equal portions into two White Leghorn baby chicks.

At the same time, an equal number of chicks of the same age and source were placed in opposite cages to those inoculated. Subsequent inoculations were made in exactly the same manner within every 10-day period until 15 inoculations, falling into seven 10-day periods, were completed. A total of 301 chicks received blood, and 285 served as controls.

The experiment has not yet been completed and final results are not available.

In a study of the blood of healthy birds as compared to blood of fowl paralysis-affected birds, it was found that birds affected with fowl paralysis did not show any specific blood changes which were detectable by ordinary methods of blood examination.

Blackhead in Turkeys (A. J. Durant, H. C. McDougle).—A study has been made on young turkeys six to seven months of age to check the protective efficiency of abligated birds as compared to unabligated birds when running on blackhead infested grounds.

Seventeen birds were abligated for the prevention of blackhead and an equal number of unabligated birds of the same age were used as controls. Of the seventeen birds operated, eight died of peritonitis as a result of the operation. The nine successfully operated birds with the controls were exposed to affected grounds for a period of one year. None of the nine abligated birds developed blackhead, whereas thirteen of the control birds died of that disease.

Preliminary experiments with bismuth and turpentine have been carried out in the treatment of turkeys affected with blackhead. This treatment consisted in the administration of bismuth followed by doses of turpentine. Three grams of bismuth were given, followed the next day by turpentine, the turpentine being repeated until four doses had been given. Of the six birds thus treated, four recovered.

Leucosis in Fowls (A. J. Durant, H. C. McDougle).—An attempt has been made to transmit leucosis to healthy chicks on an infected farm.
Leucosis was diagnosed in a flock of Jersey White Giants on a farm. The birds were icteric and their blood picture was typical of erythro-leucosis and proved on test to be transmissible by blood inoculation. This flock of Jersey White Giants was disposed of during January and February, 1938. No effort was made to disinfect the brooder house or laying house where these birds had been kept. Three months later 250 day-old White Leghorn chicks were placed in the brooder house and cared for in the ordinary manner by the owner and were allowed access to the ground and building at all times. To serve as a control, 250 White Leghorn chicks were kept in a laboratory not in contact with other birds. Forty-seven days later the control chicks were moved to a clean farm.

Each group of birds were given the same feed but the quarters were kept clean where the control birds were kept. At the contact farm very little, if any, cleaning was done where the exposed birds were located.

Crows and predatory animals were responsible for the disappearance of 43 birds on the experimental contact farm, and diagnosis was made on only 18 birds from this group. The experiment results were not conclusive in any way and a definite report cannot be made at this time.

**SERVICE PROJECTS**

**Answering Agricultural Questions.**—During each year the Agricultural Experiment Station answers thousands of questions for the farmers of Missouri by personal interview, by letter, by bulletin, by the Farm News Service, and by radio. This is a very real service to the farmers of Missouri and is one that is often overlooked. Each day's mail brings many questions of an agricultural nature that are answered promptly and specifically by the Station. Increasing numbers of people call at the Station for help with individual problems and every effort is made to handle these calls courteously and efficiently. The answering of questions relating to Missouri agriculture is one of the principal duties of the Experiment Station. The success of the Station in rendering this service is reflected by the confidence of the people of the State in the Agricultural Experiment Station as indicated by the increasing number of requests for information.

**Chemical Service** (L. D. Haigh, W. D. Stonecipher, E. W. Cowan, L. L. Wiseman).—The Experiment Station chemical laboratories are located in the Department of Agricultural Chemistry, and conduct analyses on feeds, crops, and soils in connection with research projects in other departments of the Station. In addition, agricultural workers, county agents, teachers of vocational agriculture, farmers, and others call upon the laboratory for chemical services. Many of these problems are handled by correspondence, in which information is given without expense for chemical analysis. Approximately 1600 letters were written for this purpose. A classified summary of the analytical work completed during the past year follows:
Agricultural Chemistry

Synthetic feed materials used in vitamin and nutrition experiments were analyzed as follows: 5 samples for complete feed analysis, 45 samples for organic matter and ash, 136 samples for dry matter, 6 samples for ash, 19 samples of grass juice for dry matter, 3 wheat samples (rust infected) for complete feed analysis, 4 wheat samples (rust infected) for nitrogen, 1 sample chick feed for ash, moisture, calcium, and phosphorus; 234 determinations.

Animal Husbandry Department

One hundred sixty-four samples of liver and soft parts from young pigs to be analyzed for dry matter, ash, protein, and fat; 1 sample molasses for ash, protein, and moisture; 439 determinations.

Dairy Department

Three experimental feeds for protein, fat, moisture, ash, crude fiber, calcium, and phosphorus; 16 urine samples and 69 goat milk samples for nitrogen; 106 determinations.

Field Crops Department

On pasture project there were handled 140 greenhouse samples, 280 field samples, 65 samples from Sni-A-Bar Farms, and 25 samples from Green Ridge Farm—all for moisture, ash, protein, fat, crude fiber, calcium, and phosphorus; 3570 determinations.

Horticultural Department

Sixty samples of apple twigs, spurs, and leaves for phosphorus and potassium; 120 determinations.

Poultry Department

Four feed samples for protein and manganese, 7 alkali solutions for determination of hydroxide; 15 determinations.

Soils Department

Seventy-nine samples of soil for nitrogen determination; 158 determinations.

Veterinary Department

Five samples (white clover, lespedeza, Sudan grass, etc.) for calcium, phosphorus, magnesium, potassium; 8 samples organs of sheep (liver, kidney, stomach) for copper; 25 determinations.

Miscellaneous Materials

Two samples water for qualitative examination, 1 combustion powder, 2 samples lime dust, 1 colored liquid, 1 dried food, 1 pipe scale, and medical salts for qualitative identification of constituents; 9 determinations.

Three soap powders and 1 paint cleaner for chemical analysis; 10 determinations.

Feed analyses as follows: 3 oyster shell samples ground for phosphorus and calcium content, 2 mineral feeds for the nature of constituents, 7 bird feeds for determination of protein, 4 feeds for complete feed analysis, 1 ensilage for moisture, and 2 feeds for sodium chloride; 36 determinations.
Seven samples stomach contents for chemical examination for presence of poison; 7 determinations.

Eight samples including oats, ground corn, mixed feed, buttermilk, shorts, and ensilage feed to laboratory animals to establish presence of poison; 7 determinations.

Grand total, 4736 determinations.

**Administration of the Missouri Fertilizer Control Law (M. F. Miller, director; L. D. Haigh, chemist).**—The inspection, analyses of samples, and publications of results are described and reported in Missouri Agricultural Experiment Station bulletin 393. A brief summary follows:

### Inspection

- Number of towns visited: 235
- Dealers, manufacturers, farms, and distributors visited: 384
- Number of samples collected for analysis: 478

### Analyses of Samples

The laboratory work on the samples collected for analysis is summarized as follows:

- Total nitrogen determinations: 343
- Water insoluble nitrogen determinations: 331
- Nitrogen activity determinations: 35
- Total phosphoric acid determinations: 442
- Insoluble phosphoric acid determinations: 419
- Water soluble potash determinations: 307
- Basicity determinations: 142

There were also 8 samples of registered brands sent in for analysis by purchasers. Fifty-eight determinations were represented by these samples. Eight samples were received for special study from the A.O.A.C. for water soluble phosphoric acid, citrate insoluble phosphoric acid and basicity. A total of 12 determinations was involved.

In addition to the above, 1287 samples of limestone, mineral material, and lime residues of various kinds were tested for their value for use in application to land for the correction of soil acidity. These samples were received from farmers, agricultural extension agents, soil conservation engineers, and agricultural leaders and groups.

### Publication of Results

Missouri Agricultural Experiment Station Bulletin 393 issued in March, 1938, is a report of the results of inspection for the calendar year 1937. The chemical composition of the fertilizer obtained by the inspectors are reported in comparison with their guarantees. Ten per cent of the results obtained indicated deficiencies small and great. The other results ranged from figures equal to the guarantee to varying amounts over the guarantees. As a result all the samples indicated that the buyers received on the average 106.2 per cent of the amount
of plant food guaranteed to them. This showing is an indication of the reliability in general of the fertilizer goods offered for sale in the State.

The bulletin lists the companies and the brands which were registered for sale in the State for the calendar year, 1938.

Tables indicating the consumption in tons of fertilizer sold in each county by grades and kinds, the tonnage of plant food constituents, and the tonnage of each brand for the State as a whole were published.

Mare Pregnancy Tests (Fred F. McKenzie, F. N. Andrews).—During the year 154 mares and jennets have been tested for pregnancy.

Fertility Tests (Fred F. McKenzie, V. Berliner, John Lasley).—During the past year the following fertility tests on male farm stock have been made and reported: 8 stallions, 2 jacks, 75 bulls, 88 rams, and 22 boars.

The Identification of Plant Diseases (C. M. Tucker, C. G. Schmitt, J. T. Middleton).—Continued experiments on the control of the mushroom disease previously described have shown that the causal organism may survive over the summer in compost from infected beds, but apparently not in the casing soil. A system of limiting the disease to small areas in commercial beds by placing partitions at intervals has been developed. Apparently the disease is transmitted only in living mycelium. The causal organism has not been isolated or determined.

The bacterial canker of sweet cherry nursery stock caused by Bacterium pruni, which proved so destructive in 1933 and 1934, has failed to appear in serious amounts in 1935, 1936, and 1937.

Inbred strains of the corn smut fungus Ustilago zaeae showed marked and apparently constant cultural characters. Compatible strains were used for inoculation of corn, and chlamydospores from the resulting galls were germinated; single sporidial cultures were obtained from sporidia from each cell of the promycelium for a study of the inheritance and segregation of cultural characters. This study has been carried through several generations.

The stem rot of ornamentals caused by Sclerotinia sclerotiorum has been found affecting the crowns, stems, and buds of Centaurea Cyanus and Delphinium Ajacis. The basal portion of the plant is first attacked, the fungus then growing up the stem in either the vascular system or cortex, or in the stem cavity, reaching and destroying, in some plants, the terminal bud. A general wilting of the plant usually is followed by death. The disease appeared among bench-grown greenhouse plants, and steam sterilization of the soil and prompt removal of infected plants, followed by an application of copper sulphate solution to the immediate area have been suggested as control measures.

Official Testing of Dairy Cows (H. A. Herman).—Official tests were conducted for 34 Missouri breeders on 1,084 purebred cows. This represented 1,250 one-day and 180 two-day Advanced Registry or Register of Merit tests on 319 cows and 6,845 Herd Improvement
Registry tests on 665 cows. Lactation records were completed by 613 cows and 443 cows were started on test. At the beginning of the year 629 cows were on test, 705 at the close of the year.

The highest individual butterfat producer was Campus Lothian Sweet Fairy 1489883, a Holstein-Friesian cow owned by the University of Missouri. Her record was 19,771 pounds milk containing 792.7 pounds of butterfat in a 365-day lactation, tested when seven years, two months of age. Another Holstein-Friesian cow, U-Mo. Abbekerk Lady Manora 1739682 broke all existing Missouri records for cows tested in the junior 3-year-old class. Her record was 16,961 pounds of milk containing 745.9 pounds butterfat.

In the Jersey division, Sultan's Princess, 926005, a six year old cow owned by R. L. Smith, Kansas City, Missouri, produced 10,520 pounds of milk containing 581.53 pounds butterfat.

Sunnymede Southern Lass 329090, owned by Sunnymede Farms, Bismarck, Missouri, led all Guernseys officially tested with a yearly record of 13,435 pounds milk and 612.1 pounds butterfat at six years, eight months of age.

In the Herd Improvement Registry division the Holstein herd at State Hospital No. 4, Farmington, Missouri, ranked first. This herd of 34 cows averaged 12,303 pounds milk containing 432.7 pounds butterfat per cow.

The highest producing Jersey herd was that of Seth Hensley, Montgomery City, Missouri, with 10 cows averaging 8,021 pounds milk and 415.45 pounds butterfat.

Insect Identification (L. Haseman).—During the year, hundreds of collections and single specimens of insects from fruit growers, county agents, teachers, collectors, and others have been received for identification; and in most cases for control recommendations. This is a service of much value to the people of the state and often means the difference between saving and losing a crop where some unfamiliar pest is involved.

During the year 2,574 letters were received and a very large proportion of these dealt with the control of certain insects or other animals which were harmful or beneficial to man and his possessions. Complaints were received about rats, ground hogs, crayfish, crows, spiders, scorpions, and many different insects. A large number of these complaints called for personal letters, but where possible bulletins or mimeographed sheets of information were used. Since pests of different kinds harm or annoy not only country people, but also those in towns and cities it is readily seen that the scope of this service reached into every community of the State.

In grasshopper control, material help has been rendered in carrying out the grasshopper surveys and control campaign.

Numerous calls for assistance with bees have been received during the year. Most of these dealt with general beekeeping help, swarm control, requeening, disease control, bee pasture, and the location of favorable honey-producing regions in the State.
Information and assistance with livestock parasites, especially ox warbles and bot flies, have been given to dairymen and general farmers. The statewide bot control program of the Agricultural Extension Service and the Departments of Entomology, Veterinary Science, and Animal Husbandry have now resulted in the treatment of from 70,000 to 80,000 horses and mules this year.

**Distribution of Fruit Insect Parasites (L. Haseman).**—In cooperation with the Federal Bureau of Entomology and Plant Quarantine, new wasp parasites of the codling moth and the Oriental fruit moth have been planted in a number of commercial orchards. A checkup on the implantations of these parasites showed them to be well established. Also, these parasites were proving very valuable in helping to reduce especially the Oriental fruit moth in peaches in the states to the east.

**Seed Testing Laboratory (W. C. Etheridge, Clara Fuhr).**—The service of the seed testing laboratory is in the free analysis of farm seeds for purity and germination. Farmers, seedsmen and public service projects send sample lots of seed to the laboratory for the accurate measurement of these qualities.

During the year 5678 lots of seeds and plants were tested and examined by the Seed Testing Laboratory. Of these 4819 were for Missouri farmers and seedsmen. Approximately 235 lots were tested for the soil Conservation Service, and 278 Custom House samples subject to the Federal Seed Importation Act.

The samples tested for farmers and seedsmen of other states, a total of 311, were distributed as follows: Colorado 65, Kansas 62, South Dakota 51, Iowa 42, Arkansas 34, Nebraska 21, Oklahoma 19, Illinois 7, North Dakota 5, Ohio 2, Texas 1, Minnesota 1, and Indiana 1.

A classified list of the number of tests follows: purity and germination 1925, germination only 1540, approximation and germination 1288, identification 712, purity only 65, examination only 60, examination and germination 51, examination, purity and germination 1, purity and examination 1; total number of tests made 8843.

Number of samples received:

- July 1, 1936 to June 30, 1937 .............. 5593
- July 1, 1937 to June 30, 1938 .............. 5678

**The Production and Distribution of Bacteria for Legumes (W. A. Albrecht).**—During the year ending June 30, 1938, sufficient cultures were distributed to treat 11,525 bushels of legume seed. The number of bushel units furnished for the different legumes was as follows: soybeans 5621, sweet clover 1726, alfalfa 332, Korean lespeadeza 3424, red clover 396, and miscellaneous 26.

The above cultures were sent to 1,185 individuals.

**Testing Soils for Their Lime Need (W. A. Albrecht).**—During the past year 2335 farmers from 85 counties had soils submitted for test for nutrient deficiencies, according to the method worked out in the laboratory and reported in 1937.
In addition to these more detailed tests, the Modified Comber's reagent is now supplied to many county extension agents who test soils for lime requirement. It is reported that over 8000 farmers used this service.

These tests are serving to help farmers decide on returning more soil fertility to their lands in the form of limestone and fertilizers.

**Agglutination Blood Testing for Pullorum Disease in Fowls (A. J. Durant, H. C. McDougle).—**During the year, 44,897 tube agglutination tests were run for Pullorum disease. Of these 2,311 specimens of blood were from turkeys. The total number of reactors or infected fowls was 10.11 per cent of the total, or 4,540. Of the 2,311 turkeys which were tested, 4.6 per cent were found to be infected.

In routine testing of chicken samples a dilution of 1 to 25 was used, but it has been found by experimentation that a dilution of 1 to 50 is preferable in testing turkey blood. Turkey blood has a higher normal antibody content than chickens.

**Agglutination Tests for Bang's Disease in Cattle and Swine (Cecil Elder).—**A total of 322,321 blood samples have been tested by the agglutination method for Bang's disease. Of this number, 314,084 were federal tests and 11,437 of them gave positive reactions, which showed that 3.64 per cent of the animals tested were infected with Bang's disease. State tests were conducted on 8,737 animals for veterinarians and owners. Of this number, 508 were reactors showing 5.8 per cent infection.

Considerable progress has been made in reducing Bang's disease infection in Missouri cattle and swine, proving that this disease can be successfully controlled by the proper application of the blood agglutination test and the removal of infected individuals from the premises.

**Distribution of Experimental Chicken-Pox Vaccine (A. J. Durant, H. C. McDougle).—**During the past year, 20,620 doses of fowl pox vaccine were distributed to poultry owners located in twenty-eight counties in the State. Slightly over eighty per cent of the vaccine was distributed to poultry flock owners south of the Missouri River.

Satisfactory results were reported concerning the use of this vaccine as birds may be vaccinated with a minimum amount of equipment and the owner may be assured of a mild reaction resulting in a high degree of immunity.

**Rabies Diagnostic Service (Frank Olvey).—**One hundred and forty-seven examinations were made for rabies during the fiscal period. Of the 147 examinations 62 heads or 42.1 per cent were found to be affected with rabies.

Dogs continue to be the most prevalent source of rabies. Though the number of heads examined was less for the past year than the preceding year, there continues to be a considerable amount of rabies in Missouri as shown by these examinations.
Diagnostic Service on Diseases of Animals and Poultry (A. J. Durant, H. C. McDougle, Frank Olvey).—During the year more than 2900 specimens of diseased animals and poultry were either treated or an examination made for diagnosis of the disease. This does not include the 147 rabies cases reported previously.

PUBLICATIONS

A. A. Jeffrey, Editor

During the year ending June 30, 1938, the Experiment Station issued 36 new publications and 8 reprints, with a total content of 1,921 pages and in editions totalling 185,600 copies.

During the same period, distribution of Experiment Station publications through mailing reached a total of 151,140 copies, including 83,783 mailed to residents of Missouri, 51,926 mailed to other states, and 15,431 sent to foreign countries. Thousands of additional copies were handed to residents of the State at the mailing room.

The publications issued during the year are listed as follows:

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Soil Fertility Investigations. Brown Limestone Land of Southwestern Missouri (Newtonia Experiment Field), by H. H. Krusekopf, June, 1938; Figs. 3 .................. 15 5,000

Soil Fertility Investigations. Rolling Prairie Land of Southwestern Missouri (Eldorado Springs Experiment Field), by H. H. Krusekopf, June, 1938; Figs. 2 ........... 11 4,000

Winter Barley, A New Factor In Missouri Agriculture, by W. C. Etheridge, C. A. Helm, and E. Marion Brown, Reprinted September, 1937; Figs. 12 ................... 23 10,000

The Feeding of Livestock, by A. G. Hogan, Reprinted November, 1937; Figs. 8 .......................... 36 5,000

Some Production Costs with Growing Chicks, by H. L. Kempster and E. M. Funk, Reprinted November, 1937; Figs. 3 .......................... 11 8,000

The Farm News Service.—The Missouri Farm News Service each week carried from the College to every Missouri newspaper timely information on the results of experimental work, announcements of new publications, reports on new crops and practices, and timely subject matter bearing on current farm and home problems. This official clipsheet of the College of Agriculture, entered as second class matter at the Columbia Post Office, was mailed to all Missouri newspapers and farm journals, county extension agents, home demonstration agents, teachers of vocational agriculture, soil conservation project managers, and rural rehabilitation supervisors, as well as many others engaged in the dissemination of agricultural information.

Special Press Service.—The weekly news service is augmented by a constant flow of material designated as the Special Press Service. This service, written as spot news especially for the news syndicates and larger dailies, announces new discoveries, tells of the more important activities of the staff, and carries information designed to meet special emergencies in farming or rural life. This service frequently includes news photographs.

Radio Broadcasts.—Radio broadcasting stations took a larger part in spreading agricultural information during the year, with additional program directors requesting the manuscript radio service of the College. Fourteen stations received the service regularly
throughout the year, as follows: KWOS, Jefferson City; WDAF, Kansas City; KMOX, St. Louis; WHE, Kansas City; WMBH, Joplin; KWK, St. Louis; KWTO, Springfield; KFUO, St. Louis; KFEQ, St. Joseph; KFRU, Columbia; KFNF, Shenandoah, Iowa; KFVS, Cape Girardeau; WTAD, Quincy, Illinois; and KOAM, Pittsburg, Kansas.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS


530 Brody, Samuel, Relation Between Physiological and Gravitational Weight, Submitted September, 1937, Missouri Academy of Sciences.


533 Murneek, A. E., Branch Ringing and Fruit Set of Minkler and Arkansas (Black Twig) Varieties of Apples, Submitted November, 1937, American Society for Horticultural Science.


White, D. G., The Size of Apples in Relation to Their Location on the Tree, Submitted November, 1937, Horticultural Science.


Albrecht, W. A., Physiology of Root Nodule Bacteria in Relation to Fertility Levels of the Soil, Submitted December, 1937, Soil Science Society of America.


Ralston, Noel P., and Herman, Harry, Milk and Fat Production of Dairy Cows as Influenced by Thyroxine and Anterior Pituitary Extracts, Submitted April, 1938, Journal Dairy Science.


COOPERATIVE PROJECTS, RESEARCH GRANTS AND FELLOWSHIPS

The Agricultural Experiment Station received during the year material aid and highly important cooperation from a number of agencies and institutions on various projects, as follows:

United States Department of Agriculture

A Study of Farm Organization and Soil Management Practices in Missouri in Relation to Agricultural Conservation and Adjustment with Special Reference to Formulation of Programs Under the Soil Conservation and Domestic Allotment Act.

The Levels of Living of Farm Families.

Land Use Planning.

The Economic Use of Power, Labor, and Machinery in Crop Production.

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

Investigations on Parasites of the Oriental Fruit Moth.

Fruit Disease Investigations in the Ozarks.

Investigations on Diseases of Orchard Fruit.

Hydrologic Investigations on the Tarkio, Missouri, Demonstration Project of the Soil Conservation Service.

Soil Erosion and its Control.

Improvement of Pastures in the Corn Belt.


Cereal Improvement with Special Emphasis on Corn.

Laws and Principles Underlying the Industrial Utilization of the
Soybean and Soybean Products.
   Agronomic, Physiologic, and Genetic Research with Soybeans.
   Physiology, Edaphology, and Breeding of Pasture Plants.
   A Study of Beefiness and Milk Production in Dual Purpose Cattle.
   Factors Influencing Quality and Palatability of Meat.
   Beef Cattle Husbandry Investigations with Special Reference to Breeding.
   Physiology of Reproduction in Farm Animals.
   Improvement of Swine Through Breeding.
   Wildlife Research in Cooperation with Missouri Conservation Commission and the Bureau of Biological Survey.

International Cancer Research Foundation of Philadelphia
   For extending investigations on hormones as related to mammary tumor production.

De-Raef Corporation
   For research on "The Influence of High Serum Solids and Methods of Manufacture to the Physical Qualities of Ice Cream."

National Research Council
   For further extending researches on the subject of endocrinology, particularly as related to milk secretion.

American Philosophical Society
   For purchase of a wide angle centrifuge.

Carnegie Corporation
   For the purchase or building of certain equipment needed for chemical investigation of virus diseases.

NEW EQUIPMENT
   New equipment has been added as follows: 1 tractor, 2 electric refrigerators, 1 Roller-Smith Model B precision balance with accessories, 1 vacuum cleaner, respiration apparatus for hormone studies, stethoscope, 1 operating table with trough, 1 551-T Spencer microscope with accessories, 1 microscope stand, Model "BI-M" without binocular body, 1 stopwatch, 1 Torsion balance, 3 calculators, water-still, compressor, 1 large angle centrifuge, 1 blower, shaking apparatus, 2 Aminco absorption cells, 2 crystal quartz lenses, 2 phototubes-Corez, 1 Micro-Kjeldahl distilling apparatus with pyrex condenser, constant temperature bath, 12 greenhouse humidifiers, 3 hygro-thermographs, 1 wheelbarrow sprayer, 1 chainomatic balance, 1 electrophotometer, galvanometer and 2 optical cells for same, Stokes vacuum pump, 1 automobile, 1 Spencer research microscope, 1 immersion heater, 3 research microscopes, 1 speed graphic camera, soil sterilizer, sprayer, low temperature room, 1 Freas constant temperature chamber, miscellaneous chemicals, laboratory glassware, instruments, office equipment, farm tools and dairy equipment.
   One 120 acre farm, swine barn, large number of movable hog cots, fences.
CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1938

Appointments
Willard H. Bixby, Research Assistant in Agricultural Engineering
Ralph Bogart, Instructor in Animal Husbandry
Eades H. Carroll, Research Assistant in Horticulture
Hughston Elijah, Assistant in Animal Husbandry
Gladys Faye M. Eslick, Research Assistant in Home Economics
Frances J. Gillespie, Research Assistant in Home Economics
Ellis Graham, Research Assistant in Soils
William H. Griggs, Research Assistant in Horticulture
Nathan S. Hall, Assistant Soil Surveyor
Frederick Kavanaugh, Research Assistant in Botany
Arthur A. Lewis, Assistant Instructor in Dairy Husbandry
Charles E. Lively, Professor of Rural Sociology
Esther G. McGuire, Research Assistant in Home Economics
Frank H. Olvey, Instructor in Veterinary Science
Jesse E. Parker, Instructor in Poultry Husbandry
Allan G. Peterson, Research Assistant in Entomology
William Edward Pugh, Research Assistant in Agricultural Chemistry
Noel P. Ralston, Assistant Instructor in Dairy Husbandry
E. P. Reineke, Instructor in Dairy Husbandry
William D. Shrader, Soil Surveyor
William Ward Smith, Research Assistant in Entomology
Adelia E. Weis, Research Assistant in Home Economics
David White, Research Assistant in Horticulture
Virginia Batie White, Instructor in Home Economics
Eugene Wilkening, Research Assistant in Rural Sociology
Curtis W. Wingo, Research Assistant in Entomology
C. F. Winchester, Research Assistant in Agricultural Chemistry
L. L. Wiseman, Assistant in Agricultural Chemistry
Clarence M. Woodruff, Instructor in Soils

Resignations and Withdrawals
L. D. Baver, Assistant Professor of Soils
Guy Weston Bohn, Research Assistant in Botany
Margaret Brainard, Assistant Professor of Home Economics
D. W. Colvard, Research Assistant in Animal Husbandry
Spencer Dakan, Assistant in Animal Husbandry
Gladys Faye M. Eslick, Research Assistant in Animal Husbandry
Frances J. Gillespie, Research Assistant in Home Economics
Clarence S. Harris, Research Assistant in Entomology
Peter Heinze, Research Assistant in Horticulture
Virgil Herring, Research Assistant in Agricultural Chemistry
Frederick Kavanagh, Research Assistant in Botany
E. L. Morgan, Professor of Rural Sociology
Esther G. McGuire, Research Assistant in Home Economics
Xzin McNeal, Research Assistant in Agricultural Engineering
Frank H. Olvey, Instructor in Veterinary Science
J. Boyd Page, Research Assistant in Soils
William Edward Pugh, Research Assistant in Agricultural Chemistry
David White, Research Assistant in Horticulture
FINANCIAL STATEMENT
UNIVERSITY OF MISSOURI
AGRICULTURAL EXPERIMENT STATION
in account with
THE UNITED STATES APPROPRIATION, 1938

<table>
<thead>
<tr>
<th>Dr.</th>
<th>Hatch Fund</th>
<th>Adams Fund</th>
<th>Purnell Fund</th>
<th>Bankhead-Jones Fund</th>
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</thead>
<tbody>
<tr>
<td>To balance from 1936-37</td>
<td>$...........</td>
<td>$...........</td>
<td>$...........</td>
<td>$...........</td>
</tr>
<tr>
<td>Receipts from the Treasury of</td>
<td>15,000.00</td>
<td>15,000.00</td>
<td>60,000.00</td>
<td>57,725.85</td>
</tr>
<tr>
<td>the United States, as per</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>appropriations for fiscal year</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ended June 30, 1938...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15,000.00</td>
<td>15,000.00</td>
<td>60,000.00</td>
<td>57,725.85</td>
</tr>
<tr>
<td>Cr.</td>
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<tr>
<td>Personal services</td>
<td>14,913.55</td>
<td>8,832.59</td>
<td>40,512.16</td>
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<td>Supplies and materials</td>
<td>83.62</td>
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<td>9,682.88</td>
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<td>Communication service</td>
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<td>16.20</td>
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<td>154.72</td>
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<td>Travel expenses</td>
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<td>40.83</td>
<td>955.94</td>
<td>1,963.15</td>
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<tr>
<td>Transportation of things</td>
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<td>71.35</td>
<td>387.99</td>
<td>405.12</td>
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<tr>
<td>Printing and illustrating</td>
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<td></td>
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<tr>
<td>publications</td>
<td>2.83</td>
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<td>3,291.85</td>
<td>3,042.31</td>
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<td>Heat, light, water, and power</td>
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<td>64.33</td>
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<td>738.75</td>
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<td>Contingent expenses</td>
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<td>21.50</td>
<td>89.73</td>
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<tr>
<td>Equipment</td>
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<td>4,249.19</td>
<td>4,872.54</td>
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<tr>
<td>Buildings and land</td>
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<td>839.02</td>
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<td>7,036.49</td>
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<tr>
<td>Balance</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15,000.00</td>
<td>15,000.00</td>
<td>60,000.00</td>
<td>57,725.85</td>
</tr>
</tbody>
</table>