

UNIVERSITY OF MISSOURI      COLLEGE OF AGRICULTURE  
AGRICULTURAL EXPERIMENT STATION

M. F. MILLER, *Director*

# Research in Agriculture

Work of the Agricultural Experiment Station  
During the Year Ending June 30, 1937

F. B. MUMFORD AND S. B. SHIRKY

COLUMBIA, MISSOURI

# Agricultural Experiment Station

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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, 1937. 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.*

December, 1939.

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# Research in Agriculture

Work of the Agricultural Experiment Station During the Year  
Ending June 30, 1937

F. B. MUMFORD, *Director*

S. B. SHIRKY, *Assistant to the Director*

We have clearly come to a time when science, as we have interpreted it, falls short of a complete instrument for social progress. It has made man a little lower than the angels in respect to his dominion over the materials and forces of nature. It has increased man's power immeasurably. Today he rules nature, controls its tremendous forces, and has been responsible for a degree of physical and material progress, during a comparatively short period of time which transcends the achievements of centuries of effort by primitive man groping for solutions to nature's plan and purpose. For all this progress we must give chief credit to science.

Along with the development of science and the scientific method there has been a quickening of the intellect and a much wider diffusion of knowledge. This notable advance in the intellectual development of the masses has been co-extensive with the progress of science. The development of science and intellect have not only solved problems, but they have created new ones. With all man's higher intelligence and all the advantages of science as an instrumentality for solving physical and material phenomena, we seem to have been less successful in controlling the results of science and intellect, and utilizing these for the welfare of mankind.

Our knowledge of the forces and influences motivating human nature and human behavior is very limited. Science has solved the problems of prevention and control of human disease but has not gone very far in preventing or controlling social disorder. The scientific method has proven its worth. It can be utilized for a study of human behavior. Perhaps the next great advance in science will be social research.

The colleges of agriculture owe their great progress and present popularity to their use of science and the scientific method. They have undertaken to apply the methods of science to rural social problems. It is yet too soon to make any pronouncement on their achievements in this field. After all their researches there may still be a need for a more conscious development somewhat outside of the field of science.

# Experiments in Progress During the Year Ending June 30, 1937.

## AGRICULTURAL CHEMISTRY AND ANIMAL NUTRITION

A. G. HOGAN, *Chairman*

**Vitamin Studies** (A. G. Hogan, L. R. Richardson, R. E. Guerrant).

In 1932 a basal ration was developed which contained an unappreciable amount of any known vitamin. This made it possible to produce dermatitis in rats. The antidermatitis vitamin was provisionally designated as vitamin H. It was probably identical with the vitamin B<sub>6</sub> of British workers.

An effort has been made to concentrate this antidermatitis vitamin. It was not precipitated by phosphotungstic acid.

The rat required at least three members of the old vitamin B complex. These were found to be the antineuritic vitamin, riboflavin, and the antidermatitis vitamin. Now, it seems equally certain that there is at least one more, which we designate as the fourth factor. It is found in yeast or liver extracts, and in a dilute alcohol extract of rice polishings. It was not absorbed on fuller's earth or on charcoal.

Pigeons, fed on rations containing the antineuritic vitamin, became severely anemic. Undoubtedly, there is an antianemic vitamin, and an effort has been made either to identify it with some recognized vitamin, or establish its separate existence.

Riboflavin or the antidermatitis vitamin did not prevent the anemia. An alcoholic extract of rice polishings healed the anemia promptly, but did not enable the pigeon to maintain normal weight. Apparently, the pigeon requires two vitamins that are not required by the rat.

The antianemic factor was absorbed by fuller's earth, but efforts to elute it were unsuccessful.

Rats which receive deaminized casein soon die. If the deaminized casein is supplemented with lactalbumin, they survive much longer, but ultimately become anemic and die. If the deaminized casein is supplemented with casein, they do not become anemic, and they survive indefinitely.

Efforts have been made to isolate the casein agency. Casein was hydrolyzed with sulphuric acid and the acid removed by barium. This hydrolyzed casein was separated into the following fractions (1) Tyrosine, (2) the dicarboxylic amino acids. The remaining amino acids then were separated into the following copper salt fractions: (3) those insoluble in water, (4) those soluble in water but insoluble in methyl alcohol, (5) those soluble both in water and methyl alcohol. The amino

acids which are soluble in water but insoluble in methyl alcohol make up much the larger fraction and contain the active agent. When included in the ration at a level of 3 per cent, the anemia was healed, and the animals grew rapidly.

Known amino acids were added to the anemia producing ration. One hundred grams of the ration contained the following quantities of amino acids:

arginine	0.25 gm.	glutamic acid	3.00 gm.
histidine	0.50 gm.	glycine	1.00 gm.
lysine	0.45 gm.	tyrosine	0.14 gm.
alanine	0.50 gm.	threonine	0.50 gm.
serine	0.70 gm.	leucine	0.50 gm.
cystine	1.00 gm.	isoleucine	0.50 gm.

The gain in weight on this mixture was 3 grams daily for a period of 5 weeks, but new red blood cells were formed slowly.

Post mortem observations showed that the only abnormality of any consequence was frequent enlargement of the spleen. This organ was of normal size in anemic rats, but it enlarged greatly if the anemic condition was allowed to heal.

**Nutritional Requirements of Poultry** (A. G. Hogan, E. M. Parrott). Some time ago, a synthetic ration was devised which was adequate for the chick. During the last few years, this ration was less satisfactory, and investigation showed the inconsistencies were due to variability of the liver extract. Presumably, the extracts were prepared in the same manner, but they were of very unequal value.

An attempt now is being made to find a more dependable source of the vitamins carried by liver extracts.

Recently it has been reported that perosis in chicks was due to a deficiency of manganese. While there is no reason to doubt that manganese is concerned with this abnormality, data at this Station indicate that other factors also are implicated.

This year anemia occurred among some of the chicks. This was observed first when one of the commercial liver extracts was included in the ration. Later preparations obtained from the same source did not produce this disorder. Two possibilities now are being tested to determine (1) if the active agent is precipitated by alcohol during the process of manufacture in concentrations of 70 per cent or more, or (2) if it is destroyed by heat temperatures of 70° or more.

Evidence of another deficiency in the ration was obtained from observations on the feet of chicks. It was noted frequently that the skin was cracked, thickened, and rough, in marked contrast to the skin of normal birds.

**Quantitative Meat Studies** (A. G. Hogan, S. R. Johnson, D. T. Mayer). Many reports have indicated that rabbits and guinea pigs can not be reared on the dried constituents commonly used in chick rations or as a stock diet for rats. A ration of these dried constituents can be made adequate by the addition of alkaline salts, but wheat germ oil was more effective. These rations permit normal growth, but are inadequate during the reproductive stage. When the fresh extract of cereal grasses was supplied, these animals bore normal young and reared them successfully.

An effort has been made to study the active agents in plant extracts. Apparently, there are two, and at least one of them is exceedingly labile. If the plant extract is concentrated in vacuo, at 40° C., it loses its effectiveness. Animals that received the concentrate bore few litters and seldom reared their young. The most striking feature was that practically all of the young were severely hemorrhagic and had enlarged fatty livers.

An ether extract of freshly dried plant material was effective in preventing the hemorrhage, but the mothers did not secrete a normal amount of milk. In addition to the antihemorrhagic factor, one other factor is required in order that the flow of milk may be normal.

**AGRICULTURAL ECONOMICS**O. R. JOHNSON, *Chairman*

**Livestock Marketing and Prices** (Herman M. Haag). Data for the period July 1, 1930, to December 31, 1936, with reference to differences in hog prices among markets through which Missouri hogs are sold have been tabulated and analyzed. Day to day variations in prices also have been studied.

Results so far indicated that the same weights of hogs' prices at East St. Louis normally averaged from 30 to 40 cents higher than prices at Kansas City and were about the same as those at Chicago.

**Farmers' Cooperative Organizations in Missouri** (Herman M. Haag, E. G. Schiffman). Information was secured from 410 farmers' local cooperative purchasing and marketing associations. These records have been tabulated and analyzed.

It has been estimated that local cooperatives handled more than \$31,000,000 of products and supplies for Missouri Farmers in 1935. Although livestock shipping associations, fruit shipping associations, creameries, and other local associations were included, more than \$29,000,000 of this business was handled by exchanges and elevators. Commodities making up a large part of sales of exchanges and elevators were commercial feeds, corn, wheat, eggs, poultry, and cream.

The exchanges and elevators were scattered widely throughout the State, but were most numerous in southwestern Missouri, in central Missouri along and immediately below the Missouri River, and in the northeastern part of the State.

**Commodity Prices** (Herman M. Haag, E. G. Schiffman). The work during the past year has been almost exclusively a revision of the Missouri farm price index. This involved recalculation of price relatives on a 1924-28 base for each product in the index. An additional 13 commodities also were included. The new index has been published in "Economic Review and Outlook for Missouri Farmers", a publication of the Missouri Agricultural Extension Service.

**Effects of Production Control on Farm Practices** (O. R. Johnson, B. H. Frame). Approximately 100 farm records have been summarized. These records deal with revised practices on farms where production control and intensive Soil Conservation programs have been practiced. Reports have been sent back to the cooperators, and an analysis of the combined results now is being made.

**Production Planning and Soil Conservation** (O. R. Johnson, Elsworth Springer, Homer L'Hote, Darryl Francis). In eight counties in Missouri, 4 in south Missouri (Texas, Lawrence, Pettis, and Vernon) and 4 in north Missouri (Monroe, Marion, Nodaway, and Sullivan) 206 farm records were started and 193 completed. 156 farms have

been mapped, and summaries were made on 193 and returned to the cooperators. 209 farm records are under investigation for 1937. Summaries for individual farms have not been combined in any very large numbers. Grasshoppers and dry weather together last year prevented representative results. However, these records are regarded as exceedingly valuable, particularly in indicating the degree of dependability of pastures and pasture crops in a highly adverse season.

**Adjustments in Farming** (O. R. Johnson). A preliminary analysis of the 103 farms studied in Nodaway County and 103 in Callaway County indicated that in the Nodaway area, three-eighths of the farms studied were roughage farms. That is, farms that produced approximately one-half or more of their total feed volume in the form of roughages were classified as roughage farms. Thirty per cent of the farms were classified as concentrate farms, or farms which produced over seventy per cent of the total feed in the form of concentrates. Yields per acre were considerably higher on the roughage farms. When all feeds were converted to corn equivalents, the corn equivalent production per acre of total land in the farms was for the roughage farms 1524 and for the concentrate farms 1418. Pastures also were more productive and better utilized on the roughage farms. The roughage farms provided 129 cow days per acre of rotation pasture, while the concentrate farms provided 72 days. Cow days on permanent pasture were for the roughage farms 116 and for the concentrate farms 89. One-third of the roughage farms were tenant farms, while three-fifths of the concentrate farms were tenant farms. The roughage farms were stocked more heavily than were the concentrate farms.

In this area the roughage farms would have a normal production with present acreages of around twelve million units. This is on the basis of the 1936 acreages. According to operators' statements, the intention is to increase this to approximately fifteen million units or an increase of twenty-five per cent. Most of this increase will be in the form of roughages. The concentrate farms, on the other hand, had a normal production program in 1936 of 14.2 million units, and these operators plan to reduce this to thirteen million. This means a reduction of about twelve per cent.

In the Callaway area, slightly less than one-third the total area was in roughage farms. About one-fourth the farms were concentrate farms. The roughage farms produced 1153 corn equivalents per acre and the concentrate farms 1042. Thirty-two per cent of the roughage farms were tenant farms, and thirty-eight per cent of the concentrate farms were operated by tenants. There was no great difference in the degree of stocking, but the concentrate farms carried more livestock

than did the roughage farms. Permanent pastures on the roughage farms provided 98 cow days per acre and on the concentrate farms 86 cow days. The concentrate farms grew 50 per cent more acres of corn than did the roughage farms, and about doubled the wheat acreage. They also grew 40 per cent more oats. The roughage farms had more soybeans, timothy, and clover, double the lespedeza, and one-third more permanent pasture.

One highly significant item was the intention to change the rate of production or the recommendations of the individual farmers in the community. In 1936, the normal yields would have produced 8.8 million corn equivalents on the roughage farms. The intentions were to increase the acreage so that this production would be changed to 9.3 million units, an increase of 6 per cent. The concentrate farms, with a normal capacity for 7.6 million corn equivalents, proposed to increase this to 7.9 million, or an increase of 4 per cent.

The adjustment, therefore, seems to be a shift to more acres of erosion control crops, but, at the same time, to increase the supporting capacity of these acres.

**Land Tenure in Missouri** (O. R. Johnson). An analysis has been made of tenure records collected in Nodaway and Callaway counties. Work has been done on improving lease forms and facilitating acquiring of ownership by tenants. The result of this work has been published in Missouri Agricultural Experiment Station Bulletin 378.

Study has been made of the evolution in farm lease forms and of the provisions of present successful lease arrangements. In order to do this work, information has been secured from approximately 1000 tenants and 100 landlords rather evenly distributed over the State. Only tenant-landlord agreements were used where the agreement had been in force at least three years.

**Farm Real Estate Situation for Missouri** (Conrad H. Hammar). Studies have been made of the effect on farm labor income of varying proportions of fixed and operating capital, the percentage equity that Missouri farm operators have in their land, the relation of the physical aspects of the land to its quality and productivity, the areas of particular hazard as these relate to investment, and the effect of the size of farm on the success or failure of investment. Arrangements have been made to collaborate with the Federal Land Bank and secure data from their files to be used in connection with data tabulated at this Station.

**Land Use Classification in Callaway County** (Conrad H. Hammar). Studies have been made on the classification of buildings and farms, a classification of roads, an inventory of telephone lines, an inventory

of electrical lines, an assessment map, a tax delinquency map, a farm mortgage foreclosure map, and a cooperate ownership of lands map.

**Expenditures for Local Rural Government in Missouri** (Conrad H. Hammar, Glen T. Barton). This study has been completed and is reported in Missouri Agricultural Experiment Station Bulletin No. 385, "The Farmer and the Cost of Local Rural Government in Missouri".

**Farm Cost Accounting and Cost of Family Living on the Farm** (B. H. Frame). This project includes two phases: first, external accounting, or the financial transactions between an individual farm and outside interests; second, internal accounting, or accounting between the different departments within a farm.

On the first phase of this project, 118 records have been summarized. One hundred of these records were located in the Soil Erosion area in Harrison County, Missouri, and in Ringgold and Decatur counties in Iowa. The greater portion of the area and records were located in Missouri. These records were summarized and classified on the basis of management returns, various factors of efficiency and use of land, capital, and labor in the production of livestock and crops were computed for the various groups.

Records were classified on the basis of size of farm and type of farming. A study also was made of the net returns and management factors on all of the farms. Most of the remaining 18 records were located in Atchison County.

Nine farm diaries have been summarized during the past year. These furnished a complete record of all financial transactions on the farm, all labor performed on livestock and crops, feed fed, production of livestock and crops, and other miscellaneous records, so that it is possible to keep a complete set of costs between different departments of the farm.

TABLE 1.—COMPARISON OF GENERAL MANAGEMENT FACTORS FOR ALL FARMS WITH RECORDS FOR BOTH 1935 & 1936 (FARMS GROUPED ACCORDING TO MANAGEMENT RETURNS IN 1935)

	14 Farms in High Group in 1935		26 Farms in Middle Group in 1935		15 Farms in Low Group in 1935	
	1935	1936	1935	1936	1935	1936
Management Return .....	\$798.93	\$161.29	—\$44.50	—\$106.96	—\$766.00	—\$360.60
Net Farm Income .....	\$1758.14	\$1019.71	\$748.65	\$600.69	\$34.73	\$262.60
Total Acres in Farm .....	215.4	208.6	171.4	184.9	190.9	205.1
Gross Income Per \$100 Invested .....	\$27.87	\$21.92	\$21.53	\$16.13	\$16.60	\$14.15
Percentage of Cash Income From Livestock .....	70.2	74.2	75.9	75.3	62.6	57.3
Livestock Return Per \$100 Feed Fed .....	\$229.86	\$153.63	\$191.92	\$136.91	\$137.06	\$108.78
Gross Value of Crops Per Crop Acre .....	\$9.97	\$12.92	\$9.72	\$10.68	\$7.44	\$6.86
Machinery & Equipment Cost Per Crop Acre .....	\$1.46	\$1.07	\$1.34	\$1.06	\$1.32	\$0.85

**AGRICULTURAL ENGINEERING**J. C. WOOLEY, *Chairman*

**Size, Depth, and Spacing of Tile Drains for Missouri Soils** (J. C. Wooley). Inspection of the project on Callahan Creek, Boone County, showed that it was still functioning satisfactorily. Two hundred and forty foot spacing of the tile has given good drainage. This soil was typical creek bottom soil. However, at Elsberry, the project still failed to function. The 18" depth and 28' spacing plots have given no better drainage than the wider spacing and greater depth. Drainage wells located across the laterals have shown no change in the water table that might be credited to the drains.

**Electric Brooding of Chicks** (M. M. Jones, W. A. Junnilla). Two electric chick brooders located in standard 10 x 12 Missouri type brooder houses have been tested. One brooder was equipped with a ventilating fan, and the other one was not. The results from both brooders were quite satisfactory, and there was no particular difference, except the one without the fan was more economical, consuming 1.06 Kwh per chick per eight weeks' brooding season, compared to 1.22 Kwh per chick for the brooder equipped with the fan.

A coal heated brooder operating under similar conditions at the same time consumed 50 pounds of coal per day, giving a fuel cost of 5c per chick for the brooding season. The humidity in the houses equipped with electric brooders, although not excessive, was higher than in the house with the coal-heated brooder.

**Operating Costs of Electric Fence Controllers** (M. M. Jones, W. A. Junnilla). Observations were made on the operation and energy consumption of two commercial electric fence controllers. One was a battery type and operated on four standard dry cells. The unit operated for six weeks on one set of dry cells. The other unit was operated from 110-volt alternating current and used five Kwh per month.

**Contour Furrowing for Pastures** (J. C. Wooley, M. M. Jones, X. McNeal). Contour furrowing for pastures has been tested in different parts of the State, and from reports and observations, it seems that this will become a rapidly increasing practice.

There are many questions relating to the practice that must be standardized. Some of these questions are: spacing, size of furrows, frequency of checks in the furrows, methods of laying out the furrows, and methods of construction.

A furrowing machine has been designed to build furrows without losing sod or exposing subsoil and that will have drafts sufficiently

low that an ordinary farm tractor may be used for power. The machine can be controlled from the tractor seat and is reversible.

It consists of two plows, one right and one left, mounted to form a "middle-buster," each 18" plow cutting a 20" furrow, since they are spaced 4" apart. A rolling coulter cuts the sod midway between the two plows.

The curvature of the moldboards was reduced to prevent inverting the sod, and outside guards or fenders attached to hold the sod in a raised position. Back of the two plows a disc plow was mounted on a short beam, pivoted to provide means for throwing a furrow right or left.

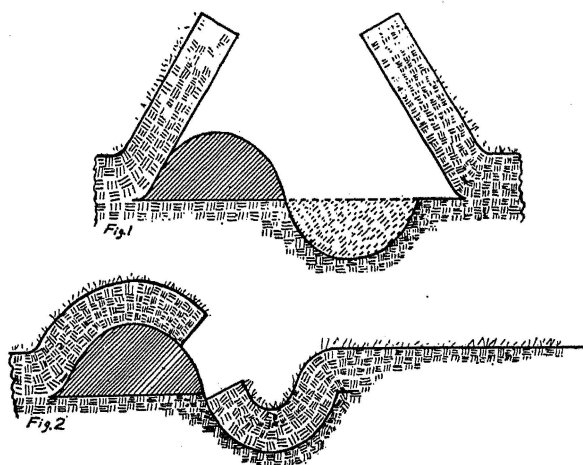


Fig. 1.—Principle of operation of furrowing machine. Top: sod raised and furrow plowed. Bottom: sod replaced.

The two plows raised two 20-inch strips of sod, leaving the outside edges in place. While these are raised, the disc plow throws over a furrow in the subsoil. The strips of sod then are lowered, one falling in the furrow cut by the disc, and the other falling on the ridge. Thus the sod is replaced, covering most of the cut, and a contour furrow covered with sod, as shown in Figure 1, results.

**Seed-Bed Preparation Studies** (M. M. Jones, X. McNeal). Owing to the extremely dry weather of 1936, the original plan, which called for three cultivations, could not be followed. The third cultivation was omitted. No grain was produced because of drouth. The efficiency of the various methods therefore is expressed in terms of horsepower-hours of work required per ton of fodder produced. There was no significant difference in the yields except for the plot which was fall plowed and received no further work on the seed-bed except harrowing before planting. This plot gave the lowest yield. On all

other plots, the yields were about the same, the most efficient method was the one requiring the least work. This was the plot which was spring plowed, disced, harrowed, and planted.

In the cultivation studies, due to the abnormally dry season, many of the crops did not receive all of the cultivation that originally was planned. Plots that were harrowed, cultivated twice with shovels, required the lowest number of horsepower-hours per ton of fodder produced.

**The Effect of Environment on Laying Hens** (J. C. Wooley, E. M. Funk). An experimental poultry house was built in 1934, in order that it might be compared with the standard Missouri 20' x 20' poultry house. The experimental house was built, particularly, to control temperature, relative humidity, and to limit the investment per bird. The house was double-decked, and charts of temperatures showed that it offered much even temperatures in periods of extreme cold or extreme heat.

The results at the present show that if the double-deck house is to have any advantage over the single-deck, it must come from a decrease in the cost of housing the birds, or from a decrease in labor. The closed house with controlled ventilation provided better winter temperatures, and perhaps a better control of humidity, but these improved conditions have shown but little effect when measured by production or growth.

The 20' x 20' standard house cost approximately \$266, first cost, and had a capacity of 100 hens. The double-deck house cost approximately \$398, first cost, and had a capacity of 200 hens. The double-deck house was more crowded than the standard house.

## ANIMAL HUSBANDRY

E. A. TROWBRIDGE, *Chairman*

**Cross Breeding of Swine** (L. A. Weaver). This project has been planned to study the relative merits of crossbred and purebred swine for commercial pork production.

Five purebred Duroc sows and five purebred Poland China sows were double mated to a Duroc boar and a Poland China boar at an interval of approximately six hours during the same heat period. It was hoped that from such matings both purebred and crossbred pigs would be produced from the same sow. Three additional purebred Duroc sows were mated to the purebred Duroc boar, and the same number of purebred Poland China sows was bred to the Poland China boar. The eight Duroc sows on the experiment were from the same

Duroc boar and out of sows of similar breeding. The eight Poland China sows also were by the same Poland China boar and out of sows of similar breeding.

As a result of these matings, three groups of pigs were available for comparison: purebred Duroc's; crossbreds (Duroc Jersey on Poland China and Poland China on Duroc Jersey); and purebred Poland China's.

Thirty-four purebred Duroc pigs, forty-seven crossbred pigs, and fifty-one purebred Poland China pigs were farrowed. Of the three groups, twenty-eight Duroc pigs were weaned at an average of 27.52 pounds at 8 weeks of age; forty-two of the crossbred pigs weighed 28.94 pounds at 8 weeks of age; and forty-nine of the Poland China pigs weighed 24.5 pounds per head.

The crossbred pigs had a slightly heavier birth weight and weaning time weight than either group of purebreds, although the difference cannot be significant on account of the small numbers weaned.

Twenty representative pigs were selected from each group for feeding to a marketable weight as fat hogs. Each group was fed the same ration until an average weight of approximately 225 pounds was reached.

The results for the fattening period indicated that the crossbred pigs made more rapid gains and were ready for market approximately two weeks earlier than either group of purebreds. The crossbred pigs also made slightly more economical gains, but the difference in this respect cannot be considered significant, since there was as much variation between the two purebred groups as there was between the crossbred group and one of the groups of purebreds.

**A Limited Grain Ration for Steers** (E. A. Trowbridge, H. C. Moffett). By far the greater portion of beef steers going to market (76.4% over a 10 year period at one market) produced carcasses grading "medium" or "good". Such carcasses make beef which is economical and of desirable quality. Many of these steers were of such type and quality as to make higher finish unprofitable.

Soil conservation has reduced the corn acreage and increased grass and small grain.

These conditions make it important to use "medium" quality cattle and large quantities of roughness with limited grain in the production of beef.

Four lots of "medium" grade feeder cattle, eight steers to each lot, were used in an investigation on the use of a limited grain ration. The grain ration fed all lots consisted of 10 parts shelled corn and 1 part cottonseed meal. Good quality alfalfa hay, purchased locally, was used as roughage.

Two-year-old and yearling steers fed roughage ad libitum 84 days and followed by full feed on grain made greater total gain than similar steers fed half feed of grain with roughage the entire period.

Approximately the same total gain in weight was required to produce a comparable degree of finish. Somewhat more gain was required to finish yearling steers to grade "high medium" than was required to finish two-year-old steers to a comparable degree.

There was little difference in total grain consumption of two-year-old steers fed roughage ad libitum, followed by a full feed of grain, and those fed a half feed grain with roughage for the entire period. The latter lot consumed a somewhat less total amount of roughage. The most economical use of grain on two-year-olds was produced by cattle full fed the grain during the latter part of the period.

Maximum use of roughage on yearling steers occurred in the lot fed half a grain ration for the entire period. Highest grain consumption by yearling steers occurred in the lot fed grain the last 84 days.

While the cattle in all lots appeared to be in approximately the same condition at the time of slaughter, physical analysis showed more fat in the carcasses of both lots of cattle fed roughage alone, followed by full grain feeding, than in those of the cattle fed half a grain ration throughout the experiment. The two-year-old steers showed more fat than the yearling carcasses.

Palatability scores and cooking losses on ribs from two-year-old steers were higher than for the yearling steers.

All lots of cattle in this investigation produced carcasses grading "medium" to "good" and not more than 20 bushels of corn, 100 pounds of cottonseed meal, two and one-half tons of corn silage, and 600 to 700 pounds of alfalfa hay was used per steer.

**Blackstrap Molasses in Rations for Fattening Yearling Steers** (E. A. Trowbridge, H. C. Moffett). The scarcity and high price of corn resulting from the drouth of 1936 caused the extensive use of molasses as a corn substitute in cattle rations.

Four lots of cattle were fed as follows:

Lot I	$\left\{ \begin{array}{l} \text{Shelled corn, 10 parts} \\ \text{Cotton seed meal, 1 part} \\ \text{Corn silage, ad libitum} \\ \text{Alfalfa hay, ad libitum} \end{array} \right\}$	Approx. $\frac{1}{2}$ full feed.
Lot II	$\left\{ \begin{array}{l} \text{Molasses, 5 parts} \\ \text{Cotton seed meal, 1 part} \\ \text{Corn silage, ad libitum} \\ \text{Alfalfa hay, ad libitum} \end{array} \right\}$	Approx. $\frac{1}{2}$ full feed.

Lot III	<table> <tr><td>{</td><td>Shelled corn, 8 parts</td><td>}</td></tr> <tr><td>{</td><td>Cotton seed meal, 1 part</td><td>}</td></tr> <tr><td>{</td><td>Wheat straw, ad libitum</td><td>}</td></tr> <tr><td>{</td><td>Corn silage, ad libitum</td><td>}</td></tr> </table>	{	Shelled corn, 8 parts	}	{	Cotton seed meal, 1 part	}	{	Wheat straw, ad libitum	}	{	Corn silage, ad libitum	}	
{	Shelled corn, 8 parts	}												
{	Cotton seed meal, 1 part	}												
{	Wheat straw, ad libitum	}												
{	Corn silage, ad libitum	}												
Lot IV	<table> <tr><td>{</td><td>Molasses, 4 parts</td><td>}</td></tr> <tr><td>{</td><td>Cotton seed meal, 1 part</td><td>}</td></tr> <tr><td>{</td><td>Wheat straw, ad libitum</td><td>}</td></tr> <tr><td>{</td><td>Corn silage, ad libitum</td><td>}</td></tr> </table>	{	Molasses, 4 parts	}	{	Cotton seed meal, 1 part	}	{	Wheat straw, ad libitum	}	{	Corn silage, ad libitum	}	Self fed.
{	Molasses, 4 parts	}												
{	Cotton seed meal, 1 part	}												
{	Wheat straw, ad libitum	}												
{	Corn silage, ad libitum	}												

The full fed cattle were fed 133 days and the half fed cattle 161 and 168 days respectively.



Fig. 2.—Yearling cattle fed 4 parts blackstrap molasses and 1 part (41% protein) cottonseed cake, with corn silage and wheat straw, gained 1.8 pounds per head daily, and consumed an average daily ration of 10.89 pounds of molasses, 2.72 pounds cottonseed cake, 29.42 pounds of silage, and 1.42 pounds of wheat straw.

Yearlings of "medium" grade were used.

The molasses was standard Louisiana blackstrap molasses, guaranteed 42 Baume at 90° Fahrenheit. The corn was No. 2 and No. 3, mixed or yellow. The cottonseed meal was pea sized, 41% protein. The alfalfa hay was of good quality, purchased locally. Corn silage was made from corn that had been damaged badly by the drouth and contained very little grain.

Cattle fed a half ration of corn or blackstrap molasses and cottonseed meal gained much more slowly than cattle full fed the same rations and, therefore, required a longer time to become finished.

Steers fed a half feed of corn or molasses with cottonseed meal, silage, and alfalfa hay utilized more roughage and less concentrates in their production than similar steers on full feed of corn or molasses

with cottonseed meal, silage, and wheat straw. Very little wheat straw was eaten by the full fed cattle.

One-half full feed of molasses with cottonseed meal produced slower gain than one-half full feed of corn and cottonseed meal. Self fed molasses with hand fed cottonseed meal also produced less rapid gains than the same quantity of shelled corn and cottonseed meal.

After the cattle were on full feed, they consumed 12 pounds per head daily of molasses from the self feeder for a period of approximately 100 days. During the test they appeared less attractive because of molasses about their heads and necks, showed some tendency to scour, did not shed their winter coats, and did not seem to fill up and round out as much as similar cattle being fed approximately the same amount of corn.

Considering the concentrates required to produce a unit of gain, a ration of five parts molasses and one part cottonseed meal, one-half full fed the entire period, was 94 per cent as efficient as a ration of ten parts corn and one part cottonseed meal fed in a similar manner. The ration of four parts molasses and one part cottonseed meal self fed was 92 per cent as efficient as a corn eight parts, cottonseed meal 1 part ration. Fifty-six per cent more roughage was required by cattle full fed molasses than was required by cattle fed a comparable quantity of corn and cotton seed meal.

There was little difference in physical analysis and palatability in the four lots of cattle.

**Substituting Molasses for Corn in Rations for Calves** (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.

Cane molasses was substituted for half the corn in a ration for high-grade Shorthorn fall steer calves. They ate an average of 1.56 pounds of molasses, 1.56 pounds of shelled corn, and .39 pound of cottonseed meal per head daily during the 168 day nursing period. The check lot of steer calves fed shelled corn and cottonseed meal in the proportion of 8 to 1 ate a daily average of 3.66 pounds of shelled corn and .46 pound of cottonseed meal. Both lots were fed 1.9 pounds alfalfa hay daily. After the first thirty days, .4 pound of alfalfa hay was chopped and mixed with the grain to serve as a carrier where the molasses was fed. During the nursing period the calves receiving corn and cottonseed meal without molasses gained 79.5 pounds more than the gain made by the calves receiving the molasses. Those receiving molasses did not have enough finish at weaning time to grade as slaughter calves.

The two lots were continued on the same rations for 168 days after weaning. The steers receiving molasses gained 301.1 pounds per head, while the steers receiving corn and cottonseed meal gained 314.25 pounds per head. The corn and cottonseed meal steers were better finished at the end of the experiment. The cost of gain was less in this particular trial when molasses was substituted for one-half the corn because of the prevailing high price of corn.

**Growth in Draft Colts** (E. A. Trowbridge, H. C. Moffett). Four purebred Percheron fillies, foaled the spring of 1935 from dams used on the University Farm, were fed what they would eat of a ration consisting of 200 pounds oats, 100 pounds bran, 100 pounds corn, and 50 pounds linseed oil meal until they were weaned at approximately five months of age. From that time until they were turned on grass, May 1, they were fed four pounds of the same grain mixture per head daily with what hay they would consume. Equal amounts of alfalfa and timothy hay were fed on alternate feeds. The colts averaged 550 pounds at weaning time and 938 pounds at twelve months of age. They were sound and in excellent growing condition.

During the second summer and fall season, the colts were on a mixed pasture and received four pounds per head daily of a ration consisting of equal parts by weight of corn and oats. During the second winter, the same amount of grain was fed daily with the hay that they would consume consisting of equal amounts of alfalfa and timothy fed at alternate feeds. They weighed an average of 1,350 pounds when two years old. During the spring when they were two years old, they were broke to work and used one-fourth of a day at a time when crops were being planted.

**Rations for Weanling Pigs** (L. A. Weaver). Four lots of pigs were fed for a period of 133 days in dry lot. Shelled yellow corn and a mineral mixture of equal parts of ground limestone, bone meal, and salt were self-fed each lot. Lot I received only these feeds; Lot II received in addition self-fed tankage (60% protein); Lot III, a mixture of equal parts tankage and expeller type soybean oil meal (41% protein); Lot IV received the same supplement as Lot III, plus alfalfa hay.

The pigs fed corn and minerals made a very poor showing, weighing only 75 pounds at the end of 133 days' feeding, as compared with an average weight of 235 pounds, the final weight of the pigs which in addition to corn and minerals received a supplementary feed of tankage, soybean oil meal, and alfalfa hay. The pigs fed tankage as the protein supplement and those fed a mixture of tankage and soybean oil meal also made satisfactory gains. There was little difference in the amount of feed consumed per 100 pounds gain in the case of the

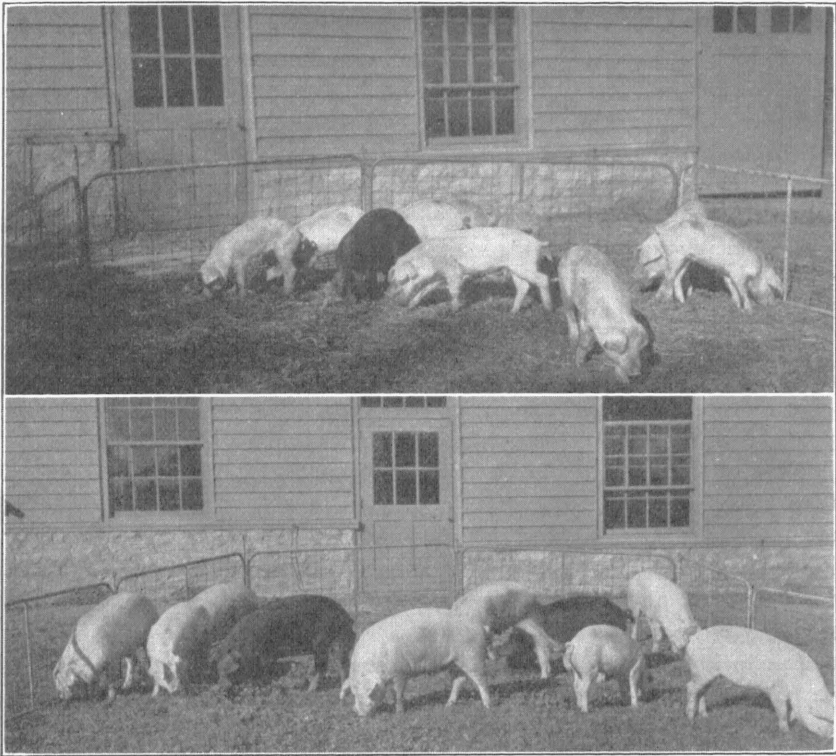


Fig. 3.—Top: Hogs fed corn and a mineral mixture of equal parts ground limestone, bone meal, and salt gained an average of only .15 pounds daily and required 1,020 pounds of corn to produce 100 pounds gain.

Bottom: Hogs fed corn, tankage, and minerals made an average daily gain of 1.3 pounds and consumed 344 pounds of feed per 100 pounds gain.

lots fed a protein supplement (344 to 352 lbs.), while the lot fed corn and minerals required 1,020 pounds of corn for each 100 pounds' gain.

**Adaptability and Value of Winter Barley as a Forage Crop for Swine** (L. A. Weaver). Two trials were conducted, one beginning in October and ending in January, the other beginning in February and ending in April. The general plan was the same for both trials. Ten hogs were fed in each of four lots as follows:

Lot I	Corn + tankage . . . . .	3 parts	Dry
	linseed oil meal . .	1 part	Lot
	alfalfa meal . . . .	1 part	
Lot II	Corn + tankage		Dry Lot
Lot III	Corn + tankage		Barley pasture
Lot IV	Corn + tankage . . . . .	1 part	Barley pasture
	soybean oil meal	1 part	

Shelled yellow corn and protein supplement were self-fed free choice to all lots. The tankage was a 60% protein packing house by-

product. Expeller type soybean oil meal guaranteed to contain 41% protein and 34% protein old process linseed oil meal were used. The alfalfa meal fed was Triple X quality. A mineral mixture of equal parts ground limestone, bone meal, and salt also was self-fed all lots.

Pigs fed on barley pasture made slightly more rapid gains than those fed in dry lot, but the difference was too small to be significant.

Less concentrate was required to produce 100 pounds of gain when fed to hogs grazing barley pasture, but again, the difference in total feed required was small. Less protein supplement was used by the hogs pastured on barley. Hogs fed corn and tankage in dry lot ate 1 pound of supplement to each 12 pounds of corn, while those fed on barley consumed 1 pound of tankage for each 22 pounds of corn. The pigs fed corn and tankage on barley pasture used approximately 55 per cent as much tankage as those fed corn and tankage in dry lot.

**Kind of Concentrate to Feed on Pasture** (L. A. Weaver). A mixture of equal parts 60% protein tankage and 41% protein expeller type soybean oil meal, fed with shelled yellow corn and minerals to hogs on rape and oat pasture, produced more rapid gains when hogs were full fed, and less feed was required per unit gain than when the ration was only corn and minerals.

Due to the extreme drouth, the pasture was neither as abundant nor as palatable as during a normal season. However, some pasture was available at all times.

The hogs fed corn on rape and oat pasture required 409.4 pounds of corn to produce 100 pounds of gain. The hogs fed corn, tankage, and soybean oil meal on rape and oat pasture required 305.8 pounds of corn and 45.02 pounds of supplement to produce 100 pounds of gain.

**Nutritional Requirements of Brood Sows** (A. G. Hogan, E. G. Gahley). Investigators have concluded that the concentrates commonly used in swine feeding are not adequate during the stage of lactation. In order for the pigs to attain satisfactory weaning weights, the sows must have access to forage.

For several years when sows received the basal rations, the pigs usually averaged between 15 and 20 pounds at 8 weeks of age, and were decidedly unthrifty. In the spring of 1936, the results were surprising. The pigs average about 27 pounds at 8 weeks, which was 35% heavier than ever had been obtained before. These results were more unexpected, since a survey of the literature did not disclose a single instance of comparable weights under comparable conditions.

The ration had been changed in only one respect. The change consisted in the addition of a small amount of manganese to the basal ration. A feeding trial was made with pigs to determine whether or not the manganese was responsible for the difference. The pigs

that received added manganese were slightly heavier than those that did not, but apparently manganese was not the primary factor in the improvement in previous group.

A study also was made of the effect of omitting alfalfa from the ration of the sow. This change was disastrous, for the mortality of the suckling pigs was very high.

The effect of greatly increasing the amount of alfalfa also was studied. A ration was fed containing about 20 per cent alfalfa. The average weight of the pigs was increased somewhat, but the mortality was high, and evidently alfalfa could not make the rations adequate.

In the spring of 1937 it was decided to make another study of manganese. Again, some evidence was obtained that manganese had improved the weights of the suckling pigs.

In previous years it had been observed that while the presence of alfalfa meal in the ration did not insure success, its absence always resulted in failure. The use of alfalfa meal, therefore, again was studied in the spring of 1937. Reducing the alfalfa meal from 5 per cent of the ration to 2.5 per cent did not decrease the weights of the suckling pigs.

Other sows were started on rations containing 10 per cent of alfalfa meal. They were changed about 10 days before farrowing to rations which contained none. Not at all in accord with earlier work, these pigs did about as well as any.

It seemed impossible to explain the variability in performance of the suckling pigs, unless there was some important variation in the nutritional properties of the corn. A small supply of corn from the 1935 crop was obtained. This was substituted for new corn. The ration that contained old corn resulted in weights of pigs at eight weeks significantly lower than those for the other groups.

Apparently, rations made up of commonly used feedstuffs may be deficient in manganese, and perhaps the nutritional value of corn may decline during storage, presumably because some vitamin is destroyed.

**The Reproductive Organs and Semen of the Boar** (F. F. McKenzie, J. C. Miller, L. C. Bauguess). Whole and fractionated semen collections from thirteen yearling boars have been made with the aid of especially designed apparatus. Some of the accessory glands have been removed and semen collections made subsequently. Some of the boars have been slaughtered and the genital organs and their contents have been studied histologically and chemically.

Normal boar semen has about 5 per cent solids. Seminal vesicle and Cowper's gland material each range from 15 to 18 per cent solids. Prostate and urethral gland fluid have only 1 per cent solids.

The seminal vesicles were the only source of glucose (2-3 mg. per gram wet weight) and the main source of total nitrogen, potassium, and phosphorus. These glands are tortuous, elongated, saccular bodies with an actively secreting epithelium. They supply 15-25 per cent of the volume of the total ejaculate.

The Cowper's glands were the main source of sodium, calcium, and magnesium, and were rich in total nitrogen. They are compound tubuloalveolar glands with actively secreting cells lining the ducts, alveoli, and tubes. Their contribution constitutes 10-20 per cent of the ejaculate.

The prostate glands has several lobes, some disseminated through urethral tissue. Its secretory activity has been observed. Its products have not been collected separately, but together, with those of the urethral glands.

The urethral glands extend the entire distance of about 20 cm. between the openings of the vasa deferentia and the Cowper's glands. Their epithelium is actively secreting.

The prostate and urethral gland material combined was watery clear, quite different chemically from serum or plasma, and was the chief source of chlorides in the semen. Together they (prostate and urethral glands) were responsible for 55-70 per cent of the ejaculate.

The fluids from the testicles and epididymides made up less than 8 per cent of the ejaculate (probably only 2-5 per cent).

Use of boars more frequently than once each two days resulted in (1) reduced volume of ejaculate from the normal of 250-400 cc. to less than 200 cc., (2) reduced number of sperm from 50 billions to 24 billions or less per ejaculate, (3) reduced motility of sperm, from sperm that would retain its motility three days and more to sperm that remained motile two days or less, (4) the appearance in the semen of sperm with a cytoplasmic cap.

Removal of the accessory sex glands did not affect libido nor reduce fertility. Castration had little immediate effect upon libido.

The large volume of semen, the extremely great number of sperm per ejaculate, the relatively long time required for ejaculation, and the chemical composition of the semen gave some indication of the heavy drain on the protein, mineral, and energy supply of the boar during excessive sexual activity. Observations on the effects of frequent ejaculations on semen volume, sperm numbers, duration of sperm motility and sperm morphology indicated that yearling boars should not be used more often than once in 24 hours, and that best results might be expected at 48-hour intervals if the breeding season extended over a period of two weeks or more.

An apparatus has been designed that was satisfactory for artificially inseminating sows.

**Reproduction in the Horse** (F. F. McKenzie, F. N. Andrews). Through the foaling and breeding season, 29 draft mares (Belgian and grade Belgian) and 15 light mares (mostly grade Thoroughbreds) were under observation at the United States Range Livestock Experiment Station, Miles City, Montana.

Most mares were in heat 5-7 days. The foal heat lasted usually 5 days. The interval from the last of one heat until the beginning of the next was 15-17 days. From parturition to first day of foal heat was 6 to 10 days.

There was a variation in the intensity of estrus of heat on the part of the same mare and in different mares. The first day of heat showed mild to medium receptivity, and the receptivity increased until the day before ovulation, remained at this high level until the day after ovulation, then receded. Mares ovulated 1 to 1½ days before the end of heat.

The physical characteristics of the ovarian follicles were: (1) Medium tense and variable in size first day of heat, (2) Increase in tenseness and in size to day before ovulation, and (3) Decrease in tenseness and decrease in size just before ovulation.

Ovaries of mares immediately after foaling were small and fibrous.

The vagina became increasingly red and vascular until ovulation. The secretion of the vagina changed from the scant, thick material of the non-estrual mare, to a rather copious amount of thin secretion the latter part of heat. The cervix increased in redness and vascularity until the day after ovulation, and its secretion increased in amount and became thinner and less viscous, reaching a peak the day after ovulation. The secretions of the vagina and cervix were slightly alkaline.

Certain breed differences were evident. The nervous temperament of the light mares accentuated the need of careful, quiet handling of those of this type, else the mating reactions were masked. When properly handled the light mares showed equally marked receptivity and resistance to the stallions, as compared with the draft mares at similar stages of the estrual cycle.

**The Reproductive Capacity of Rams** (F. F. McKenzie, V. Berliner). Shropshire and Hampshire rams showed breed differences in spermatogenic activity with regard to season. This was at a high level from October to January in the Shropshires, and from August to January in the Hampshires. A distinct decrease was noted from June to September in the Shropshires and in July only with the Hampshires.

During the warm season all rams showed increased numbers of abnormal sperm. Individual and breed differences were apparent. The same rams submitted to high environmental temperatures in winter showed the same differences, thus pointing to the direct influence of high temperatures and to individual and breed differences in ability to withstand such conditions.

Pronounced mating desire was not necessarily co-existent with high sperm production; these qualities appeared to be fairly independent of each other.

Semen from rams may be 0.6 to 1.5 cc. in volume; may have 2 to 4 billion sperm per ejaculate; and may have 3 to 5 million sperm per cubic mm. After the third or fourth copulation on any one day, there was a marked drop, varying with the individuals and with the breed. Exhaustion of sperm was difficult to attain with some individuals, and with others this was reached readily.

In estimating the reproductive capacity of a ram, it is important to consider: the breed or strain, the season of the year, the number of matings just prior to sampling, sperm concentration, total sperm number, proportion of abnormal sperm, and volume of semen.

**Sperm as Influenced by Different Parts of the Female Tract** (F. F. McKenzie, V. Warbritton, F. N. Andrews, V. Berliner). Thirty-seven ewes were inseminated (naturally or artificially) during estrus and slaughtered 2, 14, or 22 hours after insemination. At autopsy the ewe's genitals were opened, and sperm were recovered from the vagina, cervix, uterus, and tubes. Sperm had reached the tubes in every case, even when only two hours had elapsed between insemination and sperm recovery. Judging from the condition of the sperm in each level of the tract, the tubes and vagina would appear to be the least favorable. In the cervix the concentration of normal sperm remained greatest and for the longest time interval. Hydrogen-ion concentrations were determined.

**The Cells of the Adrenal Cortex of the Ewe during the Estrual Cycle and Pregnancy** (Laura J. Nahm, F. F. McKenzie). Missouri Agricultural Experiment Station Research Bulletin, No. 251, is a report upon this project.

**The Pituitary Glands of Ewes in Various Phases of Reproduction** (V. Warbritton, F. F. McKenzie). Missouri Agricultural Experiment Station Research Bulletin, No. 257, is a report upon this project.

**The Origin of the Corpus Luteum in the Ewe** (V. Warbritton). Almost immediately after ovulation the cells of the stratum granulosa of the ovary of the ewe developed into fibroblasts similar to those seen in tissue cultures. Mitotic figures may be quite numerous. These cells developed into lutein cells and connective tissue as they

spread across the central cavity. Within a few hours the lutein cells were undergoing conspicuous hypertrophy and were almost fully developed by three or four days after ovulation. Blood vessels from the theca interna were able to invade the fibroblastic mass very quickly. The lutein cells which were present in the theca interna before ovulation were carried a short way into the granulosa by the growing blood vessels and the folding of the walls. They showed no tendency to form fibroblasts or to undergo hypertrophy and soon showed cytoplasmic and nuclear changes associated with fatty degeneration.

**A Smear Method for Mammalian Chromosomes** (V. Warbritton). Pieces of rat testis were frayed to isolate the individual seminiferous tubules. Either a block of tissue or the tubules can be fixed in Carnoy's alcohol-acetic. On the slide a tubule may be torn apart until single cells were numerous. Belling's acetocarmine was used, and the pressure of the coverslip flattened the cells until many of the membranes broke, first in the large primary spermatocytes and then in the smaller cells. Additional manipulation usually can break the nuclear membranes and allow the dark red chromosomes to be spread over a fair sized area. A yellow green filter was needed for counting these chromosomes.

**Sexual Cycle and Time of Breeding in Mares** (E. A. Trowbridge, H. C. Moffett). The time between the onset of one heat period and the onset of the subsequent heat period is known as the sexual cycle. Percheron mares on the University farm were checked daily with the stallion.

Seven Percheron mares that produced foals during the year 1936 came in heat from 5 to 7 days after foaling. The "foal heat" lasted from 3 days in one case to 6 days in another, the average "foal heat" period being 5 days. Observed heat periods inclusive of "foal heat" periods varied from 2 days in one case to 17 days in another. The average of 39 "heat periods" observed in 10 mares during the year was 6.66 days. The time between heat periods varied from 8 to 19 days, averaging 12.5 days. The average sexual cycle was found to be 21.4 days.

The practice was followed of mating mares with the stallion every second or third day as long as the heat continued. By this practice, 8 of the total of 10 mares studied through the year were pregnant.

**A Comparison of Systems of Grazing Bluegrass Pastures** (J. E. Comfort, J. M. Poehlman). This project is in cooperation with Sni-A-Bar Farms and the United States Department of Agriculture, and the Departments of Field Crops, Soils, and Agricultural Chemistry.

Three systems of grazing (continuous, rotation, and supplemented) have been under comparison at Sni-A-Bar Farms for six years. A summary of the first five years appeared in the last Annual Report. The method of grazing on the supplemented grazing pasture was changed to a combination of the rotation and supplemented grazing systems in 1936. A bluegrass pasture was divided into three parts, and the cattle were rotated on these divisions. In previous years, the cattle on the supplemented bluegrass pasture were transferred in midsummer to a field of Korean lespedeza and left on this field until about September 1. In 1936, the severe drouth completely killed the Korean lespedeza making it necessary to take all of the cattle under the supplemented grazing system out of the experiment on July 6.

Sixty-six two-year-old grade Shorthorn heifers, averaging 494 pounds, were placed on the experiment pastures on April 21, 1936. The number of heifers placed on each 25 acre pasture was as follows: 28 on the supplemented, 20 on the rotation, and 18 on the continuous. At the beginning of the 1936 season, the rotation pasture was in better condition than the continuous grazing pasture.

The drouth made it necessary to reduce greatly the number of cattle in the continuous and rotation pastures on July 2, and all cattle were taken off these pastures on August 5, because the supply of feed was exhausted. The bluegrass on these pastures made some growth in the late fall of 1936, but not enough for grazing.

The heifers on the supplemented grazing pasture made 3,058 pounds total gain, or 122.3 pounds per acre over a 72 day period. The cattle on the continuous pasture made a total gain of 2,390 pounds, or 95.6 pounds per acre over 107 days. The cattle on the rotation grazing pasture made a total gain of 2,219 pounds, or 88.76 pounds per acre in 107 days. All the experimental cattle made normal gains during the time they were on the pastures. The larger gain made by the cattle on the supplemented pasture system may be explained in part by the greater number of cattle and the closer grazing.

**BOTANY**C. M. TUCKER, *Chairman*

**Studies on the Genus *Phytophthora*** (C. M. Tucker). Investigations on the physiology, morphology, and taxonomy of the Genus *Phytophthora* have been continued. Fifty cultures have been received for identification and study from Italy, Ireland, Argentina, South Africa, Japan, and various regions in the United States.

**The Effect of Seed Treatments for Smut on Yields of Oats** (C. M. Tucker). In 1936, seed of the Columbia variety of oats nearly free from smut was treated on March 15 and planted on March 17. Twenty replications of random distribution were planted at the rate of about six pecks per acre. A duplicate series was planted at the rate of about ten pecks per acre.

The season was unusually dry. The oats were short and poorly headed. The plots were harvested on June 22.

The amount of smut was small, 1.29% in the check plots. The formaldehyde soak and the Ceresan treatments resulted in complete elimination of smut. The formaldehyde spray treatments resulted in a reduction of infection.

The formaldehyde-soak treatment plots produced significantly larger yields at both rates of planting. Since no water-soaked checks were included, it could not be determined whether the increases were due to the soaking or to the effect of the formaldehyde. However, it seemed likely that the soaking was the important factor.

The Ceresan-treated plots produced yields surprisingly greater than those of all others, and greater than those obtained in other seasons more favorable to growth. This indicated the need for testing the effects of these treatments under a variety of environmental conditions.

**The Control of Barley Diseases** (C. M. Tucker, J. J. White, J. E. Livingston). Experiments with eleven samples of winter barley seed grown at various points in the state have been carried on to determine the effects of various seed treatments on germination, smut control, and yield.

The chemicals used for seed treatment included formaldehyde, Ceresan, Corona Dust, Ansul Dust, Cuprocide, copper carbonate, basic copper sulphate, dusting sulphur, and zinc oxide. At the concentrations used, none caused significant injury to germination in samples germinated at intervals to six months after treatment.

Hot water treatments at various exposures were used. All caused some reduction in percentage of germination. In most cases there was a notable recovery, the treated seeds showing a higher percentage of germination two to six months after treatment than immediately after exposure.

In field plots, planted with high quality, nearly smut-free samples of Missouri Early Beardless and Kentucky No. 1, there were no significant increases in yield as a result of seed treatment with the chemicals. Marked decreases occurred following the hot water treatments.

In the germination tests, Kentucky No. 1 showed more injury in each treatment than Missouri Early Beardless; however, the yields were much less reduced. Therefore, it appears that germination tests are not reliable criteria for determining the extent of injury resulting from hot water seed treatments.

Surface-sterilized seeds were plated to obtain growth of internal fungi data. The fungi, in order of their frequency, were: *Alternaria*, *Gibberella*, *Fusarium*, *Chaetomium*, and *Helminthosporium*.

The presoaking method, the more prolonged hot water treatments, and the Ceresan treatment eliminated more than half of the internal fungi of Missouri Early Beardless. *Fusarium* and *Gibberella* usually were killed, while *Alternaria* proved more resistant.

The treatments with copper and zinc compounds did not affect the internal fungi.

Small barley seedlings were placed on cultures of the various fungi commonly isolated from seed for thirty hours and then planted in soil. Only *Helminthosporium* and *Gibberella* proved pathogenic.

Average yields and smut incidence in eleven lots of barley, using some of the commoner types of seed treatments were determined. One seed lot was infected by three types of smut caused by *Ustilago hordei*, *U. nuda*, and *U. nigra*. The loose smut caused by *U. nigra* was controlled by the chemical treatments, while *U. nuda* was killed by the hot water treatment only. *U. nuda* appeared in much more abundance in the bearded (Kentucky) varieties. The intermediate type of smut, *U. nigra*, did not appear in the bearded varieties. All three species appeared to be well distributed in the State.

The Ceresan-treated plots gave the highest yields; however, the increase in yield was not due to smut control, since the formaldehyde-treated plots had approximately the same smut control factors.

The hot water treatment caused a reduction of about 20% in germination, yet the plots planted with this seed averaged only 50% of the check. Hooded varieties showed greater reductions in yield than bearded varieties.

Powdery mildew appeared in the plots, the Missouri Early Beardless being more heavily infected than the Kentucky and Tennessee varieties.

A leaf spot caused by *Rhynchosporium secalis* appeared in the plots of Missouri Early Beardless, Kentucky No. 1, and Tennessee No. 5.

The plot of Tennessee No. 6 appeared highly resistant, showing only a trace of infection.

In the autumn of 1936, plantings were arranged to determine: the effect of treating the seed with Ceresan on the yield of winter barley; whether or not winter injury is affected by seed treatment; the effect of plot arrangement on increases or decreases in yield due to Ceresan seed treatment; and to locate smut resistant varieties of winter barley.

**Corn Root Rot** (C. M. Tucker, C. G. Schmitt). Drought conditions prevailing throughout the summer of 1936 interfered with the investigations on the microflora of corn roots. Over fifty different organisms were isolated from the roots of corn. The isolations included members of the following genera: *Fusarium*, *Aspergillus*, *Penicillium*, *Chaetomium*, *Helminthosporium*, *Gibberella*, *Trichoderma*, *Meerophomina*, *Arachniotus*, *Rhizoctonia*, *Bacillus*, and *Bacterium*. Inoculations made in the greenhouse during the winter indicated that none of these were comparable to *Phthium arrhenomanes* in pathogenicity. With the exception of *Fusarium moniliforme*, *Gibberella saubineti*, and *Macrophomina phaseoli* (*Rhizoctonia Bataticola*), the isolates probably represented secondary invaders.

*Aspergillus terreus* was isolated from a number of kernels affected by scutellum rot.

**The Effects of Various Treatments of Seed Corn on Stands and Yields** (C. M. Tucker). Two-hundred ears of Reid's Yellow Dent corn were indexed for seed infection by germinating fifty seeds from each ear. Those with germination percentages below ninety were discarded. In the germinator *Fusarium moniliforme* appeared more frequently than other fungi, among which were *Cephalosporium*, *Rhizopus*, *Penicillium*, *Aspergillus*, and *Basisporium*. *Diplodia* and *Gibberella* were not detected in the lot. Seed showing less than 40% infection was used as slightly infected seed, and seed showing more than 60% infection was used as a source of heavily infected seed.

The slightly infected ears produced seedlings showing some rotting of the roots in 23.8% and some shoot rot in 7%. The corresponding figures for the heavily infected ears were 39.2% and 10.1%.

One-half of each lot was treated with New Improved Semesan, Jr., at the rate of two ounces per bushel. The slightly infected seed produced significantly larger seedling stands than the heavily infected seed. The seed treatment gave no significant differences in either lot or at any of the planting dates.

This project has been in cooperation with the Department of Field Crops.

**Tomato Wilt Studies** (C. M. Tucker, G. W. Bohn). Studies on the resistance and inheritance of resistance to wilt of tomatoes, caused by

*Fusarium lycopersici*, have been continued. The 1936 season was very dry and hot, and wilt developed early in the plots. A high mortality rate following transplanting due to drought and insect injury interfered to some extent with securing clear-cut data.

The strain of *Lycopersicum pimpinellifolium* which has been free from infection during the two previous seasons again showed no evidence of infection. Hybrids between this species and various tomato varieties were considerably more resistant to wilt than any commercial variety tested.

During the warm period pollination was infrequent, and crosses were difficult to secure in the field; approximately 5,000 pollinations yielded six fruits containing from three to twenty-five seeds.

The method of testing resistance consisted of planting seeds in autoclaved soil heavily inoculated with the most virulent isolation available. At transplanting time the surviving plants were inoculated by dipping the roots in a suspension of mycelium and spores; finally, the plants were set in a heavily infected field. The stands of all plants surviving in early October were cut and examined for vascular discolorations indicative of infection. Only plants free from such symptoms were included in the "healthy" groups.

Hybrids of *L. Pimpinellifolium* crossed with commercial varieties showed considerably more resistance to wilt than the commercial varieties.

**A Disease of Cultivated Mushrooms** (C. M. Tucker, K. W. Simons). A serious disease of cultivated mushrooms has appeared at two points in the State. The first evidence of an abnormal condition is the appearance of a few sporophores with stipes slightly crooked, longer and smaller in diameter than normal; the pilei fail to attain normal diameter and are often in a tilted, rakish position, instead of at right angles to the stipe, due to irregular growth of the stipe, resulting in failure of the veil to break evenly. The abnormal elongation of the stipe results in early rupture of the veil and premature flattening of the pileus. The entire sporophore is slightly gray and dead in appearance. The disease has appeared during the third break or later in every outbreak observed.

The first affected sporophores are usually few in number and confined to a small area in the bed.

When the next break appears, the infected area has increased greatly in size and extends from five to ten feet in each direction from the original site; a normal mushroom rarely is found in the diseased area. The disease spreads through the bed at the rate of about one foot per day. An infected bed does not produce marketable mushrooms and, therefore, is valueless.

Examination of the casing soil and compost failed to reveal the presence of other organisms or any abnormal condition of appearance, texture, or odor. Hydrogen-ion determinations were made on soil and compost from six pairs of comparable beds, one diseased and one healthy. The casing soil was slightly more acid in four of six cases in diseased than in healthy beds, while the compost in diseased beds was slightly more acid in five of six cases. The differences were small and supply no evidence that the disease was associated with the development of abnormal acidity.

Sections through infected sporophores showed the tissues swarming with bacteria. The rhizomorphs attached to diseased sporophores were normal in external appearance, but brown and soft in the interior; they contained many bacteria.

Isolations from about twenty-five lots of the diseased mushrooms invariably yielded bacteria. At least six different species of bacteria were found, each of which was predominant in at least one lot of sporophores. Failure to demonstrate the constant association of a particular species with the disease suggested a secondary saprophytic role.

Isolations on acidified agar yielded various fungi, usually *Acrostalagmus*, *Penicillium*, or *Trichoderma*. In a few cases at least two species of *Pythium* were secured. Isolations from normal and diseased rhizomorphs and from soil and compost from normal and diseased beds yielded similar flora.

Inoculations of small beds with pure cultures of the bacteria and fungi found gave negative results.

Beds inoculated in January by casing with soil taken directly from a diseased bed produced diseased mushrooms at the first break. Soil from a diseased bed taken to Columbia, held for seven weeks and used for casing beds, resulted in the development of normal mushrooms at the first break. After two weeks, abnormal distorted mushrooms appeared along with normal individuals.

Soil from the diseased bed was heated at 55° C. for two hours, treated with formaldehyde, calcium cyanide, or carbon bisulphide and used for casing beds. In all cases, normal mushrooms developed throughout the season. All treatments caused the disappearance of the toxic condition.

Three beds were inoculated two weeks after casing by removing a portion of the casing soil and replacing it with about three handfuls of soil from an infected bed. Two beds remained normal, and the third bed produced typical diseased mushrooms at the first break twenty-two days later.

Attempts to transmit the disease by burying infected caps or entire diseased mushrooms in the casing soil gave negative results, as did mixing a supernatant liquid from a suspension of infected soil with the soil. The mixing of moderate amounts of compost from an infected bed with the compost in new ones failed to transmit the disease.

The disease was transmitted by placing diseased beds in contact with healthy ones so that soil and compost were in contact. The disease appeared in the healthy beds in about three weeks and spread throughout them.

Removal of casing soil and recasing with new soil was of no value, the new breaks showing universal infection.

Experiments on the control of the disease have included treatment of the casing soil on infected beds with various amounts of formaldehyde, lime, lime sulphur, ethyl mercury phosphate, and sulphur. However, none was beneficial.

Barriers, made by soaking the soil and compost with 1-250 mercuric chloride in a strip six inches wide across the beds six feet in advance of the diseased mushrooms, were effective in preventing the further spread of the disease. Trenches six inches wide proved even more effective. Trenches placed three feet in advance of evidence of infection were seldom effective, but the disease rarely appeared beyond those placed six feet in advance.

The disease invariably spreads throughout a bed unless isolated by barriers.

The division of beds into short units by two crossboards one inch apart seemed advisable where trouble with the disease is anticipated.

**A Disease of Korean Lespedeza** (C. M. Tucker, K. W. Simons). An undescribed disease has caused damage in strains of Korean *lespedeza* selected for early maturity. The disease causes the death of the stems and, in severe cases, completely destroys these strains, since they are killed before maturing seed.

During the fall of 1936, a number of organisms were isolated from infected plants. These will be used to inoculate various strains and varieties of *L. stipulacea* during the summer.

**Sweet Cherry Canker** (C. M. Tucker). Work has been continued at a nursery in Northwest Missouri on a canker of sweet cherry nursery stock that developed very abundantly in 1933 and 1934.

Inoculations confirmed *Bacterium pruni* as the causal organism and showed that a strain isolated from plum leaves was equally virulent with strains isolated from the cankers. Inoculations made on wounded and unwounded trees at intervals through the season resulted in the development of cankers when the bacteria was placed in contact with wounded surfaces. Attempts to induce infection by hanging infected

plum leaves among the foliage of sweet cherry trees gave negative results. Apparently, natural infections probably occur in June, about the time the trees are wounded by the removal of lateral branches.

In 1936, an extensive experiment was carried on, using seventeen spray combinations applied at ten-day intervals through the spring and summer. Very few cankers developed during the season, and the purpose of the experiment was defeated. The varieties in the experiment were Black Tartarian, Schmidt, and Bing.

The Bordeaux-Kolofog combination was the only spray that caused a significant reduction in growth, probably due to injury caused by the first application made at the concentration of 4-6-50 and 3 lbs. Kolofog. Subsequent application using 2-4-50 Bordeaux and 3 lbs. Kolofog caused no injury until mid-July when the temperatures were very high.

Some increases in growth were secured when zinc-lime-arsenate and lime-arsenate were applied. These probably were due to a partial reduction of grasshopper injury. A severe infestation by the insects occurred during July and August.

**Apple Measles** (C. M. Tucker). In the spring of 1936, apple trees in an orchard in Lawrence County, showing pronounced scaly bark and target canker, were selected for experiment. The varieties selected included Golden Delicious, Paragon, and Starking.

The Paragon trees were interplanted among the Golden Delicious, and the scaly bark condition was more prevalent in this variety than in the Golden Delicious.

The Starking trees were in a less thrifty condition than either of the other varieties, and the target canker and measles symptoms were more pronounced.

Thirty-eight trees with two or more branches with pronounced scaly bark or target canker were used. Injections of various amounts of zinc sulphate, copper sulphate, or borax were made into the scaffold branches, leaving one untreated branch on each tree. Zinc glazier's points were driven into the wood of branches on some trees. A series without treatment was given a heavy application of stable manure.

In Webster County in the orchard in which Stayman Winesap and Starking trees showed very severe measles in 1934 the various chemicals applied to the soil in 1935 were applied again in 1936.

Young trees of the varieties Grimes Golden, Stayman Winesap, Winesap, and Starking planted near badly affected trees in 1935 showed no evidence of developing the measles condition during 1936.

The general condition of all trees was improved over that prevailing when the experiment was started.

## DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

**The Precursors of the Constituents of Milk and the Energy Requirements of Milk Secretion** (C. W. Turner, W. R. Graham). The function of the mammary gland is the manufacture of milk and, like any biological unit, it must receive nutrients to perform its normal function. The source of these nutrients is in the blood of the animal. Constituents are removed from the blood as it passes through the mammary gland during lactation. These portions of the blood then are transformed into milk substance.

Experiments have been conducted on lactating goats in an attempt to extend the knowledge of the nutrition of the mammary gland during lactation. Comparisons of the level of constituents in the arterial and mammary venous bloods have been made. Also, the blood volume flow through the mammary gland has been measured.

A review of the literature showed that milk protein was formed from blood amino acids, and lactose from blood glucose. However, this experiment showed that the amount of glucose removed from the mammary gland was not large enough to produce the lactose formed. Therefore, a search was made for further substances which were removed from the blood by the mammary gland and which had a potential ability to form carbohydrate.

It was found that inroads were being made on the nitrogen metabolism of the gland for carbohydrate synthesis. The amount of milk nitrogen precursor was not large enough to form the milk nitrogen produced. Therefore, other sources of milk nitrogen must be found.

Records at this Station showed that the blood flow through the mammary gland was considerably less than the calculated flows hitherto published. The mammary gland removed from 20 to 50 per cent of the glucose from the blood which passed through it. This was slightly more than half of that required to form the lactose in the milk. In addition to the glucose removal, there was a removal of lactic acid of from 10 to 30 mg. per 100 cc. of blood passing through the gland. It is possible for the glucose plus the lactic acid removed to equal the lactose formed.

The levels of urea nitrogen in the arterial and mammary bloods showed that urea was being formed in the mammary glands. This indicated that nitrogenous substances were being broken down to form carbohydrate.

The respiratory quotient of the gland was generally above 1, indicating that fat was being formed from the carbohydrate.

The amount of urea nitrogen formed in the mammary gland was often more than the uptake of amino nitrogen by the gland.

Work has not progressed far enough to make any definite statement concerning the other possible nitrogen fractions used. Indications were that there was a considerable shift of the albumin-globulin ratios of the blood. Apparently, there was some substance of non-protein nitrogen origin being removed from the blood, which was neither amino nitrogen nor urea.

The mammary gland appeared to be in definite negative nitrogen balance directly after milking. This changed to a positive balance in a few hours.

**Hypophysectomy and Replacement Therapy in Relation to the Secretory Activity of the Mammary Gland** (C. W. Turner, E. T. Gomez). It has been shown at this Station that, under favorable conditions, the secretion of milk in laboratory mammals may be initiated by the injection of pituitary extracts or the purified preparation of the lactogenic hormone, galactin. However, galactin was ineffective in stimulating the secretion of milk when administered to hypophysectomized laboratory mammals with mammary glands which previously had been prepared for lactation, or in maintaining lactation when established. Lactation could be initiated or maintained after hypophysectomy of the guinea-pig by the injection of crude pituitary extracts.

These observations were interpreted as indicating that the failure of galactin to stimulate or support lactation in hypophysectomized guinea-pigs, rabbits, or cats was not due to the inadequacy of the hormone in stimulating the secretory activity of the lobule-epithelium, but rather resulted from the general physiological disturbance in hypophysectomized animals, which invariably reduced to a low level the available precursors of milk in the blood. Since the regulation of the precursors of milk was under the control of the endocrine glands, maintained directly or indirectly by the pituitary, the need for the study of the influence of these glands was obvious. Since the thyroid and the adrenal (cortex) glands atrophy following hypophysectomy, attention was turned to the hormones of these glands.

Indications were secured that the pituitary secreted a hormone which influenced carbohydrate metabolism. The physiological influence of this hormone was indicated by the reduced concentration of glucose in the blood after hypophysectomy. First attention was given to this hormone, since much was dependent upon the level of glucose in the blood for the maintenance of the general well-being of the animal, as well as the source of an adequate supply of the precursors for the synthesis of lactose in the milk. The regular administration of glucose after hypophysectomy prevented the development of hypoglycemic coma and further maintained the level of blood glucose.

**Influence of the Thyroid in Lactation** (C. W. Turner, E. T. Gomez). Thyroid glands become inactive and atrophic following hypophysectomy. The atrophy was prevented and the normal structures and functions restored by pituitary implants or by the administration of extracts containing the thyrotropic hormone. In thyroid insufficiency induced by thyroidectomy or hypophysectomy there occurred a marked reduction of the pulse and basal metabolic rate.

Thyroidectomy caused a decline in milk secretion, while thyroid feeding of the parenteral administration of thyroxine during the declining phase of lactation increases milk production. Therefore, the thyroid glands seemed in some way concerned in the mechanism of milk secretion. Injection of thyroxine alone, or in combination with galactin and a glucose solution, was incapable of stimulating the initiation of milk secretion in hypophysectomized guinea pigs with mammary glands properly prepared for lactation. Upon established lactation, this therapy likewise was ineffective in preventing the rapid cessation of lactation which followed hypophysectomy. Therefore, the atrophy of the thyroid glands and the probable decrease in the secretion of thyroxine was not a limiting factor in the rapid cessation of lactation observed in hypophysectomized guinea pigs.

Since the pulse rate of the animals was reduced markedly in thyroid insufficiency, the reduced rate of blood flow through the mammary gland may account for the reduced milk secretion. The increased milk secretion in hyperthyroid animals may have been due to the stimulation of the secretory cells by thyroxine and the increased amount of blood flowing through the mammary gland.

**The Influence of the Adrenal Cortex in Lactation** (C. W. Turner, E. T. Gomez). Hypophysectomy of lactating animals resulted in effects similar to those reported in adrenalectomy. However, the administration of adrenal cortical extract, eschatin, into hypophysectomized lactating guinea pigs failed to initiate or prevent the rapid cessation of lactation after hypophysectomy.

The injection of adrenal cortical extracts (eschatin or the purified pituitary adrenotropic hormone which influences the activity of the adrenal cortex), beginning immediately after hypophysectomy of lactating guinea pigs, was incapable of supporting the continuance of the secretion of milk. However, when galactin was injected simultaneously with either eschatin or the adrenotropic hormone, the rapid cessation of milk secretion which followed hypophysectomy was prevented, and continued treatment resulted in apparent, normal lactation.

Apparently, the cessation of lactation following hypophysectomy in the guinea pig was due to the withdrawal of the lactogenic, the adrenotropic, and probably the carbohydrate metabolism hormone of the

pituitary. The adrenotropic hormone stimulated the production of a hormone or hormones by the adrenal cortex, which in turn influenced the salt and fluid metabolism. In adrenal insufficiency induced by hypophysectomy, there occurred a rapid shifting of fluids and salts (NaCl) from the tissue and intercell spaces in the blood stream. The resulting polyurea after hypophysectomy and the associated increased excretion of salt caused a gradual withdrawal of fluid and a dehydration of the tissues. Thus, the passage of the precursors of milk from the blood stream to the mammary gland was prevented, thereby depressing the secretory function of the lobule cells.

**The Separation and Purification of the Pituitary Hormones** (C. W. Turner, A. J. Bergman). Since the discovery of the lactogenic hormone of the pituitary, efforts have been made to develop better methods of separation, purification, and assay of the hormone. It now is possible to prepare a highly purified preparation. While such preparations will stimulate copious lactation in normal animals, in hypophysectomized animals it will neither initiate nor maintain lactation. Implants of crude pituitary extracts will maintain lactation. Apparently, other pituitary factors play an important role in lactation.

Ten pounds of the anterior lobes of sheep pituitaries have been dried with acetone and ground until the material passed through an 80 mesh sieve. This material assayed as follows:

Assay of Sheep Pituitary Powder		
Lactogenic	—1 pigeon unit	= 2 mg. or 500 units per gm.
	(McShan & Turner)	
Thyrotropic	—1 guinea pig unit <sup>1</sup>	= 20 mg. or 50 units per gm.
Adrenotropic	—1 guinea pig unit <sup>2</sup>	= 75 mg. or 13.3 units per gm.
Gonadotropic	—1 chick unit <sup>3</sup>	= 4 mg. or 250 units per gm.

<sup>1</sup>One unit is the amount required to increase the thyroid weight of 140 to 200 gm. normal male guinea pigs by 50 per cent.

<sup>2</sup>One unit is the amount required to increase the adrenal weight of 140 to 200 gm. normal male guinea pigs by 50 per cent.

<sup>3</sup>One unit is the amount required to increase the testes weight of white Leghorns seven to eight days old by 100 per cent.

The acetone dried powder then was extracted with 60% aqueous alcohol at pH 9 to 10 and then precipitated by bringing the pH to 5.5 and increasing the alcoholic concentration to 86%. This precipitate was dried and again assayed as follows:

Assay of the First Extraction of Sheep Pituitary		
Lactogenic	—1 pigeon unit	= 0.26 mg.
Thyrotropic	—1 guinea pig unit	= 2-3 mg.
Adrenotropic	—1 guinea pig unit	= 8-10 mg.
Gonadotropic	—1 chick unit	= 0.4-0.5 mg.

The lactogenic hormone then was separated from the thyrotropic, adrenotropic, and gonadotropic fractions and further purified. The powder containing these hormones then was assayed with the following results:

Lactogenic		
Thyrotropic	—1 guinea pig unit	= 0.25 mg.
Adrenotropic	—1 guinea pig unit	= 1.5-2 mg.
Gonadotropic	—1 chick unit	= 0.15 mg.

Apparently, a product of increasing purity was obtained without much loss of potency.

**The Composition of Rabbit Milk Stimulated by the Lactogenic Hormone** (C. W. Turner, A. J. Bergman). Glands which were rated a (+) according to the method of Gardner and Turner contained from 0.05 to 0.14 per cent of lactose in the fresh gland. The (++) glands contained from about 0.15 to 0.35 per cent; the (+++) glands about 0.36 to 0.75 per cent; and the (++++) glands from 0.76 to 1.00 per cent lactose.

In comparing normal colostrum with the "experimental" milk from a plus 4 rabbit, it was observed that the lactose and total solids were similar, but the fat was higher and the ash content lower in the "experimental" milk.

**The Vitamin C Content and Curd Tension of Goat's Milk** (C. W. Turner, E. R. Garrison). A large number of goats are being raised for milk production in Missouri, and interest exists in the food value of this milk. There is very little information on the amount of vitamin C in goat's milk. Samples of the complete morning milk from twenty-five goats, mostly of the Toggenburg breed, were analyzed once each week. Eleven such weekly analyses have been completed. The vitamin C content was determined by precipitating the proteins of the milk with trichloroacetic acid, filtering, and titrating the serum with the indophenol reagent, the vitamin C value of which was ascertained by standardizing against a 0.01 N iodine solution and freshly prepared strained lemon juice. The vitamin C analyses were made within three hours after milking, and precautions were taken to avoid exposing the milk to light. The Cobb curd test instrument was used, and the Hill technique was followed in making the curd tension determinations. For comparison, the vitamin C content and the curd tension of the mixed milk from the cows in the University dairy herd also were determined once each week.

Considerable variation existed in the vitamin C content of the milk from the same goats from week to week. The average value of all the goats was approximately 2.0 mg. ascorbic acid per 100 cc. milk, while

the average value for the individual goats varied from 3.40 to 1.45 mg. per 100 cc. milk. The mixed milk from the University herd of dairy cows contained on the average 1.7 mg. vitamin C per 100 cc. milk.

The curd tension determinations also showed variation. The average value for all goats was approximately 55 grams, while the average value for individual goats varied from 30 to 100 grams. The average value for the milk from the University herd of dairy cows was 70 grams.

**Variations during the Lactation Period in the Chlorine, Catalase, and pH Values of the Milk from Cows with Normal Udders** (C. W. Turner, E. R. Garrison). For two years, the milk from the individual quarters of the udders of all cows in the Experiment Station dairy herd has been analyzed for certain constituents at monthly intervals. From this information, the normal variations of the various constituents throughout the lactation period have been determined on forty-four cows.

Considerable variation between the average and the maximum and minimum chlorine values was noticed. Excluding the last month of lactation, the average chlorine content of the milk varied from 0.101 to 0.150 per cent. The cows that milked only nine months had higher average chlorine values than those that milked for longer periods. The percentage of chlorine in the milk remained fairly constant during the first three or four months, then gradually increased during the remainder of the lactation period, the increase being very pronounced during the last month.

The chlorine content from Guernsey and Jersey milk was appreciably lower throughout the lactation period than it was in Holstein milk.

The average catalase value was less than 0.50 during most of the lactation period, but increased to over 1.0 for the last month.

**The Germicidal Action of Antiseptic Dyes on Streptococcus Agalactiae in Naturally Infected Milk** (C. W. Turner, E. R. Garrison, R. G. McCarty). Before any dye may be used for treating mastitis, it would seem desirable to know at least two things about it: (1) what strength of dye solution is necessary to destroy the infecting organism in the presence of milk, (2) how strong a solution of the dye will the udder tissue tolerate without being permanently injured. It is apparent that the udder must be able to withstand a dye solution of equal or greater concentration than is required to destroy the infecting organism. Since streptococcus agalactiae is the predominant bacteria causing udder infection in dairy cows, this investigation was limited to this organism.

Milk was drawn from quarters of the udder known to be infected with streptococcus agalactiae into sterile flasks under aseptic conditions. Eleven different samples, ranging in bacteria plate counts from 4,000 to 400,000 per cc. were used. Ten cc. of the freshly collected milk were placed in individual test tubes and a sufficient amount of a water solution of the dye added to give the dye concentration desired. The concentrations employed ranged from 0.9 per cent to 0.006 per cent with the different dyes. The mixtures were incubated at 37 degrees C., and at the end of 3, 6, and 12 hour intervals, about 0.1 cc. of the milk and dye mixture were transferred to tubes containing 10 cc. glucose, nutrient broth, to which andrades indicator had been added. The tubes of inoculated broth were incubated for 48 hours and examined for the growth of streptococcus agalactiae. Doubtful tubes were confirmed by a microscopic examination.

Nineteen different dyes were tested, but eight of them were not studied extensively because of their weak bactericidal action against streptococcus agalactiae in milk. These dyes were Methanamine, Acid fuchsin, Colloidal iodine, Proflavin, Neutral red, Mercurochrome, and Pyridium.

Table 2 shows the strength of dye found necessary to destroy Streptococcus agalactiae in naturally infected milk with bacteria plate counts of 4,000 and 40,000.

TABLE 2.—DYE STRENGTH NECESSARY TO DESTROY STREPTOCOCCUS AGALACTIAE

Dye	Plate Count 4,000	Plate Count 40,000
	% dye in milk	% dye in milk
Acriflavin .....	0.01	0.02
Neutral acriflavin .....	0.01	0.02
Trypaflavin .....	0.03	0.04
Rivanol .....	0.03	0.04
Brilliant Green .....	0.01	0.03
Crystal Violet .....	0.01	0.02
Methylene Blue .....	0.03	0.04
Basic fuchsin .....	0.03	0.05
Safranin .....	0.03	0.04
Merthiolate .....	0.01	0.01
Iodine solution .....		0.05
Azamine .....	0.9+	0.9+

The dye concentration necessary to be effective varied from 0.01 to 0.05 per cent with the various dyes. The length of time the organisms were exposed to the dye in the milk seemed to have very little, if any, effect. The germicidal action was practically as great at the end of 3 hours as after 12 hours. Therefore, it would seem that the dye solution after injection into the udder could be removed after an interval of a few hours and thereby reduce its toxic effect on the mammary gland.

While several investigators have reported beneficial results from the injection of a solution of 0.5 per cent Azamine into infected udders, this dye failed to destroy *Streptococcus agalactiae*. Also, it was observed that the udder of dairy cows was affected severely when 500 cc. of a 0.5 per cent solution of this dye was introduced into a quarter of the udder and left there for 8 to 12 hours. It appeared that this dye had very little promise as an effective agent for treating mastitis.

**Hypophysectomy and Replacement Therapy in Relation to the Growth of the Mammary Gland** (C. W. Turner, E. T. Gomez). It has been found that the injection of estrogen, or estrogen and progestin were ineffective in stimulating the growth of the gland parenchyma of completely hypophysectomized mammals. When administered into normal or castrated male and female animals, however, these hormones produced complete hyperplasia of the mammary gland parenchyma. These observations indicated that either (1) the ovarian hormones required the supplementing effect of the pituitary hormones, or (2) that they stimulated the production of a specific hormone or hormones by the pituitary, which in turn exerted a direct action upon the mammary gland and stimulated the growth of the glandular complex.

In order to test the first of these hypotheses, the purified thyrotropic, adrenotropic, and lactogenic hormones were injected alone and in combination with estrogen, or estrogen and progestin into hypophysectomized male and female laboratory mammals, including the rat, mouse, guinea-pig, cat, rabbit, and ground squirrel. These therapies were ineffective in stimulating the growth of the mammary gland parenchyma of the above mentioned animals. Likewise, the administration of thyroxine or the adrenal cortical extract, eschatin, alone, or in combination with estrogen, were ineffective in stimulating mammary duct growth. Therefore, the purified pituitary thyrotropic, adrenotropic, and the lactogenic hormones, or the hormone elaborated by the thyroid and the adrenal cortex, do not represent the factors which in conjunction with estrogens stimulate mammary gland growth. Since other known pituitary hormones were not available in pure or isolated form, an experiment was conducted to determine grossly whether the whole pituitaries of sheep contained the factor or factors which supplement the ovarian hormones in their action on the mammary gland.

The administration of desiccated whole sheep pituitaries alone and in combination with estrogen and progestin were ineffective in stimulating mammary gland growth of hypophysectomized male and female guinea-pigs. The whole pituitaries of the sheep, therefore,

did not contain the principle concerned in mammary development.

Therefore, the second part of the hypothesis was tested, namely, that the ovarian hormones, estrogen and progesterin, stimulated the production of an, as yet, unrecognized hormone of the pituitary, which in turn causes growth of the mammary gland parenchyma.

The daily implants of the pituitary glands of rats which received injections of estrogen daily for 10 to 20 days produced extensive hyperplasia of the mammary gland complex of completely hypophysectomized or hypophysectomized-castrated immature male and female guinea pigs. The pituitary of adult, normal rats, on the other hand, was ineffective in stimulating mammary gland growth. Therefore, the estrogen, and probably estrogen and progesterin, stimulated the production of a "mammary gland growth stimulating hormone" by the pituitary gland of rats.

It may be stated that although the normal growth of the mammary gland parenchyma proceeded only in the presence of the functional ovaries, the action of the ovarian hormones was an indirect one by way of the pituitary.

**The Lactogen Content of Cattle Pituitaries** (C. W. Turner, R. P. Reece). Of all the pituitaries assayed, those from fetuses contained the lowest concentration of lactogen. As the animals grew larger, there was not only a greater number of bird units per pituitary gland, but also a greater concentration of lactogen within the glandular tissue. Pituitaries from immature bulls contained more lactogen than did glands taken from steers of similar age, while pituitaries from sexually immature heifers were slightly higher in lactogen concentration than those from bulls.

As heifers reached sexual maturity, there was a further increase in the size of the pituitary gland, accompanied by a considerable increase in lactogen concentration. Steers varying in age from 11 to 23 months had pituitary glands which were considerably larger than steers varying in age from 4 to 10 months.

Pituitary glands from dairy cattle contained more units of lactogen per gland than did glands from non-lactating beef cattle. This was due entirely to larger pituitary glands of the lactating animals. No great difference was found between pituitary glands taken from lactating, pregnant beef cows and non-lactating beef cows. Pituitaries from pregnant, nor lactating dairy cows were slightly higher in their lactogen content.

The glands taken from pregnant beef animals contained considerably more lactogen if the animals were dry; however, in lactating beef animals, no difference was found between pregnant and open cows. Pituitaries from pregnant dairy cattle contained slightly more

lactogen than did the glands from non-pregnant animals.

**Lactogen Content of the Rat Pituitary** (C. W. Turner, R. P. Reece). The sexually immature female rat pituitary contained about three times as much lactogen as did glands taken from sexually immature males. As the male rat matured, the pituitary gland grew larger and contained more lactogen, due entirely to its greater size. Neither castration nor cryptorchidism had any influence upon the lactogen content of male rat pituitaries. Thyroxine had a tendency to decrease the lactogen content, while injection of one of the estrogens definitely increased the lactogen content per pituitary gland.

Pituitaries from sexually mature, full-grown female rats contained about four times as much hormone as did glands from sexually immature females. No change was found taking place during pregnancy. Following parturition, there was a doubling of the lactogen content, due mostly to increased concentration. Nursing had no influence on the lactogen increase following parturition, but it did have a profound influence on the discharge of lactogen from the pituitary gland. This influence of nursing was due to a stimulus and not to the removal of milk, since the pituitary glands taken from females in which the young nursed but secured no milk, the primary milk duct having been ligated, contained lessened amount of lactogen than did the glands taken from rats in which the final nursing period was not allowed. Females ovariectomized when sexually immature and permitted to live 60 days had pituitary glands which contained 40 per cent less lactogen than did those of non-ovariectomized rats. The injection of estrogens elicited an increase in the lactogen content of castrated female pituitaries. The injection of progesterin into sexually mature castrated female rats brought about no change in lactogen content of the pituitary gland, and the simultaneous injection of estrogen plus progesterin into castrated female rats had the same effect as did the injection of estrogen alone.

The male guinea pig pituitary gland was found to be much richer in lactogen than was the male rat pituitary. On the basis of body weight, the female guinea pig pituitary contained about the same amount of lactogen as did the female rat pituitary. The injection of estrogen into normal male guinea pigs brought about an enormous increase in lactogen. It contained the greatest concentration per 1 mg. of pituitary tissue which had been assayed, either from normal or experimental animals. Pituitary tissue from male and anestrus cats was very low in lactogen, while mice pituitaries were somewhat lower in lactogen than were rat pituitaries.

**The Functional Activity of the Right and Left Bovine Ovaries** (C. W. Turner, R. P. Reece). While collecting pituitaries, ovaries

also were collected. Of 59 pregnant cases, the corpus luteum of pregnancy occurred in the right ovary 39 times. In sexually mature, non-pregnant heifers, the most recent corpus luteum occurred in the right ovary 59 times and in the left ovary 39 times. In sexually immature heifers, the largest follicle occurred in the right ovary 100 times and in the left ovary 36 times.

**Rapid Growth in Dairy Calves** (A. C. Ragsdale, S. Brody, H. A. Herman, R. G. McCarty). The economy and efficiency of growth, rapidity of development, sexual development, longevity, relative milk production, and energy and nitrogen metabolism of Holstein calves fed diets designed to give the most rapid growth possible have been studied. The rations selected were rich in nutrients, vitamins, and minerals. Dairymen have long debated the advisability of rapid, but usually costly, growth in heifers; likewise, there has been a general feeling among practical breeders that rapid growth and high condition in heifers resulted in poor milk production.

Several groups of calves were used in this study. Group I consisted of three calves of purebred Holsteins selected from the Station herd. All were normal in weight at birth, and on the basis of genetic make-up, compared closely with the other calves used on this project.

The calves were fed wholemilk at the usual rate of about 1 pound daily per 10 pounds of body weight until the daily consumption was 20 pounds. Wholemilk feeding continued at this level throughout the experiment. As soon as they were capable of consuming other foods than milk, the calves received, ad libitum, the following ration (defined as a super ration):

Green, leafy, ground alfalfa hay .....	35 lbs.
Yellow corn meal .....	14 lbs.
Wheat germ meal .....	10 lbs.
Wheat bran .....	5 lbs.
Linseed oil meal (O.P.) .....	5 lbs.
Dried Skimmilk powder .....	14 lbs.
Soluble blood flour .....	5 lbs.
Dried yeast .....	9 lbs.
Irradiated yeast .....	1 lb.
Salt .....	1 lb.
Steamed bone meal .....	1 lb.
Potassium iodide .....	0.5 gram

The analysis of this ration showed 25.99% crude protein, 22.49% digestible crude protein, and 70.68% total digestible nutrients.

The calves were weighed and measured on three successive days each month. The blood picture was studied with respect to calcium, phosphorus, magnesium, cell volume, and hemoglobin.

Group II was composed of three purebred Holstein females and fed whole milk in the same manner as Group I. They were fed a

ration, ad libitum, as soon as they were able to consume other feeds than milk as follows:

Super Ration (Composition given above) .....	90 lbs.
Dehydrated green grass (oats cut at joint stage) .....	10 lbs.
Total .....	<u>100 lbs.</u>

This ration contained about 26% crude protein and 70% total digestible nutrients, agreeing closely with the ration fed Group I in chemical analysis.

Group III consisted of two Holstein calves (high grades). They were fed all of the raw Holstein milk they would consume. This approximated one pound of milk daily per 10 pounds of live weight. In addition, dehydrated green grass (oats cut at the joint stage) was fed in the milk at the rate of 10% of the dry matter in the milk. The mixed Holstein milk contained about 12% dry matter.

There was very little difference in the rate of growth and development of calves in Group I, II, and III to six months of age. All were distinctly above normal at the ages of 3 and 6 months. True growth, as measured by height at withers, was taking place, and the calves were not simply fat. All calves were in excellent condition.

The blood picture of all calves was normal, although the calves in Groups I and II seemed to have an unusually high cell volume. Calves in Group III have shown no evidence of anemia.

**Growth, Blood Picture, and Related Physiological Phenomena in Calves Fed on an Exclusive Milk Diet Supplemented Only by Minerals and Cod Liver Oil** (H. A. Herman, R. G. McCarty). The Missouri Agricultural Experiment Station Research Bulletin No. 245 is a report on this project.

Dairy calves fed diets of milk alone and milk supplemented with iron, copper, manganese, and cod liver oil made supernormal growth, but were unable to survive after 12 to 15 months of age. At 6 to 10 months of age, the calves were about 20 per cent above normal in body weight. Calves fed milk alone showed evidences of anemia after 6 months of age. Those fed mineralized milk and cod liver oil showed no evidence of anemia and continued to gain in weight longer than the calves fed milk only. Death was preceded by anorexia, dyspnea, and physical weakness.

Milk was found to supply sufficient minerals, including calcium, phosphorus, and magnesium, for growth, as evidenced by normal blood serum values and failure of tetany to develop. Sufficient vitamin D was provided by the wholemilk and solar radiation for normal bone development. The bones of the calves fed cod liver oil were slightly more dense than those of the group fed exclusively on milk.

The energy metabolism of both milk-fed groups was above normal. After 6 to 8 months, the calves were dyspneic, nervous, and highly irritable. This may explain the relatively high energy metabolism.

Postmortem findings were characterized by hemorrhages of the kidney, lung, thymus, and heart. Enlargement of the thymus and degeneration of the heart muscles usually were noted. The digestive tract, with the exception of the abomassum, was underdeveloped.

The nature of the dietary deficiency responsible for death is obscure, but the evidence accumulated would suggest a vitamin deficiency.

**Growth and Development of Dairy Calves Fed Only Alfalfa Hay and Milk** (A. C. Ragsdale, H. A. Herman). Five Holstein heifers have been raised to approximately two years of age on a diet of milk and chopped alfalfa. The calves were fed wholemilk at the usual rate of about one pound of wholemilk daily for each 10 pounds of live weight for the first three weeks. At three weeks of age, the calves were changed gradually to a diet of skim milk and chopped alfalfa hay. Skim milk feeding was continued (never above 20 lbs. daily) until the calves were nine months of age. Thereafter, the calves have been fed a diet of chopped alfalfa, ad libitum. Body weights and measures were taken at monthly intervals. The blood was analyzed for calcium, phosphorus, and magnesium once a month.

The five calves averaged 84 pounds in weight at birth. The oldest calf now is approximately 27 months old, and three of the calves are above 24 months of age. All five came into oestrus at the normal age.

The calves were below normal in body weight throughout the period of growth between 6 and 24 months. The gain in weight was affected most between 6 and 12 months. At 12 months of age, the average calf was only 78.5 per cent of normal. At 18 months, and also at 24 months, of age, the calves were about 88 per cent normal in weight.

The skeletal development was arrested only slightly.

Feed consumption showed that the daily intake of chopped alfalfa closely approximated the total dry matter consumed by a calf fed the usual ration of hay, silage, and grain. The intake of protein was normal or above, but the total nutrients consumed were somewhat below normal.

The calves in this group were very thrifty and desirable in appearance. Their hair was sleek and fine, the eyes bright, and the calves were alert and healthy in every respect.

The blood picture was normal for calcium, phosphorus, magnesium, cell volume, hemoglobin, and erythrocyte values.

**Seasonal Variations in the Fat and Solids-not-fat Content of Mixed Herd Milk** (H. A. Herman). It has been observed that, in addition

to breed, such factors as temperature, season of the year, stage of lactation, age of the cow, and perhaps feed, affect the solids-not-fat content of the milk. During seasons of drouth and extremely high temperatures, normal mixed herd milk, particularly from the lower testing breeds, has been observed to fall below the standard of 8.5 per cent solids-not-fat. Likewise, during extremely cold weather, the percentage of solids-not-fat increased. In case of warm periods of weather, a fall of 0.3 to 0.5 per cent in the solids-not-fat and a reduction in the percentage of fat were evident. The decrease in solids-not-fat usually was accompanied by an increase in the total volume of milk produced.

The Station herd, made up of 49 per cent Holsteins, 39 per cent Jerseys, and 12 per cent Guernseys, ranged from 8.3 to 9.2 per cent solids-not-fat during the period of November to May. The herd included many fresh cows, which, in part, explained the wide variation. During this period, the fat content ranged from 3.8 to 4.9 per cent.

**The Solids-not-fat Content of Milk** (A. C. Ragsdale, H. A. Herman). The variations in the composition of milk are chiefly in the percentages of fat, lactose, and protein. According to Davis (1935) milk low in solids-not-fat was characterized by a low lactose content (high chloride content), low total protein, and a low casein nitrogen of the total protein.

Cows suffering from streptococci infection of the udder produced milk low in lactose, high in chlorides, and often of low solids-not-fat content.

Because of the variations in the solids-not-fat content of milk attributed to age, season, stage of lactation, temperature, plane of nutrition, dry feeds, etc., a study of the composition of the milk produced by 25 cows has been made. In this study, cows were fed both dry and green feeds.

The milk from each cow has been weighed daily, and 2-day composite samples were taken each two weeks for chemical analysis. The following determinations have been made: fat, specific gravity, total solids, solids-not-fat, total protein, lactose, and chlorides.

The project has not developed far enough for definite conclusions.

**The Comparative Value of Korean Lespedeza, Soybean Hay, and Alfalfa Hay for Milk Production** (A. C. Ragsdale, H. A. Herman). The trials for each hay consisted of two feeding periods of 30 days each. Four groups of 8 cows each, producing an average of 30 pounds of milk daily, were used. The hays were fed at the rate of  $1\frac{3}{4}$  pounds per 100 pounds of live weight daily. Silage feeding was held to  $1\frac{1}{2}$  pounds daily per 100 pounds of live weight, and a grain mix, averaging about 11 per cent digestible protein, was fed at the rate of 1

pound for each 3 pounds of milk produced daily by Jerseys and Guernseys and 1 pound for each 4 pounds milk produced daily by Holsteins. The 16 cows fed alfalfa average 30.5 pounds of milk daily; those fed Korean lespedeza averaged 28.7 pounds; those fed soybean hay averaged 29.45 pounds.

The soybean and Korean lespedeza apparently were about equal for milk production. The alfalfa hay was somewhat better than either of the other two. In chemical analysis, the alfalfa contained considerably more nitrogen, and the alfalfa and soybean hay were higher in calcium and phosphorus than the lespedeza.

**The Effect of Thyroxine on Milk Production** (H. A. Herman, C. W. Turner, W. R. Graham). The injection of thyroxine in cows in the declining phase of lactation increased milk secretion. An effort has been made to determine the changes in composition produced by the feeding of thyroxine.

Cows in the various stages of lactation were selected. Since thyroxine raised the metabolism level, feed consumption was carefully checked and the weight of the cows obtained weekly. Thyroxine was supplied (1) by feeding the desiccated thyroid at levels of two ounces daily, and (2) by the injection of thyroxine daily in doses of 5 to 10 mg.

Milk production declined rapidly when thyroid feeding was discontinued for a 4 week period. Resumption of feeding, however, resulted in a rapid rise in daily production. In one case, the increase amounted to 34.5 per cent, but averages of approximately 20 per cent were secured.

The percentage of fat in the milk produced was increased by both thyroid feeding and thyroxine injection. The solids-not-fat apparently were increased slightly during the periods of injection or feeding.

Three cows injected with thyroxine at the peak of their production showed a rapid decline in daily production.

There was no marked change in the weight of the cow during the phases of thyroid feeding or thyroxine injection.

**Interrelations Between Growth in Linear Size and Body Weight** (A. C. Ragsdale, S. Brody). Many years ago, this Station initiated an investigation on growth of dairy cattle, with the idea of ultimately interpreting the interrelatedness to 21 linear measurements: weight, age, feed supply, milk production, etc. As this work continued, various research bulletins have been published from time to time. In Research Bulletin 103, 1927, it was shown that the interrelations between practically every one of the 21 measurements and body weight followed a constant pattern or design, and that this pattern was rep-

resented by the equation  $Y = bX^n$ , in which  $Y$  is the magnitude of a given measurement and  $X$  is the weight of the body. Thus, if  $n$  in the equation were 2, then the *percentage* increase in  $Y$  is 2 times as great as the *percentage* increase in  $X$ .

A cooperative arrangement with Professor H. P. Davis of the Nebraska Station has resulted in the expansion of the data on inter-relatedness between various linear measurements and body weight on a vast scale. There now are available 16,000 pairs of measurements, such as size of chest and size of the whole body. The quantitative interrelations, including statistical constants, were obtained for each of 6 groups and also for the whole of the population.

The remarkable feature is that in spite of change in form with increasing age, in spite of the bewildering diversity of growth phenomena, the pattern of change is surprisingly simple and can be represented *formally* by the simple equation,  $Y = bX^n$ .

As a sample, the interrelatedness between weight,  $W$ , and chest girth,  $G$ , is  $W = bG^n$ . The *numerical value* of  $n$  is 2.82 of the standard error of estimate of all the 15,610 sets of measurements, and the equation is  $+13.3\%$  and  $-11.7\%$ , and of the index of correlation is 0.9746. The meaning of the 2.82 is that the *percentage* increase in weight is 2.82 times as rapid as the percentage increase in chest girth; of  $+13.3\%$  and  $-11.7\%$  is that  $\frac{2}{3}$  of all the 15,610 sets of measurement are within  $+13.3\%$  and  $-11.7\%$  of the computed average curve.

The above analysis was carried out on the weight-chest relationship, *disregarding age*. Similar analyses were carried out for the weight-chest relationship for short age intervals. The numerical value of the basic constant  $n$  then was somewhat different. This work places growth investigations on a new plane, namely on the basis of a "unified field theory" which points to a remarkable unity of pattern in animal life in apparent surface diversity.

**Diurnal Variations in Basal Energy Metabolism** (S. Brody, Virgil Herring). The work on basal metabolism has been based on the same "field" theory as the work on growth. The magnitude of a biologic function of a structure can be interpreted only in relation to other functions and structures and in relation to the internal and external environment of the organism. The term "organism" implies organization, interrelatedness. Growth and development do not follow a haphazard process—each organ growing according to its "will," but rather a well-defined developmental pattern. Likewise, basal energy metabolism, or body temperature, which usually is considered as a constant, is not really a constant independent of other considerations. It goes through a diurnal rhythm, synchronized with the position of

the sun. "Basal metabolism" is correlated with the time of day when the measurements are made.

The metabolism of the rat in the simplest situation is an average value between the energy expense of a certain quantity of activity and the post-absorptive metabolism. The daily cycle of daylight and darkness form a conditioned rhythm of activity. The energy metabolism of a fasting, adult rat was more than 20% greater during a three-hour period about midnight than during a similar period about noon. The average metabolism was 46% greater at the peak (9 P. M.) than at a similar period the next day about 9 A. M.

The activity and, therefore, the metabolism, were very constant if rats were kept under constant illumination and a maintenance level of food intake with equal meals every three hours. The basal metabolism of the rat cannot be determined in the strict sense of the definition, for the rat rarely is inactive except during sleep, and periods of activity alternate with periods of sleep at frequent intervals.

The daily rhythm in activity is accompanied by not only quantitative, but also qualitative metabolic changes. A high carbohydrate or a high protein dietary for several weeks caused a rhythm of fasting respiratory quotients that were highest at the time of inactivity about noon and lowest during the period of activity about midnight. A high fat dietary resulted in a respiratory quotient that remained very constant, regardless of whether the rat was active or quiet.

**Respiratory and Fermentation Gases of Ruminants** (S. Brody, L. E. Washburn). In order to differentiate fermentation carbon dioxide from that of body tissue metabolism, ratios between fermentation carbon dioxide and combustible gasses (methane and hydrogen) were determined for rumen and intestinal gases of cows, sheep, and goats. Total gas volumes, ratios between carbon dioxide and combustible gases, and in some cases oxygen and nitrogen percentages, in the entire alimentary tract were measured for a number of animals immediately after death. Rumen and expired gases of a dairy cow also were measured simultaneously at different times after feeding.

Approximately 92% of the gas in the entire ruminant digestive tract was contained in the rumen. In the few cases in which the intestines yielded enough gas for analysis, low carbon dioxide combustible gas ratios (0.07 to 0.88) were observed. Rumen gas ratios for 26 slaughtered animals ranged from 0.50 to 2.86. The ratio was not constant. The ratio reached its maximum value about 2 hours after eating, remained fairly constant until the sixth hour, and then declined to a value approximating that for intestinal gases at 24 hours. The ratio appeared to rise and fall in parallel with the rumen carbon dioxide percentage. Rumen methane remained fairly

constant until about 12 hours after feeding and then decreased during the next 12 hours to reach a value of about one-fourth to one-third of the original. Rumen oxygen and nitrogen percentages changed inversely with the carbon dioxide values. The results for oxygen and nitrogen indicated that while aerobic processes undoubtedly occurred in the rumen, they probably were not appreciable.

Energy loss in fermentation gases was calculated to be 16.5% of the feed energy intake, or about 25.4% of the maintenance requirement, when the cow was fed alfalfa hay in an amount which was just sufficient to maintain body weight. With grass feeding at approximately twice the maintenance level, fermentation gases accounted for an energy loss equal to 12% of the feed energy, or 40.4% of the maintenance requirement. The respiratory quotient showed that twice maintenance intake of grass was digested as quickly as a maintenance intake of alfalfa hay. In the case of hay and grain feeding the energy loss in fermentation gases amounted to 14.6% of the feed energy and 30.6% of the maintenance requirement. Fermentation carbon dioxide accounted for about half of the total energy loss in fermentation gases when hay was fed, slightly more than half for grass feeding, and slightly less than half for hay and grain feeding.

**The Length of Gestation in the Dairy Cow, with Particular Reference to Bang's Disease** (H. A. Herman, Cecil Elder). The average length of normal gestation in dairy cows in the Missouri Station herd has been found to be 280.86 days for Jerseys and 277.78 days for Holsteins. Males were found to be carried from 1 to 3 days longer than females in the case of both breeds. Twins and triplets averaged from 5 to 8 days less than the normal.

Cows reacting to the Bang's test in 1:110 dilutions (positive) were found to abort in 24 per cent of the cases. Cows reacting to 1:25 and 1:50 dilutions carried their calves full term in about 95 per cent of the cases. Approximately 90 per cent of all abortions occurred after the fifth month of pregnancy. The average termination of pregnancy due to abortion occurred at 207 days of gestation.

**Comparison of the Polarimetric and Copper-iodometric Reduction Methods of Determining Lactose in Milk** (E. R. Garrison, A. J. Bergman). Thirty-five samples representing herd milk and milk from individual cows have been analyzed for lactose by the polarimetric and by the copper-iodometric methods. Both normal and abnormal milk were included in the samples from individual cows in order to secure variable lactose results. Some of the samples were analyzed for sugar, both before and after fermenting with yeast to remove any glucose that might be present.

The polariscope always gave higher results than the Shaffer-Somogyi method. These differences varied from approximately 1 per cent with samples of high lactose content to 0.34 per cent for the samples having the lower percentages of lactose. While the differences in the two methods were not always proportional to the percentage of lactose, they tended to decrease with a decrease in the amount of lactose in the milk.

**Methods of Clarifying Milk Preceding the Optical Determination of Lactose** (E. R. Garrison). The usual method for clarifying milk preceding the polarimetric determination of lactose has been found unsatisfactory because the proteins were not removed completely. Since proteins and their cleavage products are laeno-rotary, they reduce the dextro-rotary power and hence the lactose value of the filtrate if not removed completely by the clarifying agents.

The mercuric iodide solution was prepared by using 200 cc. of glacial acetic acid instead of the usual 20 cc. When thus prepared, 30cc. of this reagent was quite satisfactory for clarifying 65.8 grams (twice the normal weight) of milk.

In the preparation and use of the acid mercuric nitrate solution, it was found that better results were secured if the usual solution was diluted with 5 volumes of water instead of 1, and if .15 cc. of the dilute solution were used. The addition of 20 cc of a 5 per cent phosphotungstic acid solution also removed more completely all of the protein material from the milk filtrate.

**The Effect of Temperature and the Addition of Sugars to Milk on the Methylene Blue Reductose Test** (E. R. Garrison). The methylene blue reductose test used commonly by dairy plants and milk control laboratories for grading raw milk has two important objections: (1) too much time is required to complete the test on milk of good or average quality, and (2) the reduction time is not always closely correlated with the bacterial content of the milk.

The effect of temperature has not been carefully investigated. It has been assumed generally that the reduction occurred the quickest when the samples were incubated at the optimum temperature for growth of the majority of bacteria present in the milk. Therefore, the standard temperature for conducting this test has been 37 degrees C. Samples of producers' milk of varying quality have been obtained and the reductose test conducted on each of them at several different temperatures: 32, 37, 42, and 47 degrees C. On a second group, temperatures used were 34, 37, 40, 43, and 46 degrees C.

The average reduction time decreased as the temperature was raised from 32 to 43 degrees C, but at 46 and 47 degrees C. the average reduction time was prolonged considerably. The average samples re-

quired a somewhat shorter period at a temperature of 42 degrees, rather than 37 degrees. Therefore, considerable time can be saved by conducting the methylene blue test at 40 to 42 degrees C. instead of at 37 degrees C. This procedure required a different reduction time value for grading milk than now is used.

The addition of different sugars and sodium formate to the milk on the reduction time at 37 degrees C. also has been studied. The addition of 1 per cent glucose, 2 per cent glucose, and 1 per cent lactose to milk decreased the reduction time, while the addition of 1 per cent sucrose had no effect. The addition of 2 per cent glucose had the greatest effect of any of the sugars studied. The addition of 1 per cent sodium formate to the milk increased the average reduction time by 3.71 hours.

Samples with a certain reduction time at 42 degrees C. have a lower average bacterial content than samples with a similar reducing time at 37 degrees C.

**The Effect of Serving Temperature upon Consumer Acceptance of Ice Creams and Sherbets** (W. H. E. Reid, W. S. Arbuckle). Consumer acceptance was determined by recording the observations made by 181 different people who judged seven different flavors of ice creams and four sherbets at serving temperatures of 6, 10, 14, and 18 degrees Fahrenheit. Serving temperature was of decided importance in determining consumer acceptance of frozen desserts.

Ice creams served at 10 degrees Fahrenheit were considered by a large percentage of judges as being desirable in flavor, smooth and mellow in body, and close in texture. Those served at 14 degrees Fahrenheit were slightly objectionable because of the tendency for the flavor to be too pronounced, sweet, and warm. The body tended to be lacking in resistance, and the texture was slightly open.

At 6 degrees Fahrenheit the ice creams were criticised severely for having a cold submerged flavor and resistant body. All ice creams were least desirable for consumption at 18 degrees Fahrenheit.

Due to the higher sugar content and the more pronounced flavor, sherbets were preferred at a slightly lower serving temperature than was ice cream.

As the serving temperature increased, the flavor became more pronounced.

In dipping studies, it was indicated that smaller portions of ice creams were dipped when temperatures of 6 and 10 degrees Fahrenheit were used.

Serving temperatures appeared to have little effect upon the stability of ice cream. However, the ice creams became undesirable for consumption much faster when the smaller sized dippers were used.

**Developing a Strain of Dairy Cattle for High Production by Selection and the Continued Use of Proved Sires** (A. C. Ragsdale, C. W. McIntyre, This project is in cooperation with the Bureau of Dairy Industry, U. S. D. A. and is conducted at the Hatch Experiment Farm). The dairy herd consists of 63 head of purebred Jersey cattle, including ten of the foundation cows. Three foundation daughters of Avanelle's Forfarshire 220377 remain in the herd with 33 other descendants of this sire. Avanelle's Forfarshire was lost during 1936 due to infirmities of age at 14 years. Four foundation daughters of Fauvic's Gamboge Knight 253701, with 12 of their descendants remain in the herd.

Only one daughter, five granddaughters, and one son (leased) of Ayredale's Exile 197339, first sire used, remain in the herd. The second sire used was Lady's Rinda St. Mawes 226037. Only two daughters from this sire were raised and tested in the Hatch Station herd. They showed a decrease of 42.4 pounds of fat compared with their dams, and 122.4 pounds fat less than the tested daughter of the sire in the herd where he previously had been used. One son of this sire still is owned by the Station and will have daughters in milk during the present year (1937). All of the offspring were above average in type.

Peggy's Majestic Duke 259690, the third sire now in service, has 23 daughters and 7 sons in the herd. Progress Owl's Pilgrim 319668 was the next sire purchased. He was sired by Spermfield's Owl's Progress 163331, a tested sire with 83 daughters averaging 690.74 pounds of fat, mature equivalent.

Thirteen bulls bred at the Station have been leased in Missouri, Illinois, and Iowa to dairymen under cooperative agreements.

**Herd and Farm Records, Hatch Farm** (C. W. McIntyre). Complete production, feeding, breeding, growth, and health records were kept on the entire herd. The Herd Improvement Registry record for 1936 was 6,896 pounds of milk, 5.26% and 362.63 pounds of fat, on 17.14 cow years, with an average of 13.95 cows in milk. The herd is Federal Accredited for tuberculosis and free of Bang's Disease.

Complete cost records on all crops were continued. The total cost of producing silage was \$7.33 per acre. Harvesting cost \$6.74 per acre. The total cost of a ton of silage, exclusive of land and building, was \$3.25. The low yield was due to drouth. Winter barley cost \$5.79 per acre and yielded 137 cow days of pasture between October 21 and November 24, 1936. The feed replaced amounted to \$69.21 on 11.8 acres. Spring pasture will produce additional feed.

Alfalfa seeded August 27 cost \$30.55 per acre, including team, tractor and man labor, seed, fertilizer, lime, and inoculation. It

yielded 2.23 tons per acre from the first and 0.2 tons from the second cutting. It was worth \$13.00 per ton or \$28.60 per acre. Harvesting cost \$3.72 and \$0.90 per acre, respectively, for the two cuttings. Alfalfa seeded on 8.9 acres, September 8 and 9, 1936, cost \$22.60 per acre for all costs except land. A good stand was obtained.

**Roughage Feeding of Dairy Cattle** (A. C. Ragsdale, C. W. McIntyre, in cooperation with the Bureau of Dairy Industry, U. S. D. A.). Four mature cows, having one or more complete lactation records on grain feeding, were started on a ration of alfalfa hay and corn silage one month before they were due to freshen. A mixture of equal parts salt and steamed bonemeal was before them at all times.

These four cows ate from 20 to 30 pounds of alfalfa hay and 20 pounds of corn silage per day and approximately 25 pounds of hay per day. From 2 to 3 pounds of the salt bonemeal mixture were consumed by each cow weekly. To date, three of the four cows have produced more on roughage alone than they produced last year with grain feedings. All of them have lost more body weight than during previous lactations. Present indications are that they will decrease more rapidly in production as lactation advances.

**Pasture Records, Hatch Farm** (A. C. Ragsdale, C. W. McIntyre). Rotational grazing of blue grass pastures was practiced for the first time.

All blue grass pastures have been manured heavily with barnyard manure during each of the past five years. Weeds have been mowed once or twice each year. The stand of blue grass has improved steadily each year, in spite of the severe drouths of 1934 and 1936 and heavy grazing in 1936. Blue grass pastures on land surrounding the Station farm were practically all lost in 1936, even when not grazed. The application of manure, undoubtedly, is the chief reason for this difference.

Seedings of sweet clover, orchard grass, and lespedeza in wooded ravines were lost due to dry weather.

Meadow fescue, orchard grass, and Scotch timothy, of the six English pasture grasses seeded in 1932 made good yields during 1936. Dry weather eliminated the remaining white clover.

In the pasture fertilizer experiment, the severe drouths of 1934 and 1936, undoubtedly, were important factors in yields. The increased yields, have not paid for the commercial fertilizer treatments. Farm manure has given significantly superior results to the commercial fertilizers. The application of lime was found to increase materially the calcium, and the nitrogen fertilizers slightly increased the protein content of the grass.

**Quality Improvement of Milk Products** (W. H. E. Reid). Methods practiced in milk and cream production have improved the quality of the farmer's products and have resulted in the production of a larger volume of cream of a desirable quality.

The application of improved methods of manufacture and receiving, along with the higher quality of cream, has improved the score value of butter from 1 to  $1\frac{1}{2}$  per cent. The ice cream quality and cheese quality improvement programs have resulted in improving the scores of these products.

In the work with cottage cheese, the addition of compounds to the wash water and storage water has been studied in an effort to improve the flavor and keeping qualities of sweet curd cottage cheese. The addition of variable amounts of chlorine solution of known strength to the water used in washing the cheese improved the aroma, but had no marked influence upon the flavor.

When the cottage cheese was permitted to remain in the same storage water for a period of time, the flavor of the curd was impaired. Frequent changing of the storage water improved the aroma and flavor.

**ENTOMOLOGY**L. HASEMAN, *Chairman*

**The Periodic Return of Insect Pests as Scourges** (L. Haseman). Special attention has been paid to the action of weather and other natural forces on (1) chinch bugs, (2) grasshoppers, and (3) armyworms.

The heavy rainfall period, early in 1935, combined with state-wide control measures used in 1934, so reduced the chinch bugs that even in spite of the drouth in 1936, the pest was not able to rebuild its population to any extent. The carry-over of chinch bugs into 1937 was light, and favorable spring rains prevented the pest from doing harm in 1937, except on scattered farms in a few localities. Chinch bugs thrive under dry conditions and when winters are not too severe.

The severe 1936 epidemic of grasshoppers found the excessive heat and scarcity of food a decided handicap, even though grasshoppers are dry weather pests. Conditions in the fall were adverse to egg-laying, but in spite of this, sufficient eggs were deposited to cause a very serious epidemic of hoppers in the summer of 1937.

The 1937 armyworm outbreak was one in which local conditions did not play a very important part. At apple blooming time, a large flight of moths from the southern states occurred. This resulted in the severest outbreak Missouri ever has experienced. They appeared over practically the whole State. The spring and early summer were favorable for breeding, but the adult moths came to us due to conditions in the South, which made possible the development of an early generation, the moths of which moved north. The armyworm, similar to the cutworm, usually thrives and causes greatest damage in seasons of normal rainfall and when the temperature is perhaps below normal, thus preventing its parasites from keeping it in check.

**The Tolerance of the Codling Moth to the Toxic Action of Insecticides** (L. Haseman, H. E. Brown). A set of manometers for use in measuring the toxic action of chemicals on codling moth larvae, by determining their metabolism before and after they are given measured doses of the different chemicals, has been secured and calibrated.

In previous experiments, the median lethal dose for determining the relative toxicity of the different chemicals has been used. A more accurate determination of the toxic action can be made by studying the insect's metabolism as affected by the chemical used.

No new chemical or combination of chemicals which shows special promise as a possible substitute for arsenate of lead has been found during the year.

**Grasshoppers** (L. Haseman). Among the severe insect outbreaks during the year was the grasshopper epidemic, which covered most of the State, with an especially heavy outbreak in the northwest quarter. The departmental staff, cooperating with the extension staff, county agents, and federal workers, dispensed over six thousand tons, dry weight, or 300 carloads of grasshopper bait, resulting in a saving of more than ten million dollars worth of crops.

**Armyworms** (L. Haseman). At the time when the preparations for the grasshopper outbreak were at their height, a very severe infestation of armyworms appeared. The same bait used on grasshoppers was supplied to farmers for fighting the armyworm. Very effective results were secured, netting a saving of thirty bushels of barley per acre on many farms.

**Codling Moths** (L. Haseman). With a heavy apple crop, the problem of worms again has been an important one. Bi-monthly spray letters were sent to all growers in the State, keeping them posted on codling moth activity and spray dates. Breeding cages and bait traps were maintained in forty selected orchards throughout the State. These cages and traps provided data on moth activity and served as local centers for the dissemination of this data. The control campaign proved very effective against the pest, resulting in a reduced carry-over of worms for the following year in all well-sprayed orchards.

**Beekeeping** (L. Haseman). For several years climatic conditions in the State have been unfavorable to beekeeping, resulting in a reduction in number of colonies and in beekeeping interest. A number of conferences have been held, and many requests for help have been received by the department. Weak, queenless, and diseased colonies have been very common. Personal letters and bulletins on beekeeping in Missouri have helped to keep the beekeeping business growing.

**Codling Moth Investigations** (Leonard Haseman, Lee Jenkins, C. S. Harris). The codling moth has continued to be one of the growers' most important problems. Again this year, the control program, where properly followed, enabled growers to keep the pest in bounds. Worms were most abundant in the north central, northwest, and southwest parts of the State. Some orchards, not properly managed, showed very serious worm damage.

During the year, work on this project was continued at Columbia, in the Kenmoor Orchards at DeKalb, in the Seneff orchard at Marionville, at the State Fruit Experiment Station, Mountain Grove, in the Leming and the Ochs orchards at Cape Girardeau, in the Ringhausen orchard at Elsberry, and the Shepley orchard at Clarksville. In all, 42 experimental spray blocks were included in the investigation dur-

ing the year. Life history studies showed that there were two full broods and practically a complete third brood of worms. Emergence records were used in timing the cover sprays in experimental plots, and timely spray letters were sent to all interested growers in the State. By timing the sprays, a grower is able not only to control the worms more effectively, but also to save one or more sprays.

In spraying investigations this year, arsenate of lead, calcium arsenate, cryolite, phenothiazine, fixed nicotine, summer oil emulsions, Petrocide, the so-called "Dynamite" spray, and a commercial sheep dip were tested. The results showed that six cover sprays, besides the cluster bud and calyx sprays, were necessary. Where worms had been abundant, arsenate of lead plus a deposit builder gave the best results. Of the different deposit builders, Petrocide, summer oil emulsion, and the so-called "Dynamite" spray gave the best control.

Aside from general orchard sanitation, including disposal of wormy culls and drops and mothproofing of packing sheds where located in the orchard most growers found it unnecessary to apply supplementary controls. Very few growers scraped the trees and applied the regular chemically treated bands.

Except where growers failed to carry through the recommended control program, worm control this year was the best since this project was started. There is one of the lightest worm carry-overs to start the next year that we have had in Missouri for several years. The control program, together with more favorable climatic conditions, seems to be slowly clearing Missouri of the recent abnormal codling moth epidemic.

**Strawberry Insects** (Leonard Haseman). The most important strawberry foliage pest during the year was the leafroller. Arsenate of lead was used to control this insect, and when applied before leaves were folded severely, satisfactory control resulted. However, after the infestation develops to the point that the individual leaflets are folded, the caterpillar feeding from within the fold largely escapes the poison.

**Hessian Fly Resistant Qualities of Different Varieties of Wheat** (Leonard Haseman). Observations and counts on field plots have been made to determine the relative degree of resistance to Hessian fly shown by the different strains grown by the Field Crops Department. Fly infestation at Columbia was so light that the year's results have not been striking. The plots at Elsberry showed slightly more infestation than at Columbia, but less than usual at Elsberry. Fulcaster and Kawvale continued to show high degrees of resistance to the fly.

**Insect Pests of Melon and Related Crops** (Leonard Haseman). Striped and the spotted cucumber beetles, the squash bug, melon louse, squash vine borer, and the pickle and melon worms were the most important melon pests in Missouri during the year. For the beetles, dusting with a poison as soon as the plants appeared above ground and repeated so as to keep all new growth covered was necessary where beetles were abundant. A dust consisting of 1 part of calcium arsenate to 10 or 15 parts of dusting gypsum was the cheapest material. Satisfactory results also were secured by using one of the fluorine compounds or a strong nicotine-lime dust.

For the squash bugs, hand destruction of the adults as they appear on the plants or of the eggs and young nymphs later, combined with the use of a nicotine dust to kill young nymphs, protected the crop. The melon louse was controlled by spraying or dusting with nicotine. Hand worming was the only sure way of controlling the vine borer, and damage to the vines in removing them was almost as severe as that by the worms. The pickle and melon worms may be controlled by cleaning up and plowing the land as soon as the crop is off to reduce the carryover of the pest. This, coupled with careful spraying early, usually gave satisfactory control.

## FIELD CROPS

W. C. ETHERIDGE, *Chairman*

**Cotton Production in Southeast Missouri** (B. M. King). A number of factors are involved in the production of profitable cotton crops. However, the use of superior varieties offers the grower one of the most efficient means of obtaining larger returns.

Cotton variety tests are conducted annually at the Sikeston Experiment Field, on Lintonia fine sand. One or more tests are conducted cooperatively with farmers each year on other soil types. The yields at Sikeston in 1936 are recorded in Table 3.

TABLE 3.—COTTON VARIETY TEST AT SIKESTON, 1936

Variety	Pounds per acre		% Lint
	Seed Cotton	Lint	
Stoneville 5 .....	1036.5	370.0	35.7
Stoneville 4A .....	1044.0	351.8	33.7
Stoneville 3 .....	1044.0	342.4	32.8
Stoneville 2A .....	1072.5	356.0	33.2
Hibred .....	1048.5	402.6	38.4
Half & Half .....	1008.0	419.3	41.6
D.P.L. 11A .....	988.5	370.7	37.5
Rowden 40 .....	1027.5	341.1	33.2
Delfos 719 .....	1036.5	340.0	32.8

It may be noted that Half-Half produced the highest acre yield of lint cotton, but the lint was short and otherwise of poor quality. D. P. L. 11A and the Stoneville strains 4 and 5 have consistently produced good yields of lint of excellent quality in all of the varietal experiments.

**Barley for Missouri** (B. M. King). Winter barley has reached an important place in Missouri agriculture because of its excellence as a feed grain, fall and spring pasture, nurse crop for legumes and grasses, and as a protection from erosion. Methods of growing and handling the barley crop for its various uses have been developed through experimentation. The development of better varieties would greatly improve the crop.

Fifty-six varieties and strains were compared in a nursery yield test at Columbia in 1935-36. Acre yields ranged from 7.2 to 26.4 bushels. The most productive varieties and their yields in bushels per acre were as follows: Michigan Winter, 26.4; Alaska C. I. 534, 23.8; Cusado, 23.1; Union Winter, 21.1; Arabel C. I., 896, 21.1; Alaska C. I., 4106, 20.5; Missouri Early Beardless, 19.1.

Four varieties of winter barley were tested in field plots at Columbia, Sikeston, Grain Valley, Maryville, Elsberry, and Green Ridge. The results are recorded in Table 4.

TABLE 4.—ACRE YIELDS OF FOUR VARIETIES OF WINTER BARLEY AT SIX LOCATIONS IN MISSOURI

Variety	Columbia	Sikeston	Grain Valley	Maryville	Elsberry	Green Ridge	Average
Mo. Early Beardless ..	27.6	30.5	33.0	36.5	55.9	9.7	32.2
Kentucky #1 .....	31.4	31.8	53.0	39.1	67.7	8.3	38.5
Michigan Winter .....	29.1	32.7	34.2	39.7	86.3	5.4	37.9
Tennessee #6 .....	24.0	16.4	31.2	18.9	35.9	6.4	22.1

Tennessee #6 was inferior to the other varieties. There was little difference in the productivity of the three other varieties, except on heavy, poorly-drained soils at Elsberry and Grain Valley, where Kentucky #1 and Michigan Winter produced larger yields than Missouri Early Beardless.

Since the Missouri variety was developed by mass selection, it should be possible by pure line selection to make a quick and substantial improvement in the variety. Thirty-five pure lines have been grown in single three rod-row plots, and forty-six lines have been grown in single rod-row plots. Ten of the pure lines from the Missouri Early Beardless have been crossed with an equal number of productive winter hardy, awned varieties. It is hoped that by hybridization a superior variety may be developed.

**The Development of Oat Varieties Resistant to Loose Smut and Covered Smut (B. M. King).** Thirty-four selections from crosses between Fulghum and Richland, a smut and stem rust resistant variety, were grown in a nursery yield test in 1936. The yields ranged from 13.4 to 38.1 bushels to the acre. The yields of comparable commercial varieties were as follows: Columbia, 28.7; Fulghum, 17.3; Burt, 21.3; Bruncker, 26.2. Twelve selections from the cross Fulghum x Markton, the latter a highly smut resistant variety, also were included. The yields among this group ranged from 23.8 to 37.2 bushels to the acre. Little opportunity was afforded for a study of the smut resistance, since the smut infestation throughout the nursery as a whole was unusually light.

The variety, Navarro, is practically immune to smut, but is otherwise very inferior for Missouri. One hundred and forty-six selections from a cross of Columbia x Navarro and backcrossed to Columbia were grown in observation plots. Most of the selections showed a fairly large percentage of plants with practically all the morphological characters of Columbia. The remainder of the plants displayed a wide variation of forms, indicating that the initial plants selected were heterozygous. Reselection of the hybrid population was therefore necessary to make available true breeding lines for performance studies on yield, smut resistance, and lodging. Approximately five hundred selections have been made for continuing tests.

In the spring of 1937 Columbia was crossed with C. I. 3311, a pure line developed from the cross Victoria x Richland. Victoria is highly resistant to smut and crown rust, and Richland is resistant to stem rust. These crosses have been made in the hope that a productive line that was resistant to the three most serious oat diseases could be developed.

**Soybeans for Missouri** (B. M. King). During the past twenty years the area devoted to soybean production in Missouri has expanded from a few hundred to more than one-half million acres. The efficiency of the Virginia variety for the production of legume hay on medium to poor land where clover and alfalfa will not succeed has in a large measure been responsible for the steadily increasing importance of soybeans as a crop. However, a variety possessing the desirable vegetative characters of Virginia plus the capacity to produce a high yield of yellow seed would increase the usefulness of the soybean crop in this state. The development of such a variety by hybridization has been the major objective of the soybean improvement program during the past eight years.

In 1929, Virginia was crossed with Manchu, Aksarben, Midwest, Ito San, Mikado, Wyokatenn, and B. P. I. 37062. Segregates were selected from the  $F_3$  generations and grown for observation. By 1934, all this material had been discarded except the progeny of two initial plant selections from the cross Virginia x B. P. I. 37062. Plants were chosen that showed essentially the same growth habits as Virginia and the yellow seed of the male parent. One hundred of these lines were selected and grown in progeny rows in 1936. Fifty have been retained for seed multiplication and comparison. The remainder were discarded, mainly because of the tendency to lodge.

Twenty-six varieties and strains, grown in the nursery yield test in 1936, were damaged so severely by heat and drouth that they were not harvested.

**Corn Breeding Investigations** (L. J. Stadler, G. F. Sprague, J. G. O'Mara, E. R. Sears, Luther Smith). Yield tests on experimental hybrids, commercial hybrids, and open-pollinated commercial varieties were made at Maryville, Columbia, Grain Valley, Sikeston, and Jasper, Missouri. The breeding plots were on river bottom land near McBaine, Missouri.

The yield tests were a complete failure at all stations except Sikeston on account of drouth. The results on the Sikeston field were in substantial agreement with those of previous trials. In spite of the dry season, the average yield of the hybrids represented an average increase of 36.5 per cent over the average yield of the open-pollinated varieties.

The yield test for the evaluation of the selfed-crossed plants of 1935 was lost through drouth. None of the pollinations in 1936 produced sufficient seed for testing in 1937. It also was impossible to produce adequate supplies of single crosses for double crossing in 1937. Some valuable information was obtained on the relative drouth resistance of the long-time inbreds.

In the genetic investigations with corn, studies of the genetic effects of ultra-violet light were continued and extended. A grant from the Rockefeller Foundation made possible the purchase of a crystal quartz monochromator especially designed for the application of monochromatic ultra-violet light to corn and other biological materials.

Pollen was treated with monochromatic radiations of wave-lengths 235, 238, 240, 248, 254, 265, 280, 297, 313, and 365 $\mu$ . Absorption determinations on pollen grain contents showed that penetration did not vary widely with wave-length in this range.

The maximum dosage permitting seed production varied from  $1.2 \times 10^3$  ergs/mm<sup>2</sup> at 235 $\mu$  to more than  $2.5 \times 10^6$  ergs/mm<sup>2</sup> at 365 $\mu$ . There were four fairly distinct tolerance levels: (1)  $1.2 \times 10^3$  ergs/mm<sup>2</sup> for  $\lambda$ 235-240, the limiting factor in this range being clumping of pollen; (2)  $1.2 \times 10^4$  ergs/mm<sup>2</sup> for  $\lambda$ 248-280; (3)  $1.3 \times 10^5$  ergs/mm<sup>2</sup> for  $\lambda$ 297 and 302; and (4) more than  $10^6$  ergs/mm<sup>2</sup> for  $\lambda$ 313 and 365, at which the highest doses applied had no effect on seed production.

Deficiencies (marked by loss of *A*, *Pr*, *Su*, *Wx*, and *Y*, in endosperm) were induced in large numbers by all wave-lengths of the range 235-302 $\mu$ . Throughout this range fractionals as well as entire endosperm deficiencies were numerous. Longer wave-lengths had no appreciable effect on the frequency of deficiency.

The frequency of "germless" seeds was increased markedly by radiation of wave-lengths 280 $\mu$  and shorter but not materially affected by longer wave-lengths, even at much higher dosages. Thus,  $\lambda$ 297 and 302, which are tolerated in heavy doses, are highly effective in inducing deficiencies and have little or no effect in producing germless seeds. The results suggest that the three phenomena are the result of induced alterations which have distinctive spectral characteristics.

**A Genetic Analysis of *Triticum Monococcum*** (L. J. Stadler, G. F. Sprague, J. G. O'Mara, E. R. Sears, Luther Smith). In investigations of polyploidy in the *Triticum* group, the genetic analysis of *Triticum monococcum* was continued. More than fifty genes suitable for use in genetic investigations are now available. Most of these are the result of mutations induced by X-ray treatment.

Fifteen chromosome rings induced by X-ray treatment have been found to resemble a naturally occurring one in that very little sterility resulted, even though cytological examination showed that approximately half the rings were non-disjunctional. The naturally occurring ring has been used to prove that considerable homology existed between certain chromosomes of einkorn and *Triticum durum*.

Six types of meiotic irregularity have been found, all of which appeared to be determined genetically. Three were due to single recessive factors. One of the latter three yielded offspring with approximately twenty-eight chromosomes.

Most of the reciprocal crosses between *T. Monococcum*, *Hordeum vulgare*, *Secale cereale*, *Haynaldia Villosa*, two 7-chromosome species of *Agropyron*, and six 7-chromosome species of *Aegilops* have been attempted. *T. monococcum* x *Ae. caudata*, *Ae. speltooides* x *Ae. squarrosa tornea*, and *Ae. squarrosa tornea* x *Haynaldia* were the only inter-generic crosses to succeed. Failure of inter-specific and inter-generic crosses apparently was due to ineffective pollen-tube growth.

**Breeding Early Wheat for Missouri** (J. M. Poehlman). An earlier maturing variety of wheat than any of those now available in Missouri would be of great value because (1) it would escape most of the diseases, insects, and inclement weather of late spring and early summer, (2) the early harvesting and early marketing of the crop would be advantageous, and (3) it would be superior as a nurse crop for legumes and grasses. The small reduction in yield, which is associated with early maturity, would be a small price for the advantages listed above.

A variety, Missouri Early Premium, which is fairly productive and matures at least ten days earlier than other standard Missouri varieties, has been developed. In 1937, it ripened ahead of the disastrous stem rust infection and produced good yields on all experiment fields and on many farms where later varieties were failures.

The three leading varieties and their acre yields on experiment fields where Missouri Early Premium was tested, were as follows:

At Columbia—Missouri Early Premium, 41.3 bushels; Clarkan, 41.0 bushels; Kawvale, 39.9 bushels.

At Grain Valley—Kawvale, 30.5 bushels; Clarkan, 23.4 bushels; Missouri Early Premium, 20.6 bushels.

At Sikeston—Michigan Wonder, 35.3 bushels; Missouri Early Premium, 33.1 bushels; Kawvale, 31.6 bushels.

At Green Ridge—Missouri Early Premium, 20.9 bushels; Kawvale, 20.1 bushels; Clarkan, 19.1 bushels.

**The Improvement of Permanent Pastures** (E. M. Brown, J. M. Poehlman). Kentucky bluegrass and other pasture grasses do not

thrive during the hot summer months. This act constitutes one of the major problems of pasture management. An investigation has been made to determine the influence of different temperatures on the growth and chemical composition of some of the more important pasture grasses.



Fig. 4.—A view of the experimental plots in the studies of pasture grasses.

Kentucky bluegrass made its maximum growth during 1935 from June 9 to June 22, when the average soil temperature one-half inch below the surface was 73° Fahrenheit; in 1936 from May 9 to May 22, when the average soil temperature near the surface was 72° Fahrenheit. The average air temperatures for these periods was 68°. When soil temperatures were 77° Fahrenheit, or above, bluegrass made little or no growth, even when an adequate supply of soil moisture was maintained.

The combined effects of high temperature and moisture deficiency, conditions which usually prevail during mid-summer, not only reduced the productivity of the grass, but also lowered its quality. The dry matter of Kentucky bluegrass herbage contained 26.8 per cent of crude protein and only 17.7 per cent of crude fiber on April 24, as compared with 16.8 per cent of crude protein and 25.8 per cent crude fiber on June 8.

Continuous grazing, rotation grazing, and supplemented grazing were measured and compared in terms of their influence on the density and productivity of bluegrass sod and live-weight gains made on

pasture by beef cattle. This part of the project has been carried on in cooperation with Sni-A-Bar Farms. It has shown the beneficial effect of rotation grazing on the stand and productivity of bluegrass and the value of Korean lespedeza as a supplementary pasture during the hot, dry period of mid-summer. A combination of rotation grazing and supplemented grazing made possible the complete use of the bluegrass during the spring and early summer when the grass was most nutritious and palatable without injury resulting to the grass and provided high-quality pasture in the form of Korean lespedeza during the mid-summer period.

In a grass breeding investigation, one  $F_2$  progeny of the hybrid made by crossing *Poa arachnifera* and *Poa pratensis* proved to be much more uniform than expected and to be more resistant to drought and heat than either of the parent species.

**Rotation Pastures Compared with Cultivated Crops in the Production of Feed for Cattle** (C. A. Helm). As a means for a safer, steadier, and more economical production of livestock feed on land limited in fertility and as a means of conserving the strained resources of soils limited in fertility, rotation pastures are a reasonable and attractive substitute for cultivated crops. The substitution may be extended as far into the farm practice of the State as its comparative profits and its benefits to the soil warrant. Therefore, quantitative measurements of such returns are necessary in order to establish the value of the rotation pasture system. It should be observed, however, that the rotation pasture system may not be restricted to the production of herbage for the grazing of animals nor to the conservation of only the soils which are low in productivity. It may give even higher net cash returns and function with equal efficiency in conservation on good land; and it yields grain and hay as well as pasturage.

One-year pasture rotations are now being compared at Columbia, Green Ridge, and Paris. The rotations are wheat-lespedeza, barley-lespedeza, oats-lespedeza, rye-lespedeza, rye pasture-soybean hay, and barley pasture-soybean hay.

At Columbia, these rotations were conducted on worn Putnam silt loam, cultivated for approximately 100 years and now capable of producing an average of not more than 20 bushels of corn per acre. In 1937, eleven acres in lespedeza-grain pastures produced a total of 3,354 pounds of liveweight gain in eleven head of 4-year-old steers during the period April 15 to September 25. Rye pasture-soybean hay rotation produced 72 cattle pasture days and 1.6 tons of soybean hay per acre. Barley pasture-soybean hay produced 82 cattle pasture days and 1.8 tons of soybean hay per acre.

At Green Ridge in 1937, on Gerald silt loam, a soil with a low level of productivity, wheat-lespedeza pasture furnished 95 cattle days of grazing per acre; barley-soybean rotation yielded 32 cattle days of fall grazing, 18 bushels of barley grain, and 1,600 pounds of soybean hay, all per acre; and corn on an adjoining field yielded 10.2 bushels per acre.

At Paris, on Putnam silt loam, barley-soybean rotation gave 21 cattle days of fall pasture, no spring grain (crop winter killed), and 1,750 pounds of soybean hay per acre; rye-lespedeza and wheat-lespedeza pastures gave, respectively, 145 and 144 cattle days of grazing per acre; red top pasture 45 cattle days per acre; and corn, finding the best local season in many years, yielded 38 bushels per acre.

**HOME ECONOMICS**BERTHA BISBEY, *Acting Chairman*

**Household Utilization of Cotton and Competing Textile Fabrics** (Jessie V. Coles). Many consumer demand investigations have been concerned only with the kinds and quantities of goods desired. However, the qualities of goods available for purchase also must be considered. This investigation, therefore, was designed to secure information concerning qualities of clothing and household textiles demanded.

Four articles of women's clothing: house dresses, afternoon dresses, slips, and hose, and four household textiles: window curtains, blankets, sheets, and towels were studied.

A total of 3694 usable questionnaires was secured from consumers in fifty-four counties of Missouri. The analysis of data for the present year was limited to that relating to the four articles of clothing. The incomes of the consumers ranged from \$500 to \$4500 or more a year. However, by far the majority was from families with annual funds not exceeding \$1500. The need for economy was suggested further in the prices paid for garments and materials.

A high percentage of the women was buying commercially-made garments. This practice was favored by those women who had neither the time, the desire, nor the skill required for home sewing, who thought the saving in money was negligible and who perhaps were willing to sacrifice something in the way of good materials and good construction in order to secure the style and the designs wanted. However, a large proportion did some home sewing.

The greater number of homemakers bought from local stores. A proportion ranging between one-eighth and one-fifth patronized mail-order houses. Superficial examination of the data showed little relation between the type of store used and the degree of satisfaction or dissatisfaction with the purchase.

Three qualities, attractiveness, durability, and comfort, were given outstanding emphasis. Cotton and silk were the two fibers in greatest use. Rayon materials were quite unpopular. However, this disfavor probably was not altogether merited, since many women buying the less expensive garments probably were wearing rayon dresses under the impression that they were made of silk. Wool was used to some extent for afternoon dresses for winter, but lagged behind silk in popularity. Linen was favored by a number of homemakers, but was not considered sufficiently superior to cotton to justify the added cost.

Criticisms of washable fabrics centered about shrinkage and loss of color. A significant number of women preferred pre-shrunk and

color-fast materials and were willing to pay more, either for yard goods or for garments, in order to obtain these features. Some, buying goods so labeled, often found them to lose color and to shrink when laundered. Water-spotting and rotting under the arms were the faults in silk indicated most frequently. Rayon was criticized on account of its tendency to pull at the seams, to ravel, and to stretch out of shape, and because of the difficulty in ironing or pressing it.

In regard to construction, the need was indicated for deeper seams, better finishing, fasteners sewed on more securely, and greater care that portions of the garment needing to be placed on the straight of the material be cut in that way.

Difficulties with the fit of garments were of two kinds. Waists and skirts of dresses were too long, and hip measurements too "skimpy." Labeled sizes varied and made the process of finding a garment difficult. About two-thirds of the homemakers paid less than \$1.50 for house-dresses and from \$0.10 to \$0.25 per yard for materials for house-dresses. Summer afternoon dresses cost less than \$5.00. Those for winter ranged from \$5.00 to \$10.00. The majority paid from \$1.00 to \$2.00 for their slips for dress wear and less than \$1.00 for those used for everyday. Four-fifths of the homemakers paid less than \$1.00 per pair for hosiery.

In general, an outstanding need was manifest for materials of better quality and for better fitting and more durably constructed garments. Better labeling also was desired.

**An Analysis of Family Living Data** (Jessie V. Coles). A group of 288 families from Moberly, Missouri, was studied as to size of family and family income. The average size was small, three persons. The economic family, including all of those dependent upon the family income, was 3.2 persons, and the household group was 3.3 persons. Families of the smallest average size were not found in the occupational groups having the largest average incomes. The largest economic family, 3.7 members, occurred when the principal bread winner belonged to the salaried business class, while families supported from an independent business and from clerical work were the smallest, the average being 3.1 members. Approximately 31 per cent of all families consisted of a husband and wife only. A similar proportion had three members. Only twenty-seven families had five members or more. Wage-earning bread winners and their wives had the shortest average years of parental responsibility (16.5). Those having incomes from an independent profession spent an average of 20.2 years in bringing their children to an age where they might be employed legally. In the group there were eighty-five persons, other than husbands, wives, and elderly persons, who were at

least sixteen years of age but still being supported from the family income. The burden of family support seemed to fall more heavily upon the older than upon the quite young breadwinners.

The average income for the group, excluding one income over \$13,000, was \$1,582. The median was \$1,422, and the modal peak fell between \$750 and \$1,000. The wage-earning families had the lowest average incomes (\$1,386). Those engaged in an independent profession provided the largest annual fund (\$3,041). Of the 288 families, 30 per cent had less than \$1,000 for the year's expenses. Sixty-two wage-earning families belonged in this class, and twenty-five of these had less than \$750. About 27 per cent of all the families had funds of \$2,000 or more. Families of the largest size tended also to have the largest average incomes. Occupational earnings accounted, upon the average, for 94 per cent of the total incomes of all the families studied.

One person provided the total income in two-thirds of the families. Husbands were the principal earners in 98 per cent of all families. Nine wives were principal earners and forty were employed gainfully, while eighteen others had occasional employment. Eighteen sons and eighteen daughters were contributors to the family income. Contributing wives and children were found largely in the independent business, clerical, and wage-earning occupational groups. They were distributed widely as to income class. One-fifth of the families analyzed finished the year with a deficit, the average being \$175 per family. Four-fifths had a surplus averaging \$326 per family.

**Standardizing Methods of Broiling Beef Steaks and Methods of Cooking Pork Chops** (Jessie Alice Cline, Helen McLachlan). Four "pairs" each of U. S. "good" grade club, porterhouse, and pin-bone sirloin steaks from long yearling steers, ripened from 12 to 15 days, were used in the steak study. Sixty-nine rib and loin pork chops from four hog carcasses were purchased from a local dealer and were used for the pork study.

Steaks were broiled at 175° and at 225° Centigrade. The doors of the broilers were left open, and the steaks were placed so that the distance between the top of the meat and the bottom part of the burner was three inches. Steaks were cut two inches thick and cooked to an internal temperature of 58° Centigrade. Cooking losses, cooking time, fuel consumption, and percentage of bone and edible meat were measured. The palatability of the steaks was judged by a committee of from three to five experienced meat judges. Tenderness was measured by the mechanical shear.

Steaks broiled at the higher temperature showed greater cooking losses, required less time but more fuel to cook, showed a greater rise

in internal temperature after removal from the oven, and gave a smaller percentage of edible meat than did the steaks cooked at the lower temperature.

The club steaks, the smallest ones, showed the greatest total cooking losses. The pin-bone sirloin steaks, the largest steaks, showed the least cooking losses. Steaks broiled at 175° Centigrade graded higher in desirability of flavor of lean and tenderness of the large muscle, were more attractive in outside appearance, and were cooked more uniformly.

Sixty-nine rib and loin pork chops, cut one inch thick, were cooked by four methods: (1) braised *with* water, (2) braised *without* water, (3) broiled at a constant temperature of 150° Centigrade, and (4) broiled at a constant temperature of 175° Centigrade. The chops were cooked to 84° Centigrade internal temperature.

Two chops were cooked at the same time in one broiler or frying pan. A meat thermometer was inserted into each chop, and cooking losses were determined for individual chops. Gas broilers were used for broiling; electric plates were used as a source of heat for the braised chops.

Cooking losses were not determined for pork chops which were judged for palatability. Shearing tests were made on all of the pork chops to determine the tenderness.

Pork chops broiled at either 150° or 175° Centigrade showed much greater cooking losses, required a much longer time to cook, and graded lower in palatability than did the pork chops braised *with* or *without* water. Braised pork chops showed similar cooking losses and required a similar amount of time to cook whether braised *with* or *without* water. Pork chops braised *without* water graded highest in the palatability factors of intensity and desirability of aroma, texture, tenderness of large muscle, quantity and quality of juice, and intensity and desirability of flavor of lean.

**HORTICULTURE**T. J. TALBERT, *Chairman*

**Walnut, Pecan, Hickory, Filbert, and Chestnut Investigations** (T. J. Talbert). Harvest records indicated that the Stabler variety was one of the most consistent bearers among walnut trees. This variety was followed by Thomas, Tucker, Ohio, Miller, and Ten Eyck.

All varieties have been top-worked successfully by means of cleft grafting. The cleft graft has been as successful with walnuts as it has been with apples and pears. This method of propagation, however, was not satisfactory for pecans or hickories. Budding has proved more satisfactory for pecans and hickories, and the work may be done in the spring, after the bark begins to peel through the summer and up until September.

Budding also has given better results as a means of propagation with the chestnut and filbert.

**Embryo Growth and Development of the Apple Fruit** (A. E. Murneek). A relationship exists between the abscission of immature apples and their seed development. Numerous histological examinations and measurements have been made of embryo development in a large number of seeds obtained from naturally dropped and growing young apples of various ages and known pollinations. Ovules in abscised fruit of the second drop rarely contained embryos. Those of the third drop frequently contained embryos, but these embryos were conspicuously smaller in size than in non-dropping fruits of a corresponding age. Almost invariably embryos were present in ovules of fruit of the fourth or last drop, but again, they were very much smaller in size than in normal fruit collected at the same time. The embryos seemed to have grown in the drops, but at an increasingly reduced rate.

Preliminary attempts to influence the rate of embryo development by lessened physiological competition for the available nutrients were not successful. The 1936 growing season was extremely hot and dry, and the trees used were in the "off year" of bearing.

Many kinds of culture media have been tried, but none has yet been found for the growing of very young embryos *in vitro*.

**The Relation of Photoperiodic Induction to Photoperiodic Inhibition** (A. E. Murneek). Previous work has shown that it is possible to separate the effects of photoperiod on vegetative growth (increase in stature) and on sexual reproduction. By exposing *Rudbeckia* plants for various periods to combinations of long (14 hour) and short (7 hour) photoperiods, it has been possible to obtain striking combinations in growth and reproduction. Growth in height se-

cured during the long-day exposure was inhibited at once and completely when the plants were subjected to a short-day exposure to light. Sexual reproduction induced during the preliminary exposure to a light period of 14 hours continued when the plants were exposed to a 7-hour day. The short photoperiod, therefore, while inhibiting growth in *Rudbeckia*, did not prevent the development of sexual organs and accessory tissues. Since the short days do not initiate or foster reproduction in this species, only the amount and character of reproductive tissues induced under the preceding long-day exposure were developed. Therefore, it is possible to obtain various quantities and types of reproductive tissues.

By separating photoperiodic induction from photoperiodic inhibition, an approach is made to a more detailed analysis of the mechanism and quantitative aspects of photoperiodism in plants.

**Photoperiodism and Enzyme Activity** (A. E. Murneek, A. D. Hibbard). The effects of catalase, peroxidase, amylase, invertase, and reducase in a typical short-day plant, the soybean, variety Biloxi, growing under conditions of long and short photoperiods, have been studied. A detailed study of the changes which occurred in the tips and leaves while the plant was developing from seed to flowering under a seven-hour and fourteen-hour day was made. The day lengths were so adjusted that the plants under the short day passed into the reproductive condition as rapidly as possible, while those under the long day would remain in the vegetative condition indefinitely.

The changes occurring in nine different crops of plants of the Biloxi variety were followed. In the leaves of the short-day plants, the catalase activity was inhibited at first. It began to increase about the tenth day, became equal to the long-day plants near the eighteenth day, and was increasingly greater thereafter. Catalase activity in the tip of the short-day plant was inhibited from the first. Maximal depression (in activity) was reached about the twentieth day.

Peroxidase was more active in both the tips and leaves of the short-day plants. This difference steadily increased as the treatments were continued. Invertase showed a tendency to increase in the short-day plants similar to that exhibited by peroxidase. The changes in enzymatic activity were observed as early as five days after the beginning of the treatments. These differences were detected prior to any morphological or chemical changes.

**Effects of Photoperiod on Respiration** (A. E. Murneek, F. L. Wynd). The comparative metabolism of plants during the earliest stages of initiation of sexual reproduction was studied by determining the comparative respiration rate ( $\text{CO}_2$  output) of long- and short-day plants. During the period of initiation and development of re-

productive organs, the  $\text{CO}_2$  output per weight of fresh tissue was much greater in the short than the long-day plants of corresponding age (20-70%). The peak of this increase in respiration occurred as early as 3-4 days after switchover from a long to a short photoperiod, or it may be evident as late as the 28th day after emergence of the seedlings, in the case of plants growing slowly during extremely cold weather in midwinter.

This increase in respiration would seem to suggest that at this period the metabolism of the short-day plants was catalyzed in some way, possibly through the production of some hormone-like substance or substances. The augmented respiration rate preceded any comparable, observable changes in chemical composition of the plants.

**The Effects of Temperature on the Physiology of Reproduction in Beets** (A. E. Murneek, Seth Shaw). Mother beets (sugar and garden varieties) were stored at  $0^\circ \text{C}$ .,  $7^\circ \text{C}$ . and  $14-17^\circ \text{C}$ . for a period of 60 days and then planted in cool ( $15^\circ \text{C}$ .) and warm ( $21^\circ \text{C}$ .) greenhouses. No plants have flowered in the warm house excepting the garden beets which were stored at the two lower temperatures and were given additional 4 hours of lighting to increase the day length. In the cool house, under normal day length, the garden beets receiving these treatments have elongated seed stalks. No seed stems have appeared as yet on those stored at  $14-17^\circ \text{C}$ .

Beets in the warm house have been treated with certain hormones which were supposed to have different effects upon plant reproduction. So far, there has been no observable influence on development of seed stalks.

Perhaps at lower temperatures conditions were less favorable for complete oxidation of carbohydrates than at high temperatures. If this were true, then organic acids or their salts might have accumulated in plants kept in a cool place. Holes were bored into the crowns of beets growing in the warm house, and different organic acids were added daily for 21 days. As yet, there has been no response to this treatment.

**Complete Fertilization of Apple Trees** (A. E. Murneek, E. J. Gildehaus). Wealthy and Jonathan apple trees, growing on typical loess soil under sod culture, have been fertilized for 6 consecutive years with (1) normal amount of nitrogen, (2) normal amount of nitrogen plus normal amount of potassium, (3) normal amount of nitrogen plus 2 x normal amount of potassium, (4) normal amount of nitrogen plus normal amount of phosphorus, and (5) normal amount of nitrogen plus 2 x normal amount of phosphorus. All of the above fertilizers were applied in two ways: by broadcasting on the ground in the usual way, and by spading in to a depth of 12-15 inches. So

far, no significant differences have been noted in rate of vegetative growth, amount of flower buds formed, and fruit set among the trees of the various fertilizer blocks. The recent drouths have delayed the drawing of definite conclusions from this experiment.

**Comparative Value of Calcium Cyanamid as a Source of Nitrogen for Apple Trees** (A. E. Murneek, G. E. Smith). Cyanamid was compared with ammonium sulfate and sodium nitrate when applied to mature apple trees. The cyanamid nitrogen was equally effective in stimulating growth and fruit production as nitrogen from the other two sources. The use of cyanamid required more care, but it proved a very satisfactory fertilizer. Fall applications gave the best response.

When moisture conditions in the spring were favorable for the decomposition of cyanamid, the results from applications made even as late as two weeks before bloom were equally as good as from the other materials used at the same time. When conditions were not conducive for rapid decomposition, the results were inferior to those secured with nitrate of soda and sulfate of ammonia.

With the exception of 1936, a year of extreme drouth which prevented the utilization of any form of nitrogen, differences in shoot growth of trees receiving either fall or spring application of the used fertilizers were small. Fall applications of sodium nitrate were slightly superior to spring fertilization. The differences in this respect from ammonium sulfate were insignificant. Fall application of cyanamid was more satisfactory than spring fertilization, and late applications in the fall were more satisfactory than those made early. This difference was due largely to the weather. Evidently when moisture conditions were conducive to a rapid decomposition of cyanamid, it was utilized more effectively.

The residual effects of these three nitrogen carriers indicated that they will leave a different effect on soil properties. Ammonium sulfate increased soil acidity and reduced exchangeable calcium. Sodium nitrate caused little change; cyanamid raised the Ph and calcium content of the soil. Over a period of years, the calcium added by cyanamid would appear to be sufficient to have a measurable effect.

**Decomposition of Calcium Cyanamid on the Soil Surface** (A. E. Murneek, G. E. Smith, P. H. Heinze). The decomposition of calcium cyanamid in granular form applied to the surface soil was influenced by moisture conditions. Rain, soon after application, washed the cyanamid rapidly into the soil where it changed to ammonia. With a deficiency of moisture, the slow absorption of water from the soil or air caused much of the calcium cyanamid to break down the cyanamide and calcium hydroxide within the granule. With alternate wetting

and drying, the soluble compounds were deposited on the surface of the granules. Here the calcium hydroxide was changed to carbonate, forming an impervious layer around the granule. Once this layer was formed, the removal of nitrogen by rain was retarded greatly. Therefore, granular cyanamid should be worked into the soil or put on at a time when the soil has a high moisture content or when rain is expected.

**Grape Nutrition** (H. G. Swartwout). Analyses of Concord grapevines were made to determine the storage and movement of carbohydrates and nitrogenous materials as a basis for a practical fertilizer program. The nodes, internodes, leaves, trunks, and roots at different seasons of the year have been analyzed. Fall applications of 2 lbs. sulfate of ammonia; 2 lbs. sulfate, with one of sodium nitrate per vine failed to show any evident response in growth. Analysis for nitrogen of samples collected during the late winter following the fall application showed no consistent difference in nitrogen content of fertilized and unfertilized vines. The difference between treated and untreated vines was very small, and in some cases the percentage of nitrogen was greater for the unfertilized vines.

**Substitutes for Arsenical Sprays** (H. G. Swartwout, C. G. Vinson). Tests have been continued with zinc arsenate as a substitute for lead arsenate in codling moth control. During the wet spring of 1935, zinc arsenate caused serious arsenical injury and was less effective than was lead arsenate. To reduce injury, several materials were tested in combination with zinc arsenate. Zinc oxide, hydrated ferric oxide, and iron sulfate-lime mixture were used. During the 1936 season, while no injury occurred where the above materials were used in conjunction with zinc arsenate, there was little damage from zinc arsenate alone, so the results had no significance. The dry weather of the past summer prevented the development of arsenical injury in any of the plots. With lead arsenate in the calyx and the two peak emergence applications and zinc arsenate in the others, codling moth control was as good as with lead arsenate throughout the season. Codling moth was only moderately abundant in the orchard.

Nicotine tannate and nicotine salt of abietic acid were prepared and tested for codling moth control. Neither material was effective under the conditions of 1936.

Tests were continued with the zinc-lime spray as a corrective for arsenical injury from lead arsenate on the apple, but failure of any injury to develop on the lead arsenate alone plot, gave no significance to the results. A 4-4-100 zinc-lime spray did not cause any injury itself in 1936. However, in 1935, a 4-4-100 spray caused considerable injury.

Work was continued with the iron-calcium arsenate product. Seven sprays of this material were applied to Ben Davis trees. The last spray was applied August 6. Arsenical injury to the foliage was quite pronounced. This was due to the wet season of 1935 until July 10. An adhesive substance was added to the spray material used on one Ben Davis tree. At harvest time, 44 per cent of the fruit from this tree showed injury from codling larvae. Two adjacent Ben Davis trees, sprayed with the iron-calcium combination without adhesive, showed 41 per cent injury at harvest time. Other Ben Davis trees, sprayed with standard lead arsenate, showed about 33 per cent injury at harvest time.

Nicotine, in combination with Lloyd's reagent, also was used again. During the growing season of 1934, five sprays of Lloyd's reagent nicotine combination were applied to a Winesap tree. Eighteen per cent injury resulted, whereas only 9 to 15 per cent resulted from standard lead arsenate sprays. One of the main difficulties with the Lloyd's reagent-nicotine combination was securing good adherence to the foliage. A shower readily removed the material.

In 1935, a Stayman Winesap tree was sprayed with Lloyd's reagent-nicotine combination only. A Golden Delicious tree was sprayed with the Lloyd's reagent-nicotine combination to which was added a spreading and sticking agent. •

In spite of heavy rains during June, it was obvious that where a spreader had been used, the Lloyd's was adhering much better than where no sticker was used.

At picking time, injury a little above 16 per cent was shown from codling moth larvae. Adjacent trees, sprayed with standard lead arsenate, showed slightly over 16 per cent injury by codling moths.

Lead arsenate was used at the rate of 3 pounds to 100 gallons of water; nicotine sulphate at the rate of one pint to 100 gallons of water.

**A Chemical Investigation of Virus Diseases of Plants** (C. G. Vinson). Virus preparations have been prepared which contained only one per cent ash. Aluminum sulphate has been used to precipitate the virus from juice of diseased plants without preliminary steps. The precipitate was highly pigmented. Calcium oxide was very helpful in removing pigment from a suspension of this dark-colored precipitate. In this way a solid, free of pigment, was obtained. This solid was virtually pure protein and was suitable for organic analysis.

Bases and some dibasic acids were present in this fraction. The greater part, however, was composed of monoamino monocarboxylic acids.

**Variety Tests of Various Vegetables** (R. A. Schroeder). Three plantings of sweet corn were made to study the new hybrid varieties recently developed. From the entire planting, only about a half dozen ears were harvested due to the drouth, grasshoppers, and chinch bugs.

Variety and strain tests of the following vegetables were planted: peas, beans, beets, carrots, eggplant, onion, spinach, radish, cucumbers, squash, pumpkin, turnip, salsify, parsnips, fennel, chicory, okra, chervil, celeriac, kale, and Kohl-rabi. However, the adverse growing season did not permit the best development of the crops. The following new, or comparatively new, varieties showed considerable promise:

Beans—Bush Green Pod: Asgrow Stringless Green Pod, Asgrow Black Valentine, Tendergreen, Idaho Refugee, U. S. No. 5 Refugee, Wisconsin Refugee.

Beans—Wax, Bush: Top Notch Golden Wax.

Beets: Asgrow Canner, Asgrow Wonder.

Carrot: Asgrow Imperator, Morse Bunching.

Cucumber: Straight-8, Shamrock Resistant, Mandarin.

Turnip: Snowball.

**Fertilizer Treatments to Influence Quality in Vegetables** (C. G. Vinson). Fertilizer trials with vegetables indicated that quality of the product was improved due to increased tenderness when fertilizers higher in potash than those customarily employed were used. Yields also were increased, even on the more fertile soils.

The Vitamin C content of vegetables apparently was influenced appreciably by growing conditions. Fertilizers high in potash appeared to promote the formation of Vitamin C.

**Greenhouse Tomatoes** (R. A. Schroeder). In the growing of a fall crop of greenhouse tomatoes, the following methods of pollination were used: hand pollination, shaking of vines, and normal pollination.

The hand pollinated series gave a marked increase in set of tomatoes, and the shaking of the vines was better than normal pollination.

**Greenhouse Cucumbers** (R. A. Schroeder). The growing of the fall crop of greenhouse cucumbers was handicapped by a disease which caused the rapid death of plants due to the drying of the leaves. The "burning" of the tip of small cucumbers just set also was an evidence of the injury.

No organism causing a primary infection has been isolated. The disease was more prevalent during a day of sunshine following a period of cloudy weather. The first leaves affected were old leaves, rather than young ones. Heavy watering did not control the "burning." The addition of minor elements did not aid in its control.

The type of soil, ranging from pure sand to well-rotted manure, had little or no influence. The disease has not occurred so severely on the spring-grown crop. Syringing helped retard, but did not control the disease.

**Tomato Variety Tests, Fertilizer Requirements, and Seed Selection for Disease Resistance** (R. A. Schroeder). Since no other ground was available, it was necessary to plant all the experimental tomatoes on soil which had been planted previously to tomatoes and which was heavily inoculated with tomato wilt. This factor, along with the drought, made the yield records unreliable.

Varieties which showed resistance to wilt and also promise commercially were: Marglobe, Master Marglobe, Pritchard, Break O'Day, Marglobe 3025, New Zealand, and Rutgers. Two new varieties developed by the Illinois Agricultural Experiment Station, Illinois Pride and Prairiana, were promising except for the extremely rough blossom end (catface).

**Cabbage Variety Trials for Disease Resistance and Fertilizer Requirements** (R. A. Schroeder). Several varieties of cabbage have shown almost complete immunity to "yellows" under Missouri conditions. These varieties also have been tested on disease-free soil for total production, date of maturity, and quality, as compared to the "yellows" susceptible varieties. Plantings made during the spring of 1936 were complete failures on account of the drouth, even with several waterings.

**Varieties of Cantaloupe and Watermelon** (R. A. Schroeder). Variety plantings were made to test new varieties, especially varieties resistant to wilt. The growing conditions of 1936 were very unfavorable, but the following varieties were sufficiently promising to warrant further studies: Improved Kleckley Sweet No. 6, Improved Stone Mountain No. 5, and Improved Iowa Belle. For varieties not resistant to wilt, Honey Cream, Japanese Honey, and Sweet Japanese again were very promising as home garden melons.

**Cultural Experiments with Irish Potatoes** (T. J. Talbert, R. A. Schroeder). In fertilizer tests, ammonium sulphate, superphosphate, and potassium chloride were applied separately and in various combinations and at various rates per acre. During the first part of the growing season, the plants did not suffer severely from lack of moisture and high temperatures, and the vines receiving applications of nitrogen were distinctly more vigorous and greener in color. Later, due to the drouth, the differences disappeared and the yields were so inconsistent as to be unreliable.

The new varieties resistant to mild mosaic that were planted were Warba, Chippewa, Katahdin, and Golden. The yield for all varieties

was very poor, but some facts regarding their performance were observed. Warba, under the growing conditions, was somewhat earlier than Cobbler and set a larger number of tubers in each hill. Chippewa was somewhat later than Cobbler and set about the same number of potatoes as did Cobbler. Katahdin and Golden were later in maturing than Cobbler. Chippewa, Katahdin, and Golden did not show any mild mosaic. Warba showed about 1 per cent; Cobbler and Triumph as high as 20 per cent.

Attempts have been made to break the rest period of the early crop, so that it might be used as a source of seed for the late crop. In general, the attempts have given negative results. One chemical, ethylene chlorohydrine, was used. The treatments included treating cut and whole pieces, treating for different lengths of time, giving several treatments to one lot of tubers, and treating after the lapse of varying amounts of time.

None of the treatments gave a satisfactory stand of potatoes.

**Growing Sweet Potatoes** (R. A. Schroeder). Fertilizers used included ammonium sulphate, superphosphate, potassium chloride, and lime, individually and in combination. The slips were planted in the field May 30 in very dry soil and did not receive any rain until late fall. The mortality of the plants was very high with both varieties.

On account of adverse weather conditions, only one finding is considered significant. Under drouth conditions, the Nancy Hall variety produced a larger yield as well as a larger percentage of No. 1 sweet potatoes than did small Stem Yellow Jersey.

**Factors Limiting the Production of Sweet Cherries in Missouri** (T. J. Talbert). Apparently, the early blooming is the chief reason for the unfruitfulness of the sweet cherry in central and north Missouri. The fruit buds, however, are more hardy than those of the peach to winter cold, and the blooming time is approximately the same. Therefore, the sweet cherry should be profitable if grown in the peach sections of the State. Scattered plantings of small producers confirmed this conclusion.

**Increasing the Durability of Fence Posts** (R. H. Westveld). This project is in cooperation with the Department of Agricultural Engineering. Approximately 300 fence posts have been prepared and data on diameter of post, type of post, thickness of sapwood, and number of growth rings have been recorded. Fourteen of the more common Missouri tree species were included. The posts will be seasoned for one year then treated by several variable methods, after which they will be set in the ground and observed for an extended period of time.

**Site Requirements and Growth Rate of Native and Exotic Tree Species** (R. H. Westveld). A three-tenths acre sample plot in one of the University woodlands has been established. Each tree in the plot has been numbered permanently and a record of diameter, total height, crown class, bole defects, and species has been made for each tree. A soil description also has been prepared.

Several one- and two-acre plantations have been established on the Ashland Wildlife Tract. The following species are included in these plantations: northern white pine, Norway pine, ponderosa pine, southern cypress, jack pine, shagbark hickory, silver maple, and green ash. Planting stock for this project came from Iowa State College, Illinois State Forestry Department, Arkansas State Forestry Department, and the U. S. Forest Service. Labor for planting was furnished by the Resettlement Administration.

Detailed data on soil, methods and cost of planting, and related information were secured.

**Christmas Trees as a Crop** (R. H. Westveld). One hundred trees of each of the following species have been planted on University property at Columbia: Balsam fir, white spruce, Norway spruce, eastern red cedar, and jack pine. Records of mortality and growth rate are being kept. One-half of each lot of trees will be cultivated, while the others will be left in a natural state. More than 95 per cent of the trees are alive.

## POULTRY HUSBANDRY

H. L. KEMPSTER, *Chairman*

**Time of Hatching in Relation to Egg Production** (H. L. Kempster). Chicks were hatched each week from February 2 to April 25. The egg production up to November 1 was 41, 19, and 7 eggs, respectively, for pullets hatched in February, March, and April. For the winter period (November 1 to March 1) the February hatched pullets produced 7 less eggs than did those hatched in March and 9 less eggs than did those hatched in April. There were no significant differences in the egg production of the various groups for the period March 1 to June 30. The February hatched pullets produced a few less eggs during the winter period, but this was compensated by more liberal production during the early fall months.

**Growth of Chicks Under Normal Conditions** (H. L. Kempster). During 1936 there were two periods of extremely high temperatures. The average maximum temperature for the week ending July 18 was 106; for the week ending August 22, 104. The percentage of normal growth declined to 70 for July 11, rose to 94 on August 1, and declined to 85 during the middle of August. As the temperature declined in September, the percentage of growth rose to slightly above normal.

Smaller chicks were less affected by periods of extreme heat. Therefore, it has been concluded that chickens are sensitive to environmental conditions, and that the type of growth curve varies, depending upon the date the chicks were hatched and the temperatures that prevailed during the growing season.

Another study on rate of growth showed that chickens which eventually became affected with paralysis grew at a normal rate. Weight records for 180 such birds showed no significant differences in weights at various ages from 0 to 40 weeks, as compared with normal.

Growth of chicks in 1924 has been compared with the growth of chicks for 1936. The percentage of normal growth from May 1 to July 29 in 1924 ranged from 60 to 96 per cent normal. After August 1, the percentage of normal growth was sufficiently above normal, so that when the pullets were 36 weeks old their weight was equal to normal standards.

Apparently, the methods of feeding and rations employed in 1924 resulted in chickens which grew much slower when young and made more rapid weight accumulations when older than did chickens produced on the rations used in 1936. The 1936 chickens followed more nearly standard, normal development.

**The Feed Purchasing Power of the Eggs Laid by a Hen** (H. L. Kempster). A slightly less favorable relationship between feed and egg prices prevailed in 1936 than in 1935. The eggs from a 122-egg hen would purchase 131 pounds of feed as compared to 135 for the previous year. Normal feed prices prevailed for the first six months and then rose to 146 per cent of pre-war for the latter part of the year. Egg prices, while above pre-war for most of the year, did not increase sufficiently to counteract the effect of high feed prices. The feed purchasing power of eggs declined from 111 in July to 66 in December. The farm price of eggs, based on a mixture of corn, wheat, and oats 5-3-3, ranged from \$1.21 in January to \$1.89 in December. Egg prices fluctuated from 15 cents per dozen in March to 29.9 cents in November. The egg-feed ratio for the year was 8.28, which was more favorable than for 1934.

**Nutritional Requirements of Poultry** (H. L. Kempster, Bertha Bisbey). 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 basal ration containing 65 per cent yellow corn produced 73 eggs per hen from October 10 to July 4. The balance 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 resulted in a slight decrease in egg production. The addition of 10 per cent alfalfa leaf meal resulted in a marked increase in production. This may be attributed either to the increased vitamin A or, possibly, vitamin G. 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. The addition of 2 per cent cod liver oil to the 35 per cent yellow corn ration resulted in an egg production comparable to the other groups receiving 10 per cent alfalfa leaf meal or 5 per cent alfalfa and 1 per cent cod liver oil.

**Factors Influencing the Production and Keeping Quality of Eggs** (E. M. Funk). The effect of cleanliness of eggs on keeping quality has been studied. There were wide variations in the percentages of clean eggs produced during different seasons of the year. Hot and dry weather increased the percentage of clean eggs. Frequent gathering also was important. The proportion of dirty eggs gathered was reduced 50 per cent by gathering the eggs four times per day instead of only at the end of the day.

The percentage of dirty eggs was decreased when open nests were kept dark. Shavings, oat hulls, sawdust, and excelsior were the most

effective materials to use for nests for producing clean eggs. Keeping the birds in the laying houses increased the percentage of clean eggs. Some breeds produced very few dirty eggs, whereas other breeds produced a larger number. The percentage of dirty eggs was higher from trap nests in the morning than in the afternoon. More than 99 per cent of all eggs were clean before they came in contact with the nest.

**The Effect of Environment on Egg Production** (H. L. Kempster, J. C. Wooley). (In cooperation with the Department of Agricultural Engineering). White Leghorn pullets housed in the Missouri 20 x 20 straw loft poultry house have laid a few more eggs per hen than similar pullets housed in a two-story 20 x 20 experimental poultry house designed by the Department of Agricultural Engineering. The greatest difference occurred from November 15 to December 15. The egg size also was slightly larger for the pullets in the Missouri poultry house.

The differences may be attributed to ventilation problems, or to the greater ease with which the pullets in the one story house could be exposed to sunshine.

**The Effect of All-Night Lights on Egg Production in Turkeys** (E. M. Funk). All-night lights were started January 15 in one breeding pen, and in another, no lights were used. There was a very decided shift in production due to the use of artificial lights. Turkey growers, located in the northern sections of the State, where the days were relatively short, may increase early egg production and, therefore, increase the production of early hatched poults by using artificial lights. Table 5 shows the effect of all-night lights on Turkey egg production.

TABLE 5.—EFFECT OF ALL-NIGHT LIGHTS ON EGG PRODUCTION IN TURKEYS

Week	All-Night Lights	No-Night Lights
	Percentage Production	Percentage Production
February 14-20 .....	27	0
February 21-27 .....	69	14
February 28 - March 6 .....	79	30
March 7-13 .....	80	43
March 14-20 .....	73	61
March 21-27 .....	56	43
March 28 - April 3 .....	37	53
April 4-10 .....	53	56
April 11-17 .....	57	59
April 18-24 .....	59	49

**The Size and Shape of Turkey Eggs** (E. M. Funk). Seven hundred and sixty-eight turkey eggs, laid during the spring of 1937 by twenty Bronze pullets, were weighed to the nearest gram and measured to the nearest millimeter. The average of the measurements gave an average weight of 84.5 grams, with a standard deviation of 6.8 grams; an average width of 48.6 millimeters, with a standard deviation of

1.5 millimeters; an average length of 66.6 millimeters, with a standard deviation of 2.3 millimeters.

**The Relation of Yolk Movement and Hatchability** (E. M. Funk). Eggs which showed rapid yolk movement when they were rotated before an electric egg candler did not hatch as well as those eggs which showed slow movement. Observations were made on more than 4,000 eggs. The results showed that those eggs which appeared sluggish when rotated gave a 65.5 per cent hatch of all eggs and 77.5 per cent hatch of fertile eggs. Those eggs whose contents moved rapidly showed only a 50.1 per cent hatch of all eggs and a 63.6 per cent hatch of the fertile eggs.

**The Effect of Washing Eggs on Hatchability** (E. M. Funk). It has been reported that washing dirty eggs is detrimental to hatching results. This investigation has indicated that eggs soiled with poultry droppings may hatch as well as clean eggs, and that eggs which have been washed hatch equally as well as clean eggs. Washing eggs with hydrant water and also with one per cent lye water did not reduce the percentage of hatch.

## SOILS

M. F. MILLER, *Chairman*

**Crop Rotation and Fertilizer Experiments** (M. F. Miller, H. H. Krusekopf). The year, 1938, will mark the fiftieth year of cropping on Sanborn Field. All clover was a failure in the spring of 1937 on account of the extreme drouth of 1936. Heavy rains during the spring months produced a heavy growth of timothy and small grain. Most of the small grain lodged, and the wheat was severely attacked by rust. In some cases, heavy applications of fertilizer resulted in lodging so severe that some of the plots receiving smaller treatments made greater yields. Corn made good growth and demonstrated the value of legumes, crop rotation, and fertilizer treatments in maintaining soil productivity.

These plots now have great value because of their age. The effects of widely different crops and treatments have had a most pronounced influence on the soil of the different plots.

On the University Farms, a wide variety of rotation experiments, with and without fertilizers, have been established. Plots where sweet clover had been turned under produced the best yields of corn and oats. The season was ideal for these crops, and the yields were the best that have been secured on any of the experiment fields in some years.

One-year rotations of small grain with lespedeza or soybeans have shown promise. The effect of phosphate on yields was remarkable.

**Systems of Soil Management for the Most Important Soil Types in Missouri—Soil Experiment Fields** (M. F. Miller, H. H. Krusekopf). The drouth in 1936 resulted in a complete failure of clovers on all outlying fields. Wheat at Green Ridge showed the usual excellent response to fertilizers despite rust and chinch bugs. Oats made only moderate yields, and corn yields were low and the differences not significant. Wheat was a failure at Kidder, but corn made a fair yield and gave significant response to fertilizers. The limed block at Moberly, where a heavy crop of sweet clover was turned under, gave a 20-bushel greater yield of corn than where no lime was applied and the clover failed. Sweet clover plots gave the best yields of corn and soybeans at Elsberry on the heavy gumbo soils. Cotton at Sikeston gave very profitable response from fertilizer. The plots where lime and fertilizer had been applied gave the best yields of corn.

The outlying experiment fields continued to indicate the most satisfactory systems of soil management for the more important soils of the State. These fields are visited yearly by a large number of farm-

ers, and these demonstrations are influencing soil management practices on many farms.

**The Mapping of Missouri Soil Types—Soil Survey** (M. F. Miller, H. H. Krusekopf). The last general assembly of the State of Missouri provided funds for reestablishing the Missouri soil survey. The survey of Linn County has been completed. Also, the Soil Conservation Service was assisted in the survey of Chariton County. The area surveyed in the two counties was approximately 900 square miles.

The present detailed method of classifying the soils, together with the classification of slope and erosion, has slowed the rate of work. However, the use of aerial maps has largely offset this.

**Land Classification of Missouri** (H. H. Krusekopf). A growing demand for land-use information has caused the development of methods of land classification. Most of these methods are based on economic factors, as indicated by crop and census data. The soil factor has been given only secondary consideration.

A land classification from an agricultural viewpoint, based primarily on soil factors has been made. Various soil features that influence land use have been classified and interpreted. Each group of related soil features has been indicated on a separate map, and all of these have been integrated in a general land classification map.

The agricultural viewpoint in the land classification has been based on a prospective land use.

**The Fineness of Grinding Limestone** (W. A. Albrecht). The exchangeable calcium supply in the most productive soils in Missouri is about three times as high as it is in the least productive ones. Therefore, the practice of liming becomes an attempt to increase the supply of exchangeable calcium for the plant.

In order to determine whether liming was the most beneficial because it provided plants with calcium or because it corrected soil acidity, experiments were carried on at the South Farms. Small amounts of limestone and calcium salts were drilled, like a fertilizer, with sweet clover seeding in contrast to heavier applications of limestone mixed into the soil to reduce its acidity.

Observations indicated that calcium played an important role as a nutrient, since drilling the smaller amounts of limestone gave fair stands and growth of sweet clover. The more soluble calcium form, as gypsum, did not carry the crop over into the second year as did limestone. Finely ground limestone established the crop very well when used at a rate of 600 pounds per acre. Heavy liming mixed with the soil gave the best stands and growth.

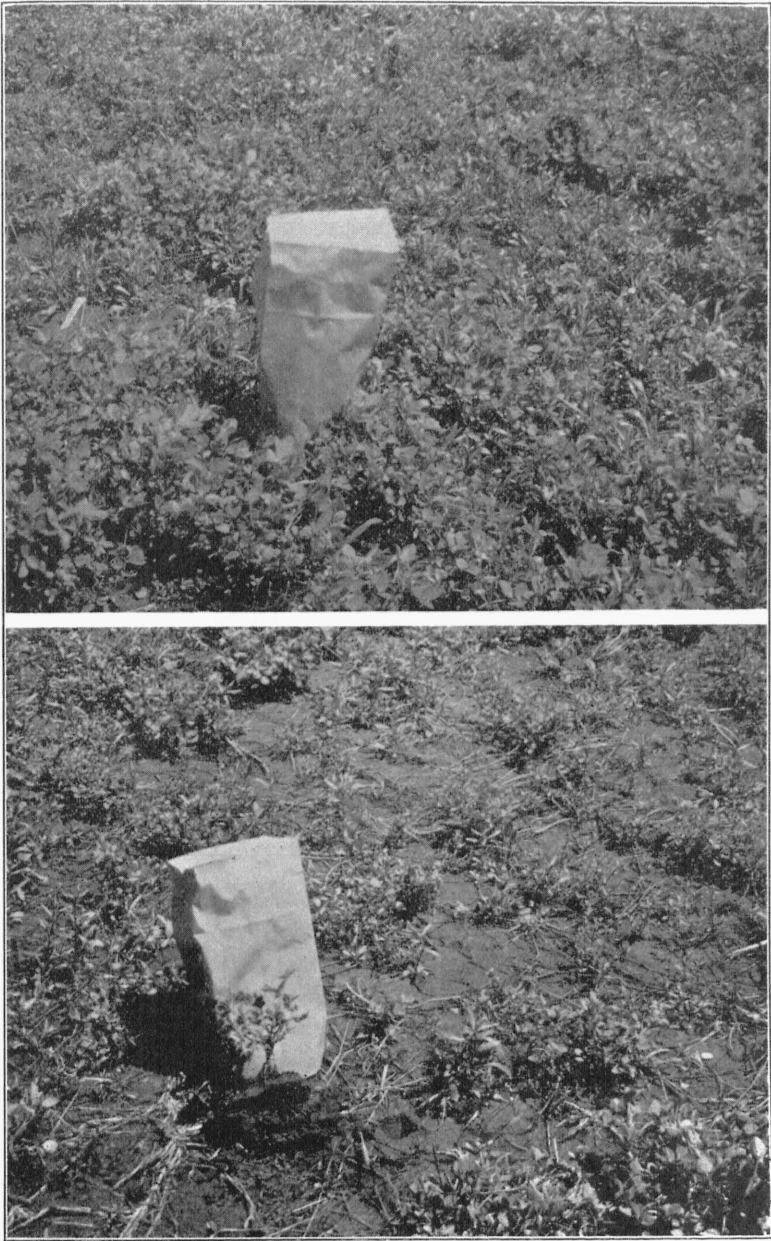


Fig. 5.—Differences in winter survival by sweet clover where 600 pounds of limestone were drilled with the seeding (above) as compared with the heaved condition (plant before bag) and poor stand where no limestone was used. (Spring 1937).

**The Calcium Content of Soils and Its Relation to Acidity and the Response of Soils to Liming** (W. A. Albrecht, Ellis R. Graham). The use of colloidal clay of known degrees of calcium saturation for growing soybean plants has shown that growth and nitrogen fixation activity were related to both the degree of calcium saturation and to the total amount of calcium offered. The more complete saturation, with a constant amount of calcium per plant, gave effects similar to increased amounts of clay at any degree of calcium saturation where



Fig. 6.—Increasing calcium (left to right) whether accompanied by decreasing hydrogen (acid) or barium (neutral) improved the soybean growth and utilization of seed phosphorus and potassium.

more total calcium was offered. When the degree of calcium saturation approached fifty per cent of the remaining capacity occupied by hydrogen, growth was very poor or almost inhibited. Such plants contained less basic nutrients than originally were in the seed. This condition was similar when other elements than hydrogen accompanied the calcium, or when the soil was neutral.

Calcium apparently helped the plant in the use of other elements. unless the calcium supply was sufficient for good growth, the crop failed to metabolize even the seed phosphorus. Similar relations of the calcium to the potassium also were suggested.

**Mechanical Analysis of Colloidal Clays** (C. E. Marshall). By using a centrifugal method of quantitative mechanical analysis, subfractions of the clay were prepared and examined by a mineralogical technique

which enabled the density, refractive index, and birefringence to be determined. From these results the homogeneity or lack of homogeneity of these sub-fractions was determined.

Finally, a complete chemical analysis was made of each sub-fraction. These investigations have been planned to yield information bearing on the origin of soils and on the chemical constitution of the colloidal clay.

**The Colloidal Nature of Soil Organic Matter** (L. D. Baver, N. S. Hall). Studies on the colloidal properties of the inorganic soil colloids have shown that acid and lime-containing clays have similar physical properties. Therefore, it has been necessary to study the properties of the organic colloids. The exchange capacity of the organic colloids was found to be about six times that of the inorganic clay systems. Hydration of colloidal humus was about the same order of magnitude of bentonite. The effect was summarized as follows:

1. Flocculation:  $Ba > Ca > H$  (Li, Na, K systems completely dispersed).
2. Hydration:  $Ba > Ca > H$ —hydration due to water of occlusion  
 $Li > Na > K$ —hydration due to water hull.
3. Charge:  $Li = Na > K > H > Ca > Ba$
4. Dehydration:  $Ba > Ca > H$  (Li, Na, K systems not dehydrated).
5. Energy of absorption against H:  $Ba > Ca > Mg > Sr > K > Na > Li$
6. Flocculation of H system:  $Ba > Ca > Sr > Mg > K > Na > Li$
7. No significant differences were shown between H and Ca systems.  
Ca-humate was a little more flocculated, but less stable than H-humate.

**The Nature of Soil Structure and Its Influence upon Soil Tillage** (L. D. Baver). Various methods of measuring soil structure in terms of degree of aggregation and of the stability of aggregation in water have been tried, with the conclusion that the elutriator may serve as a good instrument for this purpose. Another method is more simple and serviceable. It consists of a nest of immersed sieves moving up and down in water for a given time to segregate granules into their percentage distribution of sizes as they break down to smaller ones from a given size with time.

**The Nitrogen and Carbon in Soils Under Different Systems of Soil Treatment and Management** (M. F. Miller, W. A. Albrecht). Experiments covering nineteen years with different systems of cropping have

shown that a level of around 3,000 pounds of nitrogen in the surface seven inches of an acre, seems about as high as can be reached under good systems of cropping and soil management.

On Sanborn Field a plot which has been in continuous timothy for forty years and which has received six tons of farm manure annually contained about 3,200 pounds of nitrogen in this seven-inch layer. This, of course, is an impractical situation. In the regular plots of the nitrogen-carbon series, the three-year rotation of corn, wheat, clover, to which manure was added every three years, approximately equivalent to that produced from the crops grown during nineteen years, the nitrogen amount was about 2,900 pounds in the top seven inches of soil. The continuous sod plot, from which nothing had been removed, contained something over 3,000 pounds. From the economical standpoint, the important thing is the nitrogen turnover, rather than nitrogen accumulation.

The study of the influence of additions of clover on nitrogen accumulation has been completed and the data published as Research Bulletin 249. Also, the study of the factors influencing the level of nitrates in the soil has been published as Research Bulletin 250.

The influence of various cropping systems on an exposed sub-soil has been studied for a number of years. The use of lime and fertilizers in a two-year cropping system of wheat and mixed hay on this sub-soil has resulted in yields at approximately the same level as those of the untreated surface soil when the crops were removed and no manure returned. On treated sub-soil, the nitrogen content of the surface seven inches, beginning with 1,660 pounds, was increased by about 28 pounds annually. If the crops had been fed back, this increase would have been greater, but the maximum which will be reached under this system is, of course, unknown. From other investigations, it probably will not be much over 3,000 pounds, and many years will be required to reach this level.

**The Utilization of Corn Stalks and Straw in Soil Building** (W. A. Albrecht, J. C. Wooley). The maintenance of soil organic matter is of primary importance in soil management, since the release of the various plant nutrients from this source supplies a large share of the nutrients delivered to the plants. Organic matter upkeep requires nitrogen. Ample carbon is supplied in woody plant residues, but the nitrogen shortage keeps these from being of service. When such residues are put into the soil, they may be detrimental to the following crops. This has led to burning cornstalks and straw. If given nitrogen, this organic matter would build up the supply and activity of the organic matter in the soil for benefit, rather than detriment.

The mechanics of handling organic matter involves labor. A method is being developed to reduce this to the simplest mechanical basis, so that cornstalks, straw from the combine or stack can be converted into artificial manure and fitted into the farm and soil management schemes most effectively.

**Effects of Different Soil Treatments, Long Continued, Upon Bacterial Activity in the Soil** (W. A. Albrecht, B. R. Browning). Nitrification activities have been studied in the soils from three plots [four-year rotation plots including: (1) no treatment; (2) fertilizer; and (3) lime and fertilizer].

Without the addition of nitrifiable matter, these three plots behaved similarly, giving a low level of nitrates. When given green manure, the plot with lime and fertilizer was higher in nitrate accumulation than the fertilized plot. It accumulated as much nitrate in four weeks as the fertilized plot did in eight weeks. The fertilized plot functioned more effectively in breaking down the green manure than was true for the untreated plot.

These results indicated that lime stimulated the microbial processes, making plant food available.

Studies have been continued on the differences in degree of lignification of the residual soil organic matter as a result of different long-continued treatments. An arbitrary standard of digestion by 80% sulfuric acid has been used. Analyses also have been made of the "humus" extract from some of the plots.

**The Improvement of Permanent Pastures** (M. F. Miller, H. H. Krusekopf). This project is in cooperation with the departments of Animal Husbandry and Field Crops. Applications of phosphate ranging from 100 pounds to 4,000 pounds have been made on bluegrass pasture, with and without nitrogen and potash. Clippings were not made in 1937, and the only visible effect was the increased growth and depth of color resulting from the applications of nitrogen.

On another group of plots, a single harvest was made showing differences varying from 500 to 800 pounds of dry matter. Nitrogen alone, or nitrogen and phosphorus, gave the greatest increases. The return from potash was very small.

**Increasing the Productivity of Missouri Pastures** (L. D. Baver, J. B. Page). This project is in cooperation with the departments of Agricultural Chemistry, Animal Husbandry, Dairy Husbandry, and Field Crops. Greenhouse experiments have been carried out to determine the adaptability of Missouri soil types to different pasture plants. Outstanding differences in the growth of lespedeza, sweet clover, redtop, and bluegrass have been noted between several of the more important Missouri soil types. Relative data on the growth

of lespedeza, using the cultivated Putnam silt loam from the University South Farm as 100 are as follows:

Putnam silt loam	
University South Farm .....	100
Virgin prairie .....	75
Cultivated adjacent to prairie .....	133
Lindley loam—virgin .....	28
Oswego silt loam .....	135
Crawford silt loam .....	122
Summit silt loam .....	49
Marshall silt loam, No. 1 .....	104
Marshall silt loam, No. 2 .....	111
Marshall silt loam, No. 3 .....	86
Shelby loam .....	75
Union silt loam .....	93

The results from bluegrass, sweet clover, and redtop are not yet available, but observations indicate a different relationship for each of these. The rather remarkable results on land of low fertility and the poor returns on virgin soil are of special interest.

**Soil Erosion and Runoff** (M. F. Miller, H. H. Krusekopf, L. D. Baver, J. H. Neal). The results of 14 years of measurements of runoff and erosion losses as influenced by cropping and cultural practices have been published. This length of time was sufficient to provide for all ordinary irregularities, and, therefore, the plan of treatment on these plots was changed in 1933 to a system of continuous fallow. The purpose of this change was to determine definitely the influence of previous cropping and cultural practices upon runoff and erosion losses. It was thought that the varying amounts of organic matter, existing in these plots as a result of the different cropping systems should have an influence on the losses which would take place. It was believed that under continuous fallow for four or five years, these various influences could be accurately measured.

Four-year results now are available. The losses of both runoff and erosion are in approximately the same order as they were under the various cropping and cultural systems. However, the plot which was originally in sod shows much less runoff and erosion than the plot which was formerly carried in a crop rotation. Perhaps the narrower nitrogen-carbon ratio of the organic matter in the rotated plot permits more rapid decomposition of the organic matter with a resultant dispersion of the soil particles. Aggregate analyses and dispersion measurements of eroded material from all plots have been made in an attempt to explain these differences.

Erosion measurements having to do with length and degree of slope continue to corroborate earlier findings. Increasing the slope from 3.68% to 6% and 8½%, respectively, has resulted in increased ero-

sion losses of three and five times, respectively. Increasing the length of the slope resulted in decreased runoff and increased erosion.

**Effect of Rainfall Impact on Soil Erosion** (L. D. Bayer, J. H. Neal). Soil erosion is caused by the beating of rain upon the soil and the movement of water over the surface soil. The impact of the raindrops breaks up the structure of the soil and permits the soil particles to be brought into suspension. A rainfall impactometer has been devised to measure automatically and continuously the force of impact of rainfall per unit area of soil surface. By studying the velocity of falling drops of water by the use of a stop-watch and a movie camera, it was found that after a few seconds the acceleration was negligible. From this point, the drop maintained constant velocity.

## VETERINARY SCIENCE

A. J. DURANT, *Chairman*

**Fowl Paralysis** (A. J. Durant, H. C. McDougle). A study of the transmissibility of fowl paralysis from parent to progeny through the egg has been continued. Of twenty chicks from the third generation of infected birds, twelve, or 60 per cent developed some form of fowl paralysis in from 171 to 337 days.

In a group of seventeen control birds in the same room, but in separate pens, none developed evidences of fowl paralysis within a period of 459 days.

A chick with a diseased eyeball, reported in the last report, was killed, and two minims of fluid were drawn from the diseased eye and injected into two Leghorn chicks nine days old. Neither of the two chicks showed signs of fowl paralysis from these inoculations. The affected eye may have been due to some other condition, or else there was no virus of fowl paralysis in the fluid injected.

Of the first generation of fourteen chicks which were hatched from diseased parents, eight of the fourteen were hatched from eggs which were laid in the litter. Six developed fowl paralysis. Of the the six chicks from the trapnested eggs, only one developed paralysis. It is assumed that the eggs recovered from the litter were from birds which were in the more advanced stages of blindness due to paralysis.

Apparently, in the more advanced stages, the disease is transmitted more readily. It also is possible that the virus of this disease may be concentrated in the ovaries, and that inoculum from the ovaries of affected birds may be a fertile source of the virus for transmission experiments.

One-hundred thirty one-day-old White Leghorn chicks were purchased from a farm where no disease had been reported and were placed on a farm where both leucosis and fowl paralysis had occurred and were occurring. At the same time, eggs from this infected farm flock were obtained and 86 chicks were hatched and banded. These chicks were placed on a farm where no chicks had been for ten years. Unfortunately, 61 of the 86 chicks were stolen when quite small; 6 later disappeared, leaving only 19 birds. Six of these nineteen birds developed leucosis. One developed in the left eye. Of 131 chicks which were placed on the farm where both leucosis and fowl paralysis had existed, 23 were destroyed or killed by predatory animals. Of the remaining 108 birds, 10 developed definite fowl paralysis and 6 definite leucosis.

The age at which fowl paralysis developed varied from 240 to 303 days. For leucosis, the time varied from 80 to 362 days.

A litter infection experiment was started to test whether or not fowl paralysis can be contracted by birds feeding over ground where infected birds were raised. Unfortunately, most of the birds died from an acute attack of coccidiosis, and the number of remaining birds was too small for definite conclusions.

**Leucosis in Fowls** (A. J. Durant, H. C. McDougale). Attempts were made to transmit leucosis of fowls by means of desiccated liver from a case of a transmissible form of leucosis. The desiccated liver was preserved for 328 days in a refrigerator at a temperature near 40° F. Fifty milligrams for the desiccated liver was emulsified in 5 c. c.'s of sterile water and each chick received intravenously .6 c.c. At 240 days none of the birds showed any evidence of sickness. The bird from which this desiccated liver was obtained was an artificially infected bird which died with leucosis 59 days after inoculation.

In attempts to transmit leucosis from field cases of the disease, 12 chicks were inoculated with the blood from 3 suspected cases of the disease. Thirteen birds of the same age were used as controls. Up to 248 days after inoculation, none of the inoculated birds or control birds showed symptoms of leucosis. The brain of one of the three birds which was suspected of leucosis was obtained aseptically and inoculated into five chicks in an attempt to transmit leucosis. This brain material was injected subcutaneously. Five birds were used as controls. After 247 days following the inoculation, none of the birds showed signs of the disease. The brain and all the organs were cultured in an attempt to determine whether or not other organisms complicated the leucosis picture. The results of these cultures were all negative.

Other studies on leucosis have been reported in connection with the studies on fowl paralysis. With the method of blood counts which was devised and reported in the Director's Report for the year ending June 30, 1936, much more uniform results have been obtained in the study of leucosis.

**Blackhead in Turkeys** (A. J. Durant, H. C. McDougale). In studies on mode of transmission of blackhead in turkeys, Dr. Tyzzer of Harvard, has demonstrated the *Histomonas meleagridis* in young cecal worms by longitudinal histological sections of these worms. This would indicate that the blackhead organism was transmitted through the cecal worm as an intermediary host, and that the cecal worm egg may carry the *Histomonas meleagridis*. This organism, however, never has been demonstrated in the egg of the cecal worm.

In order to obtain histological sections of the cecal worm egg, large numbers would have to be collected and fixed in paraffin for sectioning. This work has been started, and the ceca of large numbers of birds have been collected from the packing house and contents of the organism washed out and the cecal worms collected. The recent drouth years have reduced greatly the number of cecal worms and hampered the collection of cecal worm eggs. This work will be continued until a sufficient number of eggs are obtained for the section work.

If these blackhead organisms could be demonstrated in the cecal worm eggs, it would be the last link in the proof that the cecal worm was a definite intermediate host for the blackhead organism, and that the egg of the worm actually carried the parasite from the cecal worm to the next host inside the shell of the egg.

The use of turpentine and bismuth subcarbonate for the prevention of blackhead in turkeys has been attempted. Forty-two birds were used in the experiment; 14 were given 1 c. c. of turpentine every other day; 14 received 20 grains of bismuth subcarbonate at the same interval; and 14 birds were used as controls.

Due to unfavorable weather conditions for the development of blackhead, only 3 of the 14 control birds died during the course of the treatment, which was one year. Two of the turpentine and one of the bismuth subcarbonate group succumbed to the disease. The number that contracted blackhead was too small to draw definite conclusions, but it would appear that the two drugs had little effect on the prevention of the disease.

In field studies on blackhead, some interesting observations were made on a disease which in its clinical manifestations resembled blackhead. On the farm where this disease occurred, there was a loss of 60 adult turkeys. An investigation revealed that the disease

was one of the mycoses (thrush), due to *Monilia albicans*. Since this investigation, two other farms have reported similar outbreaks.

The principal feature which may be confused with blackhead is the color of the droppings of affected birds. However, there was a slight difference in the color, since the birds affected with typical blackhead have a deep sulphur color to the droppings, whereas in thrush the color is not so marked and is lighter.

The lesions of thrush, as revealed by these investigations, were found throughout the digestive tract, from the oesophagus to the vent.

No definite treatment has been discovered for this disease. The source of the infection has not been determined in the three outbreaks, but contaminated feed usually is suspected as being the most likely source of the *Monilia albicans*.

**Parasites of Sheep** (Cecil Elder, O. S. Crisler). Sheep which had been on the parasite experiment and on which several parasite egg counts already had been made were divided into two groups. The division was made on the basis of egg counts and upon the kinds of parasites known to be present. The animals were removed to the veterinary Research Farm and placed in specially constructed pens in the west end of the large barn. The south pasture was divided, the division fences being located so as to avoid as much as possible the drainage from one pasture to another. Twenty-two sheep were placed in each of the two pastures. Those in the southeast pasture, as determined by the egg count, were infested with both nodular worms and stomach worms, while those in the south pasture were heavily infested with stomach worms, but were comparatively free from nodular worms. Each group of sheep was further sub-divided into three smaller sub-groups. These sub-groups were handled as follows: One group received 1 per cent copper sulphate every 14 days; another group received copper sulphate every 28 days; and the third group was left untreated as controls. The 1 per cent copper sulphate solution was given at the rate of one ounce to every 20 pounds of body weight (maximum dose four ounces). On the second day following the time that the copper sulphate was administered, fecal samples were collected from all sheep in the pasture, and microscopic egg counts made. Flotation method with saturated sodium chloride solution was used. Care was taken to get a complete sample, and from this one-half grams of fecas, by weight, was mixed with the saturated salt solution, strained through cheesecloth, and allowed to stand 30 minutes by the watch. This method has insured uniform samples. In all, a total of 963 fecal samples have been examined, egg counts made, and the numbers and kinds of eggs found recorded.

Although the total stomach worm egg count for each of the sub-groups was reasonably high in the summer of 1936, the counts decreased at about the same rate, regardless of the sub-groups to which the animals belonged. Indications were that good feed was a very important factor in the reduction of the number of microscopic eggs found.

**Cattle that Consistently Give Low Titre Reactions to the Bang Agglutination Test** (Cecil Elder, O. S. Crisler). Cows on this project have been kept at the Veterinary Research Farm and have been protected during the entire period from outside contamination and other cattle. The animals all have been kept under close daily observation.

Seventeen cows have been on the experiment, and each one of the animals has calved during the period. Exact breeding dates were available on all the cows except two. The average gestation period for the fifteen cows was 282.66 days, with a variation from 277 to 288 days. These gestation periods can be considered as being within the the normal variation. The average number of services required to settle cows was 2.13.

Six animals were negative to all blood tests made during the year. The other eleven animals have shown some agglutinating titre on one or more tests—running as high as an incomplete reaction in 1-50 dilution with the test tube method. Colostral milk samples have been tested with the agglutination test from individual quarters from fifteen of the seventeen cows. In only four animals were all four quarters completely negative to the test. Three animals showed an agglutinating titre in one or more quarters and eight animals showed agglutination in all four quarters. These titres varied from 1-25 up to 1-200. There appeared to be no direct correlation between the cows giving the high titres of milk with those which showed the highest titres of blood, but the agglutinating titre of milk indicated that *Brucella abortus* infection actually was present, even though blood titres did not run high enough to classify the animals as reactors. Apparently the cows on experiment showing a low blood titre have not been very active in spreading Bang's disease infection to the control animals. The most logical interpretation that can be placed upon these findings at the present time is that there apparently was present a low-grade infection in the experiment animals.

Twenty-one guinea pigs have been injected, using colostrum milk, placental membrane emulsion, and one sample of stomach contents for the injection. In all cases direct cultures and guinea pig injections have been negative except from four of the cows. Very suspicious sub-cultures from these animals have been found and are being held for further study and typing to see if they belong to the *Brucella* group.

**Comparisons of the Tube Agglutination and Rapid or Plate Tests on Low Reacting Sera in Bang's Abortion Infection (Cecil Elder).** Samples which gave suspicious reactions to routine tube agglutination tests have been retested by the plate method. A total of 1,128 samples has been tested on this comparative basis. Thirty-one samples out of the 1,128 were slow in showing agglutination.

There were 1,027 samples classified identically by both methods, while 101 samples were classified differently by the two methods.

If results had been reported on the plate test instead of the tube test, a smaller number of reactors would have been reported. In this laboratory, the tube method is considered as the official test.

**Transmission of Bang's Abortion Infection from Swine to Cattle (Cecil Elder).** Work has been continued on this experiment according to the same general lines as was reported last year. Seven cows were on experiment, but one animal was killed in December because of her physical condition. Autopsy revealed a most severe sarcomatous growth which involved about two-thirds of the small intestine. Agglutination tests were run each two weeks on all animals, and all animals have shown some agglutination titre at least on a part of the tests. Colostral milk samples from individual quarters have been tested, and two cows showed agglutination titre in all four quarters. One cow showed some titre in one quarter, and three cows were negative in all quarters.

Gestation periods for all cows that dropped calves during the period were normal except the cow that was killed. This cow dropped a living calf with a gestation period of 258 days. It was impossible to conclude definitely that this premature calving was due to Bang's disease infection because of the sarcoma found when the animal was killed 38 days following calving. This animal showed a higher blood titre than any other animal on the experiment. This cow also had the highest colostrum milk titre of any animal on experiment. Guinea pig injections and cultural work have given negative results on four of the cows, but suspicious cultures have been saved for further study and typing from three of the animals. Previously it has been reported that there was little danger of *Brucella suis* being transmitted from swine to cattle by pasture contact. If the premature calving of the one cow was due to the *Brucella suis* organism, this statement should be modified.

Hogs that were dosed artificially with cultures of *Brucella suis* or that have been in contact with hogs so treated have shown very high agglutinating titres. This proves that the artificially dosed animals were shedding *Brucella suis* organisms, and that the cows on experiment also were exposed to infection.

**Low Agglutination Reactions in Unbred Gilts** (Cecil Elder). Four animals have been under investigation during the past year. Their blood titres have varied from negative to positive in the 1-50 dilution. Ten guinea pigs have been injected with colostrum milk and placental membrane emulsion. Only one animal on experiment has given suspicious cultures.

These low titre animals have continued to breed normally, have had normal gestation periods, and have failed to transmit infection to other negative gilts which have come in contact with them. At present there is no explanation for the continued low titres found in these animals.

**Toxemia in Sheep** (Cecil Elder). Studies on this project have been confined to tests to aid in the diagnosis of this disease. It has been found that curative treatment for this disease is of no value. If the diagnosis in the field could be made earlier, some treatment could be instituted. This should give more satisfactory results. It has been reported that one of the early diagnostic symptoms of toxemia is the appearance of acetone bodies in the urine. Some work has been done with tests for acetone and aceto-acetic acid. During the past year, eight ewes were placed on a narrow ration in an attempt to produce artificial cases of the disease. Six ewes were kept as controls and were allowed a good legume hay, along with what pasture they could pick up. Five of the eight narrow ration ewes have lambed normally. The other three failed to breed.

Using the acetone test, the results on the eight narrow ration ewes were quite variable. In all, 134 tests for acetone and aceto-acetic acid were made, 48 of which were positive, 82 negative, and 4 questionable. There appeared to be no direct relationship between the results of the tests and the date of lambing. The test did show some promise of being of value.

**Agglutination Blood Testing for Pullorum Disease in Fowls** (A. J. Durant, H. C. McDougle). During the fiscal period 45,851 tests were run. Of these 1,650 specimens of blood were from turkeys. The total number of reactors or infected fowls was 3,696 or 8.6 per cent positive. Of the 1,650 turkeys which were tested 64, or 3.87 per cent were found to be infected or reacted to the agglutination test in a dilution of 1 to 50.

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.

## SERVICE PROJECTS

**Answering Agricultural Questions:**—The greatest single service of the Agricultural Experiment Station to the farmers of Missouri is the answering of specific questions, by letters, by personal interviews, by bulletins, by the Farm News Service, and by radio. All questions are answered as promptly as possible.

Information regarding any agricultural practices used in Missouri may be secured by writing or personally calling at the College of Agriculture. The value of this service to the farmers of Missouri is inestimable. Often the amount of time and energy necessary on the part of the staff of the Experiment Station to render this service is overlooked. The answering of questions relating to Missouri agriculture is a primary duty of the Experiment Station. The success of the Station in rendering this service to the farmers of Missouri is evidenced by their confidence in the work of the Experiment Station.

**Chemical Service** (L. D. Haigh, E. W. Cowan, W. D. Stonecipher). The chemical laboratories of the Agricultural Experiment Station conduct analyses of various kinds of agricultural material used in connection with research problems. Also, some additional analyses are made for farmers and agricultural agents in connection with emergency problems arising in connection with rural life and farming operations. The correspondence on these matters amounted to 1,672 letters, of which 307 were to farmers and county agents.

The chemical work classified as to departments was as follows:

### Agricultural Chemistry

Vitamin supplements used in Nutrition Studies were analyzed as follows: 54 samples for dry matter, 90 samples for protein, 6 samples for ash, 1 sample for chlorine, 5 samples for calcium, 5 samples for phosphorus. Also, green barley feed was analyzed as follows: 40 samples for vitamin C, 12 samples for catalase, 213 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. One third of work completed; 200 Determinations.

### Buildings Department

Two samples of Calcite crystals used in boiler water treatment for determination of calcium, magnesium, and impurities; 6 Determinations.

### Dairy Department

Twenty samples of hays from Hatch Experiment Station for moisture, ash, protein, ether extract, crude fiber, calcium, and phosphorus; 140 Determinations.

### Field Crops Department

One hundred ninety-six samples of pasture grasses from field and greenhouse studies, in connection with the Cooperative Pasture Project, were analyzed for moisture, ash, protein, ether extract, crude fiber, calcium, and phosphorus; 1372 Determinations.

### Soils Department

Thirty-two samples of soils from experimental plots for nitrogen and dry matter; 64 Determinations.

### Miscellaneous Materials

One sample chick feed, one of buckhorn seed, one of corn silage, one of scorched wheat, two of field beans for complete feed analysis; 30 Determinations.

One sample each of cottonseed meal and linseed meal for protein, one sample of buttermilk for solids, one of new yellow corn for moisture, one sample of flour for moisture and protein; 6 Determinations.

Five Malt Flours for fat, fiber, and Lintner Value; 18 Determinations.

Eleven samples feeding molasses for Baume reading and sugar content; 12 Determinations.

Two animal stomachs, 2 feeds for examination for poison; 8 Determinations.

Four samples of water for qualitative examination of solids; 4 Determinations.

Two solutions used as worm remedies for sheep, one sample of plaster from Indian Mound, one mineral feed, one salt deposit around spring for qualitative study; 6 Determinations.

Grand Total 2,079 Determinations.

**Fertilizer Control** (F. B. Mumford, Director, L. D. Haigh, E. W. Cowan). The Department of Agricultural Chemistry is charged with the work of inspection, analysis of samples, and publication of results on this project. The results of work for the year ending June 30, 1937, are as follows:

Inspection	
Travel mileage in official cars .....	3537
Travel mileage by bus and train .....	1164
Number of towns visited .....	172
Number of calls made on dealers, farmers, manufacturers, and other handlers of fertilizers .....	385
Number of fertilizer samples collected .....	429

## Chemical Analyses

## Summary:

Total Nitrogen Determinations .....	304
Water Insoluble Nitrogen Determinations .....	294
Nitrogen Activity Determinations .....	82
Total Phosphoric Acid Determinations .....	419
Insoluble Phosphoric Acid Determinations .....	390
Potash Determinations .....	252
Basicity Determinations .....	93

Ten samples of commercial fertilizer sent in by purchasers and 8 samples of miscellaneous materials being used in an experimental way were tested for their fertilizer value. Also, 18 samples of specially prepared fertilizer materials were studied collaboratively for effectiveness as an A. O. A. C. Method in fertilizer analysis.

In addition to the above, 2473 samples of limestone, lime waste, and related materials were tested for farmers and county extension agents for their value in correcting soil acidity.

The results obtained as a result of inspection of fertilizer stocks and analyses of the samples obtained during the calendar year of 1936 are published in Bulletin 381. The summarized results show that seven per cent of all chemical determinations were deficient, which is one per cent less than last year. However, many samples showed substantial overruns in the amount of plant food content, so that an excess value of eight per cent over the guarantee is indicated as an average for all the samples tested.

The report lists the violation found for all stocks inspected. It also reports the names of all companies filing registration for 1937 with a list of the brands offered for sale. Statistics on the sales of fertilizer in the State for the year 1936 by grade classification, brands, and localities are given.

**Pregnancy Testing** (F. F. McKenzie, F. N. Andrews, V. Warbritton). During the year 103 mares have been tested for pregnancy. This involved 48 blood tests and 55 urine tests.

**Fertility Testing** (F. F. McKenzie, V. Berliner). During the year 16 stallions, 12 bulls, and 11 rams have been tested for fertility.

**Identification of Miscellaneous Plant Diseases** (C. M. Tucker). Due to the excessively dry conditions during the summer of 1936, there was little injury from parasitic fungi. Recently rooted *Chrysanthemums* in a greenhouse in Boone County were affected by a root and stem rot from which two species of *Pythium* were isolated. Cucumbers in a Jackson County greenhouse were affected in November by a shriveling and drying of young fruits starting at the blossom end, and by wilting of the leaves from the margins, often resulting in necrosis of considerable percentages of the leaf area. Isolations indicated that the symptoms were not associated with a pathogenic

organism. The trouble recurred at about the same time each year, and, apparently, was associated with environmental factors.

Squashes harvested while immature and placed in cold storage in Jackson County suffered much loss from a soft rot caused by *Rhizopus nigricans*. Barley showed considerable leaf spot, foot, and root rot in the fall of 1936, usually associated with the presence of *Helminthosporium sativum*. Sweet potatoes, often immature and small in size, harvested during rainy weather in southeast Missouri showed high percentages of loss in storage; the organism isolated in nearly every case was probably referable to *Fusarium oxysporium*.

Early blight (*Macrosporium solani*) appeared on the leaves of greenhouse tomatoes in Jackson County in April, 1937. Tomato wilt, *Fusarium lycopersici*, was very prevalent under the warm, dry conditions during the summer of 1936. Alfalfa fields were defoliated partially in southern Missouri, following a period of rainy weather in October. The causal organism was *Pyrenopeziza medicaginis*.

Narcissus, in a commercial planting in Jasper County, was slightly infected in April, 1937, by the leaf scorch fungus, *Stagonospora Curtisii*, the first report of this disease in the State.

**Official Testing of Dairy Cows** (H. A. Herman). During the course of the year 848 purebred cows were tested officially for milk and butterfat production. Twenty-two Missouri breeders carried on official testing during the year. A total of 500 one-day, and 235 two-day tests were conducted on 162 advanced Register and Register of Merit cows. In addition 5,867 one-day Herd Improvement Registry tests were made. Four retests and five surprise tests were made during the year. Four hundred and ninety-seven cows completed lactation records and 306 cows were started on test. At the beginning of the year, there were 544 cows on test and 629 at the close of the year. The most marked increase in testing was in the number of cows entered on the Herd Improvement Registry test.

The highest individual producer for the year was Farmington Pontiac Matador 1448973, a Holstein cow, owned by Mo. State Hospital #4, Farmington, Mo. She produced 21348.2 pounds of milk containing 764.4 pounds of butterfat in a 365 day lactation, starting test when 5 years and 9 months of age.

In the Jersey division I-Mo. Avanelle Lass I 992035, owned by the University of Missouri, Columbia, Mo., ranked first. She produced 9,632 pounds of milk containing 611.82 pounds of butterfat in 305 days. Her record was started when she was 4 years and 7 months of age. This cow also qualified for a gold medal under the requirements of the American Jersey Cattle Club.

In the Guernsey division, Sunnymede Knight Gloria 412848, owned by the Missouri Improvement Company, Bismarck, Missouri, start-

ing test age 3 years, 8 months, produced 11,518.8 pounds of milk, 613.1 pounds butterfat.

In the Herd Improvement Registry Division, the Holstein herd at State Hospital #4, Farmington, Missouri, ranked highest for the year. This herd, consisting of 35 cows, milked three times daily, averaged 12,905 pounds milk and 439.2 pounds butterfat per cow.

The highest ranking Jersey herd was owned by the University of Missouri, Columbia, Missouri. This herd, consisting of 16 cows, milked twice daily, average 6,949 pounds milk and 392.2 pounds butterfat.

**Identification of Insect Pests** (L. Haseman). During the year, hundreds of samples of insects, both harmful and beneficial, samples of corn injury, and samples of drinking water have been sent to the department for identification and with requests for information. These requests have been answered with bulletins when available, and, otherwise, with personal letters. During recent years, when insect outbreaks have been so serious, much time and effort has been required to answer all questions and to identify different insects.

**Seed Testing Laboratory** (Clara Fuhr). A total of 5,593 samples of seeds and plants was tested and examined by the Seed Testing Laboratory during the year ending June 30, 1937. Of these, 4,684 were tested for Missouri farmers and seedsmen, including 1,655 samples of seed corn. Approximately 155 samples were tested for the Soil Conservation Service, U. S. D. A., and 345 Custom House samples subject to the Federal Seed Importation Act.

Three hundred twenty-seven samples were tested for farmers and seedsmen of other states as follows:

Colorado .....	114	Nebraska .....	11
Iowa .....	91	Arkansas .....	6
Kansas .....	29	Texas .....	1
South Dakota .....	25	Massachusetts .....	1
Illinois .....	25	Alabama .....	1
Oklahoma .....	24		

Number of samples tested for:

Germination only .....	2663
Purity and germination .....	1581
Identification .....	620
Approximation and germination .....	528
Examination only .....	104
Examination and germination .....	42
Purity only .....	6

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5544

Custom House samples not subject to F.S.A., not tested .... 49

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5593

Total number of tests made .....

Number of samples received:

July 1, 1935 to June 30, 1936 .....	5631
July 1, 1936 to June 30, 1937 .....	5593

**Testing Soils for Their Lime Need** (W. A. Albrecht, L. D. Baver, F. H. Bruner). General appreciation of Soil deficiencies has brought increased numbers of soil samples for testing for lime need, organic matter, calcium, phosphorus, and potassium. The development of rapid soil tests throughout the country has necessitated the modification and calibration of available tests to Missouri conditions. On the basis of these studies, a standard extractant is used, and the following determinations have been standardized:

1. Common nutrients.
  - a. Available potassium—new technique which eliminates changes in density of precipitate.
  - b. Available phosphorus—Truog technique.
  - c. Available calcium—new turbidometric technique.
2. Other chemical tests.
  - a. Soluble manganese—use of new type of oxidizing agent.
  - b. Soluble aluminum—usual technique with influence of iron eliminated.
  - c. Soluble magnesium—improvement of usual method to give stable color test.
3. The Comber test is used to determine the acidity of the soil. The lime requirement is ascertained by comparing the Comber and available calcium tests.
4. Organic matter is determined by the usual rapid wet oxidation method.

The soils of Missouri are being classified as to their content in organic matter, readily soluble phosphorus, available potash, and calcium.

**Production and Distribution of Bacteria for Legumes** (W. A. Albrecht, T. M. McCalla). During the year ending June 30, 1937, sufficient cultures were distributed to treat 9,703 bushels of legume seed. The number of bushel units furnished for the different legumes was as follows:

Soybeans	4274
Sweetclover	1404
Alfalfa	1496
Korean lespedeza	1080
Red clover	1217
Miscellaneous	232

This project has been developed in connection with the project of the Agricultural Extension Service to increase the tonnage of legumes in the state. The station has encouraged the use of the soil transfer method of inoculating legumes and also has encouraged the use of standard commercial cultures.

The service rendered by this project is indicated by the following table summarizing the bushels of legume seed represented by the cultures shipped, and the number of individuals served annually from 1919 to 1937.

TABLE 6.—INOCULATION MATERIAL FURNISHED FARMERS, 1919-1937

Year ending June 30	Inoculation bushels seed	Individuals served
1919	2667	800
1920	2932	900
1921	5309	1665
1922	11161	2950
1923	20010	4145
1924	37595	7173
1925	36163	6970
1926	58441	9621
1927	41248	6096
1928	50517	6088
1929	41407	5331
1930	38679	4823
1931	31106	4204
1932	19848	2260
1933	8992	1326
1934	20143	1933
1935	14449	2013
1936	13439	1409
1937	9703	1573

**Distribution of Hog Cholera Serum** (O. S. Crisler). During the fiscal period the University Hog Cholera Serum Laboratory furnished to the swine raisers of Missouri directly or through veterinarians, county agents, or vocational teachers, 292,725 cubic centimeters of anti-hog-cholera serum distributed in 316 orders, going into 42 counties and St. Louis City.

Due to the fact that the Hog Cholera Serum Plant was closed officially and the production of anti-hog-cholera serum discontinued, only serum which was left over from the previous fiscal period was distributed during this period. The last serum was sold November 13, 1936.

**Agglutination Blood Testing for Bang's Abortion Disease of Cattle and Swine** (Cecil Elder). During this fiscal period a total of 444,799 blood samples have been tested for Bang's disease. Of these, 434,742 samples were tested in the laboratory in cooperation with the Bureau of Animal Industry. Of this number, 27,218 were found to be affected with Bang's disease, or 6.26 per cent reactors. The remaining 10,057 tests were samples tested by the State for farmers and veterinarians. Of this number, 534 were positive, or 5.30 per cent. This laboratory has continued in cooperation with the government for eradication of Bang's disease from the cattle herds of the State. Progress of the program has been very satisfactory.

**Distribution of Experimental Chicken-pox Vaccine** (A. J. Durant, H. C. McDougle). During the fiscal period 21,675 doses of chicken-pox vaccine were distributed to poultry owners in the State. The

experimental vaccine has continued to give excellent results in the control of chicken-pox. Most of this vaccine was distributed to farmers south of the Missouri River, the disease being much less prevalent north of the river.

**Diagnostic Service on Diseases of Animals and Poultry** (A. J. Durant, H. C. McDougale, A. W. Uren, O. S. Crisler, Cecil Elder). During the year, 2,861 specimens of diseased animals and poultry were examined. This did not include 226 cases examined for rabies which is reported separately.

**Rabies Diagnostic Service** (A. J. Durant, H. C. McDougale). Two hundred and twenty-six examinations were made for rabies during the fiscal period. Of the 226 examinations for rabies, 124 heads, or 54.86 per cent were found to be affected with rabies.

Dogs continued to be the most prevalent source of rabies, since they are 77.43 per cent of the total animals examined for rabies. Eight out of the 12 cats' heads examined were found to be affected with rabies. Rabies continued to be a serious disease in Missouri. Though a few less number of examinations was made, as compared to the last fiscal period, 54.86 per cent were positive, or an increase of more than 10 per cent.

## PUBLICATIONS

A. A. JEFFREY, *Editor*

During the year ending June 30, 1937, the Experiment Station issued 46 new publications and 5 reprints, with a total content of 1628 pages and in editions totalling 292,000 copies.

Distribution of Experiment Station publications during the same period reached a total of 246,348 copies, including 113,927 mailed to residents of Missouri, 52,000 handed to residents of the State at the mailing room, 60,610 mailed to individuals or institutions in other states, and 20,441 to other countries.

The publications issued during the year are listed as follows:

Research Bulletins			
No.	Series, Title, Author, and Number of Illustrations	Pages	Copies
242	Influence of Length of Day (Photoperiod) on Development of the Soybean Plant, var. Biloxi, by A. E. Murneek and E. T. Gomez, July, 1936; Figs. 11 .....	28	2,000
243	Relation of Phosphorus to Growth, Nodulation and Composition of Soybeans, by Theron B. Hutchings, August, 1936; Figs. 16 .....	46	2,000
244	Growth and Development XL. Comparison Between Efficiency of Horse, Man, and Motor, with Special Reference to Size and Monetary Economy, by Samuel Brody and Richard Cunningham, September, 1936; Figs. 17..	56	2,000

245	Growth and Development of Dairy Calves on a Milk Diet, by H. A. Herman, September, 1936; Figs. 37 . . . . .	102	2,000
246	The Utilization of Energy at Different Levels of Protein Intake, by S. R. Johnson, A. G. Hogan, and U. S. Ashworth, October, 1936; Figs. 6 . . . . .	62	2,000
247	The Normal Growth of Chickens Under Normal Conditions, by H. L. Kempster and Jesse E. Parker, November, 1936; Figs. 6 . . . . .	47	2,000
248	Cytogenetic Studies in <i>Triticum monococcum</i> L. and <i>T. aegilopoides</i> Bal., by Luther Smith, December, 1936; Figs. 32 . . . . .	39	2,000
249	Methods of Incorporating Organic Matter with the Soil in Relation to Nitrogen Accumulations, by W. A. Albrecht, December, 1936; Figs. 8 . . . . .	16	2,000
250	The Nitrate Nitrogen in the Soil as Influenced by the Crop and the Soil Treatments, by W. A. Albrecht, February, 1937; Figs. 20 . . . . .	27	2,000
251	The Cells of the Adrenal Cortex of the Ewe During the Estrual Cycle and Pregnancy, by Laura J. Nahm and Fred F. McKenzie, February, 1937; Figs. 13 . . . . .	20	2,000
252	Nitrogen and Carbohydrate Content of the Strawberry Plant. Seasonal Changes and the Effects of Fertilizers, by J. H. Long and A. E. Murneek, March, 1937; Figs. 27 . . . . .	52	2,000
253	Rural Women and the Works Progress Program. A Partial Analysis of Levels of Living, by E. L. Morgan, J. D. Ensminger, and M. W. Sneed, April, 1937; Figs. 9 . . . . .	29	2,000
254	The Utilization of Wabash Clay (Gumbo) Soils in Crop Production, by B. M. King, May, 1937; Figs. 13 . . . . .	42	2,000
255	A Study of the Relative Adaptation of Certain Varieties of Soybeans, by J. M. Poehlman, May, 1937; Figs. 6 . . . . .	43	2,000
256	Behavior of Legume Bacteria ( <i>Rhizobium</i> ) in Relation to Exchangeable Calcium and Hydrogen Ion Concentration of the Colloidal Fraction of the Soil, by Thomas M. McCalla, May, 1937; Figs. 14 . . . . .	44	2,000
257	The Pituitary Glands of Ewes in Various Phases of Reproduction, by Virgene Warbritton and Fred F. McKenzie, May, 1937; Figs. 28 . . . . .	59	2,000
258	Mosaic Disease of Tobacco. Action of Proteoclastic Enzymes on the Virus Fraction Nature of the Virus Fraction from Various Species of Plants, by A. Frank Ross and C. G. Vinson, May, 1937. . . . .	19	2,000
259	Hypophysectomy and Replacement Therapy in Relation to the Growth and Secretory Activity of the Mammary Gland, by E. T. Gomez and C. W. Turner, May, 1937; Figs. 17 . . . . .	72	2,000
260	A Method for Obtaining Arterial Blood from the Goat, by W. R. Graham, Jr., C. W. Turner, and E. T. Gomez, May, 1937; Figs. 11 . . . . .	15	2,000
261	Speed and Accuracy in Determination of Total Nitrogen, The Use of Selenium and Other Catalysts, by A. E. Murneek and P. H. Heinze, May, 1937. . . . .	8	2,000
262	Growth and Development XLI. Relation Between Live Weight and Chest Girth in Dairy Cattle of Unknown Age, by S. Brody, H. P. Davis, and A. C. Ragsdale, June, 1937; Figs. 8 . . . . .	24	2,000
263	Growth and Development XLII. Methane, Hydrogen, and Carbon Dioxide Production in the Digestive Tract of Ruminants in Relation to the Respiratory Exchange, by Lloyd E. Washburn and Samuel Brody, June, 1937; Figs. 9 . . . . .	40	2,000

## Bulletins

365	Factors Affecting the Composition of Milk, by C. W. Turner, July, 1936; Figs. 10 .....	31	15,000
366	Cropping Systems in Relation to Erosion Control, by M. F. Miller, July, 1936; Figs. 17 .....	36	12,000
367	Drilling Fine Limestone for Legumes, by W. A. Albrecht, August, 1936; Figs. 13 .....	20	10,000
368	Estimating Profitableness of Dairy Cows, by S. Brody and A. C. Ragsdale, September, 1936; Figs. 6 .....	16	10,000
369	Artificial Manure Production on the Farm, by W. A. Albrecht, September, 1936; Figs. 5 .....	12	10,000
370	Work of the Agricultural Experiment Station, by F. B. Mumford and S. B. Shirky, November, 1935; Figs. 1 ..	99	4,000
371	Fruit Varieties for Missouri, by T. J. Talbert, December, 1936; Figs. 1 .....	56	10,000
372	Coccidiosis in Chickens and Other Birds, by A. J. Durant, December, 1936; Figs. 4 .....	12	10,000
373	Controlling Borers of Fruit, Forest, and Shade Trees, by L. Haseman, December, 1936; Figs. 13 .....	24	10,000
374	Effect of Treatment on Fence Posts, by J. C. Wooley, January, 1937; Figs. 4 .....	12	8,000
375	Dairy Goats in Missouri, by C. W. Turner, A. C. Ragsdale, and E. R. Garrison, January, 1937; Figs. 11 .....	24	10,000
376	Rations for Weanling Pigs, by L. A. Weaver, January, 1937; Fig. 1 .....	8	10,000
377	Raising the Dairy Calf, by H. A. Herman, January, 1937; Figs. 10 .....	28	10,000
378	Acquiring Farm Ownership by Payments in Kind A Plan to Permit Tenants to Buy Farms Through Annual Product Payments by O. R. Johnson, January, 1937; Figs. 4 .....	12	10,000
379	Pollination and Fruit Setting, by A. E. Murneek, March, 1937; Figs. 18 .....	28	10,000
380	Missouri Peach Culture, by T. J. Talbert, March, 1937; Figs. 12 .....	30	10,000
381	Registration, Labeling and Inspection of Commercial Fertilizers, 1936, by F. B. Mumford, L. D. Haigh and E. W. Cowan, April, 1937 .....	44	5,000
382	Spray Residue Work in Missouri, by C. G. Vinson, April, 1937 .....	16	5,000
383	Efficiency of Horses, Men, and Motors, by S. Brody and E. A. Trowbridge, May, 1937; Figs. 7 .....	24	5,000
384	Factors Influencing Production of Clean Eggs, by E. M. Funk, June, 1937; Figs. 4 .....	12	10,000
385	The Farmer and the Cost of Local Rural Government in Missouri, by Conrad H. Hammar and Glen T. Barton, June, 1937; Figs. 22 .....	90	5,000
349	Soil Erosion in Missouri, by L. D. Baver, Reprinted April, 1937; Figs. 6 .....	64	10,000
Circulars			
192	The Hessian Fly and Its Control, by L. Haseman, September, 1936; Fig. 1 .....	4	10,000
193	An All-Year Pasture System for Missouri, by W. C. Etheridge, C. A. Helm, and E. Marion Brown, February, 1937; Figs. 3 .....	12	15,000
194	Good Varieties of Cotton for Missouri, by B. M. King, March, 1937; Fig. 1 .....	8	4,000
195	Garden Beans, by C. G. Vinson, May, 1937; Fig. 1 .....	11	7,000
182	Emergency Livestock Feeding, by Department of Animal Husbandry, Reprinted August, 1936; Fig. 1 .....	4	6,000
184	Cane Molasses (Blackstrap) as a Livestock Feed, by the Departments of Animal Husbandry, Dairy Husbandry, and Poultry Husbandry, Reprinted September, 1936 ..	4	3,000

166	Inferiority of Foreign Red Clover Seed, by B. M. King, Reprinted November, 1936; Fig 1 .....	4	1,000
185	Fertilizers for Vegetable Crops, by R. A. Schroeder and H. G. Swartwout, Reprinted March, 1937 .....	4	3,000

**The Farm News Service.**—Reports of investigations, news of new crops or improved methods developed by the Experiment Station, and timely subject matter bearing on current farm and home problems were issued weekly throughout the year in the official clipsheet of the College of Agriculture entered as second class matter at the Columbia Post Office under the title, "Missouri Farm News Service." This service was mailed to all Missouri newspapers and farm journals, county extension agents, home demonstration agents, teachers of vocational agriculture, soil conservation project manager, and rural rehabilitation supervisors.

**Special Press Service.**—Issued less regularly but having much faster clearance for publication, was the special press service for the larger daily newspapers of the state and for the leading news syndicates. This service handled the spot news stories announcing new discoveries, telling of the more important activities of the staff, and carrying information designed to meet special emergencies in farming or rural life.

**Radio Broadcasts.**—Throughout the year the College of Agriculture continued its daily broadcasts through the courtesy of radio station KFRU of Columbia, providing speaker for a ten-minute broadcast of timely information each morning, six days a week. Sharing this responsibility with their colleagues in the Extension Service throughout the year, members of the Station staff prepared and delivered 159 informational broadcasts varying from 1,200 to 1,500 words each.

### CONTRIBUTIONS TO SCIENTIFIC JOURNALS

- 474—Jones, Geo. D., Obtaining Cooperation of Growers in Studying Spray Schedules, *Journal of Economic Entomology*, July, 1936.
- 475—Jenny, Hans, Behavior of Polyvalent Cations in Base Exchange, *Soil Science*, July, 1936.
- 476—Haseman, Leonard, What Is Happening to the Codling Moth, *Journal Economic Entomology*, July, 1936.
- 477—Hogan, A. G., and Johnson, S. R., Plant Extracts in the Nutrition of Guinea Pigs and Rabbits, *Proc. Soc. Exp. Biology and Medicine*, August, 1936.
- 478—McShan, W. H., and French, H. E., The Chemistry of the Lactogenic Hormone Extracts, *Journal of Biological Chemistry*, Sept., 1936.
- 479—Tompkins, C. M., and Tucker, C. M., *Phytophthora* rot of honey dew melon, *Journal Agricultural Research*, September, 1936.
- 480—Gomez, E. T., and Turner, C. W., The Effect of Lactogenic Hormone Injection on the Crop Gland of the Hypophysectomized Pigeon, *Proc. Soc. Exp. Biol. and Medicine*, 1936.
- 481—Reece, R. P., and Turner, C. W., Galactin Content of the Rat Pituitary, *Proc. Soc. Exp. Biol. and Medicine*, September, 1936.

- 482—Albrecht, Wm. A., and McCalla, T. A., Longevity of Legume Bacteria (Rhizobium) in Water, *Soil Science*, September, 1936.
- 483—Gomez, E. T., and Turner, C. W., Initiation and Maintenance of Lactation in Hypophysectomized Guinea Pigs, *Proc. Soc. Exp. Biology and Medicine*, November, 1936.
- 484—Hill, R. T., Gardner, W. U., Gomez, E. T., and Turner, C. W., Oestrogenic Treatment of Hypophysectomized Male Mice, *Proc. Soc. Exp. Biology and Medicine*, November, 1936.
- 485—Reece, R. P., and Turner, C. W., Influence of Suckling Upon the Galactin Content of the Rat Pituitary, *Soc. of Exp. Biology and Medicine*, November, 1936.
- 486—Baver, L. D., Soil Characteristics Influencing the Movement and Balance of Soil Moisture, *Proceedings of Soil Science Society of America*, December, 1936.
- 487—Marshall, C. E., Soil Science and Mineralogy, *Proc. of Soil Science Society of America*, December, 1936.
- 488—Smith, Geo. E., Nitrogen Content and Growth Response from Fall and Spring Fertilization of Apple Trees, *Proc. of American Soc. of Horticultural Science*, December, 1936.
- 489—Murneek, A. E., A Separation of Certain Types of Response of Plants to Photo-period, *Proc. of American Society of Hort. Science*, December, 1936.
- 490—Durant, A. J., Ovarian Cystic Tumor in a Parrakeet, *Veterinary Science*, December, 1936.
- 491—McKenzie, F. F., Miller, J. C., and Baugess, Lyle C., Boar Semen Studies, *Proc. American Society of Animal Production*, December, 1936.
- 492—Bergman, A. J., and Turner, C. W., Comparison of Methods of Extraction of the Lactogenic Hormone, *Journal Biological Chemistry*, December, 1936.
- 493—Reece, R. P., and Turner, C. W., The Effect of the Stimulus of Suckling Upon the Galactin Content of the Rat Pituitary, *Proc. Soc. Experimental Biology and Medicine*, December, 1936.
- 494—Jones, George, Further Work in the Instruction of Entomology in 4-H Club Camps in Missouri, *Journal of Economic Entomology*, 1936.
- 495—Brody, Samuel, Relativity of Physiologic Time and Weight, *Journal of Growth*, December, 1936.
- 496—Winterkorn, H. F., The Application of a Base Exchange and Soil Physics to Problems of Highway Construction, *Proc. of Soil Science Society of America*, December, 1936.
- 497—Turner, C. W., and Gomez, E. T., The Adrenotropic Principle of the Pituitary in Relation to Lactation, *Soc. of Exp. Biology and Medicine*, February, 1937.
- 498—Gomez, E. T., and Turner, C. W., Effect of Thyroxine and Galactin on Lactation in Hypophysectomized Guinea Pigs, *Soc. of Experimental Biology and Medicine*, February, 1937.
- 499—Durant, A. J., Infectious Entero-Hepatitis, *Journal of American Veterinary Medical Association*, February, 1937.
- 500—Doolas, Geo. Z., Zonal Distribution of Nitrates in the Soil and Its Effect on Nodulation of Soybeans (1), *Soil Science*, February, 1937.
- 501—Wells, L. J., and Gomez, E. T., Some Effects of Crystalline Androgenic Materials on Spermatogenesis in Normal Hypophysectomized Male Ground Squirrel, *Proc. of the Amer. Assoc. of Anatomists*, February, 1937.
- 502—Garrison, E. R., The Clarification of Milk with Acid Mercuric Nitrate and Phosphotungstic Acid Preceding the Optical Determination of Lactose, *Journal of the Assoc. of Official Agricultural Chemists*, March, 1937.
- 503—Gomez, E. T., Turner, C. W., Reece, R. P., The Growth of the Mammary Gland of the Hypophysectomized Guinea Pig, *Proceedings, Society of Experimental Biology and Medicine*, March, 1937.
- 504—Reece, R. P., and Turner, C. W., Experimentally Altering Galactin Content of the Rat Pituitary, *Proc. Society of Experimental Biology and Medicine*, March, 1937.

- 505—Warbritton, Virgene, The Use of Pyridine-Formalin in Zenker-Formol Fixatives, *Journal of Stained Technology*, March, 1937.
- 506—Murneek, A. E., Recent Advances in Physiology of Reproduction of Plants, "Science", April, 1937.
- 507—Tucker, C. M., and Tompkins, C. M., Foot Rot of China Aster, Annual Stock, and Transvaal daisy caused by *Phytophthora cryptogea*, *Journal of Agricultural Research*, April, 1937.
- 508—Hammam, Conrad H., Expenditures of Local Governments in Missouri, *Journal of Land Economics*, May, 1937.
- 509—Reid, Wm. H. E., and Arbuckle, W. S., Some Factors Affecting the Serving and Dipping Qualities of Ice Cream, *Journal Dairy Science*, May, 1937.
- 510—Washburn, L. E., Fermentation Energy Losses in Dairy Cattle, *Journal Dairy Science*, May, 1937.
- 511—Gomez, E. T., and Turner, C. W., The Adrenal Cortical Hormone in Relation to Lactation, *Journal of Dairy Science*, May, 1937.
- 512—Reece, R. P., and Turner, C. W., The Role of the Nervous System in the Hormonal Control of Lactation, *Journal of Dairy Science*, May, 1937.
- 513—Turner, C. W., The Relation of the Endocrine Glands to the Inheritance of Milk Secretion, *Journal of Dairy Science*, May, 1937.
- 514—Herman, H. A., Graham, W. R., and Turner, C. W., The Effects of Thyroxine on Milk and Fat Production, *Journal of Dairy Science*, May, 1937.
- 515—Brody, S., Davis, H. P., and Ragsdale, A. C., Estimating Live Weight from Chest Girth of Dairy Cattle of Unknown Age, *Journal of Dairy Science*, May, 1937.
- 516—Graham, W. R., On the Carbohydrate and Nitrogen Metabolism of the Mammary Gland, *Journal of Dairy Science*, May, 1937.
- 517—Bergman, A. J., and Turner, C. W., The Composition of Rabbit Milk Stimulated by the Lactogenic Hormone, *Journal Biological Chemistry*, May, 1937.
- 518—Albrecht, Wm. A., and McCalla, T. M., New Culture Medium for Rhizobia, *Journal of Bacteriology*, May, 1937.
- 519—Funk, E. M., The Size and Shape of Turkey Eggs, *Poultry Science*, May, 1937.
- 520—Graham, W. R., Houchin, O. B., and Turner, C. W., The Production of Urea in the Mammary Gland, *Journal of Biological Chemistry*, May, 1937.
- 521—Wells, L. J., and Gomez, E. T., Hypophysectomy and Its Effect on Male Reproductive Organs in Wild Mammal with Annual Rut (*Citellus*) *Anatomical Record*, May, 1937.
- 522—Meyer, H. E., Physico-chemical reactions between organic and inorganic soil colloids as related to aggregate formation, *Soil Science*, June, 1937.
- 523—Graham, W. R., The Utilization of Lactic Acid by the Lactating Mammary Gland, *Journal of Biological Chemistry*, June, 1937.

### COOPERATIVE PROJECTS, RESEARCH GRANTS AND FELLOWSHIPS

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

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

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

Factors Influencing Quality and Palatability of Meat.

Methods of Beef Cattle Production.

Feeding Beef Calves Previous to Weaning—Fattening for Market.

Physiology of Reproduction of Farm Animals.

A Study of Beefiness and Milk Production in Dual Purpose Cattle.

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

Cooperative Investigations on Parasites of the Oriental Fruit Moth.

Seed Testing and Enforcement of the Federal Seed Act.

Cereal Improvement with Special Emphasis on Corn.

Fruit Disease Investigations in the Ozarks.

Agronomic, Physiologic, and Genetic Research with Soybeans.

Improvement of Pastures in the Corn Belt.

Physiology, Edaphology, and Breeding of Pasture Plants.

Laws and Principles Underlying the Industrial Utilization of the Soybean and Soybean Production.

Diseases of Orchard Fruit.

Soil Erosion and its Control.

#### **American Medical Association**

For further development of the investigation on certain pituitary hormones.

#### **National Research Council**

For purchase of animals and food for use in connection with the investigations upon the lactogenic hormone.

#### **Mr. E. Paramalee Prentice**

For a study of relation of pituitary hormones to lactation.

#### **Elizabeth Blee Frasch Foundation**

For the purpose of publishing a volume covering the results of the investigation under the Frasch Fund research project.

#### **Missouri State Highway Commission**

Conducting research in soils relating to the stabilization of roadbeds and supplementary highways.

#### **NEW EQUIPMENT**

Alpine ultraviolet burner; Combustion apparatus; 2 Thermocouples; Duboseq colorimeter; Magnetic damper for balance; Curd test instrument; Complete cardiometer set-up; 4 Brass drums;

3 Microscopes; 7 Manometers; Recording hygrometer; Recording hydrograph; Recording thermograph; Crystal quartz monochromator of special design; A green house for growing plants at controlled temperatures; Daylight germinator; Angle centrifuge; Constant temperature bath; Chemicals; Instruments; Glassware; 10 Centrifuge tubes; Head lamp; Meat saw; Microtome knife; 20 Electrodes; Electric refrigerator; Dairy scales; Quinhydrone pH indicator; Balance; Quinhydrody and platinum electrode; Recording fountain pens; Thermometers; 2 Thyatron tubes; Micrometer eyepiece; 2 Microscope lamps; Milk cooling cabinet; Mercury relay; Rectron; 3 Motors; 2 Heaters; Rheostat; Wet test meter; 15 Assimilation chambers; Kelvinator; Electric clock; Water bath; Hot air sterilizer; Car (exchange); Typewriter; 24 Bulletin filing cases; Record file; 2 Electric fans; Book case; Repairs to barns, sheds, and fences; Planter; Live-stock; Calf muzzles; Milk goat research shed; Oil heating stove; Gasoline pump and tank; 3 Milk scales; Bellows duster; Sprayer; Fertilizer distributor and drill seeder; Oaks battery brooder.

### CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1937

#### Appointments

Frederick N. Andrews, Research Assistant in Animal Husbandry  
 W. S. Arbuckle, Research Assistant in Dairy Husbandry  
 Guy Weston Bohn, Research Assistant in Botany  
 Margaret Brainard, Assistant Professor of Home Economics  
 Frank H. Bruner, Assistant in Soils  
 Marjorie A. Chollett, Research Assistant in Home Economics  
 Spencer G. Dakan, Assistant in Animal Husbandry  
 Paul Erbe, Research Assistant in Horticulture  
 Ruth Foster, Research Assistant in Home Economics  
 Elmer Gahley, Research Assistant in Animal Husbandry  
 W. R. Graham, Jr., Research Assistant Professor of Dairy Husbandry  
 R. E. Guerrant, Research Assistant in Agricultural Chemistry  
 Clarence S. Harris, Research Assistant in Entomology  
 Aubrey D. Hibbard, Research Assistant in Horticulture  
 Wilho Junilla, Research Assistant in Agricultural Engineering  
 Marion Dorothy Keller, Research Assistant in Home Economics  
 Homer J. L'Hote, Research Assistant in Agricultural Economics  
 Jesse E. Livingston, Research Assistant in Botany  
 C. E. Marshall, Visiting Associate Professor of Soils  
 Dennis T. Mayer, Instructor in Agricultural Chemistry  
 Raymond G. McCarty, Assistant Instructor in Dairy Husbandry  
 Mary Helen McLachlan, Research Assistant in Home Economics

Xzin McNeal, Research Assistant in Agricultural Engineering  
J. H. Neal, Research Assistant in Soils  
Ruth Norton Nisbet, Assistant in Agricultural Chemistry  
Joseph G. O'Mara, Research Associate in Field Crops  
J. Boyd Page, Research Assistant in Soils  
Ernest M. Parrott, Assistant in Agricultural Chemistry  
Edward Schiffman, Research Assistant in Agricultural Economics  
Ernest R. Sears, Research Associate in Field Crops  
Seth T. Shaw, Research Scholar in Horticulture  
George E. Smith, Instructor in Soils  
Luther Smith, Research Associate in Field Crops  
Elsworth Springer, Assistant in Soils  
F. Lyle Wynd, Research Assistant in Horticulture

#### Resignations and Withdrawals

Lyle C. Bauguess, Instructor in Agricultural Chemistry  
Frank H. Bruner, Assistant in Soils  
Marjorie A. Chollett, Research Assistant in Home Economics  
R. C. Cunningham, Research Assistant in Dairy Husbandry  
Paul N. Doll, Research Assistant in Agricultural Engineering  
Inez Eckblad, Research Assistant in Home Economics  
Paul E. Erbe, Research Assistant in Horticulture  
John R. Jackson, Research Assistant in Horticulture  
Hans Jenny, Assistant Professor of Soils  
S. R. Johnson, Instructor in Agricultural Chemistry  
Charles E. Murphey, Research Assistant in Animal Husbandry  
K. G. Parman, Research Assistant in Entomology  
Paul L. Piercy, Instructor in Veterinary Science  
Elsworth Springer, Research Assistant in Agricultural Economics  
George E. Smith, American Cyanamid Industrial Fellow  
Andrew W. Uren, Assistant Professor of Veterinary Science  
Charles S. Williams, Assistant in Animal Husbandry

**FINANCIAL STATEMENT****UNIVERSITY OF MISSOURI  
AGRICULTURAL EXPERIMENT STATION**

in account with

**THE UNITED STATES APPROPRIATION, 1937**

	Hatch Fund	Adams Fund	Purnell Fund	Bankhead- Jones Fund
Dr.				
To balance from 1935-36 ....	\$.....	\$.....	\$.....	\$.....
Receipts from the Treasury of the United States, as per appropriations for fiscal year ended June 30, 1937...	15,000.00	15,000.00	60,000.00	38,483.90
Total .....	15,000.00	15,000.00	60,000.00	38,483.90
Cr.				
Personal services .....	10,005.90	8,324.35	35,453.81	20,444.85
Supplies and materials.....	2,557.68	5,335.94	12,247.77	6,385.42
Communication service.....	133.02	24.57	143.93	177.10
Travel expenses .....	239.30	44.38	1,324.22	2,596.66
Transportation of things ....	71.32	60.79	474.43	397.91
Printing and illustrating pub- lications .....	1,304.45	.....	2,638.09	801.12
Heat, light, water, and power	22.87	12.50	267.18	972.86
Contingent expenses.....	.....	11.98	153.96	1,029.01
Equipment .....	659.96	1,075.38	7,183.50	3,401.62
Building and land .....	5.50	110.11	108.11	2,277.35
Balance .....	.....	.....	.....	.....
Total .....	15,000.00	15,000.00	60,000.00	38,483.90