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Experiment Station Research

The Report of the Director for
the Year Ending June 30, 1931

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APRIL, 1932

Agricultural Experiment Station

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Experiment Station Research

Work of the Missouri Agricultural Experiment Station
During the Year Ending June 30, 1931

F. B. MUMFORD, *Director*

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

The present report of the Director of the Agricultural Experiment Station is very much condensed. Reports of progress on minor projects have been eliminated and the reports of work accomplished on all projects have been abridged.

It will be apparent from the reading of this report that the investigators in this Experiment Station have been unusually active in prosecuting the investigations described in this publication. Significant results are reported which have extended our knowledge in a number of important fields.

It is more and more apparent that many of the problems of agriculture require for their solution researches in the fundamental sciences. The Missouri Agricultural Experiment Station has been devoting a substantial proportion of the funds available to fundamental research. It has, however, not neglected the immediate problems of farmers which are of economic importance.

The changing conditions in agriculture have imposed upon the farmer the necessity for changing his methods and modifying his operations in such a manner as to meet these new conditions. In this process the Agricultural Experiment Station is fortunately able to render immediate and valuable assistance.

The Station continues to receive some supplementary aid from grants and donations, notably the Frascch Foundation, and aid through cooperation with the United States Department of Agriculture.

The final measure of completed work in the Experiment Station is to be found in the publications of the Station. These publications of results of accomplishments are an enduring record. The publications of the past year give eloquent testimony to the real accomplishments in this Division.

The present financial situation will necessarily result in a considerable curtailment of work of the Experiment Station. It is, however, our determination that the quality of our work shall not suffer. Our first efforts to meet the budgetary requirements shall be in the direction of reducing the number of projects undertaken in order that there shall be no decrease in the quality of the work in any department.

Experiments in Progress During the Year Ending June 30, 1931

AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

Vitamin Supplements in Chick Nutrition (A. G. Hogan, R. V. Boucher). The conventional synthetic diet containing yeast as a source of the water-soluble vitamins was inadequate for the chick. Therefore, it was necessary to secure a concentrate that would complete the supplementary rations. Several preparations were tried. Some were promising; none was satisfactory. They included tiki tiki (dilute alcohol extract of rice polishings), the liver extract used in treating pernicious anemia (1376), the liver fraction precipitated by alcohol in the preparation of the liver extract just mentioned (1377), the ether extract of egg yolk, and tomato juice. The anode and cathode fractions of the water extract of yeast were used. Although they yielded encouraging results in some cases, on the whole they were unsatisfactory. Yeast was subjected to various procedures in an effort to obtain the factor it contained in more concentrated form. These included autoclaving, hydrolysis by acid and by alkali, and autolysis. Autolysis did not reduce the nutritional value of yeast, and the other preparations were affected much less than was expected. Four chicks received 10 per cent yeast plus 9.5 per cent of yeast hydrolyzed with 0.5 N sulphuric acid (equivalent to 30 parts yeast). At six weeks the weight of the four chicks ranged from 377 to 684 grams. There was one case of polyneuritis, but it recovered. Yeast, hydrolyzed with barium hydroxide, was less potent. In one case autoclaved yeast gave practically the same results as the untreated material. No one concentrate examined contained all the essential factors. A combination of them all in one ration proved satisfactory.

One of the successful rations was as follows:

casein.....	35 parts	cod liver oil.....	2 parts
corn starch.....	35 parts	acid hydrolyzed yeast...	5 parts
lard.....	3 parts	ether extract egg yolk ..	10 parts
cellulose.....	3 parts	liver extract 1376.....	1 part
salts.....	4 parts	liver extract 1377.....	1 part
	tiki tiki.....		1 part

Three males and three females received this diet and the average weight of each sex at the end of six weeks was the same, 350 grams.

Sources of Vitamin B (A. G. Hogan, L. R. Richardson). Studies on the Vitamin B complex are handicapped by the difficulty of obtaining sources of supply. Yeast is probably the best single source of the entire

complex. It would be desirable to obtain it in more concentrated form. The Osborne-Wakeman concentrate has given good results but many workers are unable to obtain preparations that are of uniform potency. An alcohol extract of rice polishings (tiki tiki) has been used successfully for some purposes. The various fractions of a water extract of liver have been examined.

Four different liver extracts were used with varying degrees of success. Mixtures of tiki tiki and liver extracts proved more useful. A total weight of 60 mg. of this mixture sustained the same rate of growth as 100 mg. of dried yeast.

Previously it was found that one factor of the Vitamin B complex was destroyed by ultraviolet rays. Several workers said this statement could not be confirmed. An attempt was made to repeat this work but was unsuccessful. However, in the meantime, four separate laboratories confirmed the original statement. The discrepancies must be due to some uncontrolled factor.

The Action of Radioactive Substances on Vitamins (A. G. Hogan, W. S. Ritchie). After exposure to mesothorium for ten days butter was completely bleached and was inactive as a source of Vitamin A. When cod liver oil, under similar conditions was treated in this manner, it was still active in doses of five mg. daily. Apparently some change was initiated, however, for five to eight days later five mg. daily of the treated cod liver oil had no curative effect on rats suffering from xerophthalmia.

Nutritional Properties of Meat (A. G. Hogan, W. S. Ritchie). Muscle meat used as the sole source of protein in the rations of rats has been adequate for growth but not for a complete reproductive cycle, due to high mortality of the young during the suckling stage. Experimental rations have been fed containing the muscle meat and in addition, starch, lard, cellulose, salts, yeast, cod liver oil, and wheat germ oil.

TABLE 1.—SUMMARY OF LITTER RECORDS OF RATS ON A MEAT PROTEIN DIET

No. of Females	No. of Litters	No. of Young Born	No. of Young Born Alive	No. of Young Weaned 4 Weeks	Mortality of Young Born Alive Per Cent
<i>First generation</i>					
17-----	20	175	165	121	26.7
<i>Second generation</i>					
17-----	32	306	295	254	13.9
<i>Third generation</i>					
5-----	5	44	42	42	0.0

Muscle meat was entirely adequate as a source of protein during the complete life cycle. The mortality of the young on the rations used was the same as on any adequate ration.

The Nutritional Requirements of Rabbits (A. G. Hogan, W. S. Ritchie). Rabbits did not survive longer than six to eight weeks on a simplified ration of the type used in studies of rat nutrition. When supplemented with carrot extracts the simplified diets were vastly improved, but did not sustain life until the animals were mature. Various other natural foodstuffs were then combined with the simplified diet, in the hope of finding one that sustained rapid and continuous growth and offered promise of being easily fractionated. Canned tomatoes, whole milk, whole milk powder, wheat germ, and alfalfa leaf meal made the simplified diets adequate.

Chemical Service (L. D. Haigh, E. W. Cowan, W. S. Ritchie, A. R. Hall, L. V. Taylor). Analyses and chemical tests of material for other departments of the Agricultural Experiment Station or for individuals throughout the State have been made to the number of 3449.

AGRICULTURAL ECONOMICS

O. R. JOHNSON, *Chairman*

Land Tenure in Missouri (O. R. Johnson, B. H. Frame). A comparison of owners and tenants on two areas, in Nodaway and Linn counties, has shown that the labor incomes of tenants and owners were practically the same. In previous years tenants could make larger incomes than owners. That is, interest on investment was no longer a handicap to the farm owner. A study was made to show the equitable-ness of rent rates. The land charge for the period 1925 to 1929 for corn was 40 per cent of the cost of the crop, for wheat 42 per cent, for oats 35 per cent, for alfalfa 35 per cent, mixed hay 52 per cent, soybean hay 32 per cent, soybean seed 27 per cent, and for sheaf oats 42 per cent.

Relation of Farm Improvements to Earnings and Value of Farm Lands (O. R. Johnson, J. C. Wooley, B. H. Frame). One hundred ten farms were surveyed in Linn county and records made.

Seasonal Hog Marketing (F. L. Thomsen). Individual car lot shipments of hogs from stations in Missouri have been furnished by the railroads. Tabulations of these shipments have been made by counties and types of farming districts. In order to allow for the truck movement of hogs data have been obtained from the central markets covering county shipments.

Farm Organization and Operation as Related to the Corn Borer in Northwest Missouri (E. E. McLean). In order to determine an effective means of controlling the European corn borer the utilization and disposition of the entire corn crop has been studied. A survey has been made in Atchison county in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture

to determine the systems of farm organization and management now in use. Seventy-eight farms were surveyed. Table 2 shows the financial statement for the average for the year 1930.

TABLE 2.—FINANCIAL STATEMENT OF FARM BUSINESS FOR THE YEAR 1930, ATCHISON COUNTY (78 FARMS)

(Average Size of Farms 237 Acres)

Investment in:	
Real Estate.....	\$22,729
Livestock.....	2,924
Equipment.....	1,270
Feed and Supplies.....	2,156
<i>Total Investment</i>	29,079
Crop Receipts.....	\$ 647
Livestock receipts.....	3,540
Miscellaneous Receipts.....	46
Increase in Inventory.....	636
<i>Gross Income</i>	4,869
Current Farm Expense.....	3,091
Decrease in Inventory.....	715
<i>Farm Expense</i>	3,806
<i>Farm Income</i> (Gross income minus farm expense).....	1,063
Interest at 5% (less interest paid).....	994
<i>Labor Income*</i>	69
House Rent.....	214
Farm Products.....	359
<i>Real Labor Income*</i>	642

*Labor Income is the income return to proprietor for his labor and management.

Marketing Live Stock (F. L. Thomsen, W. R. Fankhanel). Data have been obtained from the stockyards companies and cooperative commission companies at the four live stock markets in Missouri and from several hundred live stock shipping associations and a number of small packing companies operating in the State. This material has been tabulated. Much of it was taken from the original entry records of the organization concerned and has involved a large amount of time. Most of the cooperative organizations have given excellent support to the project.

Types of Farming in Missouri (Conrad H. Hammar, W. J. Roth†). This project is in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture. Soil, topographic and climatic conditions vary widely over Missouri and therefore the types of farming in the State are complex. The initial division of the State into type of farming areas has been superseded by newer versions and delineations. The divisions have been made on the basis of data for the years 1925 to 1929. The census for 1930 has provided some of the farm data for townships.

†United States Department of Agriculture.

Farm Costs (O. R. Johnson, B. H. Frame). All of the costs on the farms cooperating with the Experiment Station in the keeping of cost records of producing the principal farm crops in Missouri have been summarized for the period 1920 to 1929 inclusive. The actual cost of producing crops is shown in Table 3 for the year indicated.

TABLE 3.—ACTUAL COST OF PRODUCING VARIOUS FARM CROPS ON FARM COST ACCOUNTING FARMS

Year	Alfalfa	Clover Hay	Corn	Mixed Hay	Oats	Wheat
	<i>Cost per Ton</i>	<i>Cost per Ton</i>	<i>Cost per Bu.</i>	<i>Cost per Ton</i>	<i>Cost per Bu.</i>	<i>Cost per Bu.</i>
1920	\$16.77	\$21.25	\$.84	\$12.07	\$.72	\$3.17
1921	13.81	22.40	.57	9.20	.73	1.86
1922	11.07	9.14	.57	11.76	.66	1.22
1923	10.97	19.48	.47	9.31	.62	1.08
1924	11.14	7.40	.74	10.40	.61	1.14
1925	8.90	7.44	.44	8.53	.45	1.16
1926	9.21	15.97	.62	11.19	.64	1.08
1927	11.63	11.12	.48	7.55	.77	1.35
1928	10.60	12.58	.51	8.16	.43	1.02
1929	16.18	10.03	.53	11.84	.73	1.38

Farm Real Estate Situation for Missouri for 1927-1930 (C. H. Hammar, R. P. Callaway). A manuscript has been prepared on the project for publication.

Missouri Farmers Tax Position (C. H. Hammar). The results on this project have been published in Missouri Agricultural Experiment Station Bulletin 291.

AGRICULTURAL ENGINEERING

J. C. WOOLEY, *Chairman*

The Design of Farm Buildings and Equipment (J. C. Wooley). A dairy barn was designed for the Hatch Farm. It has a capacity of 32 cows; gambrel roof with the Iowa truss supports; modified King system of ventilation with suction ventilators and automatic inlets. Two concrete stave silos were built at the end of the barn.

A calf barn was designed for the young stock in the dairy herd. The barn was 36 x 94 feet with gable roof, clapboard siding, and ceiling in the stable. Two electric exhaust fans were used for ventilation. Eight automatic inlets were provided for fresh air.

Terracing Machinery (J. C. Wooley). Three standard type terracing machines were tested to determine their efficiency. These machines were of the blade grader type. It was necessary to establish a work

unit to be used as a measure of the work done. One cubic foot of earth moved one foot was taken as a work unit. If the earth was lifted the rating in work units was decreased.

A conveyor type machine has been designed and several models made. The grader type machines slide or roll the earth to one side, due to the angle of the blade. The small machines that can be operated with a general purpose tractor move the earth from 2 to 4 feet. To secure a terrace trough 8 to 10 feet wide and a resulting ridge with a 16-foot base requires the movement of the earth through a considerable distance. In the conveyor type a canvas belt conveyor, operated from the power take-off of the tractor, received the earth from the rear plow of a two-bottom, 14-inch tractor gang plow and carried it over $9\frac{1}{2}$ feet. This machine accomplished the work much more rapidly and required but one man for operation.

Silo Filling Methods and Cost (M. M. Jones, D. D. Smith). Cost records on filling 325 silos were obtained and analyzed. The results were published in Missouri Agricultural Experiment Station Bulletin No. 303.

Grain Harvesting Studies (M. M. Jones, D. D. Smith). The use of combine harvesters was practical and satisfactory where more than 80 to 100 acres of grain were harvested. In order to determine how long wheat could be left in the field before being harvested with a combine, a small plot of Michigan Wonder wheat was left standing for five weeks after binder cutting time. At the end of this time the grain was still standing in good condition.

Grain Drying (M. M. Jones, D. D. Smith). Laboratory tests have been made to determine the effect of blowing or drawing air through damp grain, the resistance of wheat containing a certain amount of moisture to the passage of air through it, the feasibility of vacuum drying, and the optimum rate of air flow through wheat containing different amounts of moisture. Vacuum drying was almost impossible unless heat was applied to the grain being dried. When heat was applied drying was very rapid, but due to the slow transfer of heat through the wheat the grain next to the supply of heat was likely to scorch.

Tractor Costs (M. M. Jones, D. D. Smith). In cooperation with the United States Department of Agriculture and the Departments of Agricultural Economics and Animal Husbandry a farm power survey was made in which cost records were obtained on 99 tractors. There was almost no relation between repair costs and the number of hours a tractor was used. The average annual repair costs were $2\frac{1}{2}$ per cent of the first cost of the tractor. The cost per hour of work done decreased appreciably as the total number of hours use increased.

Relation of Silage Density to Depth (M. M. Jones, D. D. Smith). By weighing the silage removed between different levels in the silo the density of settled silage at different depths was determined. The weight per cubic foot of silage increased as a definite power (in this case .6) of the depth.

Rural Electrification in Missouri (R. R. Parks). In 1925 there were 3,800 rural customers for central station electricity in Missouri. At the present time there are 14,200. This represents an investment of four and a half million dollars in distribution system alone. Most extensions are now calculated on the basis of three customers to the mile. Many districts show as many as twelve to the mile.

Electric Brooding (R. R. Parks). Fifty-three days of electric brooding under a 42-inch round canopy type brooder from March 11, 1931, showed a total cost of \$63.25 for 171 chickens averaging 616 grams each. Of this total cost \$3.25 (109 kilowatt-hours) was for electricity, \$19.53 for feed, \$6.00 for labor, \$4.20 for litter, \$7.50 for housing, and \$22.75 for stock. The mortality for the 181 started (6 were "culls") was $5\frac{1}{2}$ per cent. The maximum temperature outside was 83 degrees Fahrenheit, the minimum was 25 degrees. The average daily maximum was 58 degrees, the average daily minimum was 40 degrees. The average temperature for the period was 49 degrees.

Coal and oil were compared with electricity as a source of heat for brooding. The second four-week period in the growth of the chicks was selected for this comparison. One form of heat seemed to give about the same results as the others. Possibly the feathering in the electrically heated houses came sooner because heat was furnished only to the hover. There was very little difference in the cost of heating, except in the case of an oil burner which was difficult to regulate and, as a result, wasted fuel.

The Durability of Fence Posts (J. C. Wooley). At the end of eighteen years, untreated posts of the following varieties were still serviceable: White Cedar, Osage Orange, Black Locust, and Catalpa. Table 4 shows the serviceable life of varieties that have failed to date.

TABLE 4.—SERVICEABLE LIFE OF VARIETIES OF UNTREATED FENCE POSTS

Sassafras 14 years	Slippery Elm 6 years	Cotton Wood 3 years
White Oak 12 years	Honey Locust 5 years	Hack Berry 3 years
White Walnut 11 years	White Elm 4 years	Sugar Maple 3 years
Redbud 10 years	Iron Wood 3 years	Black Oak 3 years
Black Walnut 9 years	Hickory 3 years	River Burch 3 years
Black Ash 7 years	Red Oak 3 years	Dogwood 3 years
Bass Wood 2 years	Willow 2 years	Sycamore 2 years

White Cedar posts given a five-hour, double tank treatment were solid, while the sap wood was more or less rotted on the others. Table 5

shows the effect of the five-hour double tank treatment with creosote on various varieties.

TABLE 5.—THE FIVE-HOUR DOUBLE TANK TREATMENT WITH CREOSOTE AND SOME OF THE VARIETIES ON WHICH IT WAS EFFECTIVE

Variety	Service, No Treatment	Service, Treated
Sassafras	14 years	*
White Oak	12 years	*
White Walnut	11 years	14 years
Redbud	10 years	14 years
Black Walnut	9 years	*
Black Ash	7 years	*
Red Oak	3 years	13 years
Honey Locust	5 years	*
Black Oak	3 years	12 years

*Some posts still serviceable at 18 years.

Farm Building Studies (J. C. Wooley, O. R. Johnson, B. H. Frame). Ninety-one Linn county farms were surveyed. Each building was measured and studied. Replacement or new cost was computed. Present worth was obtained by depreciating this replacement cost for the percentage of total service that had already been secured. Table 6 gives certain information regarding the cost and value of buildings on these farms.

TABLE 6.—AVERAGE REPLACEMENT COSTS OF BUILDINGS ON NINETY-ONE LINN COUNTY FARMS
(Average Size of Farms 220.6 Acres)

<i>1930 Replacement or New Cost</i>	
All buildings per farm.....	\$6,822.00
All buildings per acre.....	34.86
Service buildings per farm.....	3,351.00
Service buildings per animal unit.....	150.21
Service buildings per acre.....	16.19
Buildings for living per farm.....	3,474.00
<i>Worth in 1930</i>	
All buildings per farm.....	\$4,036.00
All buildings per acre.....	20.69
Service buildings per farm.....	1,784.00
Service buildings per animal unit.....	85.85
Service buildings per acre.....	9.19
Buildings for living per farm.....	2,819.00
<i>Annual Cost of Farm Buildings, Including Interest, Taxes, Insurance, Depreciation, and Repairs.</i>	
All buildings per farm.....	\$ 395.48
All buildings per acre.....	2.02
Service buildings per farm.....	205.41
Service buildings per animal unit.....	10.92
Service buildings per acre.....	1.01
Buildings for living per farm.....	189.83
Percentage of cost of production chargeable to service buildings.....	9.97

ANIMAL HUSBANDRYE. A. TROWBRIDGE, *Chairman*

The Effect of Sex Upon the Quality and Palatability of Beef (E. A. Trowbridge, H. C. Moffett, M. W. Hazen). This project is in cooperation with the Bureau of Animal Industry, United States Department of Agriculture and Sni-A-Bar Farms. Choice yearling heifers and steers were compared as to quality and palatability of beef yielded. The cattle used were high-grade Shorthorns, bred and fed at Sni-A-Bar Farms. Both lots had been fed eight parts shelled corn and one part cottonseed meal in a creep until weaning time. The same grain ration was continued 196 days in dry lot, with alfalfa hay and a small amount of corn silage as a roughage. When finished the cattle were shipped by rail to the United States Department of Agriculture Meat Laboratories at Beltsville.

The steers dressed 0.76 per cent higher than the heifers but graded slightly lower in the carcass.

Cooking data on the 9th, 10th, and 11th ribs showed little difference in aroma, texture, flavor, and quality and quantity of juices. The heifers were slightly more tender.

Self Feeding Native Fall Calves (E. A. Trowbridge, H. C. Moffett, M. W. Hazen). This project is in cooperation with Sni-A-Bar Farms. Twenty-one head of 65-day-old steer calves from high-grade Shorthorn cows and purebred Shorthorn bulls were put into a dry lot where they had access to grain and alfalfa hay in a creep. The grain ration for the first 112 days consisted of corn, two parts, and oats, one part; for the next 56 days corn, five parts, oats, two parts, linseed oil meal, one part (by weight).

The calves were turned with the cows twice daily to nurse. They were weaned after the 168-day feeding period, divided into two groups and placed in separate lots. One group was hand fed twice daily and the other group self fed. Both lots were fed a ration of corn, eight parts, and linseed oil meal, one part. During this phase of the experiment the hand fed group gained an average of 339 pounds in 168 days and consumed 33.16 bushels of corn, 244 pounds of linseed oil meal, 6.45 pounds of sugar, and 399.7 pounds of alfalfa hay.

The self fed group gained an average of 350 pounds on 36.84 bushels of corn, 257 pounds of linseed oil meal, 6.45 pounds of sugar, and 401.4 pounds of alfalfa hay. There was little difference in the results of the two methods of feeding.

Rations for Creep Feeding Spring Calves (E. A. Trowbridge, H. C. Moffett, M. W. Hazen). This project is in cooperation with Sni-A-Bar Farms and the United States Department of Agriculture. Three lots of steer calves ran with their dams on bluegrass pasture and were self

fed different grain rations in creeps until weaning time, when they were placed in separate dry lots and the same respective grain rations continued 196 days. This was the third year in which the following grain rations were compared: Shelled corn alone; eight parts shelled corn, and one part cotton seed cake; two parts shelled corn and one part oats. Alfalfa hay and corn and cane silage, were used as roughage.

The calves getting the rations containing cottonseed cake consumed more feed during the nursing period than the calves eating corn alone. The gains were similar and the values per hundred at weaning time the same. On account of the drought pasture was very short, and possibly the mothers of the calves getting cottonseed cake suffered more on account of lack of pasture acreage.

The addition of whole oats increased the feed consumption, but resulted in less gain per steer. These calves were not as fat as the others and were valued 50 cents per cwt. lower at weaning time.

During the dry lot period the addition of cottonseed cake increased the average daily gain, but did not increase the total feed consumption. Seventy-one pounds of cottonseed cake replaced 101 pounds of shelled corn in the production of 100 pounds of gain. The selling price of the cattle was also increased 50 cents per cwt. The average daily gain of the total feed consumption of the cattle fed a ration of one-third oats and two-thirds corn was about the same as where shelled corn made up the grain ration. The lot receiving oats was valued at 25 cents a hundred higher.

Fattening Steer and Heifer Calves (E. A. Trowbridge, H. C. Moffett, M. W. Hazen). This project is in cooperation with Sni-A-Bar Farms and the Bureau of Animal Industry, United States Department of Agriculture. Spring steer and heifer calves were creep fed a ration of eight parts shelled corn and one part cottonseed cake for 140 days while nursing. The heifers consumed approximately one-third more feed, but did not gain as much as steers of similar breeding, weight, and quality.

Fattening Yearling Steers on Bluegrass Pasture (E. A. Trowbridge, H. C. Moffett). Grade Hereford steers were used. One group had been wintered liberally and the other wintered on a relatively limited ration. Each lot was re-divided into three lots. One lot for each group was full fed on grass 168 days. One lot of each group was fed one-half of a full feed the first 56 days, then full fed 112 days. The third lot from each group was grazed 56 days, then full fed 112 days.

On account of the drought clover hay was fed. The cattle wintered liberally were fatter and larger than those wintered less liberally. The cattle wintered less liberally made an average gain of approximately 40 pounds more during the summer than the cattle wintered liberally.

The cattle wintered liberally were fat enough for slaughter yearlings any time after 60 days of full feeding on grass. The other group required approximately 60 days more to arrive at a similar condition.

Feeding Wheat to Cattle (E. A. Trowbridge, H. C. Moffett). Thirty-two yearling steers of good quality were divided into four lots and fed the following rations 100 days in dry lot.

- Lot I—Corn 10 parts, cottonseed cake 1 part
 - Lot II—Corn 5 parts, ground wheat 5 parts, cottonseed cake 1 part
 - Lot III—Ground wheat 10 parts, cottonseed cake 1 part
 - Lot IV—Whole wheat 10 parts, cottonseed cake 1 part
- All lots received alfalfa hay as roughage.

Ground wheat and shelled corn, equal parts, fed with protein supplement produced more rapid and economical gains than shelled corn with the same proportion of the same supplement. Cattle fed ground wheat with a protein supplement ate only two-thirds as much grain daily and gained less rapidly than the other lots. Some difficulty was experienced in getting them to eat. Coarsely ground wheat was substituted for the finely ground. This brought some improvement, but trouble was experienced throughout the trial in keeping these cattle on feed.

Cattle fed whole wheat with a protein supplement required approximately 25 per cent more grain per 100 pounds gain. Nearly three times as much pork was produced behind the cattle eating whole wheat. A combination of corn and ground wheat produced as desirable cattle as shelled corn. After 112 days the cattle fed ground wheat lacked finish and sold for less on the market.

Since the combination proved better, a trial was made combining wheat with other feeds. Thirty-two yearling steers of "medium" to "low good" quality were divided into four lots and fed the following rations 112 days in dry lot.

- Lot I—Corn 10 parts, cottonseed cake 1 part, clover hay
- Lot II—Ground wheat 20 parts, cottonseed cake 1 part, with clover hay
- Lot III—Ground wheat 9 parts, ground oats 3 parts, cottonseed cake 1 part, with clover hay
- Lot IV—Ground wheat 20 parts, cottonseed cake 1 part, corn silage and clover hay

Ground wheat and cottonseed cake produced less rapid but more economical gains than shelled corn and cottonseed cake. However, cattle fed shelled corn sold higher. The use of oats increased the rate of gain slightly but did not affect the economy of gain. Corn silage slightly increased the efficiency of the grain ration.

Processing Roughages for Winter Stock Calves (E. A. Trowbridge, H. C. Moffett). Shocked fodder, corn silage, corn stover ground with a

hammer mill, and corn stover cut with a silage cutter, have been compared. Whole alfalfa hay also has been compared with alfalfa hay ground with a hammer mill. Six lots of calves were fed the following rations:

- Lot I—Corn silage + whole alfalfa hay
 Lot II—Corn silage + ground alfalfa hay
 Lot III—Whole corn stover + broken ear corn* + whole alfalfa hay
 Lot IV—Ground corn stover + broken ear corn* + whole alfalfa hay
 Lot V—Cut corn stover + broken ear corn* + whole alfalfa hay
 Lot VI—Ground corn fodder + whole alfalfa hay

*The corn that grew on the stover was taken off and fed as broken ear corn to the same cattle that received the stover.

The calculated gain produced per acre of 40 bushel corn was as shown in Table 7.

TABLE 7.—CALCULATED GAIN PRODUCED PER ACRE
(40 Bushel Corn)

Lot	I	II	III	IV	V	VI
Gain produced by 1 A. corn(pounds)-----	909.	742.	585.	633.	567.	539.
Alfalfa hay fed with acre corn(pounds)-----	382.	386.	275.	272.	272.	275.

Ground Rough Rice for Fattening Yearling Cattle (E. A. Trowbridge, H. C. Moffett). A ration of seven parts ground rough rice and one part cottonseed cake was compared with a ration of ten parts shelled corn and one part cottonseed cake. Soybean hay was fed as roughage. The cattle receiving rough rice required 858 pounds of concentrate and 209 pounds of hay to produce each 100 pounds gain. The cattle receiving shelled corn required 700 pounds of concentrate and 157 pounds of hay for each 100 pounds gain. Both groups sold for the same amount a hundred pounds.

The Optimum Time to Breed Gilts (F. F. McKenzie). In past work it was established that the heat period in gilts was about 45 hours and in sows about 65 hours. In order to determine if one time in the period of heat or estrus was better than another in which to breed gilts to obtain large litters, each of thirteen Hampshire gilts was mated to two boars in the same estrus. The gilt was bred 12 hours after she came into estrus and again 24 hours later (the 36th hour) she was bred to another boar. Chester White and Duroc Jersey boars were used. In eight of the thirteen double matings all the pigs were sired by the boar used at the first service. In the remaining five matings two litters were sired by the boar used at the second service and three litters were mixed. Thus,

in five out of thirteen matings, breeding the gilts twice increased the size of the litter.

The Optimum Time to Breed Ewes (F. F. McKenzie). Eighty-four ewes were bred at one of three stages in estrus: (1) During the first 6 hours, (2) from 6 to 14 hours after estrus began, and (3) later than 14 hours after estrus began. When mated to rams of only fair fertility 70 per cent of the ewes, bred after the fourteenth hour of estrus, conceived. Only 35 per cent of the ewes bred before that hour conceived. When a highly fertile ram was used the percentages were 100 for the later breeding and 66 for those before the 14th hour. It therefore seems important to avoid breeding during the early hours of estrus. By means of a series of operations it was found that ovulation occurred some 22 to 30 hours after the onset of estrus.

Estrus in Sheep (F. F. McKenzie, R. W. Phillips). Observations were made on 97 ewes. They were purebred Shropshires, Southdowns, and Hampshires, and about equal numbers of yearlings, 2-year olds, 3-year olds, and 4-year olds and over. In addition, 25 ewe lambs were observed.

The average duration of estrus was 26.8 hours. Only three per cent were less than 9 hours or more than 48 hours. In the lambs the average was $19\frac{1}{2}$ hours. The periods of duration of estrus for Hampshire, Shropshire, and Southdown ewes were respectively, 30.7, 26.3, and 24.0 hours.

The Length of the Estrual Cycle in Sheep (F. F. McKenzie, R. W. Phillips). The length of the interval from the first of one estrus until the first of the next estrus was 14, 15, and 16 days in 92 of 116 periods observed. There were no significant differences due to age or breed.

Nutrition and the Breeding Season in Ewes (F. F. McKenzie, R. W. Phillips). All lambs were weaned by the first week in July. The fall rains began in mid-August and encouraged the growth of grass. Grain feeding started soon thereafter. By mid-September all Hampshires, all but one Southdown, and two-thirds of the Shropshire ewes had been in estrus. Some breeders contend that withholding feed and water from ewes from 24 to 36 hours, then restoring feed, will cause them to come into estrus. Two trials were made. When compared with the control lots no influence from withholding feed and water was apparent.

The Ovaries of the Ewe (F. F. McKenzie, R. W. Phillips, Edgar Allen, J. W. Kennedy, Wm. K. Beare). The mature follicle of the ewe reached 9 to 10 m.m. in diameter immediately preceding ovulation. Medium large follicles that do not mature, retrogress.

Ovulation tended to alternate between the two ovaries. However, in some ewes one ovary would ovulate for four and five consecutive

periods. When two ova were produced both came from the same ovary in some cases. In others, one from each ovary.

Biological tests made on sheep corpora lutea showed no estrus-producing hormone. Liquor folliculi gave positive results.

Two Causes of Infertility in the Ewe (F. F. McKenzie, R. W. Phillips). In three out of fifty cases, ewes ovulated without showing signs of estrus. In four other cases, estrus occurred but ovulation failed to take place. Thus, in 14 per cent of the cases studied the ewe was found to be physiologically infertile. This condition was not restricted to any one part of the breeding season.

The Tubal Ova of the Ewe (F. F. McKenzie, R. W. Phillips, Edgar Allen, J. W. Kennedy, Wm. K. Beare). Ewes were bred and the fertilized ova recovered from the fallopian tubes. Ovulation occurred 22 to 30 hours after estrus began. After ovulation, fertilization and segmentation followed in rapid succession in the fallopian tubes. The segmenting egg migrated to the uterine horn about the fourth day after the onset of heat.

The Period of Gestation in the Ewe (F. F. McKenzie, R. W. Phillips). Breeding dates and lambing dates were recorded. No dates were included where there was a possibility of the ewe being field bred.

TABLE 8.—LENGTH OF GESTATION IN SHEEP (DAYS)

Breed	No. of Ewes	Range	Average
Hampshire.....	19	140-147	144.6
Shropshire.....	18	141-147	144.6
Southdown.....	14	141-148	143.7

Fertility in the Ram (F. F. McKenzie, R. W. Phillips). Sixty-three semen samples obtained from fifteen rams have been studied and the observations included 300 spermatozoa from each sample. The mean head length of each sample was calculated and the average found to be 24.4 m.m. at 3,000 magnifications.

Some abnormalities were observed and tailless heads and coiled tails were found to some extent in all the samples. Tapering heads and enlarged middle-pieces were found in large numbers in poor breeding rams. Filiform middle-pieces were found only in one ram. It was a poor breeder. The proportion of abnormal sperm seemed to be exceptionally large, after the ram had had a long rest period (several weeks or longer).

When rams were in active service a maximum of 100 abnormal sperm per thousand were found in the semen from good rams, 247 in fair rams, and a minimum of 376 per thousand in poor breeders.

In two rams the scrotum was insulated, raising the temperature from 33.5 to 36 degrees Centigrade. A marked increase in the proportion

of abnormal sperm was observed in about a week. In 20 days there was almost a total absence of sperm in the semen. When the insulation was removed normal conditions gradually returned.

Color Inheritance in Swine (F. F. McKenzie). Chester White and Duroc Jersey boars were crossed with Hampshire sows. Duroc Jersey-Hampshire pigs were black, many with the white band. The Chester White-Hampshire pigs were mostly white, but without exception showed some black spotting. There have been brought together in this cross two factors ordinarily considered dominant. The hybrid was predominantly white. The area of the white belt was free from pigment, but spotting occurred over other parts of the body. The striping of the wild hog was also present.

Overcoming Breeding Difficulties in Boars by Hormone Treatment (F. F. McKenzie). A boar lacking in sex desire up to the age of 20 months was treated with the luteinizing hormone. He became an active breeder and the treatment was discontinued. After about a month he lapsed into his former state, lacking the mating desire.

Growth in Draft Colts (E. A. Trowbridge, D. W. Chittenden, Samuel Brody). Six Percheron colts, all sired by the same stallion and out of mares of similar breeding, were foaled in the spring of 1929. When weaned they were divided into two groups. Group one received a liberal allowance of grain and all the hay they would eat. Group two received half the amount of grain fed the first group and all the hay they would eat. The grain ration fed was a mixture of 300 pounds oats, 250 pounds corn, 50 pounds of wheat bran. During the winter alfalfa hay was fed in the morning and mixed clover and timothy hay in the evening. The colts were fed grain and hay morning and evening during the winter; grain once a day when on pasture. They were put on bluegrass pasture May 16 and continued until December 21, 1930, a total of 219 days.

On account of the drought the pasture was poor; consequently hay was fed once a day beginning October 17.

The liberally grain fed colts at the beginning of the period weighed 925 pounds and were 58½ inches in height at withers. At the close they averaged 1015 pounds in weight and 60½ inches in height at withers.

The limited grain fed colts at the beginning of the period averaged 887 pounds in weight and 58.2 inches in height at withers. At the close they averaged 976 pounds in weight and 59.8 in height at withers. The liberally fed group averaged 1302 pounds of grain, 273 pounds of alfalfa hay, and were on pasture 219 days.

The limited grain fed group averaged 651 pounds of grain, 343.5 pounds of alfalfa hay, and were on pasture for 219 days.

On December 21 the weather became bad and the colts were brought into the barn for the winter.

At the close of the winter period, May 9, 1931, 139 days later, the liberally grain fed group averaged 1209 pounds in weight and 62.8 inches in height at withers, consuming 1361 pounds of grain, 834 pounds of alfalfa hay, and 812 pounds of mixed hay. The limited grain fed colts at the end of this period averaged 1106 pounds in weight and were 61.7 inches in height at withers. Each consumed 680.5 pounds of grain, 966.5 pounds of alfalfa and 943.5 pounds of mixed hay.

The Adequacy of Commonly Used Concentrates for Swine Reproduction (A. G. Hogan, S. R. Johnson). Last year sows confined at the barn during lactation did not suckle their litters satisfactorily. Sows taken to a pasture at farrowing time reared healthy pigs, but the weaning weights were low.

Sixteen Hampshire gilts were divided into four groups. (1) received the same ration as was fed last year; (2) received the basal ration, but was taken to pasture 90 days before farrowing; (3) received the basal ration and carrots in addition; (4) received a ration supposed to be richer in vitamins. Table No. 9 shows the results.

TABLE 9.—SUMMARY OF FARROWING AND LITTER RECORDS (GROUP AVERAGES)

Lot No.	1	2	3	4
No. of pigs farrowed alive.....	7	8	8.75	8.75
No. of pigs farrowed dead.....	0.25	0.75	0.00	0.00
No. of pigs alive at 8 weeks.....	5	8	0.75	6.75
Wt. of pigs at 8 weeks (pounds)....	21.4	27.9	15.4	29.0

The addition of carrots to the basal rations was disastrous. The pigs raised on pasture were thrifty and superior to any of the others. Those reared on the ration high in vitamins were superior to any hitherto obtained in restricted quarters. It seems that commonly used concentrates lack some essential nutrient.

Rations for Weanling Pigs (L. A. Weaver). This experiment began July 24 and closed November 14, 112 days. Five lots of pigs were self fed shelled corn, (yellow or mixed) in dry lot. Two different mixtures of feeds were used to furnish the protein needed to balance the corn consumed. Supplement A consisted of equal parts of tankage, linseed oil meal, fish meal, liver meal, dried skim milk, and alfalfa meal. This mixture contained 40 to 45 per cent protein. Supplement B was made up of tankage, 3 parts; linseed oil meal, 1 part; and alfalfa meal, 1 part. It contained about the same percentage of protein as supplement A. The corn and the mixed supplement were fed in self feeders.

The different supplements were fed to the various lots as follows:

	Supplement A	Supplement B
Lot I.....	First 28 days.....	Last 74 days
Lot II.....	First 56 days.....	Last 56 days
Lot III.....	First 74 days.....	Last 28 days
Lot IV.....	Entire period (112 days).....	
Lot V.....	Entire period (112 days)	

All lots were self fed a mineral mixture of equal parts precipitated calcium carbonate, di-calcium phosphate and salt. All lots gained at a satisfactory rate and produced their gains on a relatively small amount of feed. Lot IV, which received supplement A for the entire period, made the largest gain. Lot V, receiving protein supplement B, gained the least. There was approximately 12 per cent difference between the two groups.

A Comparison of Rice and Corn for Fattening Hogs (L. A. Weaver).

All lots were self fed cereal and supplement in dry lot. The protein supplement was the same for all lots, consisting of tankage 3 parts; linseed oil meal, 1 part; and alfalfa meal, 1 part. All received a simple mineral mixture. The cereals fed the various lots were as follows: Lot I, shelled corn; Lot II, ground corn and ground rough rice, equal parts; Lot III, ground rough rice; Lot IV, ground rough rice; Lot V, cooked rough rice.

Lot III, fed rough rice instead of corn, required 18 per cent more feed for a unit gain. Ten per cent more feed was required for each 100 pounds gain when the cereal was rice and corn equal parts, than when it was corn. Hogs fed corn and protein supplement gained 15 per cent faster than those fed rice and protein supplement. Lot I ate 10.59 pounds of corn for each pound of supplement. Lot II ate 11.57 pounds of corn and rice to each part of supplement. Lot III ate 6.94 pounds of rice to each part of supplement. Hogs fed cooked rice required 16 per cent more feed than those fed ground rice. Hogs fed ground rice gained 35 per cent faster than those fed cooked rice. Rice was apparently about 60 per cent as valuable, pound for pound, as corn.

Protein Supplements for Hogs on Pasture (L. A. Weaver). Due to the drought it was impossible to carry the pigs on pasture throughout the entire test. The last half of the 119 day feeding period was carried on in dry lot. No change was made in the concentrate fed when the pigs were moved to dry lot. All lots were pastured on Sudan grass from June 24 to August 23, at which time the supply of pasture was exhausted. All lots were self fed a mineral mixture composed of equal parts ground limestone, bone meal, and salt. All lots were fed ground corn and some other feed that furnished more protein to the ration. The amount of protein supplement fed was such as to furnish the same proportion of protein in every case. (Nutritive ratio 1:7+).

Lots I, II, III, IV and V were full fed by hand twice daily, the feed being mixed with water at the time of feeding. Lots VI, VII, VIII, IX, and X were self fed. Table 10 shows the rations fed.

TABLE 10.—CONCENTRATES FED THE VARIOUS GROUPS

Lots I and VI	
Corn.....	4 parts
Supplement (23% protein).....	1 part
(Supplement included: Shorts 500 lbs., hominy feed 330 lbs., blackstrap molasses 260 lbs., tankage 250 lbs., cottonseed meal 50 lbs., linseed meal 50 lbs., dried buttermilk 50 lbs., gluten meal 50 lbs., and alfalfa meal 50 lbs.)	
Lots II and VII	
Corn.....	7 parts
Supplement (33.5% protein).....	1 part
(Supplement included: Shorts 500 lbs., tankage 250 lbs., linseed oil meal 125 lbs., cottonseed meal 125 lbs.)	
Lots III and VIII	
Corn.....	10 parts
Supplement (53.1% protein).....	1 part
(Supplement included: Shorts 125 lbs., tankage 250 lbs., linseed oil meal 125 lbs., cottonseed meal 125 lbs.)	
Lots IV and IX	
Corn.....	13 parts
Supplement (53.1% protein).....	1 part
(Supplement included: Tankage 400 lbs., linseed oil meal 100 lbs., cottonseed meal 100 lbs.)	
Lots V and X	
Corn.....	16 parts
Supplement (60% protein).....	1 part
(Supplement included: Tankage)	

Sudan made a satisfactory emergency hog pasture. The length of the growing season was shorter than that of alfalfa, clover, rape and oats, or bluegrass. The crop stood drought well but was very susceptible to chinch bugs.

The more complicated protein mixtures showed no advantage compared with the more simple ones. The supplement which furnished the largest amount of protein per unit cost produced the cheapest gains. There was little difference in the amount of feed consumed regardless of manner of feeding. The self fed hogs ate slightly less than those full fed. The self fed hogs made slightly faster gains also, producing pork at a cheaper cost.

Carcass Studies of Fat Heifers and Fat Cows (E. A. Trowbridge, H. C. Moffett). This project is in cooperation with the Bureau of Animal Industry, United States Department of Agriculture. Two lots of cattle, one of 14-months-old fat heifers and the other of fat cows of good quality, had been fattened on a ration consisting of shelled corn and cottonseed cake (8-1 by weight) with corn silage and clover hay as roughage. The

heifers graded only slightly better than the cows, yielded 3.06 per cent more chilled beef and 3.01 per cent more eye of beef, and yielded 7.65 per cent less fat and 1.70 per cent more bone in the rib samples used for the tests.

Cooking data from the 9th, 10th, and 11th ribs showed little or no difference in aroma of the cooked samples. Meat from the ribs of cows was coarser than that from heifers. Fat taken from the cows was more highly flavored, but the meat from the heifers was more tender. Rib roasts from cows shrank 3.7 per cent more during roasting than those from heifers.

For Growth Studies See Dairy Husbandry Project—Changes in Energy and Nitrogen Metabolism During Growth.

DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

The Time of Circulation of Blood in the Bovine (C. W. Turner, H. A. Herman). The method of measuring the time of circulation of blood described by Lian and Barras was adapted for cattle. Five tests were made and showed that approximately 52 seconds were required for the blood to make one complete circulation of the body. The pulse rate was found to be about 63 frequencies per minute for mature cows. It ranged from 80 to 95 frequencies per minute for animals under three months of age and from 65 to 80 per minute for animals from 3 to 18 months of age.

The Volume of Plasma and Blood in Dairy Cattle (C. W. Turner, H. A. Herman). The dye injection method was adapted to the dairy cow, considering the size of the animal and the rate of circulation. Approximately 120 determinations by this method were made. Growing dairy cattle weighing from 200 to 900 pounds averaged approximately 3.5 per cent plasma and 5.81 per cent total blood by weight. Non-lactating cows had higher plasma and blood volumes than the growing animals, averaging 3.78 per cent plasma and 6.38 per cent blood by weight. Lactating cows had much higher percentages than growing and non-lactating dairy cows. The plasma constituted 4.92 per cent and the blood 8.11 per cent of the total body weight in the average lactating cow.

Mature cows showed more uniformity in blood volume than growing dairy cattle. Mature animals averaged approximately 7,768 c.c. of blood per square meter of surface area, as compared with 4,035 c.c. per square meter of surface area in growing dairy cattle. The plasma constituted from 55 to 65 per cent of the total blood volume of the dairy animal. The blood volume as determined by the dye injection method

was 47 per cent higher in the case of lactating cows and 40 per cent higher for non-lactating cows than when determined by the "drain out" method.

Composition of the Blood of Dairy Cattle (C. W. Turner, H. A. Herman). The analyses for sugar content have been made on 50 additional samples of blood. A sugar level of 50 to 60 mg. per 100 c.c. whole blood was found in the lactating cows. Non-lactating cows ranged from 55 to 80 mg. per 100 c.c. of whole blood. The average for this group was approximately 65 mg. Sugar determinations on the blood of bulls and growing heifers showed an average of 75 mg. per 100 c.c. whole blood.

A comparison of the sugar level of blood from the jugular vein and from the mammary vein was made. In 38 comparisons the blood of the jugular vein contained approximately 60 mg. per 100 c.c., while that from the mammary vein contained 49 mg. per 100 c.c. Thus, passing through the mammary gland lowered the sugar content of the blood approximately 18 per cent. As a rule there was a greater withdrawal of sugar from the blood in the mammary gland of the high producing cows. In non-lactating cows there was little or no variation in the sugar levels of these two veins after the mammary gland ceased its activity.

Calcium analyses were made on the blood serum of dairy cattle of varying ages and under different physiological conditions. The serum calcium level of mature animals ranged from nine to eleven mg. per 100 c.c. Very little difference was found in the calcium level of animals of different age or sex. The lactating cows averaged 10.4 mg. calcium per 100 c.c. of blood serum by the Clark-Collip method. A determination of the blood serum calcium and inorganic phosphorus immediately following calving showed that there might be some fluctuation at this time.

The inorganic phosphorus varied considerably. Animals that showed a reduced calcium level also showed a lower amount of inorganic phosphorus. Sugar, calcium, and inorganic phosphorus determinations were made on the blood of six dairy cows suffering from milk fever. A lowering of the calcium and inorganic phosphorus of the blood serum was indicated. The sugar level seemed to be very little disturbed.

What appeared to be milk fever was produced in Jersey cows by the intravenous injection of sodium citrate solution. Considerable quantities of blood calcium had been precipitated. After the injection of 220 c.c. of 30 per cent sodium citrate, the blood sample showed the serum calcium level materially reduced. Relief was given by the intravenous injection of 200 c.c. of 10 per cent calcium gluconate. The animals seemed unaffected by the experience after a few hours.

Six rabbits were temporarily fed diets containing 6 to 10 per cent of the following calcium compounds: Calcium gluconate, calcium lactate,

steamed bone meal, Manamar (a commercial feed high in minerals), and calcium oxide. One rabbit was fed six per cent irradiated yeast in the diet. Serum calcium determinations were made at seven to ten day intervals. No significant increase in the calcium level was obtained by feeding any of these compounds.

The Specific Gravity of the Blood and Plasma of Dairy Cattle (C. W. Turner, H. A. Herman). In order to convert volume measurements of blood and plasma of dairy cattle into mass measurements it was necessary to know the average specific gravity of the blood and plasma. The pycnometer method was used in all specific gravity determinations. The average of all samples was 1.0499. The blood of males had a higher specific gravity than that of females. The specific gravity of the blood plasma averaged 1.02677.

The Individuality of the Four Quarters of the Cow's Udder (C. W. Turner). Groups of cows have been milked for a period of one week each fourth week during the lactation period, using a special milking machine which kept separate the production of milk from each quarter. Sixty-seven records have been completed. Approximately twenty per cent of the total yield was produced by each fore quarter and thirty per cent by each rear quarter. The yields from the right and left halves were practically equal.

Growth of the Mammary Glands (C. W. Turner, A. H. Frank). Rabbits have been used as experimental animals for this part of this work. The daily injection of twenty rat units of the estrus-producing hormone during a period of thirty days caused the growth of the duct system of the glands of male castrated rabbits and females castrated previous to puberty equal to that produced during continued estrus in the normal female. The injection of greatly increased amounts of the hormone did not carry the development beyond this stage.

Lipoid soluble (Allen, 1930) and water soluble extracts (Hisaw) of the hormones of the corpus luteum were tried. When either of these extracts alone was injected into rabbits no change could be noted. However, when 12 to 20 rat units of the estrus-producing hormone and 0.5 c.c. of the corpus luteum extracts were injected simultaneously, development of the ducts and lobules similar to that of pregnancy was produced. However, lactation was not produced in these animals.

Small amounts of the estrus-producing hormone were administered to castrate immature male and female albino rats. The duct system extended in a manner similar to the growth occurring normally during the period from birth to puberty. Large amounts of estrus-producing hormone resulted in a limited lobule proliferation somewhat greater than that characteristic of the mammary gland of virgin adult female

rats, but not nearly as great as that characteristic of the gland in advanced pregnancy.

The administration of a lipid extract or a water soluble extract of sows' corpora lutea did not produce significant changes. However, the simultaneous injection of the estrus-producing hormone and the lipid or water soluble extract of sows' corpora lutea produced lobule proliferation greater than that produced by the estrus-producing hormone alone. In no case was it as great as that present in the gland of a female in advanced pregnancy. Apparently, proper proportions of the estrus-producing hormone and the corpus luteum extracts must be secured for the production of extensive lobule proliferation.

Implants of whole pituitaries of castrate rats for short periods of time were incapable of producing significant changes in the mammary gland of castrated female rats.

The administration of an alkaline extract of sheep's pituitary which was effective in initiating milk secretion in the rabbit has produced no such results in the rat.

The presence of marked lobule proliferation in the mammary gland of the adult male rat indicated that some other organ than the ovary was able to elaborate the lobule proliferation hormone.

The Initiation of Milk Secretion in the Mammary Gland (C. W. Turner, W. U. Gardner). Moderate doses of estrus-producing hormone obtained from the urine of pregnant cattle administered daily over a period of 21 days produced no significant changes on a mammary gland of mature rabbits. Large amounts of estrus-producing hormone and the corpus luteum extract administered simultaneously produced a slight secretion of milk.

Pseudo-pregnancy was produced in the rabbit by intravenous injections of extracts containing too small an amount of gonad-stimulating hormone to be effective when subcutaneously administered. Pseudo-pregnancy induced the characteristic development of the mammary glands.

The mammary glands of mature castrated female rabbits have been stimulated to secretory activity by an alkaline extract from sheep's anterior pituitary. The lactation was equal to that occurring following partuition. The degree of involution of the mammary glands of the mature castrated female rabbits did not in any way alter the effect produced by the alkaline extract.

It would appear that the initiation of milk secretion was due to a definite "lactation-producing" hormone secreted in the pituitary, as has been suggested by Stricker and Grüter (1929) and Corner (1930).

Fetal Development of the Mammary Gland of Cattle (C. W. Turner). Research Bulletin 140 has been published on the project during

the year. The form of the udder was found to appear in female fetuses 12 to 20 cm. in length. At this time the primary and secondary sprouts were confined to a very limited region above each teat. Thus it would appear that the udder was laid out in its essential form much in advance of the growth of the gland and connective tissues which eventually filled the udder. It would seem that the development of the form of the udder was not related to the development of the secretory activity of the gland within the udder.

The development of the cistern system has been observed. The primary sprout developed into the streak canal at the lower end of the teat, the cistern of the teat, and the cistern of the gland. The secondary sprouts growing out from the walls of the cistern of the gland formed the milk ducts.

The Histological Structure of the Mammary Gland of Cattle (C. W. Turner). A study of the histological structure of the mammary gland of cattle has been conducted and a complete description of the anatomy of the normal gland as viewed in section, has been written. Figure 1 shows a diagram of a cross section of a lobe of the mammary gland.

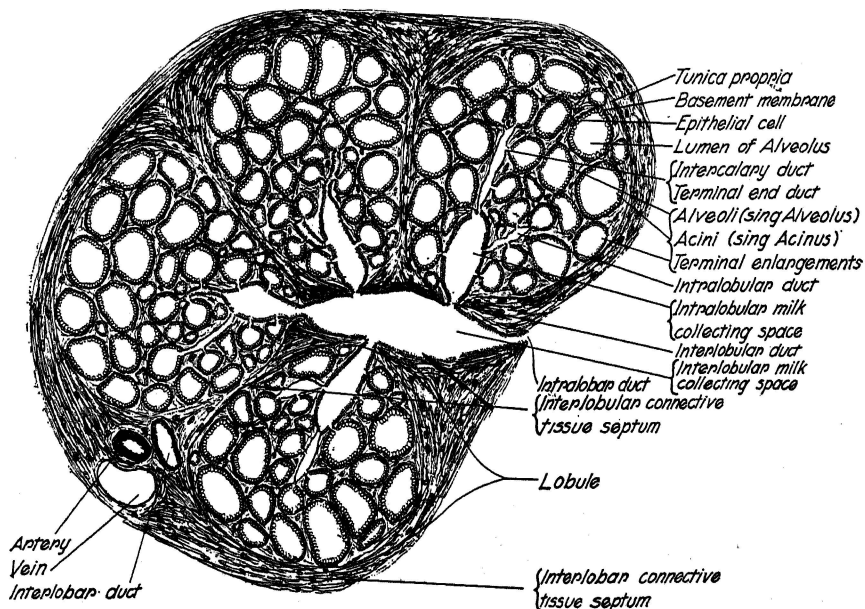


Figure 1.—Diagram of a cross section of a lobe of the mammary gland.

The Development of the Mammary Gland as Indicated by the Initiation and Increase in the Yield of Secretion (C. W. Turner). During the period from birth to puberty the mammary gland displayed little

or no secretory activity. With puberty and a recurrence of estrus the mammary glands of cattle often began to secrete small amounts of fluid, which increased during or following the occurrence of estrus.

During the greater part of pregnancy the yield of secretion in primipara heifers either remained at the level attained during puberty or declined to some extent. There was apparently a lack of stimulus to initiate milk secretion during this period. The stimulus for the growth of the mammary gland predominated. A striking increase in milk secretion occurred during the twenty days preceding parturition. This indicated the activity of the lactation stimulating hormone of the anterior pituitary.

The yield of secretion during puberty and much of the first pregnancy did not measure the growth of secretory tissue. Only at the approach of parturition were the potentialities of the gland fully realized.

Animals milked prior to calving time approached normal milk in composition. The removal of milk before parturition may be beneficial from the standpoint of the dam but the lack of colostrum may increase the difficulty of raising the progeny.

Following a successful autoplasmic ovarian graft a spayed Jersey heifer gradually increased in milk secretion until at the maximum over 5.6 pounds of milk were produced daily.

Changes in Energy and Nitrogen Metabolism During Growth (S. Brody, A. G. Hogan, H. L. Kempster, A. C. Ragsdale, E. A. Trowbridge, W. C. Hall, U. S. Ashworth, and associates). This project is in cooperation with the Departments of Animal Husbandry, Poultry Husbandry and Agricultural Chemistry. Data have been collected on thirty-three dairy calves, seven beef calves, eight hogs, six horses, nine sheep, 29 chickens, and a number of rats. The apparatus used for studying energy metabolism was of the closed circuit type and measured the oxygen consumption only. Measurements have been taken just before the morning feeding, approximately twelve hours after the preceding feeding. Data have also been collected on the hourly variation in heat production during 48- and 72-hour fasts.

For studying nitrogen metabolism urine has been collected once each two weeks for a period of 24 hours at a time from 13 dairy heifers. It has been analyzed for total nitrogen, urea nitrogen, ammonia nitrogen, creatinine nitrogen, and creatine nitrogen. Similar analyses have been made on the urine of rats on both high and low protein diets.

Six dairy heifers and three beef heifers have freshened and oxygen consumption records were obtained on the mothers just before parturition and on mother and calf soon after.

Growth Investigations (A. C. Ragsdale, S. Brody). Weights and measurements have been made on 114 females and 138 males of the Ayrshire, Guernsey, Holstein, and Jersey breeds of cattle. Complete feed consumption records also have been made on practically all of the same animals. These animals were under normal conditions of management. Growth proceeds at a constant percentage rate, 30 per cent a month until the age of 4 months. Thereafter the growth rate declines at 4.5 per cent per month. The efficiency of growth declines with advancing age, as shown by the feed consumption records on the animals.

The term "normal" as employed is less than optimum, but above that of the average farm dairy herd. It was, however, representative of conditions prevailing in the herds of the better class of dairy farmers.

Progeny Performance of Guernsey Sires and Dams (Warren Gifford). In order to locate the sires and dams that had been outstanding in transmitting high butterfat production to their progeny the records of all Guernsey sires that had five or more tested daughters reported in the Advanced Register up to April, 1929, have been compiled and compared. There were 1,232 of these sires with 12,880 tested daughters.

Methods for Evaluating and Proving Dairy Sires (Warren Gifford). In order to determine the smallest number of tested daughters a sire should have to predict with reasonable accuracy the production records of future daughters the records of 58 Jersey and 26 Guernsey sires that had 32 or more tested daughters have been studied. The Holstein records previously reported were also available.

The sire should have at least ten or more daughters with yearly records in order to predict the average records of 16 or more future daughters. Data have been compiled on 94 sires that had twenty or more tested daughters out of tested dams. The indexes (as suggested by various investigators) have been determined for each sire.

The average of the sire's daughters without consideration of the dam's records more nearly represented the sire's transmitting ability and was more valuable in predicting the average production of future daughters than any of the indexes used.

The Inheritance of Polythelia in Dairy Cattle (Warren Gifford). Six hundred seventeen dairy animals have been examined during the past year to observe the number of supernumeraries. Data have been obtained for 4,117 animals to date. Butterfat records have been secured for 1,078 of these animals. The average age corrected production for 770 cows with four teats was 455 pounds. The average production of 308 cows with supernumeraries was 440 pounds. The studies did not indicate that this difference was due to the absence of supernumeraries.

The Study of the Freezing Properties, Stability, and Physical Qualities of Chocolate Ice Cream (W. H. E. Reid, W. E. Painter). Sugar influenced the whipping ability of a chocolate ice cream mixture by reducing the ability of the mixture to incorporate air, prolonged the freezing time, induced a lower temperature of the ice cream and created a physical condition resulting in a lower overrun. The balancing of the chocolate mixture with respect to the sugar content caused it to freeze equally fast and to attain an overrun equal to the vanilla mixture. Sugar, in excess of 17 per cent in chocolate ice creams submerged the chocolate flavor and caused the body to be sticky and soggy. The stability of the ice cream was lessened.

Egg powder added to a chocolate ice cream mixture improved its whipping ability, reduced the viscosity, partially submerged the chocolate flavor, and partially removed the stickiness. It gave a smoother body and finer texture.

Aging chocolate ice cream mixtures improved the whipping ability and reduced the time to freeze.

The addition of a normal amount of chocolate flavoring to a base mixture with a normal sugar content caused a longer freezing time, increased the viscosity and produced a pronounced chocolate flavor. The reduction of the normal amount of chocolate flavoring to three-fourths or one-half produced a mixture that froze equally as fast as a vanilla mixture. Since the chocolate flavoring functioned as a stabilizer a reduction of the gelatine content was desirable.

The Deodorization of Cream for Butter Manufacture (W. H. E. Reid, J. W. Myers). The flavor of cream to be used for the manufacture of butter can be improved by the addition of a deodorizer at the churn. Deodorizers improved unsalted butter more than salted butter. The deodorization of cream to which a starter had been added did not improve the quality of either the salted or unsalted butter. The vat or flash method of pasteurization did not affect the cream previously treated with deodorizers. Some deodorizers, when used in large amounts, had a detrimental effect upon the butter.

The deodorizers used did not affect the bacterial count of the cream or the butter. The chlorine compounds decreased the mold and yeast count of butter manufactured from treated cream. The bacteria, mold, and yeast count of salted butter were higher than for unsalted butter after a ten-day storage period. Cream churned the same day as received and cream aged 16 hours after treatment showed no difference in flavor score of butter.

Methods of Reducing and Preventing Serum Separation in Twenty Per Cent Cream Without Homogenization (E. R. Garrison, M. E. Powell). Serum separation was determined by holding the cooled,

pasteurized cream in 100 c.c. graduated cylinders for 48 hours at 40 degrees Fahrenheit. The amount of serum separated decreased as temperature of pasteurization increased. The serum separation decreased as the storage temperature of the milk decreased. The cream line was less distinct at higher temperatures. Freezing the cream and thawing it immediately had no effect on serum separation. Standardizing the cream to 20 per cent fat before pasteurization resulted in less serum separation than standardization after pasteurization. No difference was found between raw and pasteurized skim milk as standardizing agents. An increase in the amount of serum required to reduce the fat content of the cream to 20 per cent increased the amount of serum separation. Aging pasteurized cream for 24 hours before standardizing decreased the serum separation. The temperature at which the milk was separated had no effect. The addition of sodium citrate and di-sodium phosphate had no effect upon serum separation. The addition of 6 per cent skim milk powder before pasteurization eliminated serum separation. The use of 7.5 per cent evaporated milk in standardizing the cream prevented the appearance of a skim milk layer in the cream.

The Manufacture of Cottage Cheese Involving the Use of Skim Milk Powder (W. H. E. Reid, C. L. Fleshman). Three differently processed skim milk powders—spray, vacuum drum, and atmospheric drum—were used. A satisfactory cottage cheese was made from skim milk powders manufactured by the spray or vacuum drum process. The acidity of the curd and whey was important. Cottage cheese manufactured from normal skim milk without heat gave the most satisfactory product. There was a gradual decrease in the quality of the finished product as the proportion of the reconstructed skim milk to normal skim milk was increased. There was a direct relation between the specific gravity, acidity, and yield of normal and reconstructed skim milk. Different temperatures of wash water had no apparent effect. Extending the setting periods resulted in a gaseous fermentation in the curd from reconstructed skim milk. The percentage of moisture and the moisture retaining properties were the same for cottage cheese manufactured from either normal or reconstructed skim milk.

ENTOMOLOGY

L. HASEMAN, *Chairman*

Grasshopper Studies (L. Haseman). Three species of grasshoppers, *Melanoplus femur-rubrum*, *M. differentialis*, and *M. bivittatus*, and two of their parasites, *Trombidium* mites and *Epicauta vittata*, have been studied. The winter of 1929-30 was a very severe one with temperatures as low as 16 degrees below zero. The summer of 1930 was unusually

warm and dry. During that summer these three grasshoppers developed in unusual numbers. The severe winter clearly did not injure seriously the over-wintering eggs. The number of mites and of blister beetles (parasitical to grasshoppers) was very small. The mild, dry winter of 1931 again proved favorable for the over-wintering eggs of the grasshoppers and with the hot, dry summer caused these three species to develop in the greatest numbers in years. However, a surprisingly heavy outbreak of the red mite parasites and the blister beetles also occurred. The cold winter did not affect the grasshopper eggs materially but did their parasitic enemies. The hot, dry summers were also favorable for grasshopper development. The abundant development of the parasite mites and blister beetles will help eliminate the grasshoppers for the following year. Two hot, dry summers with an intervening warm, dry winter and a relative scarcity of parasite enemies may cause a real plague of grasshoppers.

Codling Moth Abundance (L. Haseman). The codling moth does not appear periodically as a scourge and then become scarce for a time like the chinch bug. However, its abundance is influenced by certain conditions. The winter of 1929-30 with temperatures as low as 16 degrees below zero killed as high as 100 per cent of the worms above the snow line in some orchards. During the summer of 1930 apple worms were below normal in number in the Ozark area. During the mild and dry winter of 1930-31, apple worm mortality was low and their populations built up to unusual numbers during the summer and fall. Mild winters seemed to indicate a heavy summer population of apple worms. A complete failure of an apple crop also is an important natural check on the codling moth. The worms develop primarily in the fruit and when there is little or no fruit large numbers of the worms starve. Since 1906 there have been two complete failures of apples. In each case it required two years for the populations to again approach their usual high numbers. However, the summers of 1930 and 1931 were both very favorable for apple worm development. Unusual increases in worm populations were observed.

Chinch Bug Control (L. Haseman). The effect of summer or white oil emulsions used as sprays on the first few rows of corn where chinch bugs had migrated from small grains was tested on a small scale. A 2 per cent emulsion of Verdol was used. It gave almost perfect control of the younger nymphs, but did not kill all older nymphs and adults. An application had to be made each afternoon during the period of migration. A 2 per cent emulsion caused no damage to the corn when applied on clear, hot afternoons. The results from this test seemed encouraging but were not based on a sufficiently extensive scale to be conclusive.

“Hessian-fly-resistant” Qualities of Different Varieties of Wheat (L. Haseman, Paul H. Johnson). In cooperation with the Department of Field Crops investigations were made on Hessian fly infestation in 22 strains of Kanred, 22 selections of Michigan Wonder, 23 of Fulcaster, 23 of Poole, and 24 of Illini Chief. There was no striking difference in the percentage of culms infested and the number of flaxseeds to each one hundred culms, except in the case of Illini Chief. However, there was a number of selections in each variety which showed no infestation. Three selections of Kanred, 5 of Michigan Wonder, 7 of Harvest Queen, 9 of Fulcaster, 9 of Poole, and 13 of Illini Chief were free of infestation.

Strawberry Insects (L. Haseman, Paul H. Johnson). Strawberry plots at Aurora, Cassville, and Sarcoxie were sprayed with a liquid spray and a dust spray. Three sprays were applied, two before the fruit appeared, and the last when the berries were fair-sized buttons. The liquid spray was 2 pounds of lead arsenate to 50 gallons of water. The dust was arsenate of lead and hydrated lime, 1 to 5. At picking time there was no appreciable arsenical residue on the fruit. The crown borer did not seem to do a great deal of damage. The dust plot showed a very marked reduction in the percentage of crown borer infestations. The spray plots were better than the checks. This should mean a reduction in infestation next year and a corresponding increase in the yield of the treated plots. There was some question as to whether the sprays paid for the cost of materials and application. However, the results were only for one year and the crown borer was not exceptionally destructive, even in the check plots.

Insect Pests of the Melon (L. Haseman, Preston B. McCall). In the fall of 1930 five breeding cages were stocked with striped cucumber beetles. These were carried through the winter in confinement to find out how and under what conditions they survived the winter. One hundred beetles were placed in each cage. One cage contained dry leaves as coverage, another dried grass, another decayed wood, another chips, and the last bluegrass sod. It was found that the beetles needed food much later in the fall than was supposed. They collected in bunches beneath the winter protection and did not go into the soil.

During the summer 2 acres of watermelons, cantaloupes, squashes, and pumpkins were grown to test the insecticidal control of the striped beetle, melon louse, and squash bug. The following insecticides were tested on the striped cucumber beetle:

- (1) Hesthanol, a foreign make of calcium arsenate
- (2) Calcium arsenate used in a 1-10 mixture with common gypsum or land plaster
- (3) Arsenate of lead used in a 1-5 mixture with hydrate lime
- (4) Dutox, a proprietary preparation of barium fluosilicate
- (5) Kalite, a proprietary preparation containing apparently a form of sodium fluosilicate, sulphur and an inert carrier

All gave commercial control of the beetles. The Hesthanol, calcium arsenate-gypsum, and Dutox gave the best control. Each of the chemicals showed slight burn, the calcium arsenate-gypsum showing the least.

The spring and summer of 1931 were unusually favorable for the squash bug. Hand-picking of the bugs and the use of contact insecticides were tested. Hand-picking was satisfactory but involved too much labor. One and two per cent emulsions of the summer spray oil (Verdol) destroyed the very young nymphs and some of the older instar nymphs, but did not kill the adult bugs. Eggs treated with this oil and kept in close confinement did not hatch.

Nicotine sulphate of the usual strength of 1 ounce to 3 gallons of soapsuds also killed the young nymphs, but was not effective in killing older nymphs and adults. The best method of control so far developed seems to be the destruction of the vines after the crop has been gathered and the destruction of the bugs in their winter hiding, along with the destruction by hand of the adults and first eggs as they appear on the crop the next summer.

The melon louse was satisfactorily controlled with nicotine sulphate, 1 ounce to 3 gallons of soapy water.

Control of the Codling Moth (L. Haseman, Paul H. Johnson). Breeding records must be secured each year for each of the principal apple growing regions until the present epidemic of apple worms has been placed under control.

Worms collected and caged in the fall emerge as moths the following spring at the same time as moths emerge from worms left undisturbed on the tree trunks. The topography of the land on which the orchard was grown affected the temperature and therefore the time at which the moths emerged. However, the position on the tree trunk had little effect on moth emergence. The worm population built up rapidly with each succeeding generation as the summer advanced. This was shown by the tree band catches. In Missouri there were two full broods and a partial third brood in central and north Missouri. In the Ozarks there was practically a full third brood.

An alcoholic ferment of dilute molasses, fruit juices, or Diamalt in jars suspended in the tops of apple trees attracted and caught large numbers of moths each night that the moths were on wing. The moths were most active for the first few hours after sundown.

Maximum emergence of moths in the breeding cages occurred two or more days in advance of the maximum catch of moths in the bait jars. With accurate information as to moth activity it was possible to arrange a schedule of sprays which, when thoroughly applied, satisfactorily controlled the pest.

FIELD CROPS

W. C. ETHERIDGE, *Chairman***Corn Breeding** (L. J. Stadler, R. T. Kirkpatrick, W. R. Tascher).

The drought of 1930 caused an almost complete failure of corn breeding experiments. The loss was more serious because it followed the very unfavorable season of 1929. Records of the reaction of the inbred strains to advancing stages of drought were obtained but none of the advanced inbreds were sufficiently drought resistant to produce any considerable yield of seed. By carrying water to the field daily a few plants of the more important strains were saved, so that there was no very serious loss of breeding material.

Most first generation hybrids produced some seed. Thus, double crossing and second-cycle selfing were possible. Observation plots and yield tests of F_1 's and double crosses gave significant results on six fields. There were 328 first generation crosses included in one or more of the tests. This included the hybrids of 72 inbred strains, each crossed with as many as possible of seven tester strains. The best of the strains was W10, a St. Charles White strain. The best of the tester strains was R104, a Reid Yellow Dent strain.

Yield tests of double cross hybrids were continued as in previous years at Columbia, Grain Valley, Maryville, Shelbyville, Stark City, and Green Ridge. The yield tests included 95 double crosses produced at the Station; 9 commercial hybrids; and 18 commercial varieties. The comparative yields of the highest yielding variety, highest yielding commercial variety, and highest yielding Station hybrid are shown in Table 11.

TABLE 11.—COMPARATIVE YIELDS OF VARIETIES AND HYBRIDS

Field	Maryville	Grain Valley	Shelbyville	Stark City
Highest yielding variety (R. Y. D. Ill.)-----	33.7	50.0	36.4	26.1
Highest yielding commercial hybrid (Fields No. 3)	35.4	55.5	25.6	29.9
Highest yielding Station hybrid (Mo. hybrid No. 77)-----	35.3	65.5	28.1	24.3
Check—(R. Y. D.)-----	20.7	43.9	22.4	23.5

Fertilizer Tests with Cotton (B. M. King). At Hayti tests were conducted on duplicate series of fertilized plots. Applications of 400 pounds of 20 per cent superphosphate, 4-12-0, 0-12-4, 4-12-4, 6-8-6, and 200 pounds of 14 per cent Kainit were used. The largest increase amounted to 102 pounds of lint per acre and was secured from the plots treated with 400 pounds of 4-12-4. The smallest increase, 12 pounds of lint per

acre, was secured from the plots treated with 400 pounds of 20 per cent superphosphate.

Near White Oak on land where serious damage from rust occurred, applications of 200 and 300 pounds per acre of 14 per cent Kainit alone, or in combination with nitrogen and phosphorus, greatly reduced the rust injury and increased the lint yields 50 per cent or more.

The Genetic and Physiological Effects of Irradiation of Barley (L. J. Stadler). Irradiation of barley gave clear evidence of a wide difference in the mutation rate per unit of intensity in dormant and germinating seeds. Mutation per r-unit in dormant seeds was 7.5 ± 0.3 per million; in germinating seeds 66.7 ± 4.9 per million. In order to trace this change treatments were applied to seeds at the following times:

1. At the end of the steeping period but before aeration
2. After 30 minutes of aeration
3. After five hours of aeration

The steeping period was 14 hours for all three lots. Tolerance was reduced as germination proceeded, the tolerance of the seeds at the three stages being approximately 45, 25, and 15 respectively, as compared to 100 for dormant seed. The mutation rates were: 19.3 ± 2.9 ; 11.0 ± 2.8 ; and 38.0 ± 6.4 respectively.

Since dormancy increased tolerance more than it reduced mutability, the irradiation of dormant seed was more effective. In order to utilize this advantage dormant seeds were irradiated at a very low temperature. The seeds were imbedded in carbon dioxide snow for 15 minutes before treatment and throughout the treatment period. This maintained a temperature of -65° C. The control seeds were irradiated in the same container, with an equivalent quantity of cotton, presumably providing filtration and secondary radiation similar to that from carbon dioxide. The mutation rate per r-unit in the carbon dioxide treated seed was 4.7 ± 0.4 ; in the control 6.8 ± 0.9 . The maximum dose tolerated was increased about two-thirds by the carbon dioxide treatment.

Varieties of Cotton for the Southeast Missouri Lowlands (B. M. King). Cotton variety tests were conducted on rich, heavy land at Hayti and on fine sandy loam at Sikeston. Due to the extreme heat

TABLE 12.—YIELDS OF LINT COTTON PRODUCED BY VARIETIES GROWN AT HAYTI IN 1930

Variety	Lbs. Lint Per Acre
Cleveland (Wilson).....	288
Delfos 6102.....	301
Trice (Burdette).....	337
Misdal No. 2.....	311
Stoneville No. 1.....	365
Rowden 40.....	287

and drought the crop failed at Sikeston. Satisfactory yields were secured at Hayti, due to more favorable weather conditions. Table 12 shows the yields from various varieties at Hayti in 1930.

Stoneville No. 1, a comparatively new strain, was tested for the first time. It exceeded all other varieties in yield. It was early in maturing, dwarfy in growth habit, had large bolls that were easily picked but storm resistant, and a staple length of 1 1/32 to 1 1/8 inches.

Varieties and Selections of Soybeans (B. M. King). Thirty-seven varieties and strains of soybeans were included in a yield test in 1930 at Columbia, Shelbyville, Elsberry, and Sikeston. Among this group were Virginia, Wilson, Morse, and Midwest, known to be well adapted to Missouri conditions. The remainder consisted of promising selections made at this Station, new strains furnished by the United States Department of Agriculture, and several of the better kinds taken from a collection of 134 varieties and strains classified and described in Missouri Research Bulletin No. 131. The yields at Columbia ranged from 9.72 bushels for Mandarin, an exceptionally early variety, to 21.41 bushels for S. P. I. 37062, taken from the group of classified varieties. Other new kinds that compared favorably in seed yield with the four standard Missouri varieties included Selections 548, 539, 5463-5, and Aksarben.

Wheat Breeding (W. R. Tascher). The highest yielding varieties of wheat in the nursery plot tests were the following:

Variety	Bushels Per Acre (1930)
W 1764—Gypsy.....	34.1
W 1814—Harvest Queen.....	31.8
W 859—Poole.....	30.8
W 1817—Harvest Queen.....	30.0
W 918—Fulcaster.....	29.5

A recent taxonomic classification has changed the varietal names in some instances. Seventeen varieties and strains were tested on ten outlying fields. Harvest Queen was outstandingly high yielding in southern Missouri. May outyielded all varieties at Elsberry; Poole yielded best at Shelbyville; Harvest Queen and Kanred were the highest yielding at Maryville and Grain Valley.

Two hundred eighteen pure lines of Harvest Queen wheat were included in a yield test. Twenty-seven pure lines of May were retained. Six lines of this variety were increased for outlying field tests. Five pure lines of Fulcaster were selected for increase. Considerable variability existed in a group of pure lines from each variety with the exception of May, which continued to yield uniformly.

Oat Varieties for Missouri (R. T. Kirkpatrick). The leading varieties of oats in the nursery tests were the following:

	Bushels Per Acre (1930)
0963—Selection from Texas Red.....	75.4
01375—Columbia.....	75.3
02890—Selection from Burt.....	75.9
0955—Selection from Kherson.....	73.7
0964—Selection from Texas Red.....	73.6
0969—Ferguson 922.....	71.8
0464—Kherson.....	71.3

The higher yielding oat varieties for the drill-width tests conducted in nine different sections of Missouri were as follows:

	Bushels Per Acre (1930)
Columbia.....	43.4
Fulghum (Kanota).....	42.1
Fulghum (0149).....	41.4
Texas Red.....	39.9
Albion (Iowa 103).....	39.5
Kherson.....	39.4

The yields of 108 Fulghum pure lines varied from 46.4 to 72.8 bushels per acre. The standard variety of Fulghum, used as a check, yielded 60.5 bushels. Forty oat selections, chiefly Burt and Fulghum, varied from 42.9 to 71.4 bushels per acre, as compared with 59.7 bushels, the yield of the Fulghum check.

About 200 bushels of the new Columbia oat were distributed to farmers for the first time in the spring of 1930. Fifty-five men, located in all sections of Missouri, cooperated in 1930 in comparing the Columbia oat with the variety they may have been growing. As an average of all tests the Columbia yielded 52.7 bushels per acre, as compared with 49.9 bushels for the home variety.

Spring Barley for Missouri (R. T. Kirkpatrick.) The leading barley varieties in the nursery tests were the following:

	Bushels Per Acre (1930)
B 98—Trebil.....	46.1
B 182—Crocket.....	43.7
B 155—Limerick.....	43.0
B 175—Summit.....	41.0
B 178—Hodge.....	39.5
B 94—Manchuria 184.....	39.4
B 96—Minsturdi.....	39.3

In the drill-width tests conducted at Grain Valley and at Maryville, Trebil yielded 41.4, Velvet 26.9, and Oderbrucker 25.3 bushels per acre.

The Genetic Analysis of Maize (L. J. Stadler). Using the technique developed in the project on the genetic effects of irradiation, large numbers of gene mutations of maize have been produced. An extensive series

of mutation races of known linkage relations has been made to elaborate the chromosome map of the maize species. The mutations were induced in a cross between strains differing in genes marking each of the chromosomes. The selfed progeny of this cross segregates for the induced mutation and at the same time segregates also for the chromosome-marking genes. The linkage relations of the induced mutant genes are thus indicated in the generation in which they first appear. Treatments were applied extensively on this plan. The induced mutations with their indicated linkage relations will appear in the fall of 1931-32.

The Adaptation of Varieties of Soybeans to the Various Soil Types of Missouri (C. A. Helm, B. M. King). At Cuba the Virginia variety continued to outyield its nearest competitor, the Wilson variety, by 3.1 bushels of grain and .3 tons of hay per acre in a five-year average. At Stark City in grain yields in five-year average, Morse, Midwest, Wilson, and Virginia all made comparable yields. In hay Virginia consistently yielded slightly more per acre. Laredo proved well adapted for hay, yielding from one-fourth to one-half ton of hay more than Virginia or Wilson. Illini, Manchu, and similar early maturing varieties were decidedly inferior, especially in yields of hay.

A Comparison of Green Sorghum and Corn for Grain and Forage Production (C. A. Helm). Since 1926 on soils of varied fertility, grain sorghums in rotation involving lime, manure, fertilizer on wheat, and red clover, have averaged 4.3 bushels per acre more than corn. In rotations without lime and manure the difference in favor of grain sorghums has been 5.8 bushels per acre. At Cuba since 1928 grain sorghums have outyielded corn 16.8 bushels per acre in rotations involving lime, manure, and clover. In the same rotation without manure the difference has been 7.3 bushels in favor of grain sorghum. At Shelbyville grain sorghums in a rotation of sorghum, oats, and two years of alsike clover, orchard grass, timothy, and red top, produced an average of 33.8 bushels on manured land and 26.5 bushels where no manure was applied.

Varieties of Grain Sorghum (C. A. Helm). At Stark City the varieties Sagrain, Pink, and Red Kafir have been outstanding, averaging during the past three years 38.0, 34.1, and 33.9 bushels per acre, respectively.

At Cuba on a ten-year average, Sagrain has produced 41.4 bushels, Red Kafir 28.3 bushels, and Pink Kafir 27.8 bushels per acre.

At Green Ridge in 1930 Sagrain produced 29.8 bushels, Pink Kafir 28.4 bushels, and Red Kafir 22.8 bushels. At Shelbyville Pink Kafir yielded 35.1 bushels of grain. White Kafir produced 33.0 bushels. Red and Dawn produced 26.8 and 25.9 bushels respectively.

HOME ECONOMICS

MABEL V. CAMPBELL, *Chairman*

Methods of Cooking Steaks from Different Classes of Beef Animals (Jessie Alice Cline, Mary Esther Loughead, Bessie C. Schwartz). The meat used in this study was from two heifers from 12 to 15 months old of "good" grade; two steers, one 12 to 15 months old, and one 18 to 20 months old, of "medium" grade; and two cows, one 6 and one 9 years old, of "good" grade. Rib, porterhouse, sirloin, and round steaks were used. They were cooked by two methods; a modified roasting method, and a constant temperature broiling method. The steaks were cooked until the temperature was 136° F. The modified roasting method consisted of searing with one turning in a closed gas broiler, preheated to 500° F. and transferred to a gas oven at a temperature of 257° F. to finish. The constant temperature broiling method consisted in broiling with the oven door open and with but one turning in a gas broiler, preheated to 350° F. The loss by evaporation in all steaks was greater than the loss by drippings. The porterhouse and sirloin steaks showed the greater loss. There was no relation between the size of steak and the losses. The heavier steaks required less time per pound to cook.

The tenderloin muscle of the porterhouse graded high in tenderness, even in the 9-year-old cow. The muscle of the bottom round graded low in tenderness, even in the steer and heifer. The modified roasting method produced more tender steaks. The steer graded the highest for tenderness and the 9-year-old cow the lowest, the difference being very slight. The steaks ranked as follows, the most tender being given first: porterhouse, sirloin, rib, and round. The more juicy the meat, the higher the grade for flavor of the lean.

The Effect of Two Roasting Temperatures on Palatability of Cooking Roasts (Jessie Alice Cline, Mary Esther Loughead, Bessie C. Schwartz). Roasts from six animals were cooked by two different methods. The description of the animals was as follows: Heifer, 12 to 15 months old, "low-good" grade; steer, 12 to 15 months, "medium" grade; cow, 9 years, "good" grade; heifer, 12 to 15 months, "good" grade; steer, 18 to 20 months, "high medium" grade; cow, 6 years, "low-good" grade.

The roasts used were prime rib, chuck one, chuck two, rump, sirloin tip, and heel-of-round. Two constant low oven temperatures were used; 257° F. and 311° F. The higher cooking temperature increased the total cooking losses. The cooking losses were greatest in the roasts from the cows. The time per pound required for roasting was decreased by the higher temperature. The least tender of the six cuts

were the heel-of-round, rump, and chuck No. 2. The roasts from the cows graded lower in tenderness. In flavor of lean, and in juiciness the roasts ranked about the same. There was no decided advantage of one method of roasting over the other, as far as palatability was concerned.

The Effect of Laundering Upon the Durability of White and Colored Cotton Fabrics (Adella Eppel Ginter, Katie Marie Adkins, Margaret Shaddock). Shrinkage in garments was not overcome to the same extent by ironing as was the shrinkage in fabrics. Wear on garments affected the linear measurements, counteracting the shrinkage. The size of the garment did not influence the changes in thickness, shrinkage, and thread count. The changes during the first laundering were significant.

Five additional white cotton fabrics were laundered by home and commercial methods. The amount of shrinkage of fabrics that were washed and not ironed depended more upon the fabric itself than upon the method of washing. The direction of shrinkage of fabrics that were both washed and ironed depended upon the method of ironing. Home methods had less effect in overcoming shrinkage than commercial methods.

The Vitamin Content of Nancy Hall Sweet Potatoes (Margaret C. Hessler, Blanche Cole). One hundred twenty-two albino rats of known nutritional history were used in this determination, following the Sherman and Munsell method. Growth responses of 10 portions indicated that 0.12 grams of the sweet potato contained one unit of Vitamin A. A unit of Vitamin A is regarded as the amount which will support a gain of three grams per week when fed to a standard test animal.

The Effect of Fruit Acids on Rickets (Margaret C. Hessler, Sylvia Cover). The percentage of calcium was determined in the bones of rats and the pH determination was made on the intestinal contents. The synthesis of citric acid has progressed as far as the formation of Ketipinic ester.

The Vitamin Content of January and June White Leghorn and White Rock Eggs (Margaret C. Hessler, Sylvia Cover). The Sherman Munsell method for determining Vitamin A and the modified Sherman Stiebling method for determining Vitamin D were used. In Vitamin A determinations the unit for June eggs for both breeds was 0.03 grams. In Vitamin D determinations the relative calcification for three drops or 0.09 grams of White Rock eggs was 82 per cent; for five drops or 0.15 grams it was 95 per cent.

HORTICULTURE

T. J. TALBERT, *Chairman*

Virus Diseases of Plants (C. G. Vinson). A mosaic disease is found on all solanaceous plants (tomato, potato, egg plant, pepper, petunia, etc.). This disease is caused by a virus. It is found in almost every home and market garden and causes a reduction in yield and quality from a small percentage to a complete failure. The causal agency has never been observed or cultivated. For this reason, the problem has been attacked from a chemical standpoint. Studies have been started to determine the nature of this virus.

Tobacco was chosen as the experimental plant because (1) its culture is easy, (2) the disease may be discerned in its early stages, and (3) the plant is very easily inoculated with the disease.

Diseased tobacco plants were expressed and the juice used as a starting material because it seemed to contain most of the virus in the plant. Two successful methods have been developed for purification of the virus fraction:

1. The juice was cleared with basic lead acetate. The virus was then precipitated with neutral lead acetate. It was then removed from the neutral lead acetate precipitate by suspending in a neutral solution of ortho phosphate.
2. It was found that an aqueous solution of safranin precipitated the virus directly with very little accompanying material. Two methods were used for decomposing the safranin.
 - a. The safranin was extracted from a suspension of the precipitate with amyl alcohol. This left the virus in the aqueous fraction.
 - b. The virus was displaced by means of an infusorial earth and was left in the aqueous fraction.

Sweet Cherries in Missouri (T. J. Talbert). Sweet cherries have not proved satisfactory in Missouri. Efforts have been made to find sweet cherries which will grow well. Missouri seedlings and named and unnamed varieties from other states have been planted. Cross pollination has been studied. About twenty-five varieties are now five to six years old and are coming into bearing.

Walnut, Pecan, and Filbert Investigation (T. J. Talbert, A. E. Murneek). Methods of propagation have been studied. Some of the trees were top-worked seven years ago. Generally speaking, after four years, a normal crop was produced. Several varieties of black walnuts were top-worked on native seedlings, the more important being Stabler, Thomas, Ohio, Miller, Ten Eyck, Tucker, and Peanut. Many scions from this stock have been sent to growers in Missouri. Both budding and grafting methods of propagation have been used. For pecans, hickories, and chestnuts, budding has proved better than grafting. For walnuts, grafting was much better than budding. The varieties of pecans used were: Major, Niblack, Indiana, Busseron, and Posey.

Acclimatization tests have been made with various introduced and native varieties and species of filberts and hazelnuts. Varieties from England, France, Spain, and Italy were injured during the flowering period. All native species tested have borne fruit. *C. Americana*, *C. rostrate*, and some of the named varieties of American origin have done well.

Summer Oils for Codling Moth Control (H. G. Swartwout). The purpose of using oils, as a summer spray, is to avoid arsenical residues. White oil emulsion, was used for the control of the second and later broods of codling moths. The results were practically the same as observed with lead arsenate. Some injury followed the use of the white oil emulsion.

Analyses were made for arsenic as arsenic trioxide on Grimes, Winesap, Jonathan, Delicious, Ben Davis, York, and Ingram varieties, treated in four different ways: Group 1, sprayed with oil and selected for maximum arsenic residue; Group 2, sprayed with arsenate of lead and selected for maximum residue; Group 3, sprayed with oil and selected for maximum residue after commercial handling; and Group 4, sprayed with arsenate of lead and selected for maximum residue after commercial handling. In Group 1, Ingram, Winesap, and Ben Davis were under the international tolerance of 1/100 grain of arsenic trioxide per pound of fruit. The others in this group were slightly over. In Group 2, in all cases, more than twice the international tolerance was found. Group 3 was approximately the same as Group 1. In Group 4, an appreciable reduction in arsenic trioxide was found over Group 2, but in all cases, except that of Ingram, it was above the international tolerance.

Sulphur Spray Injury (H. G. Swartwout). Calcium sulphide, dry lime sulphur, and liquid lime sulphur, have been compared as to the amount of injury caused by their use. Calcium sulphide, a new spray, gave the least amount of russetting on apples and the highest finish. Dry lime sulphur was almost as satisfactory.

Differences in Spray Requirements Due to Variety of Apples (H. G. Swartwout). Different varieties require different dilutions of lime sulphur and to some extent different intervals between applications and different numbers of applications to control apple scab. The variety to be sprayed must be taken into consideration. In the Duchess variety good control was secured, with as low as 1/2 gallon of lime sulphur to 50 gallons of water. Wealthy, Jonathan, Grimes, and York required 3/4 to 1 gallon to 50 gallons of water. Ben Davis, Delicious, Rome, and Winesap required 1 1/2 gallons (standard dilution) in 50 gallons of water for good control.

New Spraying Materials for the Control of Insects (T. J. Talbert). After a number of greenhouse tests to determine application strengths, a number of new materials have been used as sprays to replace the later

arsenate of lead applications in order to reduce the arsenical residue. Different strengths have been used and check plots provided. The following substances have been applied to trees: Hellebore, pyrethrum, and red pepper. The following organic compounds have been used in the amounts indicated: Brucine, 50 grams to 5 gallons of water; Cinchonine, 25 grams to 5 gallons of water; Chlorine Hydrochloride, 25 grams to 5 gallons of water; Mucic acid, 25 grams to 5 gallons of water; and Pepperine, 100 grams to 5 gallons of water.

Hardiness in Apple Trees (C. G. Vinson, T. B. Gallman). Hardiness has been found to be correlated with maturity; maturity has been conditioned by food supply. Therefore, an attempt was made to increase hardiness by increasing maturity. Grimes apple trees have been found to be subject to winter injury which affected the collar, trunk, and crotch. These parts might be slow maturing. Several trees were girdled early in the fall, at the surface of the ground, expecting to favor accumulation of food materials in parts ordinarily susceptible to winter injury, and in this way, favor maturity. Microscopical and analytical determinations of starches, sugars, and hemicelluloses were made of samples from trunk, crotch, and underneath the main branches at their point of insertion on the trunk. It was not possible to do the girdling early enough to secure marked difference between the treated and the check trees. The winter was of such character that no winter killing of any sort took place, and therefore there was no real test of the treatment. Examinations of the thickness of the bark of various varieties indicated no correlation between thickness of bark and hardiness.

Oil Sprays for Increasing the Hardiness of Red Raspberry Canes (H. G. Swartwout). The death of red raspberry canes so common in the Central West seems to be due to the loss of water. To prevent such loss, canes of Cuthbert and Latham varieties were sprayed with oil emulsions during the winter. The mild winter of 1930-31 resulted in the death of few canes as compared with the usual winter loss. No difference could be noted between the treated and untreated Latham canes, but the Cuthbert plots sprayed with a linseed oil emulsion presented a better appearance and thicker stand of live canes than the check plot.

The Use of Fertilizers on Grapes (H. G. Swartwout). In very poor soil the use of a complete fertilizer has given some increased vigor in Concord vines, but on soil of moderate fertility no apparent benefit has resulted from applications of a complete fertilizer, sulphate of ammonia, or barnyard manure. Light pruning with resulting heavy fruiting has been practiced, but the untreated as well as the treated vines have maintained their vegetative vigor while maturing heavy crops.

Control of Biennial Bearing in York Apples (A. E. Murneek). The program of spring and fall fertilization with nitrogen-carrying

fertilizers have been changed to include fruit thinning in the "on" or bearing year and pruning after a heavy crop. There was no crop of fruit in 1930. Four pounds of ammonium sulphate per tree were applied in the fall of 1930. No fertilizer has been applied in 1931. A good crop is in prospect for 1931. Two hundred Gano trees have been fertilized during both spring and fall with calcium cyanamid (Ca CN_2) in order to compare it with the equivalent amount of ammonium sulphate.

The Relation of Potassium to Nitrogen in Apple Trees (A. E. Murneek, E. J. Gildehaus). Groups of semi-dwarf apple trees have been planted in quartz sand and in loess soil in tubs. These trees have been fertilized with increasing and decreasing amounts of nitrogen and potassium while the phosphorus content of the fertilizer has been kept constant. When the nitrogen was increased without a corresponding increase in the potassium supply, marginal scorching of leaves was induced. Increasing the potassium content obviated this harmful effect of the fertilizer. Chemical analyses of leaves and twigs showed that when potassium and phosphorus were kept constant and at an optimal concentration, and the nitrogen supply varied, there was a corresponding increase or decrease of potassium concentration in the leaves.

The Internal Mechanism of Photoperiodism (A. E. Murneek). Plants of soybeans, cosmos, and salvia were divided into two groups. One group was exposed to a short (7 hour) day and the other to a comparatively long (14 hour) day. Marked differences in greenness of foliage were noticed. Determinations were made of the relative amounts of chlorophyll (a and b), xanthophyll and carotin. The concentration of all three pigments was determined both spectrometrically and colorimetrically. Table 13 shows the result of these analyses.

TABLE 13.—CHLOROPHYLL, XANTHOPHYLL, AND CAROTIN IN COSMOS, SALVIA, AND SOYBEANS

	Milligrams in 10 gram samples			Ratio: Carotin Xanthophyll
	Chlorophyll (a and b)	Xanthophyll	Carotin	
<i>Cosmos:</i>				
Vegetative (long day)---	20.0	1.5	.95	.633
Reproductive (short day)	20.0	1.85	1.17	.633
<i>Salvia:</i>				
Vegetative (long day)---	25.8	2.50	1.85	.744
Reproductive (short day)	25.0	2.80	2.07	.744
<i>Soya:</i>				
Vegetative (long day)---	22.7	1.10	1.52	1.37
Reproductive (short day)	22.1	1.49	2.00	1.34

The same relative quantities of chlorophyll (a and b) were present in the foliage in plants that have been changed from vegetative develop-

ment to reproduction. There was an increased xanthophyll and carotin content in the reproductive (short day) plants. The close ratios of carotin to xanthophyll indicated that these two compounds were generically connected.

The nitrogen metabolism of these plants has been studied. Plants that reach the flowering stage as a result of a relatively short exposure to light have a much higher concentration of nitrogen, especially in the stems. A relative increase in carbohydrate concentration over nitrogen, especially in the stems, either preceded or accompanied the onset of the reproductive state.

Breeding Apples for Late Blooming Habit (A. E. Murneek). Observations were made on rate of development and type of growth of seedlings and young trees secured from various crosses. These trees have not reached the fruiting stage. Seedlings from crosses with Numbers 120 and 124 as female parents and Delicious and Golden Delicious as males have been established in nursery beds for preliminary growth and further study.

Self-Fertility and Cross-Fertility in Apples (A. E. Murneek). By the use of screened cages and small colonies of bees, self-fertility was determined on the following varieties: Delicious, Jonathan, Rome, Grimes, Stayman, and Winesap. Cross-pollination studies were conducted with several different varieties. Two hand pollination methods were used to check the results of these cross-fertility studies. Viability tests of apple pollen have shown varietal differences in the concentration of sugar which will give maximum germination of pollen *in vitro*. Some varieties, like Grimes, Jonathan, and Golden Delicious gave a high percentage of germination when the medium consisted of 35-50 per cent sucrose. Others, like York and Ben Davis, showed a decreased percentage of germinating pollen when the concentration of the medium was higher than 25 per cent. Records of the dropping of immature fruits from all trees have been continued. Histological studies of embryo development of self- and cross-pollinated fruits have been started.

Variety and Strain Tests with Irish Potatoes (T. J. Talbert, W. L. Tayloe). Greater variations were observed in the strains of the Early Ohio than in the Irish Cobbler. Northern grown certified seed showed less injury due to seed-borne diseases. Yields of Irish Cobbler potatoes were reduced and the percentage of culls increased by growing potatoes from immature seed. The following varieties were planted on June 22, 1931 in rows spaced 36 inches apart and the hills spaced 12 inches in the rows: White Burbank, Green Mountain, Peach Blow, Cowhorn, McCormick, Late Rose, Russet Burbank, Rural New Yorker, Poplar Bluff, Brown Beauty, Bliss Triumph, Hoosier Boy, and Early Ohio.

Tuber Lines with Bliss Triumph Potatoes (T. J. Talbert, W. L. Tayloe). This project is in cooperation with the Nebraska Agricultural Experiment Station, and has been planned to determine the best type of Bliss Triumph potatoes for use in Missouri. The seed potatoes used were pure tuber lines representing distinct season types (early, medium, late). They were produced on dry land at Alliance, Nebraska. Five-row plots of 50 hills to each row were planted from each tuber line. Thirty pounds of seed were used. Eight tuber lines were planted. Line 1 very early maturing, Lines 2 and 3 early maturing, Lines 4 and 5 mid-season maturing, Lines 6 and 7 late maturing, and Line 8 very late maturing. Observations have shown three to four days' difference in maturity in the early and late strains.

Fertilizer Experiment on Irish Potatoes (T. J. Talbert, W. L. Tayloe). The rows in these plots were 100 feet long, spaced 34 inches apart, and the seed spaced approximately 12 inches apart in the row. Each plot consisted of one row and the plots were repeated three times. Cobbler variety was used in all plots. The seed was treated by the hot formaldehyde method, using the formaldehyde at 127° F. for four minutes. The following fertilizers were used: 2-12-4, 4-12-8, 4-8-12, 4-8-8, 8-16-16, 9-18-18, 20 per cent superphosphate, 50 per cent potassium chloride, and 15 per cent sodium nitrate. The complete fertilizers were used at the rates of 400 to 1500 pounds per acre. The superphosphate was used at the rate of 200 pounds per acre, potassium chloride at 120 pounds per acre, and sodium nitrate at 133 pounds per acre. The crop has not been harvested.

Cultural and Management Practices with the Sweet Potato (T. J. Talbert, W. L. Tayloe). Seven varieties were used in this experiment: Nancy Hall, Yellow Jersey, Big Stem (Yellow Jersey), Red Jersey, Red Bermuda, Porto Rico, and Priestly. The rows were 75 feet long and the varieties were repeated three times. Vine cuttings were made of all the varieties, but on account of dry, hot weather, stands were secured only on Nancy Hall and Red Jersey.

Sweet Potatoes at Camden, Missouri (T. J. Talbert, W. L. Tayloe). An outlying field of approximately 2 acres is being conducted at Camden, Missouri. The experiments, on this field have been divided into three parts: fertilizer experiments, strain tests with Yellow Jersey sweet potatoes, and spacing experiments. In the fertilizer experiments, the Wabash Railway Company has cooperated in furnishing rent on land, seed, and labor. The rows were 100 feet long and plants were spaced approximately 15 inches in the row. The rows were 42 inches apart. Various fertilizers, rates, methods, and times of application were used.

No fertilizer was applied in the spacing tests. The rows were 100 feet long and each plot consisted of three rows. Four different spacings

between rows were used: 30, 36, 42, and 48 inches. In these rows all plants were spaced 15 inches in the row. A series of plots on distance between plants in the row was made. Spacing of plants in the rows was as follows: 6, 12, 15, 18, and 24 inches, all rows being spaced 42 inches apart.

Tomato Seed Selection for Disease Resistance (T. J. Talbert W. L. Tayloe). A selection has been made from the Marglobe variety that appears to be more resistant to disease, and a smoother tomato. Break O' Day was very satisfactory as a spring greenhouse crop. This tomato is a cross between Marglobe and Earlyanna, produced by the United States Department of Agriculture.

Fertilizer Requirements of Tomatoes (T. J. Talbert, W. L. Tayloe). Tomatoes were planted in rows 75 feet long, spaced 4 feet apart, and the plants spaced 3 feet in the rows. Complete fertilizers were used with the following formulae: 4-12-4, 4-8-8, 8-16-16. In addition, 15 per cent sodium nitrate, 20 per cent superphosphate, and 50 per cent potassium chloride were used. The rates of application were varied. All applications were made in the row and mixed with the soil when the plants were set. Marglobe variety was used. A similar test was made at Cassville, Missouri, on a field of approximately 2.5 acres.

Cabbage Seed Selection for Disease Resistance (W. L. Tayloe). Several varieties of cabbage were used to determine their resistance to cabbage yellows (*Fusarium conglutinans*). Marion Market and Copenhagen Market appeared to be quite resistant. Late varieties showed considerable more resistance to the disease than early varieties.

POULTRY HUSBANDRY

H. L. KEMPSTER, *Chairman*

The Relation Between Feed and Egg Prices in 1930 (H. L. Kempster). The relation between feed and egg prices in 1930 was less favorable than for the two previous years. The average farm price for a mixture of corn, oats, and wheat (5-3-3) was \$1.50 per cwt. as compared with \$1.71 for the previous year. The farm price of eggs per dozen for 1930 was 21 cents or 7.1 cents less than for the previous year. Based on an assumed egg production of 122 eggs per hen, these eggs would purchase 138 pounds of feed. In 1929 the same eggs would have purchased 157 pounds of feed.

Protein Concentrates in Chick Rations (H. L. Kempster, E. M. Funk). Satisfactory results in growth of White Leghorn chicks were obtained with rations using various combinations of dried buttermilk, meat scrap, cottonseed meal, and soybean meal. The basal ration consisted of yellow corn meal, corn gluten meal, ground wheat, steamed bone meal, alfalfa leaf meal, yeast, and salt (40-10-22-3-2½-2-5). To this

was added 10 per cent soybean meal and 10 per cent of either meat scrap or dried bone meal. Cottonseed meal was also used instead of soybean meal. All rations contained 1.5 per cent cod liver oil. The feed consumption for each lot was the same. The rations used were as follows:

<i>Ration</i>	
601	Basal + 10% dried buttermilk + 10% soybean meal
602	Basal + 10% meat scrap + 10% soybean meal
603	Basal + 10% dried buttermilk + 10% cottonseed meal
604	Basal + 10% meat scrap + 10% cottonseed meal

The economy of food utilization was particularly significant. Another group of chicks were self fed the same rations. The feed consumption was higher and growth more satisfactory, but the amount of feed required to produce gain and weight was also higher.

Table 14 shows the results.

TABLE 14.—GROWTH OF CHICKS ON DIFFERENT PROTEIN CONCENTRATES

Ration No.	Weight at 8 Weeks	Feed Consumption	Feed Required to Produce 100 Grams Gain in Weight
	<i>grams</i>	<i>grams</i>	<i>grams</i>
601	451	1146	276
602	459	1136	268
603	447	1151	280
604	454	1145	275

Meat Scrap and Milk in Chick Rations (H. L. Kempster, E. M. Funk). In several different groups of chicks changes in the proportion of milk and meat scrap were made. The basal ration consisted of yellow corn meal, bran, shorts, bone meal, and salt (50-15-15-4-1). The kinds of rations and supplements were as follows:

<i>Hatch No.</i>	
4	Basal + 15% dried milk
5	Basal + 10% dried milk + 5% meat scrap
6	Basal + 5% dried milk + 10% meat scrap
7	Basal + 10% dried milk + 10% meat scrap
8	Basal + 15% dried milk

Hatches 6 and 7 were not brooded in the same house with the other hatches. They failed to make normal growth, due to other conditions than the ration. Growth in Hatch 8 was less than that of Hatch 5, although fed the same ration. The later hatched chicks failed to make as satisfactory growth as the earlier hatched chicks.

At the age of 16 weeks the pullets on the different rations weighed as shown in Table 15.

TABLE 15.—WEIGHT OF PULLETS AT SIXTEEN WEEKS (IN GRAMS)

Hatch No.	Date of Hatch	Leghorns	White Rocks	Reds
4	Feb. 28	1006	1225	1234
5	Mar. 7	922	1205	1260
6	Mar. 14	880	1011	1035
7	Mar. 21	962	1093	1006
8	Mar. 28	971	1103	1192

Deformed hocks were more evident in Hatch 5 and very pronounced in Hatches 6 and 7. It has been suggested that when meat scrap was added to the ration the mineral content of the ration was increased to too high a level. Rocks and Reds were affected more than the Leghorns.

Will Chicks Balance Their Own Ration? (H. L. Kempster, E. M. Funk). Chicks allowed free choice of various feed stuffs selected those feeds essential for growth. The chicks had access to yellow corn meal, wheat bran, wheat shorts, dried buttermilk, dried skim milk, meat scrap, alfalfa leaf meal, bone meal, and salt. Cod-liver oil was given in the drinking water. The chicks were brooded with free choice of food until eight weeks of age. Twice daily the position of the feed troughs was changed. The following are the proportions of the various feed stuffs consumed in the rations selected by the chicks:

Yellow corn meal.....	39.4 per cent
Wheat bran.....	11.1 per cent
Wheat shorts.....	29.3 per cent
Dried buttermilk.....	6.1 per cent
Dried skim milk.....	4.8 per cent
Meat scrap.....	5.4 per cent
Alfalfa leaf meal.....	0.9 per cent
Bone meal.....	3.0 per cent
Salt.....	0.2 per cent

Influence of Yeast on Growth of White Leghorn Chicks (H. L. Kempster, E. M. Funk). The addition of yeast to a ration consisting of yellow corn meal, bran, shorts, dried milk, bone meal, and salt (50-15-15-15-4-1) did not influence growth in White Leghorn chicks. Dried yeast to the extent of 3 per cent was used.

The growth of the chicks was more variable than where a ration consisting of yellow corn meal, bran, shorts, dried milk, bone meal, and salt (50-15-15-15-4-1) was used.

Dried Skim Milk in Rations for Baby Chicks (H. L. Kempster, E. M. Funk). Growth in White Rock chicks was in proportion to the

amount of skim milk used until the amount was over 30 per cent. The basal ration consisted of yellow corn meal, bran, shorts, bone meal, and salt, (50-15-15-4-1). Table 16 shows the results.

TABLE 16.—INFLUENCE OF VARIOUS AMOUNTS OF DRIED SKIM MILK ON GROWTH OF WHITE ROCK CHICKS

Ration	Age in Weeks			
	0	4	8	12
	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>
Males				
Basal + 5% dried skim-milk...	41	135	411	713
Basal + 10% dried skim-milk...	42	194	595	969
Basal + 20% dried skim-milk...	41	191	566	1043
Basal + 30% dried skim-milk...	43	209	664	1196
Basal + 40% dried skim-milk...	42	182	509	995
Females				
Basal + 5% dried skim-milk...	39	137	403	668
Basal + 10% dried skim-milk...	41	182	511	813
Basal + 20% dried skim-milk...	39	188	504	840
Basal + 30% dried skim-milk...	42	200	562	918
Basal + 40% dried skim-milk...	41	174	500	896

Rate of Growth of Rhode Island Red, White Rock, and White Leghorn Pullets (H. L. Kempster, E. M. Funk). Table 17 shows the weight of pullets at 4-week intervals for Rhode Island Reds, White Rocks, and White Leghorns. The growth up to the age of 20 weeks was from 9 to 14 per cent higher than was reported last year. The more favorable growth was due to better care.

TABLE 17.—GROWTH OF PULLETS

Age in Wks.	Rhode Island Reds		White Rocks		White Leghorns	
	Number	Weight	Number	Weight	Number	Weight
		<i>grams</i>		<i>grams</i>		<i>grams</i>
0	235	42.4	241	42	700	40.7
4	227	183	237	170	677	174
8	228	483	229	479	683	450
12	219	856	226	830	665	741
16	204	1216	211	1158	605	990
20	190	1531	192	1473	551	1138

Influence of Time of Hatching on Rate of Growth (H. L. Kempster, E. M. Funk). Tables 18, 19, and 20 show the influence of time of hatching on growth of Leghorns, Rhode Island Reds, and White Rocks.

TABLE 18.—INFLUENCE OF TIME OF HATCHING ON GROWTH OF LEGHORNS

Time Hatched	Feb. 7-21		Mar. 1-8		Mar. 28-Apr. 4	
	Number	Weight	Number	Weight	Number	Weight
Age in Wks.		<i>grams</i>		<i>grams</i>		<i>grams</i>
0	297	40.4	128	40.7	125	41
4	281	168	126	173	122	183
8	290	473	117	452	125	433
12	287	809	110	724	120	689
16	266	1066	103	958	99	929
20	265	1147	89	1100	74	1149

TABLE 19.—INFLUENCE OF TIME OF HATCHING ON GROWTH OF RHODE ISLAND REDS

Time Hatched	Feb. 7-21		Mar. 1-8		Mar. 28-Apr. 4	
	Number	Weight	Number	Weight	Number	Weight
Age in Wks.		<i>grams</i>		<i>grams</i>		<i>grams</i>
0	74	43	67	42	55	43
4	68	176	65	172	55	199
8	72	534	62	476	55	464
12	67	969	62	887	51	798
16	67	1383	61	1256	47	1080
20	65	1657	58	1553	45	1424

TABLE 20.—INFLUENCE OF TIME OF HATCHING ON GROWTH OF WHITE ROCKS

Time Hatched	Feb. 7-21		Mar. 1-8		Mar. 28-Apr. 4	
	Number	Weight	Number	Weight	Number	Weight
Age in Wks.		<i>grams</i>		<i>grams</i>		<i>grams</i>
0	68	41	62	42	48	42
4	66	154	61	166	47	181
8	61	680	59	473	48	474
12	64	915	56	839	44	811
16	62	1223	48	1200	40	1099
20	61	1559	47	1534	40	1366

Influence of Age of Breeding Stock on Rate of Growth of White Leghorns, White Rocks, and Rhode Island Reds (H. L. Kempster, E. M. Funk). Pullet progeny from adult hens of the White Leghorn, White Rock, and Rhode Island Red breeds was compared with pullet progeny from mature pullets of the same breeds in their first laying season. There was no significant difference in the weights of either group. Evidently a pullet sufficiently matured to lay a good sized egg was satisfactory for breeding purposes.

RURAL SOCIOLOGY

E. L. MORGAN, *Chairman*

Rural Community Organization in Public Welfare (Walter Burr). Family case studies were conducted on 59 rural families in Boone county. These families constituted the total number of rural families receiving poor relief from county funds through the office of the social worker employed by the County Court. They were tenant families and families living in rural villages. The tenant families were made up of share renters and persons employed on a part-time basis receiving house and ground in part payment for work. The time period covered by the county relief ranged from six months to twelve years. In some cases where tenants were receiving aid from county funds the landlord was relieved from certain responsibility for adequate support of the tenant family. In other cases the landlord had a charitable attitude and allowed the tenant who was in poverty to remain on the land, even to his own disadvantage. The pauperizing effect of chronic poor relief upon the children of the families was observed and in instances excellent rehabilitation work toward avoiding such an effect had been done. These cases have been handled by a social worker for the County Court for six years. The case records have shown an increasing number of rural families that have been removed from the pauper list through having been aided in solving their problems.

Rural Community Trends (H. J. Burt). The following items have been selected for measurement of changing conditions in rural communities: 1. Public School System. 2. Health Conditions. 3. Utilities and Public Services. 4. Finance, Wealth and Trade. 5. Civic and Religious Interests. An index number has been worked out for each of these items. A combination of the separate indexes gives an index for the community. The study has been applied to three rural communities: a consolidated school area has been taken as a community. Community A had an index of 61.5; Community B 59.3; and Community C 42.1. The completed study has been prepared for publication.

Movements of Rural Population in Missouri (E. L. Morgan). Population changes of all incorporated places in the State have been examined to determine the numerical changes and the influences causing them. The number of incorporated places for the decade 1890-1900 was 392; for the decade 1900-1910 it was 537; for 1910-1920 it was 630; and for 1920-1930 it was 701. The incorporated places in existence over the entire 40-year period were 389.

Table 21 shows the percentage of various sized groups that increased in population over the entire period.

TABLE 21.—PERCENTAGE OF PLACES OF DIFFERENT POPULATIONS SHOWING AN INCREASE FROM 1890 TO 1930

Size of Place	Percentage
0- 499	63.3
500- 999	63.2
1,000- 1,499	71.7
1,500- 1,999	70.0
2,000- 2,499	75.0
2,500- 4,999	74.0
5,000- 7,499	87.5
7,500- 9,999	100.0
10,000-12,499	100.0

SOILS DEPARTMENT

M. F. MILLER, *Chairman*

The Use of Commercial Fertilizer With Corn (M. F. Miller, H. H. Krusekopf). Owing to the drought of 1930 the use of fertilizer with corn gave very little return. Some increases were secured but not sufficient to meet the cost of the treatments. However, contrary to the prevailing opinion among farmers, no definite tendency to decrease the yield was noticed.

The Use of Fertilizer with Wheat (M. F. Miller, H. H. Krusekopf). The drought of 1930 did not seriously affect the use of fertilizer with wheat and generally satisfactory increases were secured. The season was unfavorable for wheat, which so reduced the yields that with the prevailing wheat prices only a small profit per acre resulted.

Outlying Experiment Fields (M. F. Miller, H. H. Krusekopf). Corn yields on all the experiment fields were either a failure or so low as to be of no significance on account of the drought. However, in no case did the fertilized corn yield less than the unfertilized. The low capacity of the Oswego silt loam to withstand dry weather was apparent on the Green Ridge field. The drought made more apparent also the soil variations on the southeast Missouri experiment field near Sikeston. The more sandy areas had the poorest corn. The soil on all the experiment fields was unusually loose and mellow. On the Green Ridge field, in the spring of 1931, a comparison of fertilizers of different ratios, a comparison of different sources and rates of nitrogen fertilizers, a project to determine the efficiency of small amounts of fine lime for growing legumes and a project to determine the rate and time of liming were started. Hail and chinch bugs damaged this field seriously. The plots on the Southeast Missouri field were in their regular cropping system for the first time in 1931.

Fifteen acres of land joining the Elsberry field were leased for tile drainage investigations. The soil is heavy alluvial clay. Tile drains were placed at varying depths and distances to determine the effect of the drains on the water table.

Losses of Nitrogen and Organic Matter Through Cropping (M. F. Miller, H. H. Krusekopf, Hans Jenny). On Putnam silt loam a "virgin prairie" and a cultivated field joining were selected for this investigation. These fields were practically identical in topography, drainage, and exposition. The cultivated field had been in cultivation over seventy years and no fertilizer had been added. There had been no clover or green manure in the rotation. The average changes due to cultivation were as follows: Total loss in nitrogen through cultivation and cropping 35 per cent; total loss in organic matter through cultivation and cropping, 38 per cent. The cultivated field had a carbon-nitrogen ratio 7 per cent narrower than the uncultivated land. The actual acidity increased 157 per cent.

The Relation of Climatic Nitrogen Level to Corn Yield (M. F. Miller, H. H. Krusekopf, Hans Jenny). There is a definite relation of climatic factors to the nitrogen content of soils. Soil nitrogen decreases from north to south in relation to temperature. A study has been made to ascertain the effect of this trend upon the corn yield per acre. There was a close correlation between soil nitrogen and corn yields in regions south of Central Iowa. The climatic nitrogen level may have a decided influence upon the corn yield.

Soil Erosion (M. F. Miller, H. H. Krusekopf). During March, April, July, and December of 1930 no runoff or erosion took place. During the other eight months the losses were very small as compared with normal years. During two of the twelve preceding years the losses under continuous corn were fifteen times those of 1930. The soil on an $8\frac{1}{2}$ per cent slope in continuous corn has been removed at approximately one inch annually. At the Missouri Erosion Experiment Station at Bethany a large number of experimental projects have been started to determine the amount of runoff and erosion under different systems of cropping and cultural treatments, different systems of terracing and gully control, and from land of different lengths and degrees of slope. The effect of various soil treatments, including the addition of different kinds and amounts of organic matter upon runoff and erosion, is being studied.

The Properties of Colloidal Material in Missouri Soil (Hans Jenny, E. R. Shade). Colloidal Putnam clay behaved in certain respects like a weak acid. Titration experiments and base exchange studies showed that Putnam clay colloid was a stronger acid than permutit and a weaker one

than bentonite. Under strictly comparable conditions the following "dissociation constants" were obtained:

Type of Colloid (alumino silicate)	Apparent Dissociation Constant (base = KOH)
Permutit Clay	1.20.10 ⁻⁷
Putnam Clay	30.20.10 ⁻⁷
Bentonite Clay	70.80.10 ⁻⁷

Base exchange studies with various aluminum silicates showed that the cations behaved individually, both in adsorption and release. For adsorption of cations the following series was observed:

Permutit: $Li < Na < K < H$
 Putnam clay: $Li = Na < K < H$
 Bentonite clay: $Na < Li < K < H$

Generally speaking, the order of release was exactly the reverse of the order of adsorption. Calcium adsorbed on various aluminum silicates was compared with the availability of free ionic calcium. Soybean plants grew best if calcium ions were supplied in the presence of acetate anions. Calcium acetate, therefore was used as a standard of comparison. The following relative availabilities were found:

Free Ca ion-	Ca-acetate = 100 per cent
	Ca-bentonite = 96 per cent
Adsorbed	Ca-Putnam clay = 91 per cent
Ca ions	Ca-permutit = 81 per cent

The calcium adsorbed on natural soil colloids was readily available for plant growth. Research Bulletin No. 152 shows the significance of parent material and climate on the amount and distribution of K and Na in soil profiles. Under high rainfall and high temperature the outgo of K and Na was very pronounced. This process was accentuated in soils containing calcium carbonate. Na was also more effective than K.

The Use of Finely Ground Limestone (M. F. Miller, W. A. Albrecht). Small amounts (300 to 500 pounds) of pulverized limestone passed through a 30-mesh screen gave good results especially with sweet clover. The lime and clover seed were drilled into the drill row together. On seven widely different soil types six successful stands of sweet clover were secured in spite of the extreme drought of 1930. Six similar experiments with red clover resulted in but one successful stand. The red clover was damaged much more by the dry weather than was the sweet clover.

The success of using a small amount of finely ground limestone was determined partly by the degree of soil fertility. In the case of sweet

clover inoculated soil mixed with the limestone gave better results than inoculating the seed with artificial cultures.

A more extensive experiment in the use of small amounts of finely pulverized limestone, with and without phosphates, has been started.

Increasing the Productivity of Missouri Pastures (M. F. Miller, H. H. Krusekopf). On account of the drought of 1930 no growth of consequence was secured after the middle of June. The application of the larger amounts of nitrate increased the early season's growth. On the better pasture lands increases, both in yield and in protein content were secured. On poorer pasture land the results were much less significant. The results during the spring of 1931 were quite similar to those of 1930. In a region as far west as central Missouri where midsummer droughts are frequent, the intense fertilization of pastures was more hazardous. There seemed to be, however, marked possibilities for pasture fertilization under average or good seasonal conditions, especially on the better pasture lands. In the spring of 1931 a pasture improvement project was started at Sni-A-Bar Farm in cooperation with the United States Department of Agriculture. The marked effect of nitrogen fertilizer during the early months of the closing season again has been demonstrated here.

The Influence of Nitrogen Fertilizer on Crop Growth (M. F. Miller, R. L. Lovvorn). Nitrogen fertilizers (nitrate of soda) decreased the amount of "firing" during the dry season of 1930. The effect was not sufficient to result in an economic return, at prevailing prices. With lower costs of nitrogen, and during seasons of only moderate drought it might be possible to offset the "firing" which normally occurs during such season. Top dressings of nitrate of soda on wheat applied early in the spring markedly increased the yields. Applications toward heading time had little influence on yield, but increased somewhat the protein content of the grain. Top dressing on grass gave only moderate returns during the dry season.

Methods of Improving Heavy Clay Subsoils (L. D. Baver). Laboratory experiments on the permeability of colloidal clays have distinctly shown that calcium ions promoted a porous structure due to the formation of large, stable aggregates. The rate of percolation of water through clays saturated with calcium ions was about one and a half times more rapid than through the corresponding acid clay. Field experiments on the Putnam silt loam at Moberly showed marked beneficial effects from applications of lime on the structure of the surface soils. The surface soil on the limed plots was more distinctly aggregated and more porous than on the unlimed plots. The soil absorbed more water and dried out more quickly after continued wet weather. These beneficial effects

were undoubtedly not only due to the aggregating influences of the lime but also to the organic matter resulting from the plowing under of sweet clover. Thus far these effects have not extended appreciably into the heavy subsoil layers.

The Relation of the Plasticity Number of Soils to the Clay Content (L. D. Bayer). Analyses of 80 different soils have shown that the plasticity number was proportional to the content of particles finer than .005 mm. in diameter. These data were obtained by (1) mixing soils with a high clay content and high plasticity with non-plastic silty soils, (2) removing all particles larger than clay from the system, and (3) using the results of other investigators. All the data gave the same linear relationship between clay content and plasticity. Soils with less than 20 per cent clay under the newer dispersion methods of determining the clay fraction, were non-plastic.

An Improved Technic for Measuring the Upper Plastic Limit of Soils (L. D. Bayer). The method of Roberts has been modified. By using a Troemner balance a definite force was determined which was constant for all soils, dependent upon the moisture content. The percentage of moisture in the soil at which flow was obtained with the force resulting from a one kilogram weight on the balance represented the moisture content of the upper plastic limit. These values for different soils corresponded with those obtained with the usual hand method. Since a certain amount of flow was obtained with a given force, the influence of the personal element in the determination was decreased to a minimum. The force required to produce a given amount of flow varied logarithmically with the moisture content of the soil.

Crop Rotation and Fertilizer Experiments (M. F. Miller, H. H. Krusekopf). The extreme drought conditions in 1930 caused an almost complete corn failure on Sanborn Field. The corn on the heavily manured plot was damaged more seriously than that on plots receiving no manure or only light applications. All clover and grass seeded in the spring of 1930 were destroyed by the dry weather. These plots were reseeded in August and a good stand resulted. The hay yields in 1931 averaged more than two tons an acre and were among the highest in the history of Sanborn Field. The timothy on the plot in continuous timothy, no treatment, has practically been replaced by red clover, red sorrel, and wild grasses. After 43 years of continuous timothy the plot will no longer maintain the stand. Favorable soil and weather conditions in 1931 caused the wheat on all plots receiving fertilizer or manure to lodge. This caused the wheat yields for 1931 to be erratic, showing no close relation to soil treatment.

VETERINARY SCIENCE

A. J. DURANT, *Chairman*

Eradication of Bang Abortion Disease (J. W. Connaway, A. W. Uren). By means of the tube agglutination tests, isolation or disposal of reactors, and sanitation; the Bang abortion disease may be eradicated. Forty-one herds have been investigated. Ten of these herds have been freed of the infection and since have been maintained as disease free herds. The remainder have made progress but are still classified as infected herds.

Blackhead in Turkeys (A. J. Durant, H. C. McDougale). In last year's report it was stated that abligated birds developed an enlargement of the ceca in from 7 to 32 months after abligation. Observations were reported on 5 birds which received 2 to 4 c. c. of a 4 per cent formalin solution into the ceca immediately after abligation. Observations on the surviving birds have been continued. Twenty-two months after abligation 3 of the 5 original birds were still alive, but showed considerable enlargement of the abdomen, indicating enlarged ceca. The enlarged organ was removed successfully from 2 of these birds. The formalin solution apparently was not helpful in preventing enlargement of the ceca. The other bird died soon after the removal of the ceca. It showed considerable enlargement of one cecum. The other cecum was greatly reduced in size. It is not known why one of the 8 ceca was favorably affected by the formalin treatment. Cultures of *B. Coli communior* which are regularly present in all abligated ceca were isolated from both the enlarged and reduced ceca. It would appear that some other factor than the bacterial content of the sealed cecum after abligation was responsible for the enlargement.

Leukemia in Fowls (A. J. Durant, H. C. McDougale). Blood studies have been made on 39 adult Barred Rock females, preliminary to the

TABLE 22.—BLOOD COUNT OF 39 BARRED ROCK FEMALES

	Total	Average Per Hen	Differential Count
			<i>per cent</i>
Red cells or normoblasts.....	24,393	312.7307	-----
Polymorphonuclear Eusinophils with rods.....	194	2.4861	36.26
Polymorphonuclear Eusinophils with granules....	26	.3333	4.85
Polymorphonuclear Basophils.....	6	.0769	1.12
Endothelial Leucocytes.....	13	.1666	2.42
Transitionals.....	11	.1410	2.05
Lymphocytes.....	285	3.6539	53.27
Platelets.....	604	7.7435	-----
Basket cells.....	182	2.3333	-----
Totals.....	25,714	329.6653	99.97

inoculation of approximately half of this flock with material from the blood and organs of a leukemic fowl. The average blood count of the 39 birds at the beginning and end of a two-weeks interval was as shown in Table 22.

ZOOLOGY

W. C. CURTIS, *Chairman*

Correlation of Cytoplasmic Storage in Germ Cells and Early Stages of Growth and Development in Domestic Animals (Mary J. Guthrie). A study of the growing ovarian egg of the swine has been continued. Particular emphasis has been placed on the early origin of the cells destined to be germ cells and their relation to the cells that form the *stratum granulosa* and *theca interna* of the vesicular follicle. The follicle cells that give rise to the lutein cells which produce the hormone necessary for placentation and retention of embryos have an origin from the primordial germinal epithelium in common with the egg cells. The differentiating lutein cells contain structures in their cytosomes that resemble in all essential respects those found in yolk-laden cells. A number of tubal eggs in early stages of development have been recovered and studied. This work has been rather handicapped by the use of slaughter material of unknown history. For this reason work has been started with sheep of known history in cooperation with the Animal Husbandry Department.

TECHNICAL SERVICES TO FARMERS

The farmers of Missouri depend upon the Experiment Station to supply various services requiring knowledge, skill, and laboratory technique. The staff annually answers thousands of questions relating to agricultural practices. The correspondence required in answering these questions amounted to more than 100,000 letters during the year.

The Department of Veterinary Science examines several thousand specimens annually for identification of disease; the Department of Plant Pathology identifies thousands of plant diseases and recommends remedies; hundreds of seeds and plants are likewise identified by the Department of Field Crops; insect pests injurious to plants and animals are examined and identified by the Department of Entomology. The Department of Horticulture identifies various fruit and vegetable diseases and recommends control measures. Chemical analyses of agricultural materials are made by the Department of Agricultural Chemistry. Special laboratories are maintained for testing feeds, the production of anti-hog-cholera serum, the preparation of legume bacteria, the testing of soils for lime requirement, and analyses of fertilizers, and the official testing of dairy cows.

The following paragraphs contain more complete information regarding these special services:

The Production and Distribution of Bacteria for Legumes (W. A. Albrecht, H. F. Rhoades). During the year sufficient cultures were distributed to treat 31,106 bushels of legume seed. The numbers of bushel units were as follows: Soybean 22,596, Sweet Clover 3,828, Alfalfa 1,491, Red Clover 2,448, Cowpeas 373, Miscellaneous 370.

The use of the soil transfer method of inoculating legumes has been recommended and encouraged. The use of standard commercial cultures has also been encouraged. Table 23 shows the number of bushels of legume seed represented by the cultures shipped and the number of individuals served from 1919 to 1931 inclusive.

TABLE 23.—THE USE OF LEGUME INOCULATED CULTURES FROM 1919 TO 1931

Year Ending June 30	Inoculation Bushels Seed	Individuals Served
1919	2,667	800
1920	2,932	900
1921	5,309	1,665
1922	11,161	2,950
1923	20,010	4,145
1924	37,595	7,173
1925	36,163	6,970
1926	58,441	9,621
1927	41,248	6,096
1928	50,517	6,088
1929	41,407	5,331
1930	38,679	4,823
1931	31,106	4,202
Total	577,235	60,764

Testing Soils for Their Lime Need (H. F. Rhoades). During the year 862 samples of soil have been tested for acidity. Tests are now available on more than 10,000 samples of soil from every county in the State. More than 50 per cent of the cultivated soils in Missouri require at least two tons of finely ground limestone per acre in order to make them suitable for growing clover.

One hundred forty-two samples were tested to determine the fineness of grinding.

Fertilizer Control (F. B. Mumford, *Director*, L. D. Haigh, *Chemist*, E. W. Cowan, A. R. Hall, L. V. Taylor). Under the Missouri Fertilizer Law the Agricultural Experiment Station is required to inspect the stocks of commercial fertilizers sold in Missouri during the year, to sample the different brands found, and to make analyses of the samples. The results of this work were printed in two publications.

Five inspection trips were made, 2 by car and 3 by train, visiting 214 towns in 52 counties. A total of 487 samples were collected. These samples were secured from 225 dealers and 27 farmers. Analyses were made on all samples collected. All companies averaged 104.9 per cent of the amount of plant food guaranteed.

Seed Testing Laboratory (W. C. Etheridge, Miss Clara Fuhr). A total of 4498 samples of seeds and plants were tested and examined, during the year. Of these samples 3,639 tests were made for Missouri farmers and seedsmen, 400 inspectors' samples were tested for the Missouri State Board of Agriculture in connection with the enforcement of the Missouri Seed Law, and 22 Custom House samples were tested subject to the Seed Importation Act.

Four hundred thirty-seven tests were made for farmers and seedsmen of other States. The kinds of tests made and the number of each were as follows:

Germination only.....	2075
Purity and germination.....	1763
Identification.....	375
Examination.....	117
Examination and germination ...	90
Purity only.....	64
Identification and germination... ..	2
	4486
Number of samples received	
July 1, 1929 to June 30, 1930.....	4372
July 1, 1930 to June 30, 1931.....	4498

Distribution of Hog Cholera Serum (O. S. Crisler). This service furnished the swine owners of Missouri 1,260,270 c.c. of anti-hog cholera serum during the year. It was distributed in 1,276 orders to 58 counties and St. Louis city. During the year hog cholera was not as prevalent as usual and the demand for serum was less.

A large number of farmers, teachers, and students have visited the laboratory and farm during the year.

Post-mortem examinations of hogs brought to the laboratory have been made.

Agglutination Blood Testing for Bang Abortion Diseases for Cattle and Swine (A. M. McCapes, E. F. Sanders). There have been 19,351 samples of blood tested for contagious abortion. Of this number, 3,793 reacted to the test. Samples were received from 91 counties in the State. The testing work for the present year has been almost double that for the past year.

Agglutination Blood Testing for Pullorum Disease in Chickens and Distribution of Experimental Chicken-pox Vaccine (A. J. Durant, H. C. McDougle). There were 31,852 blood samples tested for pullorum

disease. Of these samples 13.68 per cent showed this infection to be present. The testing work had greatly increased over that of the past year.

Poultrymen are demanding of hatcheries baby chicks and eggs from blood tested stock or from disease free flocks. During the year 32,995 doses of experimental chicken-pox vaccine were distributed to sixty-four farms in the State. It is impossible at this time to make any statement regarding the efficiency of this method of controlling chicken-pox.

Diagnostic Service (A. J. Durant, H. C. McDougle, A. W. Uren). During the year 2,020 specimens of diseased animals, including poultry, were examined. Eighty-one counties of the State were represented in this diagnostic service.

Official Testing of Dairy Cows (Warren Gifford). For the year ending June 30, 1931, 985 one-day tests and 1,318 two-day official tests were conducted on a total of 477 Advanced Register and Register of Merit cows. There were 558 one-day breed Herd Improvement tests conducted on 95 cows in 6 purebred herds.

One world's record was broken during the year. Observer's Queen 767526, a Jersey cow owned by Longview Farms, Lee's Summit, made a new world's record by virtue of her remarkable record of 677.42 pounds butterfat and 12,845 pounds of milk. She became the world's champion junior two-year-old 305-day producer of the Jersey breed.

The champion Register of Merit cow in Class AA for the State for the year 1930 was Campus Owl Lass A 808636, a two-year-old Jersey cow owned by the University of Missouri. She produced 12,993 pounds of milk and 624.3 pounds of butterfat during 365 days.

COOPERATION WITH OUTSIDE AGENCIES

During the year the Agricultural Experiment Station has cooperated with the United States Department of Agriculture in the following projects: Improvement of Pastures in the Corn Belt; The Value and Utilization of Acid Tolerant Legumes in the Ozark Region; Rice Investigations; Seed Testing Laboratory; Corn Improvement; Factors Influencing the Quality and Palatability of Meat; The Physiology of Reproduction in Farm Animals; Beefiness and Milk Production in Dual Purpose Cattle; Types of Farming in Missouri; Prices and Grades of Cotton; Adjustments and Farm Organization and Operation as Related to the Corn Borer in Northwestern Missouri; The Economic Use of Power, Labor, and Machinery in Crop Production; Sunflower Insect Investigations; Hessian Fly Investigations; Some Economic Aspects of the Farm Poultry Enterprise; Soil Erosion Investigations at Bethany,

Missouri; Maintenance and Development of the Hatch Dairy Experiment Station at Hannibal, Missouri.

The Experiment Station has cooperated also with the following agencies: National Research Council, Missouri Utilities Company, The Frascch Foundation, the American Dry Milk Institute, Chilean Nitrate Soda Corporation, the Drumm Institute, and Sni-A-Bar Farms.

PUBLICATIONS

A. A. JEFFREY, *Agricultural Editor*

Thirty-three publications were issued by the Experiment Station during the year ending June 30, 1931. Of this number 19 were new bulletins, 5 were reprint bulletins, and 9 were new research bulletins. The total number of copies issued was 246,500. The distribution of publications from the Station mailing room was 178,916 copies, of which 124,349 copies went to Missouri, 43,986 to other states, and 10,581 to foreign countries.

TABLE 24.—PUBLICATIONS OF THE MISSOURI AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1931

Serial No.	Series, Title, Author, and Number of Illustrations	Pages	Copies
<i>Research Bulletins</i>			
145	The Effect of the Estrus Producing Hormone on the Growth of the Mammary Gland, by C. W. Turner and A. H. Frank. July, 1930; figs. 52.....	56	2,500
146	Marketing Stock Hogs in Missouri, by Preston Richards and F. L. Thomsen, July, 1930; figs. 24.....	72	3,000
147	The Inheritance of Body Weight in Relation to Milk Secretion, by C. W. Turner. August, 1930; fig. 1.....	44	2,500
148	Social, Economic, and Homemaking Factors in Farm Living, by Randall C. Hill, E. L. Morgan, Mabel V. Campbell, and O. R. Johnson. July, 1930; fig. 1.....	92	2,500
149	Growth and Development XVI. The Influence of Temperature and Breeding Upon the Rate of Development of Chick Embryos, by E. W. Henderson. September, 1930; figs. 18.....	48	2,500
150	A Study of the Estrus Producing Hormone in the Urine of Cattle During Pregnancy, by C. W. Turner, A. H. Frank, C. H. Lomas, and C. W. Nibler. September, 1930; figs. 13.....	44	2,500
151	Variations in Local Prices for Farm Products and Supplies in Missouri, by F. L. Thomsen, November, 1930; figs. 16.	60	2,500
152	A Study on the Influence of Climate Upon the Nitrogen and Organic Matter Content of the Soil, by Hans Jenny. November, 1930; figs. 25.....	68	3,000
153	Taxonomy of the Genus <i>Phytophthora</i> de Bary, by C. M. Tucker. June, 1931; figs. 30.....	208	2,000
Total pages and copies, Research Bulletins.....		688	23,000

Serial No.	Series, Title, Author, and Number of Illustrations	Pages	Copies
<i>Bulletins</i>			
287	Production and Feeding of Silage, by L. J. Stadler, M. M. Jones, C. W. Turner, and P. M. Bernard. July, 1930; figs. 6.-----	20	10,000
288	The Influence of Various Protein Concentrates on Egg Production, by H. L. Kempster. August, 1930.-----	20	20,000
289	Coccidiosis in Fowls, by A. J. Durant. August, 1930; figs. 2.-----	8	20,000
290	Prevention and Eradication of Infectious Abortion in Cattle, by J. W. Connaway. August, 1930.-----	24	10,000
291	The Missouri Farmers' Tax Position, by C. H. Hammar. August, 1930; figs. 4.-----	28	10,000
292	Inspection and Analysis of Commercial Fertilizers; Spring 1930, by F. B. Mumford and L. D. Haigh. October, 1930.-----	12	4,000
293	How Certain Methods of Cooking Affect the Quality and Palatability of Beef, by Jessie Alice Cline, E. A. Trowbridge, M. T. Foster, and Hazel Elinor Fry. November, 1930; figs. 20.-----	40	10,000
294	Growing Orchard Grass in South Missouri, by C. A. Helm. November, 1930; figs. 6.-----	12	5,000
295	Leukemia in Fowls, by A. J. Durant, December, 1930; figs. 4.-----	8	20,000
296	Columbia Oats, a New Variety for Missouri, by L. J. Stadler and R. T. Kirkpatrick. February, 1931; figs. 5.-----	12	7,500
297	Influence of Yield on Costs and Income in Agricultural Production, by Ben H. Frame. March, 1931.-----	12	5,000
298	Registration, Labeling, Inspection, and Sale of Commercial Fertilizers; 1930, by F. B. Mumford and L. D. Haigh. March, 1931.-----	48	4,000
299	Cotton Production in Missouri, by B. M. King. March, 1931; figs. 8.-----	36	5,000
300	Progress in Agricultural Research, by F. B. Mumford and S. B. Shirky. April, 1931; figs. 16.-----	108	5,000
301	Spraying Investigations, by T. J. Talbert and H. G. Swartwout. April, 1931; figs. 4.-----	16	10,000
302	Factors Affecting Sweet Potato Prices in Missouri, by F. L. Thomsen and W. R. Fankhanel. April, 1931; figs. 13.-----	20	3,000
303	Silo Filling Methods and Costs, by Mack M. Jones and Dwight D. Smith. May, 1931; figs. 14.-----	32	10,000
304	Electric Hotbeds, by Ralph R. Parks. May, 1931; figs. 10.-----	16	6,000
305	Beekeeping in Missouri, by Leonard Haseman. June, 1931; figs. 12.-----	52	15,000
<i>Reprint Bulletins</i>			
170	Insect Pests of Field Crops.-----	36	10,000
242	Missouri Strawberries.-----	28	6,000
247	Pastures for Hogs.-----	44	15,000
271	The Control of Gullies.-----	24	8,000
280	Korean Lespedeza in Missouri.-----	12	5,000
Total pages and copies, Bulletins.-----		668	223,500
Total Research Bulletins and Bulletins.-----		1,356	246,500

The Farm News Service.—The Missouri Farm News Service, was issued weekly throughout the year. Each issue contained about 4,000 words. This clippingsheet was released to the newspapers of the State on Wednesday of each week.

The Radio News Service.—A syndicated manuscript service was supplied by mail to five radio broadcasting stations throughout the year. This service consisted of 1,200 to 1,500 words a week. The stations to which this service was sent were KFRR at Columbia, KMOX at St. Louis, KMBC at Kansas City, WMAQ at Chicago, and KMA at Shenandoah, Iowa.

Special Press Service.—Stories designed especially to meet the requirements of the metropolitan newspapers were issued in mimeographed form at irregular intervals. These were mailed to dailies in the larger cities of the State or handed personally to correspondents of the metropolitan dailies and the syndicate news agencies. This service included a total of 106 releases.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS AND PERIODICALS

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- Moffett, H. C., and Trowbridge, E. A. *Wheat for Fattening Yearling Steers*. Record of Proceedings of American Society of Animal Production, 1930.
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- McKenzie, Fred F., and Phillips, R. W. *Some Observation on the Estrual Cycle in the Sheep*. Proc. Amer. Soc. Animal Production, 1930, pp. 138-143.
- McKenzie, Fred F., *A Method for the Collection of Boar Semen*. Jour. Amer. Vet. Med. Assoc., N. S., Vol. 31, pp. 244-246.

- Reid, W. H. E. *The Whipping Properties of Chocolate Ice Cream*. Proc. of 13th annual convention Int. Assn. of Ice Cream Manufacturers, Vol. 2, page 73, October, 1930.
- Stadler, L. J. *Recovery Following Genetic Deficiency in Maize*. Proc. Nat'l. Acad. Sci. 16, 11, pp. 714-720, 1930.
- Stadler, L. J. *The Frequency of Mutation of Specific Genes in Maize*. (Abstract) Anat. Rec., 47: 381, 1930.
- Stadler, L. J. *The Experimental Modification of Heredity in Crop Plants*. I. Induced Chromosomal Irregularities. Sci. Agr. XI, 9, 1931.
- Stadler, L. J. *The Experimental Modification of Heredity in Crop Plants*. II. Induced Mutation. Sci. Agr. XI, 10, 1931.
- Stadler, L. J. *Hereditary Mutations Induced in Plants by the Action of X-Rays*. U. S. Dept. Agr. Yearbook, 1931, pp. 287-289.
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- Turner, C. W., and Frank, A. H. *Relation Between the Estrus Producing Hormone and a Corpus Luteum Extract on the Growth of the Mammary Gland*. Science, Vol. 73, p. 295, March, 1931.
- Vinson, Carl G., and Lojkin, Mary. *Effect of Enzymes Upon the Infectivity of the Virus of Tobacco Mosaic*. Contributions Boyce Thompson Inst., Vol. 3, No. 2, pp. 147-162, 1931.
- Vinson, Carl G., and Petre, A. W. *Mosaic Disease of Tobacco*. Contributions Boyce Thompson Institute, Vol. 3, No. 1, pp. 131-145, 1931.

CHANGES IN EXPERIMENT STATION STAFF

APPOINTMENTS

- L. D. Bayer, *Assistant Professor of Soils*
 E. M. Brown, *Assistant Instructor in Field Crops*
 Wilbur Bryant, *Assistant in Soils*
 C. L. Fleshman, *Research Assistant in Dairy Husbandry*
 A. H. Frank, *Research Instructor in Dairy Husbandry*
 E. J. Gildehaus, *Research Assistant in Horticulture*
 R. S. Glasscock, *Instructor in Animal Husbandry*
 W. C. Hall, *Research Assistant in Dairy Husbandry*
 M. W. Hazen, *Assistant in Animal Husbandry*
 R. L. Lovvorn, *Research Assistant in Soils*
 Arthur Meyer, *Research Assistant in Horticulture*
 Harry Miller, *Research Assistant in Agricultural Engineering*
 J. W. Myers, *Research Assistant in Dairy Husbandry*
 H. C. McDougle, *Research Assistant in Veterinary Science*
 O. E. Palmer, *Research Assistant in Agricultural Economics*
 R. W. Phillips, *Research Assistant in Animal Husbandry*
 Bessie C. Schwartz, *Research Assistant in Home Economics*
 E. E. Smith, *Assistant in Soils*
 W. L. Tayloe, *Research Assistant in Horticulture*
 G. C. Vinson, *Professor of Horticulture*

RESIGNATIONS

- C. H. Bowen, *Research Assistant in Entomology*
 L. H. Jenkins, *Research Assistant in Entomology*
 Preston Richards, *Instructor in Agricultural Economics*
 Margaret Hessler, *Associate Professor of Home Economics*
 J. T. Lutz, *Research Assistant in Soils*
 E. F. Sanders, *Instructor in Veterinary Science*.

FINANCIAL STATEMENT

For the Fiscal Year Ending June 30, 1931

Expenditures from Federal Funds

Classification	Hatch Fund	Adams Fund	Purnell Fund
Salaries.....	\$ 9,206.70	\$ 1,465.06	\$24,559.06
Labor.....	2,463.41	5,609.43	16,479.66
Stationery and office supplies.....	175.25	109.38	487.88
Scientific supplies, consumable.....	83.41	1,119.54	2,212.31
Feeding stuffs.....	466.71	2,919.77	4,713.89
Sundry supplies.....	163.39	508.24	1,341.99
Fertilizers.....		65.03	6.20
Communication service.....	212.29	18.13	209.36
Travel expenses.....	444.49	44.81	2,020.45
Transportation of things.....	187.96	324.31	558.61
Publications.....	15.50		578.38
Heat, light, water, and power.....	45.79	38.42	134.14
Furniture, furnishings, fixtures.....	172.27		313.29
Library.....	219.11		70.34
Scientific equipment.....	439.57	1,045.85	3,640.62
Livestock.....		378.69	1,071.61
Tools, machinery, and appliances.....	166.60	610.66	1,282.61
Buildings and land.....	537.55	742.68	161.96
Contingent expenses.....			157.64
TOTAL.....	\$15,000.00	\$15,000.00	\$60,000.00