

UNIVERSITY OF MISSOURI    COLLEGE OF AGRICULTURE  
AGRICULTURAL EXPERIMENT STATION

M. F. MILLER, *Director*

# A Year's Work in the Investigation of Agricultural Problems

Work of the Agricultural Experiment Station  
During the Year Ending June 30, 1941

M. F. MILLER, S. B. SHIRKY,  
H. J. L'HOTE

COLUMBIA, MISSOURI

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PRESIDENT F. A. MIDDLEBUSH,  
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SIR:

I am submitting herewith the report of the Agricultural Experiment Station for the year ending June 30, 1941. This report is submitted in accordance with the Federal law requiring such report, a copy of which is to be submitted to the Governor of the State and to the Secretary of the Treasury of the United States.

Respectfully submitted,

M. F. MILLER, *Director*  
*Missouri Agricultural Experiment*  
*Station.*

## TABLE OF CONTENTS

	Page
Introduction .....	5
Experiments in Progress during the Year; by Departments as follows:	
Agricultural Chemistry and Animal Nutrition .....	6
Agricultural Economics and Farm Management .....	9
Agricultural Engineering .....	13
Animal Husbandry .....	16
Botany .....	24
Dairy Husbandry .....	25
Entomology .....	39
Field Crops .....	41
Home Economics .....	44
Horticulture .....	45
Poultry Husbandry .....	49
Rural Sociology .....	50
Soils .....	50
Veterinary Science .....	52
Service Projects .....	55
Publications .....	57
Contributions to Scientific Journals .....	60
Cooperative Projects, Research Grants, and Fellowships .....	63
New Equipment .....	64
Changes in Experiment Station Staff .....	65
Financial Statement .....	67



# A Year's Work in the Investigation of Agricultural Problems

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

H. J. L'HOTE, *Assistant to the Director*



Steers grazing on Korean lespedeza pasture. (See page 16.)

The progress of agriculture is dependent upon the work of the agricultural experiment stations. The extraordinary developments in agricultural production are largely the results of over half a century of organized research by these institutions in every state. However, agriculture is constantly becoming more complex and problems are multiplying. As a consequence the need for investigations expands. Farmers and the public generally appreciate this need as never before and it is essential that the work of the experiment stations be maintained and if possible expanded to meet the current and future needs.

This report is a statement of progress of the more important investigations of the Missouri Experiment Station for the year ending June 30, 1941. More complete data appears in the publications covering the results of the individual projects.

# Experiments in Progress During the Year Ending June 30, 1941

## AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

### Nutritional Requirements of Poultry.

In order to determine which vitamins chickens require it is necessary to rear them on simplified diets. In the past it has been impossible to grow chicks at the maximum rate on these simplified diets unless three different liver fractions were included. These fractions were:

1. An alcoholic extract of dried beef liver freed of fat by decantation with water at 70° C.

2. A hot water extract of beef liver following the alcohol extraction.

3. The residue fraction.

a) The residue left after the alcohol and water extractions.

b) The acid hydrolyzed residue.

Two of these liver fractions as pure compounds, choline and pantothenic acid, have been supplied in place of the alcohol extract, and gelatin has been used in place of the residue fraction. So far, it has been impossible to substitute any of the known vitamins for the water soluble fraction of liver.

The unrecognized factor or factors in the water soluble fraction have been concentrated to some extent by adsorption on fuller's earth followed by elution. The eluate incorporated in the ration made the most highly simplified diet used so far. This ration has the following percentage composition:

Casein	35%
Starch	30
Cellophane	3
Lard	17
Salts	4
Gelatin	10
Eluate of a Fuller's earth adsorbate	1
	<hr/>
	100%

	Units per 100 gms.
Vitamin A	24,000
Vitamin D	3,400
	Mg. per 100 gms.
2 methyl-1,4- naphthoquinone	1.0
alpha-tocopherol	8.0
Thiamin	0.8
Riboflavin	1.6
Pyridoxine	1.2
Ca-pantothenate	2.0
Choline	200.0

White Leghorn cockerel and pullets fed this ration weighed an average of 485 and 400 grams respectively at 6 weeks. Although these weights for 6-week-old chicks were very good, the ration was not complete in all dietary essentials. Sixty per cent of the chicks developed a severe dermatitis on the feet and 80 per cent had enlarged hocks or bowed legs. Three gamma of biotin per chick per day prevented the dermatitis. (A. G. Hogan, Boyd O'Dell, L. R. Richardson.)

**Simplified Rations for Growth and Reproduction of Rabbits and Guinea Pigs.** A. G. Hogan and J. W. Hamilton have studied the vitamins required by rabbits and guinea pigs for normal growth and reproduction. Past experience indicated that the fat-soluble Vitamins A, D, and E were required for growth. Therefore, attention has been centered on the water-soluble vitamins. The rations which contained no crude vitamin carriers but only synthetic vitamins were inadequate. Most of the

animals on these diets failed to grow, became unthrifty, and died. The addition of a water extract of yeast and a water extract of liver made the simplified diet adequate for normal growth and reproduction.

One of the simplified rations used contained no Vitamin K. Very few of the guinea pigs born of mothers on this diet survived. Usually the young were born dead or died within a day of two. Almost without exception post mortem examination disclosed subcutaneous hemorrhages on the body and head, with blood in the abdominal cavity and surrounding the brain. A few of the young survived until they were three weeks old, and in all these cases free blood was found in the sinuses of the head and inside the brain case. When vitamin K was included in the ration the mothers were moderately successful in raising their young.

Rabbits fed the same ration were more successful in rearing young, but the majority of these died with hemorrhages. In the rabbit the alimentary bacteria synthesize vitamin K and this may explain the fact that some of the young survived, even though the diet of the mothers did not contain this vitamin. When the rabbits were given a ration containing synthetic vitamin K, there were practically no hemorrhages in the young, and the proportion of survivors was increased markedly.

#### **The Vitamins Required by the Rat.**

Rats have been raised to maturity on a ration containing eight of the known vitamins. Eleven males and five females received this ration and grew at about the same rate as animals on a stock diet. Three males, observed for 26 weeks, weighed an average of 400 grams. Each had sired at least one normal litter during that time. The addition of the following amounts of other known vitamins per 100 grams of the ration did not improve the rate of growth:

1. A combination of 100 mg. of ascorbic acid, 10 mg. of nicotinic acid, and 10 mg. of 2-methyl-1, 4-naphthoquinone
2. 100 mg. of inositol
3. 30 mg. of p-aminobenzoic acid.

Two grams of biotin per rat per day did not improve the rate of growth.

Gains were reduced by 30 to 40 grams during a 6-week experimental period when the thiamin, pyridoxine, riboflavin, and choline were decreased to one-half the quantity supplied in the basal ration. Also, the gains were reduced by the same amount when each vitamin was reduced singly to one-half that of the basal ration. These data indicated that these vitamins were required in relatively large amounts for normal growth.

The average gain of the males during a six-week period was 161 grams, and this gain was increased to 195 grams by the addition of four per cent of a water extract of beef liver. This has led A. G. Hogan, L. R. Richardson, and E. L. Powell to believe that liver extract contains unrecognized vitamins which are essential for the maximum rate of growth.

The five females which were reared on the experimental ration were mated with a male from the stock colony when they weighed 160 to 170 grams. Thirty days later one litter was born but all the young died within 24 hours. The ration then was changed as follows:

1. The manganese was increased to 0.025 per cent.
2. One hundred mg. of inositol; 30 mg. of p-aminobenzoic acid; 1.0 mg. of nicotinic acid; and 1.0 mg. of 2 methyl-1, 4 naphthoquinone were added to each 100 grams of the basal ration.
3. Ten per cent of gelatin replaced an equal amount of sucrose.

Five weeks after these changes were made in the ration each female bore a litter. Two of the litters survived less than 24 hours and the other three were weaned at 28 days. At this time the

young were 40 to 50 per cent smaller than young of the same age from mothers which had received a stock ration. The mothers on the synthetic diet were very thin and unthrifty at the end of the lactation period. Two of them developed symptoms of a middle ear infection and one succumbed. Although rats have been raised successfully on a ration which contained only known vitamins it is apparent that this type of ration still is deficient for normal reproduction and lactation.

**Vitamin Requirements of Mature Pigeons.** Mature pigeons were maintained on a practical diet until their normal weight was determined. They then were placed on a synthetic diet devoid of all water soluble vitamins. After three or four weeks, when the birds had lost 30 per cent or more of their weight and some of them had developed typical symptoms of polyneuritis, they were given vitamin B<sub>1</sub> in addition to the basal diet. This usually caused some gain in weight, but when continued the birds again lost about 30 per cent of their weight and became severely anaemic. At this point other water soluble vitamins were added and their effects on the weight and anemia were observed.

Earlier observations established the fact that pigeons required riboflavin if they were to maintain normal weight. Unlike chicks, it appears that pigeons require nicotinic acid for normal maintenance. Pigeons also require vitamin B<sub>6</sub> to attain normal weight. Recently it has been shown that B<sub>6</sub> was one of the factors related to pigeon anemia. If all the known vitamins except B<sub>6</sub> were given the anemia slowly became more severe. The addition of B<sub>6</sub> to this supplement caused a prompt return to a normal hemoglobin level.

Pantothenic Acid also was necessary for the maintenance of normal weight in mature pigeons. It played an important role in permitting the birds to recover from anemia. It stimulated the

growth of new feathers in birds that had become partially denuded. There was healing of the dermatitis and new feathers were visible in less than a week after calcium pantothenate was added to the supplement.

The role of choline in pigeon nutrition has not been well established. It has been determined that the hemoglobin level rose in almost every case after choline was added to the supplement. Choline apparently helped in weight maintenance.

At the present time the evidence indicates that there is at least one more unknown water soluble vitamin necessary for normal growth in pigeons. It is adsorbed by fuller's earth from crude extracts. Birds receiving such an adsorbate, in addition to the six crystalline vitamins listed above, were still normal in every way after six months on the synthetic "B-free" diet. (A. G. Hogan, L. R. Richardson, E. L. Powell.)

**Abnormal Bleeding of Swine.** A strain of Poland China swine used in an inbreeding experiment was found to have an inherited defective blood clotting mechanism. When tested by the usual methods all the blood clotting components were normal, except that the blood platelets were abnormally stable. This swine disease resembles human hemophilia in every respect.

In handling these animals it has been frequently necessary to draw blood samples or make intravenous injections. Since the blood vessels of white-skinned animals are much more easily located than those of animals having dark skins, attempts have been made to transfer the disease from the Poland Chinas to Chester Whites.

The first requisite in this work was to find a workable method for determining which animals have a defective blood clotting mechanism. A plasma coagulation method has been developed by M. E. Muhrer which seems superior to any method previously used. The entire

spring pig crop was tested by this method and no errors in the diagnoses have been discovered. (A. G. Hogan, M. E. Muhrer, E. T. Mertz, L. A. Weaver, R. Bogart.)

#### **Service Work in Agricultural Chemistry**

Additional work in cooperation with the Departments of Field Crops, Animal Husbandry, Dairy Husbandry, and Soils on "Increasing the Productivity of Missouri Pastures" has been com-

pleted. Chemical analyses were made of the roots, rhizomes, and herbage of pasture growth of samples collected and prepared by the Department of Field Crops. The determinations included moisture, ash, protein, ether extract, and crude fiber. Also, as a service to the other departments of the Agricultural Experiment Station, various analyses were completed on a number of different samples of materials.

## **AGRICULTURAL ECONOMICS**

O. R. JOHNSON, *Chairman*

**Seasonal Variation of Various Feed Prices.** There are seasonal variations in the prices of feeds commonly used by Missouri farmers causing advantages and disadvantages to buying feeds at certain times of the year. The prices of feeds and their feeding values must be taken into consideration in determining which are the most economical and when is the best time to purchase them. H. M. Haag and Norman St. John have analyzed the prices of 14 feeds on the St. Louis market from 1924 to 1940 and have prepared price series, indexes of seasonal variation, and indexes of economy of these feeds for this period.

In the case of soybean meal, linseed meal, shorts, and meat scraps; the amount of seasonal variation in price was small. Prices of bran and alfalfa hay showed large seasonal changes. If possible, farmers should buy their year's supply of feed in the season of lowest price and store it until needed, providing the seasonal change in price exceeds the cost of storing, including deterioration and losses.

Certain foodstuffs, over a period of years, tend to be cheaper sources of nutrients but the relationship between prices and feeding values, even for these feeds, may change abruptly from time to time so that general recommendations cannot be made. During the past

5 years soybean meal, cottonseed meal, and gluten feed have been cheapest of the high-protein concentrates and bran, shorts, and oats have been the least expensive feeds of low-protein content. In most years bran and shorts were extremely economical feeds just after wheat harvest.

Missouri Agricultural Experiment Station Bulletin 422 gives a complete report on the seasonal variation and economy of basic feeds for the period 1924 to 1940.

**St. Louis Wholesale Fruit and Vegetable Market.** This market is an important outlet for fruits and vegetables from Missouri, Illinois, and other states. H. M. Haag and H. L. Schweitzer have described the organization and facilities available. They have determined as far as possible its sources of supply, its sales outlets, and the costs of handling fruits and vegetables through the market.

The average annual sales of 13 wholesalers amounted to \$474,000 per firm on which margins averaged 7.9 cents per dollar of sales and costs averaged more than 7.6 cents per dollar of sales. Margins and costs per dollar of sales declined as firms became larger. Nine wholesalers averaged handling 285,000 packages in 1939. The average sales price per package was \$1.60. Margins averaged 12.8 cents and costs, 12 cents per package. Costs and margins per

package declined as the number of packages handled increased.

Most of the selling and administrative expenses were in salaries and wages. Officers of the company were more often salesmen than supervisors. Only one-fifth of marketing costs were spent on administrative duties.

The average rent paid by each of the nine wholesalers was \$2,518 per year. This amounted to 81 cents per square foot of first floor and sidewalk space and 88 cents per 100 packages handled. The average annual rental for the entire 82 firms in the market was \$2002. Rentals per square foot declined as the size of floor space increased.

Thirteen wholesale firms made about 84 per cent of their sales on credit and had about 17 days of credit sales outstanding in 1939. Credit expense averaged 80 cents per \$100 of credit sales. Sales of six service firms amounted to \$555,000 per firm in 1939. Margins were 12.4 cents and costs 12.7 cents per dollar of sales. Retail service firms were those firms that sold and delivered fruit and vegetables in relatively small lots to retailers. About 78 per cent of the sales of these firms were made on credit and they had 16 days of credit sales outstanding. Credit expense averaged 77 cents per \$100 of credit sales.

A complete report of this work will be found in Missouri Agricultural Experiment Station Research Bulletin 327.

**The Missouri Farm Real Estate Situation.** Farm real estate values in Missouri changed very little from 1932 to 1939 inclusive. C. H. Hammar and E. S. Troelston have shown that values were stable at about 45 per cent of their 1912 to 1914 level and that land was selling at about the same price as it was in 1900. The turnover in farm real estate has been high and most sales have been voluntary.

In 1920 the ratio of gross rents to land values in 25 Missouri counties was 4 per cent while the yield on govern-

ment bonds for that year was more than 5 per cent. In 1940, by contrast, the gross return from land was 7.9 per cent and from government bonds 2.2 per cent.

**Land Utilization in Callaway County, Missouri.** During the period 1916 to 1938, a total of 23 per cent of the farmsteads in Callaway County had been abandoned. C. H. Hammar and A. M. Meyers classified the abandonments into two types. In the better land areas only the buildings were abandoned and most of the fields remained in use. In the poorer land areas the abandonment of crop land and the abandonment of farm buildings were approximately equal on a percentage basis.

On an area of Lindley-Marion soil approximately 60 per cent of the farms were either abandoned or definitely substandard. In the better land areas the more successful farms were the larger ones. An analysis of cropping systems failed to establish clearly that the use of land was more or less conservative on any particular class of farm.

This work has been in cooperation with the United States Department of Agriculture and a complete report has been published as Missouri Agricultural Experiment Station Research Bulletin 346.

**An Analysis of Farm Records from Laclede County.** Accounting records from 38 farms in Laclede County have been summarized and analyzed by B. H. Frame. The farmers were considered among the better farmers in the county. They were divided into two groups, 19 in each group, based on the net farm income. The 19 farmers having the higher incomes averaged \$1574 as compared with \$589 for the 19 having the lower incomes. The first group had \$1868 available for living or saving as compared with \$806 for the second group. The farms averaged 326.8 acres with a total investment of \$11,562 capital per farm and 228.2 acres and \$7968

capital respectively for the two groups. Those with the higher incomes also had a higher capital investment in productive improvements, but the per acre value of these improvements was much less. They also used their tillable land more intensively and planted more legumes than the low income farmers. The use of labor, power, and equipment was much more economical in the high income group. In the production of livestock they were generally more efficient with the exception of the raising of sheep in which enterprise the two groups seemed to be about equal.

**Public Ownership of Land in the Ozarks.** The buying of land for public ownership, both Federal and State, has created a problem for the local governments in areas of the Ozark upland in Missouri. Approximately 1,200,000 acres of land have been moved into public ownership and most of this is concentrated within the borders of a few counties. F. A. Clarenbach and C. H. Hammar believe that placing such land under government ownership is needed in order to restore the productiveness of the area which for the most part will be through forestry. However, publicly owned lands are removed from the taxing jurisdiction of local authorities. Arrangements have been made at the time of purchase to pay the local governments 25 per cent of the gross value of the receipts from such land, but this does not provide present income to the county since receipts will not be large for a number of years.

The financial problems of these counties are aggravated by the unusually large tax delinquency list. However, it is true that a large percentage of delinquent taxes ultimately are collected in Ozark counties. Local governmental reorganization in these areas might be helpful.

This work has been in cooperation with the United States Department of Agriculture and the results have been

published as Missouri Agricultural Experiment Station Research Bulletin 331.

**Population Resource Relationships in Missouri.** In order to determine where population adjustments are most needed it is necessary to establish the population-resource relationships in the different areas in the State. C. H. Hammar and E. D. Woodbury have assembled information which indicates where population-resource relationships are least favorable and therefore where population adjustments are most needed.

Population pressure was found to be heaviest upon the poor lands of the State. An exception to this was in the cotton producing section of southeast Missouri where population pressure was great upon relatively productive land. School child enumeration data indicated that the number of school children was decreasing most rapidly in areas of poor land or in areas where the population pressure was greatest. However, the return of people to the land during the depression was greatest in the poor land areas.

In 1937 and 1938 there was another steep decline in numbers of school children in these poor land areas indicating that a rapid population adjustment was taking place. One of the results of heavy population pressures in the Ozark area has been in the use of more than double the amount of land for crops than the amount suitable for cultivation.

In the southeast lowlands where population pressure also is very heavy, the trend in population in recent years has been rapidly upward increasing the pressure.

**The Economic Aspects of the Use of the Lake of the Ozark Area for Recreation.** The formation of the Lake of the Ozarks in 1931 with its 65,000 acres of lake surface and 1,372 miles of shore line opened a new area for recreational development in parts of Miller, Camden, Morgan, and Benton counties. By 1939 approximately 9,000 acres of land were



in recreational ownership of various types. In 1940 there were 297 commercial and 579 non-commercial recreational establishments in the area. However, by this time new developments had begun to decline as indicated by the volume of new investments, the number of land transfers, and the number of fishing permits issued. Total recreational expenditures at commercial resorts in the area in 1939 was approximately \$650,000 and the total in the area approximately \$800,000. Approximately 80 per cent of the visitors were residents of Missouri.

This study has been made by J. R. Snipe and C. H. Hammar and is in cooperation with the Missouri Conservation Commission. Missouri Agricul-

tural Experiment Station Bulletin 448 gives a detailed report of this work.

**Pasture Yields in Missouri.** In order to have information as to the value of pasture yields in different sections of Missouri, pasture records were collected in 1937 and 1938 in Lawrence, Texas, Vernon, Barton, Pettis, Nodaway, Sullivan, Marion and Monroe Counties. O. R. Johnson and Homer J. L'Hote evaluated pastures in terms of corn equivalents. A corn equivalent has been defined as the amount of feed having a net energy value equivalent to one bushel of No. 2 dent corn. The yields of permanent pastures for these two years in the counties indicated are as follows:

County	Production Per Acre in Bu. Corn Equiv.	
	1937	1938
Nodaway .....	18.1	18.2
Lawrence .....	13.6	9.7
Pettis .....	14.4	12.4
Marion .....	11.7	.....
Monroe .....	10.2	6.7
Sullivan .....	9.8	11.3
Texas .....	8.8	9.1
Vernon-Barton .....	8.0	8.2

Yields of various kinds of rotation and supplemental pastures also were determined in the same areas. The yields

in terms of corn equivalents for the various kinds of pasture were as follows:

Kind of Pasture	Production Per Acre in Bu. of Corn Equiv.
Oats and Korean Pastured Out .....	13.1
Korean Seeded Alone Pastured Out .....	9.7
Timothy Pastured Out .....	16.1
Sudan Pastured Out .....	22.0
Rye Pastured Out .....	12.1
2nd Yr. Sweet Clover Pastured Out .....	21.2
Barley Pastured Out .....	20.0
Wheat Pastured Out .....	9.9
Timothy & Korean Pastured Out .....	14.8
Barley Pastured & Harvested .....	3.8
Wheat Pastured and Harvested .....	3.1
Korean in Small Grain Stubble .....	9.8
Small Grain Stubble Pastured .....	5.0
Corn Stalks Pastured .....	2.4
Timothy Cut for Hay and Pastured .....	4.4

#### *Miscellaneous Investigations*

The Department of Agricultural Economics in its work with poultry and egg marketing has completed a mail survey of 4,000 farmers in 236 town-

ships of Missouri and the tabulation and analysis of these records are in progress. In the livestock marketing work arrangements have been made with county agents for the mailing of



25,000 farm schedules. Also a number of teachers of vocational agriculture are to secure farm schedules from farmers in their community. In studying the decline in farm unit productivity, complete farm records have been secured from a number of farms and a very detailed examination of each of the farms

has been made. A large amount of the required tabulation work has been completed and the results are being analyzed. A new phase of the work with farmers' cooperative organizations in Missouri deals with trends in sales margins and expenses.

## AGRICULTURAL ENGINEERING

J. C. WOOLEY, *Chairman*

**Combine Harvesters in Missouri.** The use of combines has increased greatly on Missouri farms with the introduction of smaller sizes. They have been used for harvesting and threshing most small grain and seed crops grown extensively in Missouri. M. M. Jones and R. P. Beasley have investigated whether or not combines were proving satisfactory and economical. A survey was made of 182 Missouri combine owners in 1937, 1938, and 1939. The average acreage of grain cut per day was 7.6 acres for a 40-inch combine; 13.8 acres for a 5-foot machine; and 25.3 acres for a 12-foot machine. Owners estimated the maximum acreage of wheat and oats that one machine should cut per year to be about 125 acres for a 40-inch machine; 236 acres for a 5-foot machine; and up to 388 for the twelve-foot size. Custom work amounted to one-third to one-half of the total combine work. This was satisfactory in general to both combine owners and farmers. Combines were dependable and reasonably trouble free. The average time lost per season on account of breakdowns was six hours. Repair costs varied from two to five and one-half cents an acre. The factor having the greatest effect on the cost of combining was the total acreage harvested. The records of 53 5-foot machines showed costs varying from 78c per acre for those cutting between 401 and 450 acres to \$2.19 per acre for the group cutting less than 100 acres a year. The average

cost was \$1.24 per acre. The average acreage harvested per season was 238. The cost of combining with 40-inch machines pulled by one-plow tractors varied from \$1.64 to \$3.03 per acre; with 5-foot combines pulled by two-plow tractors from \$1.14 to \$3.90 per acre; and with 10-foot combines from \$1.20 to \$3.61 per acre. The cost with the binder-thresher method was from \$2.98 to \$3.75 per acre.

Grain and seed losses varied with the condition of the grain, the adjustment of the machines, and the skill with which they were operated. Combine losses were somewhat lower than binder-thresher losses.

**Small Grain Straw Should be Utilized.** The practice of harvesting small grain with a combine has created a problem in the utilization of straw for maintaining or improving the soil. J. C. Wooley and R. P. Beasley have been studying different methods of handling this straw in order to determine the best practice. A field of poor quality Lindley soil was divided into four plots of three acres each. Best results were secured by adding nitrogenous material to the straw to hasten decay and to prevent the use of soil nitrogen in the decomposition process.

Lespedeza was used to furnish the nitrogenous material on one of the plots and the lespedeza and wheat straw were turned under at the time of plowing. Using the 1939 yield as a base, this plot yielded 52 per cent as much in 1940. On

another plot aero-cyanamid was added to the straw as it was turned under. The yield on this plot was 52.4 per cent of 1940. On another plot the wheat straw was turned under without treatment; the percentage was 45.4. On the fourth plot the wheat stubble was mowed following the combine and all the straw was removed and piled in a flat stack so that the maximum amount of rainfall would be absorbed. Commercial nitrogen was added to the straw to hasten decay. This material is for use the following year. The yield for the fourth plot for 1940 was 54.8 per cent. This represented the yield from a plot on which all of the straw had been removed. The consistently lower yields in 1940 were due to a severe 1939 fall freeze. The yields for this one year are not especially significant.

**Efficiency of Tillage Methods in Growing Corn.** Crop production requires a material expenditure of labor and power. Costs for these items may amount to 65 per cent of the total cost of producing a crop of corn. For a number of years M. M. Jones, L. E. Hightower, and R. P. Beasley have studied the effect of different methods of seedbed preparation and of different methods of cultivation upon the yield of corn and upon the cost of production. Putnam silt loam that had been in oats and lespedeza the previous year was used for this study in 1940. All plowing was done in the spring and the cultivation on the different plots was held constant: that is, one standard cultivation of sweep with rotary hoe, a second, and a third cultivation each with sweeps. Plowing early in the spring, with discing and harrowing just ahead of planting gave both higher yields and higher returns per man-hour and per horse power hour than plowing, discing, and harrowing just ahead of planting. The delay of planting for two weeks beyond the normal planting time permitted more weeds to sprout and be killed before planting

and appeared to have some possibilities.

There was little choice between three kinds of early cultivation: harrowing; using the rotary hoe; and using the ordinary cultivator equipped with sweeps and with rotary hoe wheels serving as fenders next to the row. Highest yields and greatest efficiency were obtained with surface cultivation. For this method the cultivator was equipped with a single long blade on each side of the row. This blade was set at an angle of 30 degrees with the direction of travel and operated at a depth of about one inch.

**Seed-Bed Preparation for Small Grain Following Lespedeza.** Lespedeza has become an important crop in Missouri agriculture and is used extensively in small grain-lespedeza rotations. In preparing a seedbed for small grain following lespedeza, the common practice has been to disc the lespedeza sod late in the summer or early fall. During dry years this method appeared to decrease the yield of small grain and more thorough seedbed preparation appeared necessary. Frequently the soil was so hard and dry that the use of moldboard plows was impractical, costly, and time consuming. M. M. Jones, R. P. Beasley, and L. E. Hightower have tried a number of different implements for the late fall preparation of seedbeds for small grain following lespedeza on Putnam silt loam. A one-way disc plow and a field cultivator equipped with narrow shovels both did good work in ground so hard and dry that a disc harrow did not secure adequate penetration. In years when winter-killing of small grain was normal, there appeared to be little choice between the field cultivator and the one-way disc plow as far as yields of grain were concerned. In the winter of 1940-41 when winter-killing was severe, yields of wheat were higher on plots prepared with the field cultivator than on those prepared with other implements. Slightly more horsepower-

hours were required to prepare a seed-bed with a one-way disc plow than with a field cultivator.

#### **Planting and Harvesting Castor Beans.**

The demand for oil from castor beans is increasing. Before castor beans can be successfully and economically grown in Missouri a number of problems must be solved. In 1940 castor beans were planted in 42 inch rows with one seed each 36 inches in the row by use of a specially adapted plate in an ordinary corn planter. Each fifth row was omitted to provide space in which to harvest the crop.

Two cultivations were made with a corn cultivator: the first on June 7 and the second on June 16. Castor beans ripen unevenly and therefore require harvesting at least three times during the season. Some of the beans shatter and are lost if left too long in the field. To determine the amount and time of shattering, twenty-five plants of each of two varieties were allowed to stand in the field until the spring of the following year. The beans on the center spikes were mature on October 2 when the first shattering occurred. Counts were made each week through the fall and spring seasons. Very little shattering occurred after November 28. The beans threshed more easily when first mature and before the hulls or pods had time to harden or case. A total of 12 per cent of the beans shattered during the season from the Conner variety and 18 per cent from the Klopff variety. The yield of the Conner variety on Putnam soil without treatment was 820 pounds of beans an acre. When 150 pounds an acre of 4-12-4 fertilizer were added the yield was increased to only 890 pounds an acre. The yield on Lindley soil without treatment was 445 pounds an acre. The oil content of mature beans was 51.4 per cent. Germination of beans from the first harvest was 99 per cent; from the second harvest 63 per cent; and from the third harvest 33 per cent.

**Methods and Devices for Hulling Castor Beans.** An attempt was made to cut and thresh the castor beans with an ordinary combine. The cutting was very difficult and a large number of beans were cracked in the threshing process. The dry pods require more pressure to open than is required to crack the cover on the bean. This makes the process difficult.

Two general methods of hulling were attempted. The first consisted of two belts placed close to each other and operated at different speeds. This gave a combined rolling and rubbing action. Pressure plates holding the belts in place made the machine about 97 per cent efficient when the beans were dry, but the capacity of the device was rather low and the wear on the belts was excessive.

In the second method the hulling action was secured by use of two cylinders about 14 inches in diameter and 20 inches long. These were made of wood and were covered with corrugated rubber matting. One cylinder was operated at 100 revolutions a minute and the other in the same direction at 50. When beans were dry these cylinders hulled about five bushels an hour, and damaged about 7 per cent of the beans. From 3 to 20 per cent of the beans were unthreshed and had to be processed a second time. Closer adjustment of the cylinders resulted in more thorough threshing but in an increase in the percentage of damaged beans.

The huller was mounted on a trailer so that it could be pulled through the field and the spikes cut and fed into the machine in a manner similar to husking corn by hand. (J. C. Wooley, M. M. Jones, R. P. Beasley, Lloyd Hightower.)

#### *Miscellaneous Investigations*

The Department of Agricultural Engineering also has designed a tractor hitch for horse-drawn scrapers; a natural draft ventilation system for farm

buildings; a heater for sheep dipping tanks; a tractor hitch for a horse-drawn mower; and equipment for the supplemental irrigation of corn. Work has been done on the effect of environment on laying hens in cooperation with the Department of Poultry Husbandry. An

experimental electric stock water tank heater has been made and tested. Inspections have been made of posts in the project on prolonging the service of wood fence posts but no significant changes had occurred during the year.

## ANIMAL HUSBANDRY

E. A. TROWBRIDGE, *Chairman*

**Grass and Roughage for Beef Production.** Choice Hereford steer calves averaging 425 pounds in weight were placed on experiment in December 1938 to study the relation of age to the production of beef with the maximum use of grass and roughage and a minimum use of grain. During the winter these calves were fed all the corn silage and legume hay that they would eat and were furnished lespedeza and wheat pasture in the summer until they were put on full feed at intervals during their third year of age. They were continued on full feed until they graded "good" in the carcass. One lot was marketed directly from pasture.

The degree of fatness of the cattle on the roughage and pasture ration increased as their age increased. The older cattle required less time and feed to reach the carcass grade of "good" when put on full feed. Two and one-half year old steers of high quality were full fed grain for thirty-five days in the fall. They required about 11 bushels of corn, 56 pounds of 41 per cent cottonseed meal, and 408 pounds of legume hay to fatten so as to grade "good" in the carcass. The live weight of the steers was 1260 pounds and their dressing percentage was 61.28.

Calves, fed 168 days, consumed 28 bushels of corn, 157 pounds of 41 per cent cottonseed meal, 525 pounds of legume hay, and 1247 pounds of corn silage. They weighed 800 pounds at the end of the period, graded "good" in the carcass, and dressed 57.83 per cent.

Yearlings were fed 130 days and consumed 29 bushels of corn, 162 pounds

cottonseed meal, and 897 pounds legume hay. They weighed 857 pounds when marketed and dressed 59.36 per cent and graded "good" in the carcass.

Steers, put on feed in January before they were two years old, were fed 112 days; consumed 25 bushels of corn, 136 pounds cottonseed meal, 445 pounds of legume hay, and 1 ton of corn silage. They weighed 1045 pounds, graded "good" in the carcass and dressed 60.8 per cent.

The two and one-half year old steers marketed directly from the lespedeza pasture without grain weighed 1157 pounds, dressed 60.3 per cent, and graded "low good" in the carcass.

The use of roughage and pasture can be increased gradually with advancing age of steers. The grain required to produce a pound of gain increased with advancing age but, due to the gain produced on roughness and grass and the shorter grain feeding period, the older cattle produced more beef for the amount of grain consumed than did the younger cattle.

Although the time required is longer, the decrease in the total grain requirement and the greater use of roughness may offer opportunity to many Missouri farmers to fit better the production of beef to their scheme of farming. (E. A. Trowbridge, A. J. Dyer, J. E. Comfort.)

**Silage From Various Crops for Wintering Calves.** Silages made from alfalfa, green barley, corn, and atlas sorgo have been compared as wintering rations for calves. All were fed with alfalfa hay. The alfalfa silage was of

low quality and the calves on this ration were given about 3 pounds of corn daily.

Another lot of steers was fed corn silage with 1 pound of cottonseed meal per head daily. Steers fed silage of excellent quality produced a daily gain of 1.14 pounds through the winter. When 1 pound of cottonseed meal was added to that ration the gain was 1.6 pounds daily.

Calves on barley silage gained .69 pounds daily and those receiving the atlas sorgo silage gained .58 pounds daily. The atlas sorgo silage was not of maximum quality because it was immature. Steers receiving 3 pounds of corn in addition to the alfalfa silage made an average daily gain of .85 pounds. Apparently, there is a possibility of increased usefulness of legumes, small grain, and sorghum as silage crops in Missouri for wintering calves. (E. A. Trowbridge, A. J. Dyer, J. E. Comfort.)

**Barley as a Feed for Fattening Cattle.** Crushed Missouri Early Beardless barley has been compared with shelled corn for fattening calves. Two lots of calves were full fed grain for 182 days after weaning. The corn fed calves consumed a total of 1911 pounds of shelled corn, 191 pounds of 41 per cent cottonseed cake, 440 pounds alfalfa hay, and 1508 pounds corn silage. They gained 2.23 pounds daily, weighed 770 pounds at the market, graded "middle good" in the carcass, and dressed 59.72 per cent. The barley fed calves consumed 1918 pounds of crushed barley, 192 pounds of 41 per cent cottonseed cake, 453 pounds alfalfa hay, and 1575 pounds corn silage. They gained 2.36 pounds daily, weighed 792 pounds at the market, graded "low good" in the carcass, and dressed 58.42 per cent.

Little difference was observed in the feed required to produce a pound of gain but the barley fed cattle appeared to grow somewhat more than the corn fed cattle and the carcass grade and

dressing percentage showed that they were not quite as fat although the difference was so slight that both lots sold at the same price, and all made satisfactory beef.

This and earlier trials have shown that grain from Missouri Early Beardless barley may be substituted for corn in rations for fattening cattle when the price is advantageous or when the barley better fits the farm production system. (E. A. Trowbridge, A. J. Dyer, J. E. Comfort.)

**The Managed Grazing of Bluegrass Pastures.** This project is in cooperation with Sni-A-Bar Farms, the United States Department of Agriculture, and the Department of Field Crops. Three systems of grazing (continuous, rotation, and supplemented) have been under comparison since 1931. During the 1940 grazing season 70 yearling Shorthorn steers, averaging 565 pounds at the beginning of the season, were used.

Under the continuous system 20 steers grazed 25 acres of bluegrass from April 16 to October 30 and averaged 228 pounds of gain per steer or the equivalent of 182 pounds per acre of pasture.

Under the rotation system a 25-acre bluegrass pasture was divided into three divisions, and the steers were rotated to a new division at the end of each two weeks. The grazing period extended from April 16 to October 30. Under this system the 20 steers averaged a gain of 220 pounds per steer or the equivalent of 176 pounds of gain per acre.

Under the supplemented system of grazing a 25-acre bluegrass pasture was divided into three divisions and the steers rotated at the end of each two weeks. The steers began grazing April 16 and continued on the bluegrass until July 10. A total of 30 steers were used and they averaged a gain of 129 pounds per steer during the period or the equivalent of 154 pounds of gain per acre. During the period July 10 to October 1

these 30 steers were transferred to 23 acres of Korean lespedeza. During this period they gained 32 pounds per steer or the equivalent of 42 pounds per acre. During the month of October the steers grazed 23 acres of winter barley and gained 64 pounds per steer or 83 pounds per acre. Using this system the steers gained 224 pounds per head during the grazing season. In December the 25-acre bluegrass pasture used in the supplemental system was grazed by 91 stocker steers averaging 500 pounds in weight. They grazed this pasture for 17 days after further development of this grass was checked by cold weather.

Too much emphasis should not be placed on results of one year. This year was not a typical year. The gain from Korean lespedeza amounted to only 42 pounds per acre while in other years a much greater return was secured. Also, another factor that should be considered is that the bluegrass pastures used were considerably better than average pastures. (J. E. Comfort, E. M. Brown, M. W. Hazen.)

**Vitamins for Growing Pigs.** Since sows require a large quantity of vitamins in order to raise their litters successfully it may be possible to feed the vitamins directly to the pigs rather than to the sows. A simplified diet was developed which supplied the available vitamins to the pigs in pure form. Pigs were allowed to nurse their dams for approximately 48 hours after being farrowed before they were transferred to the simplified ration. After being transferred they were hand fed 8 times daily. The response of the pigs to the simplified ration has been reasonably consistent. Out of 7 pigs only one pig died, and this was the result of an infected navel. The other 6 pigs, for a period of about 5 weeks, maintained a good appetite, were thrifty, and grew at a normal rate. At this time the pigs appeared perfectly normal and several were killed, but soon the remaining pigs began to

show evidence of a nutritional deficiency.

The most noticeable abnormality was a very irregular appetite and rate of growth. At 7 or 8 weeks of age the hair became long and rough, and the skin over the body became dry with a dirty black exudate around the eyes. Some of the pigs showed the effect of the deficiency less than others and one was nearly normal at 9 weeks of age. (A. G. Hogan, V. F. McRoberts.)

**The Effect of Vitamins In the Sow's Ration Upon the Mortality Rate of Suckling Pigs.** It is widely recognized that the mortality rate among suckling pigs is unduly high. The experiments of A. G. Hogan and V. F. McRoberts have convinced them that a deficiency of one or more vitamins is the chief cause of these losses. Apparently the concentrates commonly supplied to swine are partially inadequate for brood sows and presumably the vitamins that are deficient in concentrates are supplied under favorable conditions by forage. Attempts have been made to determine specifically which vitamins are not present in brood sow rations in sufficient amounts and whether or not any of the vitamins now recognized can overcome these deficiencies. Also, an effort has been made to determine whether or not barley silage can replace fresh barley grass.

About two months before farrowing 22 sows were divided into four groups. Group I was fed the basal ration of corn 77 parts, tankage 10, linseed oilmeal 5, alfalfa meal 5, cod liver oil 1, and salt mixture 2 parts by weight. Group II was fed the same basal ration plus known vitamins. Group III was fed the basal ration plus barley silage. Group IV was fed a special ration containing crude vitamin carriers. This ration acted as a positive control since it would indicate the degree of improvement one could reasonably expect.

The pigs whose dams received the



special ration (group IV) were considerably heavier than the pigs in the other three groups. The sows in Groups II and III made no better record either in percentage of pigs weaned or growth of pigs than the sows in Group I. Apparently the first limiting factor in the basal ration was neither the vitamins used as supplements nor was it carried in sufficient amounts in the barley silage.

A large percentage of the mortalities occurred while the pigs were only a few days of age. Most of these pigs showed fatty livers and hemorrhagic kidneys at post mortem, suggesting a deficiency of choline. Since these deaths occurred before the supplements could be effective, it seemed advisable to supplement the sow's ration with choline.

One sow each, in Groups I, II, and III, was given choline at the rate of .3 per cent of the ration for two weeks before farrowing date.

The sow in Group I farrowed twelve pigs and lost seven of them during the first six days. Most of these pigs showed fatty livers and petechial hemorrhages on their kidneys. The sow in Group II farrowed ten pigs and reared all but one. This pig was sacrificed for post mortem material. Its liver and kidneys appeared normal. The sow in Group III nearly died at parturition and failed to secrete any milk. Her pigs died of starvation. Most of them showed liver and kidney damage.

Although no definite conclusions can be made from these data, it appeared that a deficiency of choline was not the factor responsible for the liver and kidney damage. The fact that the sow in Group II reared a normal litter was not sufficient evidence that choline prevented mortalities in this litter, since occasionally sows on the basal ration rear all of their pigs, and often these pigs have normal livers and kidneys.

**Systems of Breeding for the Improvement of Swine.** Three lines of Poland

China and one line of Hampshire swine are being developed by moderate inbreeding and rigid selection. Half-sib matings (half-brother X half-sister) are generally practiced but the intensity of inbreeding is controlled by the ability of the line to stand close inbreeding. Fertility, suckling ability, rate and economy of gain, and live hog and carcass merit are the most important factors considered in selecting breeding animals.

These characters have been maintained in one line of Polands while inbreeding has increased to approximately 24 per cent.

A second line of Polands, in which inbreeding has increased to approximately 25 per cent, has shown no decrease in suckling ability, growth rate and economy of gain. Selection against hemophilia in this line has reduced the effectiveness of selection and as a result there is an indication of decline in prolificacy and some other characteristics.

A third line of Polands showed a marked loss in growth rate and live hog and carcass merits with no gain in other respects. Inbreeding was decreased in this line because a new line of breeding was introduced to strengthen the weaknesses which were developing.

The Hampshire line has been recently established and therefore the coefficient of inbreeding is low. Inbred Poland China sows farrowed and weaned larger litters when bred to a Hampshire boar than when they produced inbred pigs. There was no significant difference in weaning and 180-day weights between these crossbred pigs and inbred Poland China pigs produced by the same sows in previous litters. (L. A. Weaver, J. E. Comfort, Ralph Bogart.)

**Barley as a Substitute for Corn for Fattening Swine.** Feeding trials have been conducted by L. A. Weaver in which winter barley grain was used as a partial substitute for corn in rations for growing-fattening swine. When bar-

ley was used as a complete substitute for corn there was little difference in the daily feed consumption of the two lots but the hogs fed corn gained 21 per cent more rapidly and required 19 per cent less feed for each 100 pounds gain.

When barley was substituted for one-half of the corn there was little difference in the daily feed consumption of the two lots, but the hogs fed corn gained 13 per cent more rapidly and required 14 per cent less feed per 100 pounds gain.

In these tests ground barley was 85 per cent as valuable as ground corn, pound for pound, when used as a complete substitute for corn and 82 per cent as valuable when used as a partial substitute.

**Comparison of Hybrid with Open Pollinated Corn for Fattening Swine.** During the winter of 1939-40 Missouri hybrid No. 8 was compared with open pollinated Midland for growing-fattening hogs. The corn was shelled and self-fed with a supplement of tankage 2 parts, soybean oil meal 1 part, and alfalfa meal 1 part. There were no significant differences due to variety of corn in rate of gain; in amount of supplement consumed; or in total feed required per 100 pounds gain.

The trial was repeated during the winter of 1940-41 using ear corn rather than shelled corn. The data again showed no significant differences in the feeding value of the particular samples of corn tested as to rate of gains; amount of supplement eaten; or total feed consumed per 100 pounds gain.

**Supplements to Corn for Growing-Fattening Swine.** Two trials were conducted by L. A. Weaver (one in summer and one in winter) in which tankage and soybean oil meal and various combinations of these were compared with corn alone, or corn and a mixture of tankage, 50 per cent; soybean oil meal, 25 per cent; and alfalfa meal, 25 per cent for growing-fattening swine.

Hogs which were not fed some protein supplement with corn did not make satisfactory gains and the amount of feed required to produce one hundred pounds gain was excessive regardless of whether the hogs did or did not receive green forage in addition to concentrates fed. Corn and tankage, or corn and a mixture of tankage and soybean oil meal produced more rapid gains and required less feed per unit gain than hogs fed corn supplemented with soybean oil meal only. Hogs fed corn supplemented with the trio mixture in dry lot, or a combination of tankage, soybean oil meal, and green forage made the fastest gains and required the least feed per 100 pounds gain.

The results indicated that a ration of corn and tankage was improved by the addition of soybean oil meal and that the ration was still further improved by feeding either alfalfa meal or green forage.

In two other trials small amounts of fish meal, dried skim milk, and a combination of these feeds were substituted for a part of the tankage in the supplementary mixture of tankage, 50 per cent; soybean oil meal, 25 per cent; and alfalfa meal, 25 per cent for feeding with corn to pigs from weaning until they weighed 100 pounds. One trial was conducted during summer and the other during the winter.

The substitution of 20 pounds of fish meal for a like amount of tankage in the protein supplement did not change the rate of gain but slightly decreased feed consumption and feed required per unit gain.

In one test the addition of dried skim milk increased feed consumption and rate of gain but also increased the amount of feed required per 100 pounds of gain. In the second test skim milk increased the rate of gain and decreased the feed consumed per unit gain.

When 10 pounds of fish meal and 15 pounds of dried skim milk were substi-



tuted for 25 pounds of tankage in the trio mixture, there was a slight increase in feed consumption and rate of gain and a small decrease in amount of feed required to produce 100 pounds gain.

**Semen Studies.** Semen collected from stallions and jacks was diluted 1 to 1 with Phillips' egg-yolk buffer to which glucose had been added, transported 200 miles, and successfully used on mares. The usual storage period was 5-8 hours. However, in two cases the semen was held 20 hours before insemination and healthy foals were dropped. In one case the semen had been shipped 2000 miles by air.

The study of ram semen has indicated a definite correlation between the temperature of ram semen and the duration of the motility of the spermatozoa. It also has been shown that the degree of acidity of ram semen directly affected the motility of the spermatozoa at pH values below 6 and that at a pH value of 5.37 motility ceased entirely. Evidence also has been presented which indicated that temperature affected the rate of acid production which, in turn, affected the motility of ram spermatozoa. However, the metabolic activities resulting in the production of acid end products did not occur at 0°C. This indicated that the storage of ram semen could be accomplished best at this temperature.

A method has been developed for determining the relative number of live and dead spermatozoa in semen of the ram. A statistical analysis of the accuracy of this method demonstrated that the differences between individuals making the counts were insignificant and that there was only a slight variation in counts made on different smears of the same semen sample. The method is based on the fact that sperm observed to be motile under the microscope did not stain, while non-motile sperm did stain. The sperm which were killed by any method always took the stain.

The best diluter found for boar semen was a 5 per cent glucose and egg yolk (equal volumes) mixture used to dilute semen 1:1 (other diluters tried were 10 per cent glucose, 5 per cent glucose, 1 per cent trypsin, and egg yolk phosphate buffer).

Seminal plasma of the boar consumed oxygen in definitely measurable amounts which varied from 5 to 22 per cent of that of the semen sample from which it was obtained. No errors in measurement of oxygen consumption were detected which could be attributed to the presence of bacteria. Thus with measurements of seminal metabolism on a reliable basis it may be possible to determine whether or not there is a correlation between metabolic rate of spermatozoa and fertility. (F. F. McKenzie, D. T. Mayer, J. F. Lasley, B. H. Moore, G. T. Easley, C. F. Winchester.)

**The Follicular Fluid of the Mare.** The ovaries of 11 mares were palpated at different stages of the estrus cycle, the desirable follicles punctured, and their contents collected for subsequent chemical analyses and chemical assay of the estrogen concentration.

The volume of the fluid obtained ranged from 1 cc. to 112 cc., varying with the age, diameter of the follicles punctured, and the phase of the cycle in which they were punctured. With one exception the larger quantities of fluid were obtained during estrus.

The protein content of the fluid averaged 0.57 per cent and was approximately the same for all samples analyzed. The specific gravity varied between 1.008 and 1.025, but in most cases was nearer the lower figure.

The total estrogen in the fluid recovered from the individual follicles was one-third as great in the non-estrus phases of the cycle as during estrus. However, the estrogen concentration per unit volume of fluid was constant throughout the cycle. (F. F. McKenzie, D. T. Mayer, F. N. Andrews.)

**Artificial Insemination of Range Cattle.** This work has been carried on in cooperation with the San Carlos Indian Reservation in Arizona.

Between April 22 and August 24, 1940, 725 different cows were bred and required 954 inseminations. Approximately 500 cows were bred to one bull and the remainder to 4 other bulls.

Artificial insemination seems to have a practical application to range cattle production as shown by an approximate 80 per cent calf crop secured by these methods as compared to about 40 to 65 per cent calf crop secured under natural breeding conditions.

Artificial insemination made it possible to keep records on each cow so that non-breeders could be recognized and discarded. (F. F. McKenzie, J. F. Lasley, J. T. Montgomery.)

**Sperm Production as a Guide to the Adequacy of a Diet for Farm Animals.** Chemical analyses have shown a difference in the protein content and other components in lespedeza hay grown on treated and untreated soil. The lespedeza hay which was grown on untreated soil analyzed 13 per cent protein; that grown on the superphosphate treated soil, 13.8 per cent protein; and hays on lime or lime and superphosphate treated soils, 15.9 per cent and 15.25 per cent protein respectively. These hays were fed to male rabbits and the semen production studied.

Even though general thrift seemed to be maintained by all the animals, those receiving the hay grown on soil that had been treated with lime, or lime and superphosphate, produced appreciably more semen containing more sperm than did those on the hay grown on the untreated soil, or on the soil treated only with superphosphate.

Moreover, when the rabbits were shifted around so that those that had been getting the hay from the treated soil were given hay from the untreated soil, and vice versa, satisfactory sperm

production continued to be associated with the hay grown on treated soil (lime or lime and superphosphate). (F. F. McKenzie, J. F. Lasley, W. A. Albrecht, G. T. Easley, George Smith.)

**The Effects of Mating Purebred Shorthorn Bulls to High Grade Shorthorn Cows.** This project is in cooperation with Sni-A-Bar Farms and the United States Department of Agriculture. During a period of three years, three unrelated purebred Shorthorn bulls were mated to three groups of high grade Shorthorn cows to test their ability to sire offspring uniform in type, capable of efficient feed utilization, and capable of producing superior carcasses.

The calves from these cows were fed in dry lot for 196 days after weaning. The calves from one of the sires made larger and more economical gains than those sired by the other two bulls: approximately 8 per cent greater for one group and 10½ per cent greater for the other group. They consumed 6 per cent less grain for each 100 pounds of gain than one group and 11 per cent less grain than was required by the other. The fastest gaining calves were not as uniform in type as the calves in the other two groups. Some of them were slightly rangy but produced carcasses of a superior grade because of better external finish. They also had a higher valuation per head because of their greater final weight. These experiments showed that the calves sired by the different beef type Shorthorn bulls mated with high grade Shorthorn cows differed materially in their rate and efficiency of gain. (J. E. Comfort, M. W. Hazen, E. A. Trowbridge.)

**Development of the Testes and Combs in the Domestic Cock.** During the late summer and fall months relatively large percentages of infertile eggs are produced by matings in which yearling and older cocks are used. With an increasing tendency toward fall hatching in some sections this infertility results in

considerable economic loss. The possibility of using early hatched cockerels as breeders makes it desirable to have information on the sexual development of young males.

The testes and combs of 24 White Leghorn and 26 New Hampshire cockerels, whose ages varied from 1 day to 475 days, have been studied and correlations made with actual fertility of these birds.

The period from the eighth to the twelfth week of age showed the most rapid testicular growth for both breeds. The combs of the White Leghorn males grew at a more rapid rate than those of the heavier breeds. This differential in comb development was apparent at four weeks of age. Spermatozoa were first observed in the testes tissues when the males were 12 weeks of age. This was true for both breeds. The diameters of the seminiferous tubules increased from 35 micra at one day of age to approximately 250 micra when the males were mature. Results obtained from mating trials indicated that at 24 weeks of age males of both breeds were capable of fertilizing female fowls. (F. F. McKenzie, H. L. Kempster, J. E. Parker.)

**Adequacy of Commonly Used Experimental Swine Rations for the Rat.** Because of the space required and the large amount of feed consumed, it is not practical to use large numbers of swine in vitamin studies. Rats, therefore, were used for trials with the hope that any new information obtained would be useful in swine investigations.

The basal ration, Ration A, supplied to swine has proved to be inadequate. Therefore, various supplements were added in an effort to discover the nature of the deficiencies. The supplemented rations used were: Ration B, which was Ration A plus vitamins; Ration C, which was Ration A plus choline; Ration D, which was Ration A plus an alcoholic extract of dried beef liver; and Ration E, which was Ration A plus a water

extract of dried beef liver after it had been extracted with alcohol.

The weaning weights of the young of rats fed Ration A was subnormal and the percentage weaned was very low. The addition of vitamins to Ration A improved the percentage weaned and increased the weaning weights. The addition of choline to Ration A had little effect on the weaning weights but was just as effective as the more complete vitamin mixture in increasing the number of young weaned. The weaning weights of the young from rats fed Ration D were normal and the percentage weaned was significantly increased. The young of the animals fed Ration E performed as well as the controls. The differences in the appearance of the various groups were as striking as the quantitative data. The litters of the basal group were normal in appearance, except in size, until about 20 days of age. After this they gradually became inactive and lethargic. The mortality rate was especially high after 2 weeks of age, while on adequate rations it was very low at that age. Of those that died, some showed hemorrhages on the brain, and nearly all of them had fatty livers. The livers of rats on the basal ration contained about 14 per cent fat, which was approximately twice as much as was found in the livers of all the other rats examined.

It was noted that the response of rats paralleled that of sows when they consumed the same or a similar basal ration. In both species the mortality during the suckling stage was high, and the symptoms were in many respects similar. There was some uncertainty as to the effect when the basal ration was supplemented with vitamins. This supplement increased the weaning weight of rats, but did not reduce the mortalities. The effect on sows was uncertain. In one trial the weaning weights of pigs were increased, but usually there was no effect. Young pigs thrived remarkably

well when they received Ration E and rats did equally well on the same ration. The results of these trials indicated that probably rats are satisfactory for studying the nutritional requirements of swine. (A. G. Hogan, V. F. McRoberts.)

#### **Black Fibers and Dwarfism in Sheep.**

A study of the sheep in the University of Missouri flock by A. J. Dyer and Ralph Bogart has shown two types of black fibers in the breeds that have dark faces and legs. One kind of black fiber is a true black fiber and is present at birth while the second type is a black tipped fiber. This latter type of fiber was greatly influenced by environmental

factors. High temperature and poor nutrition have caused black tipped fibers to develop in large numbers. The true black fiber was not influenced by alteration of the environment. The black tipped and the true black fibers have a complicated hereditary basis.

Dwarfism, a partial lethal in sheep, is inherited as a simple recessive since as many as 22 per cent of the lamb crop have been dwarfs in some flocks. Histological examinations have indicated that dwarfism was not the result of improper functioning of the thyroid gland. All attempts to cure the dwarfism by giving thyroid material have been unsuccessful.

## **BOTANY**

C. M. TUCKER, *Chairman*

**The Development of Wilt Resistant Tomatoes.** Fusarium wilt is the principal tomato disease in commercial and home gardens. Each year it causes great loss to tomato growers in Missouri and other regions of the United States. Under the direction of C. M. Tucker, a Peruvian strain of wild tomato has been crossed with commercial varieties. This strain of wild tomato is practically immune to wilt. Hybrids of this strain and commercial varieties have proved as resistant as the parent, demonstrating that the resistance character is dominant. Back-cross progeny segregated in the ratio of one susceptible to one resistant demonstrating the single factor type of inheritance. Lines homozygous for resistance have been secured and they have remained entirely free from wilt. These progenies have yielded plants with most of the desirable fruit and plant characteristics of commercial varieties of tomatoes.

**The Mechanism of Resistance or Immunity of Tomatoes to Infection by Fusarium Wilt.** Although much breeding of plants for resistance to diseases has been done, there is little information, except in the instance of a few plants,

of the actual causes of resistance. While resistance usually is dependent upon genetic factors, the physical or chemical mechanisms responsible for the resistance are obscure. C. M. Tucker has attempted to isolate and identify a possible inhibitory substance present in the sap or protoplasm of resistant plants; and to determine whether the concentration of this material is affected by continuous generations of back crossing which give the hybrid a great preponderance of genetic factors from susceptible parents. Also, an effort has been made to determine the portion of the plant in which inhibitory materials were developed.

A virulent strain of Fusarium wilt was grown in nutrient solution to which various amounts of ground root or leaf tissue of susceptible Bonnie Best tomato, resistant Marglobe, or an immune strain of tomato were added. Increasing the amount of tissue resulted in increased growth of the fungus regardless of the variety. There was no evidence of an inhibitory substance in the tissues used. Experiments on the growth of the fungus in expressed sap indicated that sterilization by filtration or by heat had

little effect on growth; that stem juice was more favorable to growth than root juice; and that juices from susceptible, resistant, and immune varieties did not produce different effects on the growth of the *Fusarium* wilt fungus. Extracts of washed mycelium of the wilt fungus did produce a differential effect on cuttings of susceptible, resistant, and immune varieties. The susceptible variety showed wilt and yellowing first. The resistant variety was next. Heat destroyed a part of the toxic activity of the extract, as did filtration. The toxic effect of the extract was not specific for tomatoes but was exhibited on representatives of several families.

**Controlling *Dactylium* on Cultivated Mushrooms.** C. M. Tucker and J. B. Routien have made a study of means of preventing the growth of *Dactylium* on the cultivated mushroom. Trial of a number of sprays indicated that apparently complete control could be effected on the youngest spots by the use of a spray consisting of one per cent

formaldehyde with about one teaspoonful of a wetting agent per quart of spray. When carefully applied with a good hand spray the formaldehyde did no damage other than to cause a slight brownish discoloration of the cap of the mushroom. This color scarcely was noticeable in mature mushrooms.

The humidity in the growing room was decreased by closing an outlet from the mushroom cave. This caused the *Dactylium* to disappear. It seemed likely, therefore, that proper regulation of the humidity would aid in the control of this fungus.

Additional work by the Department of Botany has been done on the control of smuts of small grains, particularly with the use of New Improved Ceresan on the growth of oats. The exact period in the growth of the plant at which the effect of the treatment was noted, was determined. Also, the response of root parasites to treatment and the effect of temperature on this response were studied.

## DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

**Ration and Management Practices Affect the Rate of Growth of Dairy Heifers.** For a number of years A. C. Ragsdale and H. A. Herman have studied the relation between the amount and quality of feed and the rapidity and economy of growth of dairy heifers.

Five Holstein heifers were fed as follows: Whole milk was fed the first 9 weeks; skim milk from the ninth week until the ninth month of age; and from 9 to 28 months of age, good quality chopped alfalfa hay, salt, and steamed bonemeal constituted the entire ration. At 24 months of age the heifers were 13 per cent below normal height at withers. They freshened at 28 months and during the first lactation were fed only roughage. During the second and third lactations they were fed 1 pound

of grain for each 6 pounds of milk produced daily. During the fourth lactation a full grain allowance of 1 pound of grain for each 4 pounds milk produced daily was fed. The grain ration averaged 11½ per cent digestible crude protein. The roughage consisted of alfalfa, lespedeza, soybean hay, silage, and pasture.

At approximately 5½ years of age these cows had more growth than heifers raised normally. The beneficial effect of grain on milk production also was reflected in the third and fourth lactations.

Another group of six heifers was grown very rapidly from birth to freshening age by using a ration containing 26 per cent crude protein and 70.7 per cent total digestible nutrients. The heif-

ers were fed *ad libitum* and in addition received 10 to 20 pounds whole milk daily. At 12 months of age they were 30 per cent above normal in weight and 4.7 per cent above standard wither height. Three of them were bred to freshen at 19 months and 3 at 27 months. At these ages the heifers were 10 per cent above normal growth standards in body weight and one inch taller at the withers.

The heifers freshening at 19 months produced 7,498 pounds of milk and 284 pounds butterfat in 341 days and the group freshening at 27 months produced 7,943 pounds of milk and 299 pounds butterfat in 323 days. For the second lactation the entire group averaged 7,773 pounds milk and 303 pounds butterfat in 301 days as compared to 7,721 pounds milk and 292 pounds butterfat in 332 days in the first lactation. The difference in average production between the early and late freshening groups was not significant.

**The Feeding Value of Early Cut Soybean Hay as Compared with That Cut Late.** Ten dairy cows were used for this test. The cows were paired according to weight, stage of lactation, and daily milk production.

The early cut hay was harvested when most of the pods were developed and about one-third to one-half filled. The late cut hay was harvested when the pods were formed completely; nearly all the beans had reached full development; and the lower leaves of the plants were beginning to turn yellow.

The cows receiving late cut unchopped hay produced 2.34 pounds of milk for each pound of hay consumed, and those receiving early cut unchopped hay produced 2.32 pounds of milk. When the animals were reversed, the cows fed late cut hay produced 1.97 pounds of milk for each pound of hay consumed; and those fed the early harvested hay, 2.1 pounds of milk. Trials the past year indicated the early cut hay slightly su-

perior pound for pound to the late cut hay. However, the previous year the late cut hay was slightly superior. Two factors seemed to account for the difference. (1) In the previous year the late cut hay was more palatable than the early cut hay, whereas, last year there was no appreciable difference. (2) The protein content of the early cut hay in the first year was 13.75 per cent as compared to 18.94 per cent for the late cut, but in the past year the average protein content of the early cut hay was 15.87 per cent and the late cut, 16.94 per cent.

The late cut hay in each trial was harvested approximately 15 days later than the early cut, but in the past year a severe drought persisted from the time of harvesting the early cut hay until after the harvesting of the late cut hay, and the development of the seed pods was less than that of the first year.

In the trials of both years, the unchopped hay was more palatable than the chopped hay. The late cut chopped hay was consumed more readily and with less refusal than the early cut chopped hay. (A. C. Ragsdale, H. A. Herman, Warren Heathman.)

**Trench Silos for Ensiling Chopped Cereals.** Dairy farmers frequently desire to store cereals, often grown as pasture or cover crops, in temporary silos. Previous experience at this Station and in field trials had demonstrated that the "paper sack" or "snow fence" type of silo is not well suited for this purpose because of excess spoilage during the summer months.

Two 45-ton trench silos were located on a well drained hillside. The walls were 12 feet apart at the top and 8 feet apart at the bottom of the trench. Each silo was filled: one-half with chopped, and one-half with unchopped barley bundles. The barley was cut in the milk stage with a binder. The part that was chopped was cut into one-half or one inch lengths, and stored in one end of



one of the silos after being treated with 60 pounds of blackstrap molasses per ton. In the other end of the silo green barley bundles were stored in stack fashion. Each layer was treated with blackstrap molasses.

In the other silo the chopped barley was treated with 8 pounds of 75 per cent phosphoric acid per ton and the remaining space was filled with barley bundles and treated with acid at the same rate. The silos then were sealed and precautions taken to prevent surface water from draining into the pits.

Six months after filling the silos were opened and the contents fed to cows in milk and to growing heifers. With the exception of bundles treated with molasses the preservation was apparently satisfactory, spoilage amounting to approximately 15 per cent. The spoilage in the molasses treated bundles was approximately 25 per cent and was due largely to mold growth and excess fermentation as a result of air infiltration. The phosphoric acid silage made from bundles was preserved nearly as well as the chopped barley.

Protein loss in the phosphoric acid treated silage was almost negligible, while the finished silage from the molasses method contained approximately 20 per cent less total protein than the fresh barley.

A short feeding trial using the reversal method with 8 cows of equal weight and producing ability indicated no significant difference in the palatability of the two silages. The groups receiving the molasses silage averaged approximately 1 pound more milk per day but this difference was not significant. These trials indicated that trench silos, built and filled according to the best practices, may be satisfactorily used for ensiling chopped cereals treated with either molasses or phosphoric acid. Where unchopped cereals are ensiled care must be used to insure

proper packing to prevent excess spoilage. (A. C. Ragsdale, H. A. Herman, Warren Heathman.)

**Balboa Rye and Missouri Early Beardless Barley Do Not Produce Objectionable Flavors in Milk.** A large number of dairymen have adopted the practice of using Winter Barley and Balboa Rye as pasture crops for dairy cows. H. A. Herman and E. R. Garrison have investigated the effect that grazing of these crops may have on the flavor of the milk produced. Two lots of cows that were sound in udder and producing normal flavored milk were used. Twenty-three cows in one group were grazed on Winter Barley and 26 cows in the other group on Balboa Rye for 3 to 4 hours daily. The milk was sampled from one to two hours after the cows were removed from the pastures and scored for 18 successive days. Both the barley and the Balboa Rye produced slightly different but not objectionable flavors. The relative score of the milk produced by both groups was high and it was concluded that neither the winter barley nor the Balboa Rye produced undesirable flavors in milk.

**Machine Milking Compared to Hand Milking.** Milk production records of 16 cows milked by hand for 39 lactation periods have been compared by A. C. Ragsdale and C. W. McIntyre with records from 14 cows milked by machine for 32 lactation periods. The hand milked cows produced 37.7 pounds of milk daily during the first month of lactation and declined thereafter at a monthly rate of 5.2 per cent. The machine milked cows produced 38.8 pounds daily during their first month of lactation and then declined at the rate of 5.5 per cent per month.

The daily milk production and the rate of decline with advancing lactation, were not affected significantly by the method of milking during the first five to six months of lactation. After that time, machine milked cows declined

slightly faster than did hand milked cows.

**Milk Production on Grainless and Limited Grain Rations.** Four Jersey cows, 6 to 7 years of age, were placed on a roughage ration of alfalfa hay, silage, and pasture. In addition they received a mixture of equal parts salt and bonemeal fed *ad libitum*. Previously on a grain ration these cows had completed 15 lactation periods averaging 10,895 pounds of milk containing 562 pounds fat in 348 days on a mature basis.

The four cows completed eleven lactations on the roughage ration and averaged 7,585 pounds of milk and 362 pounds of fat in 329 days. This represented 69.6 per cent as much milk and 64.4 per cent as much fat as when the cows were on full grain ration. The lactation periods were 19 days less and the butterfat averaged 0.39 per cent less. The average loss in weight during the first lactation on roughage was 155 pounds. The breeding efficiency judged by number of services per conception was not affected.

Seven young and two aged Jersey cows (the two aged cows had been on an exclusive roughage ration) were placed on a limited grain ration with alfalfa hay and silage. The grain was fed as follows: during the first two months, 1 pound of grain for each 6 pounds of milk produced daily; during the third and fourth months, 1 pound of grain for each 8 pounds of milk; during the fifth and sixth months, 1 to 10; the seventh and eighth months, 1 to 12; and from the ninth to twelfth months inclusive, no grain at all.

The seven young cows previously had completed 19 lactations on full grain feeding with records of 9411 pounds milk and 533 pounds fat in 360 days on a mature equivalent basis. On the limited grain ration they produced 7064 pounds milk and 380 pounds fat in 331 days. This represented 75.1 per cent as much milk and 71.3 per cent as much fat as

was produced by the full grain ration. The fat test averaged 0.33 per cent lower on the limited grain ration and the lactation period was 29 days shorter. (A. C. Ragsdale, C. W. McIntyre.)

**Alfalfa Hay and Silage Costs at the Hatch Dairy Farm.** The cost of producing a ton of alfalfa hay was \$4.51 per ton. This included a harvesting cost of \$1.92 per ton, a seeding cost of \$1.27 per ton, and land rental at \$1.32 per ton.

One hundred fifty tons of alfalfa were cut and put in a silo at a cost of \$4.29 per ton of silage. This cost included molasses for treating the silage, purchase of the alfalfa, and all harvesting and silo filling costs, including the hauling of the alfalfa 12 miles from the field to the silo. The silage was of excellent quality.

Atlas sorgo silage hauled three miles to the silo cost \$2.44 per ton. Of this amount \$1.25 per ton was paid for the sorgo in the field and \$1.19 per ton was the cost of cutting, loading, hauling, and silo filling. (A. C. Ragsdale, C. W. McIntyre.)

**Development of a High Producing Strain of Jersey Cattle.** For a number of years only proved sires have been used in the Hatch Farm dairy herd. The sons of these sires from dams of proved production have been leased for service in dairy farm herds. A cooperative agreement between the lessee and the Station has provided for the keeping of complete herd records. Thus, the leased bulls may be proved on the basis of production records in these herds. Forty-four farmers have cooperated in this work and 61 leases have been made. One bull has been leased to four different farmers; three to three; thirteen to two; and the other bulls are now on leased service for the first time. Seven bulls have been proved and 6 of the 7 have increased the production of the herds where used.

Two proved sires, Progress Owl's



Pilgrim 319668 and Peggy's Majestic Duke, 259690, have been continued in service in the Hatch Farm herd. The former now has a total of 11 tested daughters averaging 11,878 pounds of milk and 690 pounds of fat mature equivalent and the latter has 20 tested daughters averaging 9827 pounds of milk and 561 pounds of fat mature equivalent. The former now has 40 and the latter 28 daughters in the Hatch Farm herd. (A. C. Ragsdale, C. W. McIntyre.)

**Stimulated Mammary Gland Growth in Various Species.** In a series of studies of the growth of the mammary gland, 3 to 6 International Units of estrone per day for 30 to 60 days applied to the shaved skin about each teat caused development of the mammary glands of 11 male rabbits. Four glands on one side of the body of each rabbit were treated. Four rabbits developed all glands with the treated glands the larger. In 3 rabbits, only the treated glands showed development. In the other four rabbits only one or two untreated glands were slightly developed.

Five male rabbits were treated similarly with stilbestrol. All treated glands showed development while in only one case did the untreated glands show no development. A second rabbit had only 1 control gland slightly developed, and in the other rabbits the treated glands were larger than the untreated.

Eight male rabbits were injected with varying dosages of either estrone or stilbestrol while turpentine was applied percutaneously. In six cases the turpentine treated glands were larger than the untreated glands while in one rabbit treated percutaneously alone, the treated glands showed some development.

Spirits of turpentine applied twice daily for 7 days to the teats and adjoining skin of lactating female mice weaned of their young on the 4th day after parturition, retarded the rate of involution of the mammary lobule-alveolar sys-

tems. Similar applications of turpentine to castrate and normal female mice failed to initiate any growth of mammary alveoli.

A 16 to 30 day treatment with 0.04 to 300 mouse units per day of anterior pituitary mammogenic duct growth extract induced duct growth while a 6 day treatment of 0.02 to 1.6 mouse units per day did not. Duct growth was obtained in hypophysectomized males and hypophysectomized virgin rats when treated for 7 to 10 days with 4 to 16 mouse units per day.

Subcutaneous injections of stilbestrol at low dosages caused extensive duct proliferation in male mice in 2 to 4 weeks. Oral administration of stilbestrol to male mice required approximately five times as high dosages to obtain similar results.

Castrate male rats required a higher dosage of stilbestrol than did mice to obtain mammary duct growth.

A 40 to 60 day treatment of .4 gamma per day of stilbestrol administered subcutaneously was adequate to secure extensive mammary duct development in male rabbits. Percutaneous administration also was effective.

Subcutaneous injection of stilbestrol into virgin goats caused abundant and prolonged lactation from lobule-alveolar glands. Little increase in the extent of the development of glands was apparent.

In rabbits, the extension of the mammary glands with succeeding lactations was measured. Any increase in the size and capacity of these glands during succeeding lactations appeared to involve thickening of the gland rather than lateral extension. (C. W. Turner, A. A. Lewis, J. P. Mixner of this Station and E. T. Gomez of the Bureau of Dairy Industry.)

**The Assay of Hormones.** The castrate virgin female mouse has been used as a test animal for the assay of the mammogenic lobule-alveolar factor of the anterior pituitary. A mammogenic lo-

bule-alveolar mouse unit has been defined as the amount of material required per mouse injected over a period of 10 days to obtain definite lobule-alveolar development in  $50 \pm 10$  per cent of 10 or more castrate, nulliparous female mice weighing between 12 and 18 grams. Pregnant cattle anterior pituitary gave a mouse unit with only 125 mg. of tissue while non-pregnant cattle pituitaries failed to give positive responses even when over 500 mg. were used.

Fresh pregnant cattle pituitary which stimulated growth of the lobule-alveolar system in castrate female mice, and lipid anterior pituitary extracts which stimulated duct growth in the male mouse were tested for the presence of progesterone by the McGinty technique. Although .0002 mg. of crystalline progesterone is detected by this method, no response was secured from either the fresh or the extract in amounts larger than necessary to produce their characteristic effects on the mammary gland of mice. This indicated that neither the mammogenic duct nor lobule-alveolar effect of the anterior pituitary was due to the presence of progesterone.

The pituitaries of male and female White New Zealand rabbits were assayed during growth for thyrotropic hormone content. The rabbits were grouped at 500 gm. interval weights and the amounts of hormone in the pituitaries of the groups compared. The average amount of thyrotropic hormone in each pituitary and the concentration per gram of fresh pituitary tissue increased in each group up to 2,500 grams. This was followed by a decline, especially marked in the concentration per gram. In the rabbit the amount of hormone in the pituitaries of the two sexes was quite similar where the mature body weights of the males and females were equal. However, in rats the amount was markedly different where the mature body weight of the two sexes differed widely.

The posterior pituitary contains a fac-

tor which causes a contraction of the lactating mammary gland and facilitates the removal of milk at milking time. In order to determine the role of this factor it seemed desirable to determine if there was a lowering of the concentration of the "hormone" in the pituitary following the stimulation of milking comparable to the reduction of the lactogenic hormone in the anterior lobe, or a measurable increase in the factor in the blood stream during the period of mammary gland contraction.

New Zealand White rabbits between the fifth and fourteenth days of lactation, nursing between 4 and 6 rabbits, were allowed to accumulate milk for a period of 15 to 18 hours and were used as assay animals. A unit was defined as the minimal amount of substance which, upon intravenous injection into an unnursed lactating rabbit, caused a definite but minimal contraction of the mammary gland within 40 seconds.

In commercial pituitrin a unit response was obtained with 0.001 unit of the International Standard of oxytocic hormone. In the pitocin reported to contain the same number of units of oxytocin, 0.0182 units were required. The assay of pitressin indicated a unit effect with 0.005 units of pressor hormone. These observations appeared to indicate that either both the oxytocic and vasopressin factors combined to influence the contraction of the mammary gland, or a third factor was involved which was present in both pitocin and pitressin in varying proportions. (C. W. Turner, J. P. Mixner, A. A. Lewis, J. J. Trentin, A. J. Bergman, W. D. Cooper.)

**Lactation in Dry and Virgin Goats Induced by Stilbestrol Treatment.** A parous dry goat giving less than 10 cc. of milk daily was treated each day for 40 days percutaneously on the udder with 1 mg. of stilbestrol in alcohol. This treatment was ineffective in increasing milk production. Within 15 days after beginning injections of one-fourth mg.

of stilbestrol daily, milk production began to rise and soon reached over 500 cc. per day from one mammary gland, the other having been removed.

A virgin goat giving about 250 cc. of milk daily in the eighth month of lactation which had been stimulated by one-fourth mg. of stilbestrol daily, more than doubled production from a single injection of initial anterior pituitary extract. Production remained high for 25 days and then leveled off at about 325 cc. daily.

To date oral administration of stilbestrol has been ineffective in initiating milk secretion. (C. W. Turner, A. A. Lewis.)

**Mammogen I Extracted from Cattle Anterior Pituitary.** Several extracts with high mammogenic activity have been prepared from pregnant and non-pregnant cattle anterior pituitaries. The fresh anterior pituitaries were ground thoroughly, dehydrated with acetone, and washed with ether. These two solutions were pooled and the acetone and ether removed by vacuum distillation at low pressure and at a temperature of 30° C. The dried gummy substance was extracted with ether and the solution fractionated at extremely low temperature. The active material continued to remain in the ether solution. The ether was removed finally by drying in a vacuum dessicator. The removal of the ether by fan drying at room temperature caused a loss of 67 per cent in activity.

The dessicated lipid like material contained 10,000 mouse units of mammogen I per gram when pregnant cattle pituitaries were the source. Extracts prepared from non-pregnant cattle pituitaries by the same procedure contained 1,000 mouse units per gram. The residues obtained in the fractionation process contained only traces of the mammogenic hormone. The acetone dried material in the extraction process served as a source for other pituitary hormones.

(C. W. Turner, A. J. Bergman, A. A. Lewis.)

**Smooth Muscle Elements Surround the Alveoli of the Mammary Gland.** The udder of a cow in advanced lactation was examined histologically by E. W. Swanson and C. W. Turner to study the cells surrounding the alveoli. Suitable staining revealed cells beneath the secretory epithelium of the alveoli and in the interlobular connective tissue which have the appearance and staining properties of smooth muscle cells. These cells were observed spaced at intervals around the alveoli and along the walls of the ducts. It is believed that they function in the expulsion of milk by contracting the alveoli and ducts and forcing the milk toward the cisterns.

**Thyroidectomy of Young Male Goats Affects Certain Anterior Pituitary Hormones.** A group of 8 male kids were thyroidectomized while between the ages of 5 and 24 days. At about 4 months of age after growth stasis appeared they were slaughtered. Their pituitaries were assayed for the lactogenic, thyrotropic, gonadotropic, and sugar elevating factors and compared with groups of normal goats of the same weight but younger; and of the same age but of normal weight.

Both the lactogenic and thyrotropic hormones were present in concentration in the cretinous pituitaries comparable to the normals of similar age. Thus, they did not appear to be the cause of the growth stasis. The gonadotropic hormone was found to be present in low concentration and the testis showed lack of stimulation, averaging lighter than the youngest group of normal controls.

Of the hormones of the pituitary concerned with metabolism, only the sugar elevating factor was studied. It was extremely low in concentration in the cretinous pituitaries. However, the histological abnormality of the pancreas and the low liver weight indicated that thyroidectomy was followed by serious de-

rangement of the glands and organs concerned with carbohydrate metabolism. This suggested that this condition coupled with the low metabolic rate of the somatic cells played an important role in the growth stasis observed. (C. W. Turner, A. J. Bergman, E. P. Reineke.)

**Lactogenic Hormone in Urine.** A comparison has been made of the concentration of lactogen in urine before and after throxine administration to lactating goats. Preliminary results indicated that there was no significant increase in the amount of lactogenic hormone in the urine of goats following thyroxine injection even with a material increase in the level of milk production. (Victor Hurst, Joseph Meiter, C. W. Turner.)

**The Specificity of the Lactogenic Hormone in the Initiation of Lactation.** C. W. Turner and A. J. Bergman have made a study of the "lactogenic hormone" and the "thyrotropic and other hormone" fractions of the anterior pituitary on lactogenesis in the pseudo-pregnant rabbit. When the "lactogenic hormone" fraction was injected at the rate of 1 mg. per 100 grams body weight glands were obtained with an average rating of 1.67. When 1.5 mg. was given the average rating was 3.17, which was considered in the range for a unit response.

A group of rabbits injected with 2 mg. per 100 gm. body weight of the "thyrotropic and other hormone" fraction showed no evidence of lactation. At the 5 mg. and 10 mg. levels six animals in each group survived the test period. Only one rabbit in each group showed any evidence of lactation.

In the group of five thyroidectomized rabbits injected with 5 mg. of the "thyrotropic and other hormone" fraction per 100 grams body weight, lactation was initiated in two animals but little or none in the other three. Another group of seven thyroidectomized rabbits injected at the 10 mg. level gave glands averaging 1.43.

The average gland rating was increased from 1.67 for 1 mg. of lactogenic hormone per 100 grams body weight, to 1.86 when supplemented by 1 mg. of the "thyrotropic and other hormone" fraction. When the level of injection of the latter was 2 mg. the average gland rating was increased to 2.60.

These results indicate that the primary function of the lactogenic hormone, which also possesses the ability to proliferate the pigeon crop gland, is to initiate and maintain established lactation. Extracts rich in the thyrotropic and other hormones, but containing only traces of the lactogenic hormones, do not possess the ability to initiate lactation in doses as high as could be tolerated. This fraction, however, has a supplementing effect on established lactation. (C. W. Turner, A. J. Bergman.)

**Comparison of Assay Methods Using International Standard Lactogen.** International Standard Lactogen, which contains one International Unit per .1 mg., was assayed by the pigeon crop response, using three different methods of injection, namely: the shallow intrapectoral; subcutaneously over the pectoral muscles; and intradermally over each crop gland. The subcutaneous method of injection required .1 mg. of International Standard per unit; the shallow intrapectoral method, .125 mg. per unit; and the intradermal method, only .000624 mg. per unit or 1/160th of the amount required by the subcutaneous method. In the latter method of assay, it was shown that 2, 3, and 5-fold differences in injection volume containing the same amount of hormone elicited no difference in the crop gland response. (A. J. Bergman, C. W. Turner, J. Meites.)

**Chemical Extraction and Purification of Cattle Anterior Pituitary Hormones.** Cattle anterior pituitary hormones have been extracted and purified. Acetone dried material was extracted with 60 per cent alcohol at pH 10-11.5. The yield of initial extract was about 7 per

cent. Since the hormones in the acetone dried material were not absorbed readily from the mass of pituitary tissue the exact amount of each hormone present was difficult to ascertain. However, an assay of the acetone dried material, as compared with the residue after extraction, indicated that practically all the hormones for which assay techniques have been developed were extracted by this procedure. The initial extract contained approximately the following units per gram:

Lactogenic	
Hormone .....	4000 international units
Thyreotropic .....	2800 chick units
Gonadotropic .....	1000 chick units
Adrenotropic .....	100-200 chick units

Carbohydrate Metabolism Hormone ....400 Guinea Pig units  
This initial extract also contained the growth and protein metabolism hormones and probably the hormone for the specific metabolic effect.

For further concentration of the hormones the initial powder was extracted with water at pH 10. The aqueous extract was brought to pH 5.5, dialyzed for several days against cold distilled water, and then precipitated with 4 to 5 volumes of alcohol. The yield of dried powder was about 22.5 per cent. The increases in units per gram were as follows:

Thyreotropic .....	12,500 chick units
Gonadotropic .....	4,000 chick units
Carbohydrate Metabolism .....	1,350 Guinea Pig units
Lactogenic .....	50 International units

From the residue which remained after the above fraction was removed the lactogenic hormone was extracted by means of 70 per cent alcohol at pH 9-10. The pH was adjusted to 6 and the liquid further fractionated at low temperature. This dried material assayed 12,500 International Units of lactogenic hormone per gram. Only traces of the other hormones were present. A yield of 25 per

cent was usually obtained. (A. J. Bergman, C. W. Turner.)

**Lactogenic Hormone Content of the Pituitary.** Various theories concerning the absence of milk secretion during pregnancy and its elaboration after parturition have been studied. Most have failed to take into account the important role of the lactogenic hormone of the anterior pituitary. Quantitative work on the lactogenic hormone has demonstrated that this hormone remains low during pregnancy and increases several fold following parturition. Perhaps lactation does not take place during pregnancy because there is insufficient lactogenic hormone in the pituitary. The agent responsible for the increase in lactogenic hormone following parturition is unknown.

Pregnancy in rabbits has no effect on the lactogenic hormone. On the 20th day post partum the lactogen content of the pituitaries of rabbits during a period of simultaneous lactation and pregnancy was just as high as the pituitaries of rabbits which were ovariectomized on the 20th day of pregnancy and killed two to five days later. The placentas of three pregnant-lactating rabbits were shown to contain lactogen. These results may indicate that pregnancy has no inhibiting effect on the lactogenic content of the hormone and it may be that copious lactation can be initiated only when there is a well developed mammary gland present and when there is a high lactogen content in the anterior pituitary. Forty-four guinea pigs of both sexes were divided equally into experimental and control groups. From 7 to 20 mg. of desoxycorticosterone acetate or desoxycorticosterone were injected over periods from 10 to 20 days. A considerable increase occurred in the pituitary weight of the experimental guinea pigs as compared to the control guinea pigs. However, there was little or no increase in the lactogen content of the pituitary of

either the injected or the uninjected animals. There was no significant change in the adrenal weights of the injected groups. Therefore it was concluded that desoxycorticosterone reacted like estrogen to the extent that it induced growth of the mammary gland and caused increase in size of the pituitary but is unlike estrogen in that it did not produce any augmentation of the lactogenic hormone content of the anterior pituitary. (C. W. Turner, Joseph Meites.)

**Artificial Thyroproteins for Increased Growth and Lactation.** In previous work at this Station E. P. Reineke and C. W. Turner have demonstrated the effectiveness of thyroid substance or thyroxine in stimulating milk production, fat percentages, and total milk and milk fat production of cows and goats. Economic application was not feasible because of the high cost of the substances used.

A new method of producing artificial thyroprotein has been found. The material possesses all of the properties of thyroid substance and is produced by chemically combining the proteins of skim milk with iodine in a neutral solution buffered by sodium bicarbonate. Sixty grams of the thyroprotein are equivalent to one gram of thyroxine which is 3 to 5 times as active as desiccated thyroid, and much higher than other artificial thyroproteins previously reported.

The activity of thyroprotein has been measured by a rapid semi-quantitative assay based upon the acceleration of the metamorphosis of tadpoles by thyroid active substances. A more accurate assay is based upon the rise in metabolism of guinea pigs and further evidence of the physiological activity of these preparations is determined by their growth promoting action in thyroidectomized goats. When thyroidectomized during the first month of life, young goats reach a complete growth stasis during the first one to two months after the operation.

The growth failure is accompanied by typical symptoms of cretinism. The oral administration of artificial thyroprotein arrested the development of cretinism and stimulated growth approaching normal. Within the range of dosage covered, the growth was roughly proportional to the amount of thyroprotein given.

Thyroprotein fed to lactating goats at a level of 5 to 10 grams daily for a period of 5 days at monthly intervals produced a gradual increase in milk production within 24 to 48 hours reaching a maximum in about 6 days and then gradually returning to the pre-thyrolactin level within the next 2 or 3 weeks. During three such feeding periods the average increase in milk production ranged from 8.5 to 18.6 per cent. The heart rate increased an average of 8.2 beats per minute.

Three cows in the declining stages of lactation were fed thyroprotein at levels of 5 to 10 grams daily for three days. Milk production started to rise the second day and reached its maximum by the fourth day and was followed by a gradual decline. Production reached normal by the 7th day after the feeding of thyroprotein was stopped. The increases for the three cows at the maximum were 8.0, 11.5, and 20 per cent respectively. These rises were paralleled by rises in the heart rate.

If thyroprotein can be economically produced on a large scale, it will be possible to secure a substantial increase in milk production by feeding it to dairy cows.

**The Precursors of Milk.** The mammary gland withdraws nutrient materials, oxygen, and water from the blood passing through it and transforms them into milk. The exact nutrient requirement of the mammary gland has been established by analyzing the arterial blood; by comparing it with mammary venous blood sampled at the same time; by measuring the rate of blood flow



through the gland; and by determining the yield and composition of the milk produced.

Earlier work by C. W. Turner and E. P. Reineke has indicated that most of the lactose in milk could be accounted for by the glucose and lactic acid taken from the blood stream. Amino acids probably were used in a large part to meet carbohydrate requirements rather than for protein synthesis. The mammary gland discharged urea back into the venous blood in significant amounts indicating that amino acids were deaminized. Furthermore, amino acids were absorbed by the blood in amounts too small to account for the protein in milk, even if used entirely for protein synthesis.

Analyses of the blood plasma proteins indicated that the globulin fraction was involved in the synthesis of milk protein. The mammary gland was 90 to 95 per cent efficient in the conversion of milk. The respiratory quotient of the mammary gland was above unity which indicated that a portion of the milk fat was synthesized from carbohydrates.

Since certain blood constituents (blood gases in particular) are seriously affected by excitement of the animal during sampling, nembutal was used to anesthetize the animal in order to eliminate this factor. Lactation and the uptake of milk precursors continued normally in the anesthetized animal. Furthermore, the respiratory quotient of the lactating mammary gland was remarkably constant at the value of  $1.09 \pm 0.0115$ .

The uptake of glyco-protein sugar by the mammary gland accounted for all the protein in milk. This establishes more conclusively the fact that the precursor of milk protein came from the globulin fraction of the plasma proteins. Sugar taken up as a part of this complex probably was available for utilization as either lactose or fat.

**The Storage of Bull Spermatozoa. A**

temperature of 40° F. was found satisfactory for storage of bull spermatozoa. Room temperature was unsatisfactory. Near freezing temperature was undesirable but not markedly injurious.

Glucose solutions and Milovanov's SCG-2 dilutor were found to be of no value in increasing the length of survival time in stored bull semen. Egg-yolk buffer dilutor was beneficial to motility of bull spermatozoa for the first 100 hours of storage. Semen varied in its reaction to dilution with this diluent.

Vigorous motility was obtained for the first 100 hours of storage by removing the sperm fluid from the spermatozoa and diluting with egg-yolk buffer dilutor. Good quality semen survived longer when stored undiluted than when diluted with any of the diluents tried.

Thirty samples of semen, stored an average of 72 hours (the oldest 198 hours) were used for insemination in 1940. Fifteen cows settled, and one produced a living calf from the 198 hour old sample. Good quality semen which has been stored undiluted at 40° F. for two or three days could be used for insemination with a reasonable degree of certainty of fertility. Conception with dairy bull semen stored for longer intervals was possible but impractical on account of the low percentage of resultant pregnancies. (H. A. Herman, A. C. Ragsdale. E. W. Swanson.)

**Line Breeding in the University of Missouri Dairy Herd.** This Station is carrying on a line breeding investigation with dairy cattle to develop useful, long lived, and high producing animals of a desirable type.

In the Holstein herd most of the sires have been of "Ormsby" blood lines and in the Jersey herd an attempt has been made to breed a high producing line of Jersey bearing "Raleigh-Owl Interest" blood lines.

In the Holstein herd the senior herd sire, Man-O-War 69th, has demonstrated his transmitting ability by producing a

total of 8 daughters completing A.R. S.O. records averaging 14,423 pounds of milk containing 520 pounds butterfat at an age of 2 years, 4 months (705 pounds fat mature equivalent basis). In addition 4 sons, 3 in D.H.I.A. associations, have proved satisfactory on account of the good production of their progeny.

Three sons of Man-O-War 69th are now in service in the Station herd. All are linebred and from cows which have demonstrated their production ability and which have two or more tested daughters with records above the breed average.

The Holstein herd was classified officially in 1940 under direction of the Holstein-Friesian Association of America. Twelve females and two males were rated "very good"; 13 females, "good plus"; 10, "good"; and 3, "fair." Man-O-War 69th and his son Mo-Vesper-Man-O-War Zirc were rated "very good."

In the Jersey herd, the "Raleigh-Owl Interest"-bred animals are being mated to Blonde Observer, a proved bull with 7 D.H.I.A. daughters averaging 452.8 pounds butterfat and 2 Register of Merit daughters averaging over 550 pounds butterfat as 3 year old. (H. A. Herman, A. C. Ragsdale.)

#### **Artificial Insemination of Dairy Cows.**

Three organized artificial breeding associations are in operation in Missouri and include about 50 herds. Many of the larger herds in Missouri (50 to 600 cows of breeding age) are furthering the use of their best sires by this plan. Complete breeding records are kept on each herd. Several samples of semen from each bull are obtained at intervals for analysis. The ratio of insemination per conception has varied greatly for different sires and for different herds. An average service rate of 1.8 per calf was secured which is about as effective as natural breeding.

In the Station herd both natural and

artificial breeding have been practiced for the past 3½ years. The insemination rate for artificial breeding has been slightly higher than natural service largely on account of the recent practice of using stored semen. The number of services per conception by both means of breeding also has increased due to 4 bulls of low fertility. In several instances bulls with a service ratio of 1:3 or 4 have been used since 1938. Where fresh semen was used the results have been almost identical. The practice of using double and even triple insemination on cows difficult to settle has continued to give desirable results. (H. A. Herman, A. C. Ragsdale, Eric Swanson.)

**Fertility of a Bull Cannot be Estimated Accurately From a Single Semen Examination.** A careful examination has been made of 342 semen samples representing 55 dairy bulls. The fertility of 51 of the bulls has been determined from their breeding records and compared with the examination of their semen.

The semen samples varied widely in all the properties studied. The variation was observed in different samples from the same bull, as well as from different bulls. The greatest differences observed were in the length of time vigorous motility persisted and in the percentages of abnormal spermatozoa.

A normal pH, good initial motility, and a low percentage of abnormal spermatozoa were indications but not assurances of good fertility. Morphologically abnormal spermatozoa were found in every sample of semen examined. Bulls which produced semen averaging over 30 per cent of abnormal spermatozoa were usually of poor fertility, but not necessarily infertile. Survival time of semen which was normally of good quality was not increased by dilution with any of the common diluents used, but the survival of semen from a few bulls was increased materially by dilution



with egg-yolk-buffer dilutor. Such semen normally became thick and viscous in storage and the dilutor apparently prevented this.

Fertility of good quality semen was maintained from 3 to 5 days when stored undiluted at 40° Fahrenheit. H. A. Herman, A. C. Ragsdale, and Eric W. Swanson have therefore concluded that a single semen examination should not be the sole basis for evaluating fertility. Three or more semen samples examined several days, or even weeks, apart with accompanying records of the bull's actual breeding record provided the most accurate method of evaluating fertility.

**Inter-relations Between Visceral Organ Weight, Body Weights, and Metabolic Levels.** Basal energy and protein metabolism increase not with simple body weight but with approximately the 0.7 power of body weight. This raises the question as to why metabolism does not increase directly with simple body weight. S. Brody and H. H. Kibler thought that the metabolic level might be dependent on the size of the metabolism-controlling organs: perhaps the thyroids, adrenals, pituitary, and brain. Therefore a study was made of the relation between organ weight and body weight. It was found that the relation was of the same order, about 0.7, between brain weight and body weight; pituitary weight and body weight; and basal metabolism and body weight of mature animals of different species. They concluded, tentatively, that metabolic levels including productive processes such as milk production were controlled by the members of the neuro-endocrine system.

The cardio-respiratory systems (such as heart, lungs, and blood) tended to vary more directly with body weight than with metabolism.

**Fluorescent Bacteria in Dairy Products.** For a number of years E. R. Garrison has studied the prevalence and biochemical properties of fluorescent bac-

teria in dairy products. In earlier work at this Station he reported having obtained these organisms from only 4.8 per cent of 104 sour cream samples as compared with 58.4 per cent of 149 sweet cream samples. Since most of the 505 cultures of fluorescent bacteria previously studied grew in beef peptone broth at a pH of 4.5 it seemed likely that they would not be destroyed by the acid in sour cream. Perhaps they were merely overgrown by the acid forming bacteria and therefore difficult to isolate. Subsequent work has proved this to be correct. By using a different procedure from that formerly employed these organisms were isolated from 70.8 per cent of 156 sour cream samples examined. This procedure consisted of inoculating the sour cream into a tube of litmus milk; holding the culture in a refrigerator at 35° to 40° F. until the litmus was reduced; and then spreading a suitable dilution of this material over the surface of a beef infusion agar (pH 7.2) plate. After three days incubation at 20° C. the plates were examined under ultra-violet light for the presence of fluorescent colonies. The growing of the organisms on the surface of the agar was essential for their detection since sub-surface colonies on poured agar plates did not produce the fluorescent pigment due to the lack of oxygen.

The standard procedure employed in bacteriological laboratories for studying the ability of pure cultures of bacteria to ferment different carbohydrates was found unreliable when applied to fluorescent bacteria. This was due to the fact that these organisms were vigorous producers of ammonia, which neutralized the acid formed when the carbohydrate in question was fermented. Thus, a false negative test was obtained. The error due to the formation of ammonia was eliminated by using a broth containing 0.25 per cent peptone, 0.15 per cent beef extract, and 1.0 per cent carbohydrate and reducing the initial pH to 6.3. None

of the 505 cultures studied gave a positive test for the fermentation of lactose by the standard procedure, while the new procedure showed that 86 cultures vigorously fermented lactose.

**Mold Mycelia in Cream.** The factors which influence the amount of mold mycelia in cream have been investigated by E. R. Garrison and J. H. Gholson. Samples of cream were obtained from 310 producers delivering to four cream stations in Columbia. These samples were taken once every three weeks. Eighty producers were interviewed concerning their methods of handling cream. The tests made included an acidity test, a modified Wildman Methyl-Blue-Borax test, and a plate count for mold on acidified potato dextrose agar. A high correlation was obtained between the acidity test and Methyl-Blue-Borax rating which indicated that in high acid cream it was probable that considerable mold was present. While the correlation between the Methyl-Blue-Borax ratings and the logarithms of the mold plate count was significant, it indicated that probably there were other factors than the amount of mold mycelia in the cream that affected the Methyl-Blue-Borax rating.

It generally is assumed that the amount of sediment obtained by this test is proportional to the amount of mold mycelia in the cream. However, occasional samples of cream that gave the sediment test contained very few mold. A microscopic examination of the sediment showed the presence of many body cells. This indicated that udder infection or late lactation might affect the test. A carefully controlled experiment verified this. There was a general but not a close correlation between the number of body cells in the milk and the amount of sediment. Centrifugally separated cream always gave a good Methyl-Blue-Borax test even when the test on the gravity cream from the same milk sample was doubtful, or

excessive. This probably was due to the removal of many of the body cells and much of the mucous protein during the centrifugal separation.

When the test was applied to the gravity separated cream from the milk from individual quarters of the udder the amount of sediment varied with the different quarters and was correlated with the severity of infection. Many of the cream samples that gave a positive test were from cows in advanced lactation with no udder infection. There was no variation with the individual quarters of these cows and the test became negative after the cows again freshened.

In order to determine the effect of separator cleaning methods on the development of mold in cream four gallons of Grade "D" mixed herd milk was separated twice daily for one week under each of the following four cleaning methods:

1. the separator parts were washed in warm water with washing powder and rinsed in scalding water after each operation;

2. the separator parts were washed in warm water with washing powder and rinsed in scalding water after the morning separation and flushed with cold water after the evening separation;

3. the separator parts were rinsed in cold water and immersed in a solution of 5 per cent sodium-phosphate and 0.25 per cent sodium-chromate between operations and rinsed again before using; and

4. the separator parts were rinsed in cold water and immersed in a solution of 2 per cent calgonite and 0.25 per cent sodium-chromate between operations and rinsed again before using.

In general the quality of the cream decreased least when the separator was washed as outlined in Method 1 with Methods 4, 3, 2 following in this order.

Tests of the effect of temperatures for holding cream samples were made at 50°, 60°, 70°, and 80° F. One sample held

at each of the various temperatures was stirred upon each addition of cream while cream was added to one each of the other samples without stirring. Acidity increased with the temperature and with the length of the holding period. The stirred samples had a slightly higher acidity than the unstirred.

**Ice Cream Studies.** High and low acid ice cream mixes were standardized to acidities of .18, .12, and .06 per cent respectively. Although the viscosity and surface tension of the ice cream mixes varied with acidity there was no apparent effect on the whipping and freezing properties. The freezing time and drawing temperature remained the same. Increasing the serum solids of the mixes lengthened the time required for freezing and lowered drawing temperature. A slightly more rapid and smoother melt down was obtained with ice creams of standardized acidities than with the original mix. Increasing the serum solids content resulted in more rapid, smoother, melt downs.

No change resulted from acid standardization or acid development in the number of dippers of ice cream that were obtained from a given volume of ice cream. Increasing the serum solids content from 9 to 11, 13, and 15 per cent respectively resulted in increased weight per dipper as did an increase in the serving temperature from 4 to 8 and 12 degrees Fahrenheit respectively.

Photomicrographs of the crystalline structure of the frozen ice creams indicated that smaller air cells and smaller ice crystals resulted from adjusting the pH of the ice cream mixes.

Adding a vitamin rich separate to ice cream mixes up to a maximum of 2 per cent (on a weight basis) gave a palatable ice cream. The carotene in the vitamin rich separate gave the ice cream a very rich appearing color. The body and texture were found to be excellent. (W. H. E. Reid, C. W. Decker, L. E. Smith.)

#### *Miscellaneous Investigations*

In addition to the work described the Department of Dairy Husbandry has conducted experiments on the nutritive value of the proteins of lespedeza hay for growing dairy heifers; on the influence of certain feeding programs; on the economy of butterfat production in Missouri D.H.I.A. herds; on variations in composition of milk and the effect of solids-not-fat.

Complete records of pasture practices and returns have been kept at the Hatch Dairy Farm. A limited use of short-wave diathermy applications has been made in the control of Bovine mastitis.

A new straw loft calf barn, designed on the general principle of the Missouri type poultry house, was constructed in 1939. From November 24, 1939, to January 1, 1941, there were no losses from pneumonia among 40 calves born during that period and housed in this barn.

A comprehensive 25-chapter book entitled, "Bioenergetics and Growth" by S. Brody has been practically completed.

Some preliminary results have been secured in the oxygen consumption of various animals. Water exhalation in animals also has been studied, as have the surface temperatures and heat radiations from various parts of the body under different environmental temperatures. Some work has been done on seasonal variation in respiration rate and pulse rate in cattle, goats, sheep, and horses.

Whey from cheese factories located in ten sections of Missouri has been analyzed for total solids, ash, lactose, fat, protein, acidity, pH, viscosity, specific gravity, surface tension, riboflavin, and water content.

Preliminary work has been done on the factors affecting the activity of the parathyroid gland. Work is in progress on the thyrotropic, adrenotropic, and gonadotropic hormone content in the pituitary of the rabbit.

## ENTOMOLOGY

L. HASEMAN, *Chairman*

**Codling Moth Control.** Codling Moth investigations and control work were conducted at Columbia, Clarksville, Cape Girardeau, Mountain Grove, and Marionville during the past year. Preliminary results have indicated that the addition of brown sugar to the arsenical spray solution increased worm control, presumably by flavoring the arsenical spray residue.

The possibility of using fixed nicotine sprays (nicotine bentonite) in place of lead arsenate, or at least in the later summer applications, again was demonstrated. However, in the applications when most apple worms were entering the fruits lead arsenate sprays with the addition of a deposit builder and spreader (summer oil emulsion) proved most effective and economical. (L. Haseman, Lee Jenkins, Curtis Wingo, W. W. Smith, H. E. Brown.)

**Control of Insect Pests of Melons.** During the past year C. W. Wingo and L. Haseman have studied the control of the striped and spotted cucumber beetles but beetle outbreaks failed to materialize. However, melon aphids were quite serious and plants which received poison sprays and dusts had more lice than the checks or those receiving applications of fixed nicotine. This probably was the result of poisoning of lady beetles and other aphid enemies, while the poison used had no direct effect on the aphids.

### *Miscellaneous Investigations*

A limited amount of work has been done by the Department of Entomology on the malarial mosquito in Missouri.

In cooperation with the Department of Field Crops and the Division of Cereal and Forage Crop Insects of the Bureau of Entomology and Plant Quarantine, seedings of inbred and hybrid strains of wheat resistant and susceptible to Hessian fly were made in Colum-

bia. However, since the infestation this year was very light, the results lacked meaning.

Spray and dust applications were made to strawberry plants at Marionville to control the strawberry leaf roller. Cryolite, derris, pyrethrum, and arsenicals were used. The first three materials showed more promise than the arsenicals.

During the year the chinch bug was reared in the laboratory in various types of cages under controlled conditions of temperature and humidity. Migration and seasonal studies of the insect were made at five widely separated areas in Missouri and correlated with the laboratory work in Columbia. Animal parasites and predators of the insect were studied in the field and many were reared in the laboratory. The testing of insecticides for chinch bug control was continued. Injury during the year was confined to individual farms in some ten or twelve of the west central and northwest counties of the State.

Efforts have been made to secure substitutes for arsenate of lead in codling moth control. Dormant oil emulsions and early foliage poison sprays for fruit tree leaf roller control have been studied, as well as sprays and dust for Oriental fruit moth, strawberry insect, melon insect, and cankerworm control. Dust and liquid applications to corn ears for corn earworm control, contact sprays and repellants for chinch bug control, and poison baits for grasshoppers, armyworms, and cutworms have been used. Dusts and washes for ox warbles, horse bots, lice, ticks, and mange mites of livestock and poultry have been tested. Also, some work has been done with insecticides for clothes moths, carpet beetles, house ants, cockroaches, and chiggers.

## FIELD CROPS

W. C. ETHERIDGE, *Chairman*

**Spring Growth of Bluegrass Most Palatable and Nutritious.** Seasonal variations in growth and chemical composition of herbage, roots, and rhizomes of Kentucky bluegrass have been determined. Growth and chemical composition of Kentucky bluegrass grown for 8 weeks in the fall were compared with those of bluegrass grown 8 weeks in the spring at the same average day length in thermo-regulated growth chambers at 60°, 70°, and 80° F.

According to E. Marion Brown preliminary results indicated that Kentucky bluegrass was more palatable and nutritious during the spring and early summer months; April, May, and June. In order to utilize the grass most efficiently, it should be pastured throughout this period so as to be nearly all consumed by early July. The bluegrass roots and rhizomes grow actively and store food reserves in the cool periods of both spring and fall. Close defoliation reduces this growth and food storage. Therefore, intensive grazing in both spring and fall weaken the plant. If the grass is protected from grazing during the autumn, reserves will be restored. It is not necessary to graze Kentucky bluegrass during this period if one uses other pasture crops, such as Korean lespedeza for early July to early October pasture and winter barley or rye sown in late August for October to December pasture. The accumulated bluegrass herbage can be used for winter grazing without injury to the grass if grazing is deferred until cold weather.

**Corn Breeding Investigations.** The corn improvement program in 1940 consisted of the selfing and crossing nursery; yield trials of commercial and experimental hybrids; seed treatment studies; and the response of corn hybrids to different levels of fertility.

The breeding experiments included

selfing and crossing plots which contained about 2,500 25-plant nursery rows. The selfing nursery contained 310 white and 445 yellow inbred lines in various stages of inbreeding; 81 ear-rows of pipe corn to be selfed for the second time; and 626 ear rows of seven white open-pollinated varieties to be selfed for the first time.

Because of the severe drought from June 25 until August 6 excellent drought notes were obtained on all of the nursery material, but the hand pollinations made during this time were very poor. As a result about half of the material in the selfing nursery was discarded.

Yield tests of hybrids and varieties were conducted at 18 different locations in the State. The bulk of the experimental material was tested at Jefferson City, Maryville, Grain Valley, Sikeston, and Fairfax.

At Jefferson City, Maryville, and Grain Valley the results were of limited value on account of drought, lodging, and chinch bugs.

At Sikeston, some of the experimental yellow double crosses were much superior to Mo. 8 and Mo. 47 in lodging resistance but were not significantly better in yielding ability. A majority of the white hybrids were superior in yield and lodging resistance to the usual white open-pollinated varieties.

At Fairfax, in the Northwestern part of the State growing conditions were very satisfactory and excellent data were obtained. The results indicated that a majority of the white hybrids were superior to the varieties in yield and lodging resistance.

In addition experimental hybrids were grown in each of the 16 tests where commercial hybrids were being tested.

In the northern region of the State 38 commercial hybrids, 9 experimental double crosses, and two varieties were test-

ed. Several of the experimental hybrids performed much better than Mo. 8 but none of them did as well as U. S. 13 or Mo. 47, the two hybrids recommended for that region.

In the central region, 35 commercial hybrids, two varieties, and 12 experimental double crosses were tested. Several of the experimental hybrids performed better than the average of the hybrids in the test, but none of them did as well as Mo. 47.

Thirty-five commercial hybrids, two varieties, and 12 experimental double crosses were grown in the southern region. The results showed the experimental hybrids tested in this region to be much better adapted than those tested in the central and northern regions. (D. C. Anderson.)

**Studies on Gene Action.** The factors determining anthocyanin pigmentation in plants provide exceptionally favorable material for studies on gene action, since single genes affect specific changes in the chemical composition of an end product which is chemically well known. Since the substance affected is not basically important physiologically, diverse changes in its composition are tolerated and viable mutant races may be established representing the effects of the absence of various factors involved. The quantity of pigment produced is large enough to facilitate chemical analysis.

Not many factors which have specific effects upon anthocyanin are known in corn, but the plant produces pigment abundantly and shows numerous variations which may be expected to prove dependent upon anthocyanin factors analogous to those which have been demonstrated in other plants.

Some preliminary experiments have been made during the past year to determine whether or not direct physiological study of the action of genes affecting anthocyanin pigmentation would be feasible.

In those genotypes which normally

produce anthocyanin in the root, excised roots cultured on media containing glucose and mineral nutrients produce anthocyanin abundantly. Anthocyanin therefore may be synthesized by the cell from externally supplied glucose, without the intercession of other substances derived from the overground parts of the plant. The genes essential for root color in the dark are **A** (or **A<sup>b</sup>**), **A<sub>2</sub>**, **P1**, and a suitable **R** allele (**R<sup>ch</sup>**, **r<sup>ch</sup>**, and some but not all **R<sup>r</sup>**'s and **r<sup>r</sup>**'s). **B** is not essential and does not replace **R<sup>r</sup>**.

It may be possible to learn something of the course of synthesis of anthocyanin, and of the role of various genes affecting it, by physiological experiments with excised tissues, testing the effects of postulated intermediates between glucose and anthocyanin, of specific enzyme inhibitors, of diffusible substances extracted from plants of contrasting genotype, etc.

Experiments with intermediates supplied in place of glucose cannot well be made with excised root-tip cultures, because the addition of some glucose or fructose is necessary to keep the roots growing. An intermediate would have to replace glucose in general metabolism as well as in anthocyanin synthesis to give positive results. Minimal quantities of sugar will maintain slow growth with little or no anthocyanin production, and experiments may be made with intermediates added to increase the anthocyanin yield.

A more satisfactory technique is to use sections of mesocotyl or leaf blade from young seedlings, since cell division is not a factor and since differentiated cells capable of anthocyanin production are present from the start. These sections remain alive for several days in buffer solutions, dilute salt solutions, or pure water. In suitable genotypes, they fail to produce anthocyanin unless sugar is added, while with added glucose or fructose they produce anthocyanin abundantly. Although these sections may



contain reserve carbohydrate which may be used in the synthesis of anthocyanin, they cannot complete the synthesis without something which they obtain from added glucose.

Leaf blades from mature plants also serve very well in  $r^{ch}$  stocks (with **A b P1**), and quite well in  $R^{ch}$ . Anthocyanin is produced poorly in mature leaf tissues with the best of the  $R^r$  and  $r^r$  alleles tested, and not at all with some. Mature leaves are convenient material, especially for producing the quantities of pigment required for chemical analysis.

Several preliminary experiments of this type were performed, and some of the results are summarized below.

Galactose, which does not support the growth of excised root tips, may be substituted for glucose in the production of anthocyanin in leaf or mesocotyl tissue. On the contrary, mannose, 1-sorbose, and 1-rhannose gave no anthocyanin.

The pentocese, xylose, and lyxose, gave a fairly good yield of anthocyanin, while arabinose (both d- and l-forms) and ribose failed.

Some modifications of the  $C_1$  and  $C_6$  groups in the glucose molecule could be made without preventing the production of anthocyanin. Sorbitol and glucuronic acid yielded anthocyanin; d-methyl-glucoside and gluconic acid did not.

The trioses, glyceraldehyde and dihydroxyacetone, in phosphorylated form, are produced from glucose in the normal course of respiration. Either glyceraldehyde or dihydroxyacetone (unphosphorylated), supplied in place of glucose, produced some anthocyanin, more in the case of glyceraldehyde than of dihydroxyacetone.

Various specific enzyme inhibitors or poisons have been supplied over a range of concentration extending to the toxic limit, without producing a distinct reduction in the yield of anthocyanin from glucose. These included cyanide, azide, iodoacetate, fluoride, malonic acid, ure-

thane, and maleic acid. The only substance which in catalytic concentrations showed inhibition of the production of anthocyanin from glucose, in the trials made so far, was 2-4-dinitrophenol. This is a well-known stimulant of respiration and glycolysis, and may reduce anthocyanin synthesis competitively by diverting glucose to other channels. At concentration of the order of  $10^{-5}$  molar it inhibited anthocyanin production, and at lower concentrations it reduced materially the quantity of anthocyanin produced. (L. J. Stadler.)

**Polyploidy Investigations.** The cytological effect of a single rye chromosome on meiosis in normal *vulgare* wheat has been studied in further detail. The effect is simply that of inducing asynapsis among the wheat chromosomes, an event which permits the extraction of various unusual and useful types. The rye chromosome which produces the asynapsis is the one which carries the factor or factors responsible for hairy neck. The asynapsis is produced when the rye chromosome is monosomic, disomic, or trisomic, and is evident in the rye chromosomes as well as the wheat when the former are present in more than a single dose. The frequency of asynapsis in the monosomic plants was determined from 500 microsporocytes in a single plant. The frequency, expressed in percentage, was  $13 \pm 3$ . The disomic and trisomic plants have much more asynapsis than this. The asynapsis produces anomalous gametes which unite to form individuals which are nullisomic, monosomic, trisomic, and tetrasomic for various wheat chromosomes. All these types, and many more complex ones, have been realized in progenies from hairy neck disomes.

A triple hybrid involving *Triticum turgidum*, *Haynaldia villosa*, and *Secale cereale* has been synthesized by using special pollinating techniques, and will be used to secure an amphitriploid. Such a polyploid is theoretically possible but



has not been realized up to the present time.

Several new nullisomes (complete deficiencies for pairs of chromosomes) have been obtained in *Triticum vulgare*, bringing the total now available to at least 15 (possibly 19) out of the possible 21. The new nullisomic material has been derived from monosomic plants found in the progeny of two partially asynaptic types, one nullisomic for a particular wheat chromosome, and the other disomic for a particular rye chromosome added to the wheat complement. Nine nullisomes, out of 14 which have been tested, have been found to involve homologues of emmer chromosomes.

One new amphidiploid, *Aegilops bi-*

*ornis* × *Haynaldia villosa* (n=14), has been obtained by colchicine treatment. (J. G. O'Mara, E. R. Sears.)

#### *Miscellaneous Investigations*

Additional projects under investigation in the Department of Field Crops include the testing of old varieties and breeding and testing new varieties of cotton; the study of the response of soybean varieties to different levels of mineral nutrition; hybridizing of wheat and testing of hybrid progeny; the breeding and testing of oats for resistance to smut and crown rust; the development of new barley varieties, superior in winter-hardiness and productivity under Missouri conditions; and the efficiency of grain-legume short rotations.

## HOME ECONOMICS

FLORENCE HARRISON, *Chairman*

**The Xanthophyll Fraction of Egg Yolk Pigments.** Young growing rats were fed a vitamin A free diet supplemented by the xanthophyll fraction from egg yolk pigments. The results of feeding this fraction at a level of 200 gamma to each rat per week indicated that the fraction contained some growth stimulating factor. A growth curve for rats has been established for vitamin A in order to test the vitamin A potency of pure crystalline egg yolk xanthophyll. (Bertha Bisbey, Margaret Blevins, Adelia Weiss.)

**Income and Expenditures of Families of Columbia, Missouri.** The incomes and expenditures of 564 families of Columbia, Missouri, have been studied by Jessie V. Coles and Eunice Werner. The median income of those studied was \$2,081 which was thought to be somewhat higher than the average Columbia family because a high proportion of business and professional families were included in the sample.

The size of the income was an important factor in the amount of expenditure for the principal groups of goods

for family living. When families having the same incomes were studied, occupation and size and composition of families were unimportant influences on expenditures for most groups of commodities and services with the exception of food.

The proportion of income spent for various commodities and services varied with size of income: the low income groups spent a larger proportion for food and housing; while the higher income groups spent a larger proportion for clothing, automobiles, gifts, welfare, taxes, recreation, and similar items. Household operation, medical care, and tobacco were quite constant at all income levels. Automobile expense was a larger item of expense than clothing for all families as a whole.

Three-fourths of the families had an average surplus of \$582 after expenses were paid. However, families with an income of less than \$1000 had an average net deficit of \$45.

**The Use of Consumption Credit by Missouri Farm Families.** Farm families in Ralls County, a general livestock

farming area, were interviewed by Mildred Spicer and Louise Young as to their use, knowledge of, and attitude toward farm credit. Data from 188 farm families were analyzed. Eighty-three per cent of these farm families used some form of credit: 73 per cent used production credit; 44 per cent used consumption credit; and 34 per cent used both types of credit. The families who rented farms used more credit than those who owned or partly owned their farms. Dealer credit was the most common source of credit for family living. Interest rates ranged from 3 to 58 per cent.

The families who used installment contracts in general knew the cash price, the carrying charge in monetary units,

the size of down payments, and the amount of each installment; but were less aware of the annual rate of interest or of the legal provisions in their contracts.

#### *Miscellaneous Investigations*

In the Department of Home Economics work also was done on the relation of the carotene and xanthophyll content of the diet to the growth of young chicks and the effects of the diet of the hen upon the thiamin content of the eggs produced and upon the tissues and its distribution.

Terry cloth towels and toweling materials available in stores in Missouri were tested for tensile strength, thread count, and weight per square yard.

## HORTICULTURE

T. J. TALBERT, *Chairman*

**Increasing Fruit Set and Size by Ringing and Scoring.** In 1940 A. E. Murneek increased the fruit set and size of fruit on limbs of vigorous 20-year old Delicious apple trees, by ringing and scoring the limbs while the trees were in full bloom. These trees were growing in a deep loess soil in a commercial orchard. Bees were provided for ample cross-pollination. Scoring increased the set of fruit fourteen per cent and ringing increased it seventeen per cent. Also, ringing increased the size of fruit more than scoring. The average weight of fruit from the ringed branches was twelve per cent greater than untreated branches while the average weight of the fruit from the scored branches was ten per cent greater. In only one case has ringing and scoring failed to increase the fruit set and size. In 1940, young Black Twig apple trees in their first year of bloom, were ringed and scored, and the effect was insignificant. Branch ringing also has a measurable and beneficial "carry over" effect on flower bud formation and fruit set the following year.

**The Reduction of Preharvest Drop of**

**Apples.** Shortly before the normal harvest period of apples a natural drop of the fruit begins, varying with the variety and the year. Several years ago, the United States Department of Agriculture discovered that certain so-called plant growth substances when sprayed upon trees previous to harvest time prevented excessive dropping of apples. A number of commercial preparations for this purpose have been tested by A. E. Murneek on several varieties of apples at the recommended dilutions. These results have been compared with the results from trees sprayed with pure naphthalene acetic acid, its potassium salt, and naphthalene acetamide. All the commercial products were satisfactory when the dilution was kept as recommended by the manufacturers.

In the fall of 1940 over 500 acres of apple trees were sprayed in Missouri. The treatment was beneficial in approximately 95 per cent of the cases. In order for these sprays to be most effective the spraying should be prompt and should begin as soon as the drop starts. The application should be thor-

ough, and normally requires about  $\frac{1}{2}$  gallon of spray for each year of age of the tree. The effects of the spray begin in about 2 to 4 days and continue for 10 to 14 days. The delay in harvesting made possible by these treatments resulted in an increase in the size and a marked improvement in the color of the fruit.

**The Physiology of Reproduction in Horticultural Plants.** Apparently there is a relation between sexual reproduction and carotinoid pigmentation in plants. Earlier results which indicated that the total carotene and xanthophyll concentration reached a maximum in leaves of sexually reproductive plants at the approximate time of full bloom have been verified. There were no significant changes in the carotene-xanthophyll ratio, but there were distinct alterations in the ratio of individual carotenes (alpha & beta) and individual xanthophylls during the reproductive cycle.

Satisfactory methods and equipment have been devised for chromatographic analysis of the carotene and xanthophyll pigments by adsorbing them in certain regions of columns of various adsorbents. Magnesium oxide and calcium carbonate were found most satisfactory for this purpose. Of the solvents tested, petroleum ether was best for carotenes and cyclohexane for xanthophylls.

Efforts have been made to stimulate fruit setting of apples and the prevention of early drops by the use of sprays containing naphthalene acetic acid, naphthalene acetamide, indole acetic acid, indole butyric acid, phenyl acetic acid, and a proprietary compound. The materials were sprayed in aqueous solution at intervals from early bloom to the beginning of the third drop on 5 different varieties: Minkler, Jonathan, Black Twig, Delicious, and Stayman. The setting of fruit was not increased in any case nor was there a reduction in the various drops that normally occurred

in May. The injection of some of these chemicals and trimethylamine into the bark of large limbs also had no beneficial effect.

Indole butyric acid when applied to tomato plants increased the number of fruits and the speed of fruit development. The treated tomato plants also set and developed more parthenocarpic fruit than fruit developed as a result of normal pollination.

Stringbeans sprayed every other day with an aqueous solution of naphthalene acetamide beginning when the first flower buds appeared gave a markedly increased yield ranging from 60 to 75 per cent. Similar results were secured with naphthoxyacetic acid, but in one case the use of this substance gave a slight decrease in size of pods.

Normally, fruits have a marked inhibitory effect on vegetable growth in proportion to the quantity per plant and proximity of the fruit to the terminal region of the stem. However, parthenocarpic fruit inhibited growth much less and permitted tomato, cucumber, and pepper plants to produce flowers with less interruption.

The suppression of one fruit by another within the same fruit cluster of tomatoes could not be overcome by an application of indole-butyric acid in lanolin, although this treatment usually stimulated fruit development. The preceding results are based on investigations by A. E. Murneek, D. D. Hemphill, I. Meites, and S. H. Wittwer.

**Flower Bud Opening Retarded.** Late spring frosts frequently cause great damage to fruit not only in Missouri but in many other fruit producing sections. If fruit growers were able to delay the growth and flowering of fruit plants and thus avoid these frosts, it would be a great asset. C. G. Vinson and D. R. Rodney in laboratory experiments have retarded the breaking of vegetative and flower buds on peach twigs by inserting the basal ends in an aqueous extract of

dried peach leaves. Similar extracts of apple, pear, cherry, elm, walnut, oak, poplar, persimmon, and spirea acted in the same way upon the respective twigs. This suggested that the substance which caused this was widely distributed in plants.

An aqueous dispersion of tannic acid delayed opening of buds on twigs in the same manner.

Dilute solutions of malic, maleic, fumaric, and succinic acids sprayed on dormant peach twigs definitely stimulated the fruit and vegetative buds to break ahead of those buds on twigs which had been sprayed with water only.

If these results can be applied to field conditions losses from late spring frosts may be greatly reduced.

#### **Vitamin B<sub>1</sub> and Plant Development.**

A great deal of interest has been created and sensational claims made of the value of vitamin B<sub>1</sub> for plant development. A. E. Murneek has used this vitamin as an accessory growth substance in a large number of cases. At concentrations of .025 to 5.0 milligrams per gallon of water, vitamin B<sub>1</sub> stimulated the growth of several kinds of plants (cosmos, dill, ornamental pepper) in soil. Root development was influenced the most. This seemed to indicate that this vitamin was a more or less specific root growth factor. However, equally good and sometimes better results in plant growth were obtained when the surface of the soil was covered with a one-half to three-fourths inch layer of leaf mold, which supplied not only sufficient vitamin B<sub>1</sub>, but undoubtedly a good many other growth promoting substances.

Also, it has been claimed that adenine, uric acid, vitamin B<sub>6</sub>, and nicotinic acid have a growth promoting effect on plants. These substances were used in concentrations of .01 mg. per liter of water in tests with cosmos plants. Results were very variable. Possibly they may be of benefit only when the soil is very poor. Good soil, amply supplied

with organic matter, gave the best growth and development of plants.

**The Control of Cherry Leaf Spot.** In 1941, the infection of cherry trees with cherry leaf spot was very light. A number of proprietary insoluble copper fungicides gave nearly perfect control. Equally effective results were obtained with lime sulphur 2½-100 and Bordeaux mixture 4-6-100 and 2-3-100. H. G. Swartwout made these tests and used the manufacturers' recommendations with the addition of 1 quart summer oil per 100 gallons of spray in the case of all the proprietary copper compounds. The Bordeaux mixture 2-3-100 was used with and without summer oil. There was no noticeable burning of the foliage.

**Nicotine-Bentonite as a Substitute for Lead Arsenate.** The establishment by the Federal and State Food and Drug Administration of a definite tolerance of arsenic on fruits and vegetables has forced many growers to curtail their spraying programs with a risk of inadequate control, or to adopt cleaning methods. Special cleaning machinery is expensive. For many years arsenate of lead has been the standard insecticide for the control of codling moth. A suitable substitute for lead arsenate therefore would be very useful.

C. G. Vinson, for four years, has used nicotine-bentonite for the control of codling moth with the results equal to that of lead arsenate. Combinations of the dry-mix nicotine-bentonite with milk powder, with summer oil, and with a number of proprietary compounds have given better results than the nicotine-bentonite alone. However, the cost of the nicotine-bentonite at this time probably is too high to warrant its use on a commercial scale as a substitute for lead arsenate.

#### **The Use of Fertilizer on Tomatoes.**

The value of commercial fertilizers in vegetable gardening has long been known but the vegetable grower needs definite information as to formula; the

time, rate, and method of application; and the effect upon each individual crop. R. A. Schroeder has applied varying amounts of the elements which make up a complete fertilizer to the tomato crop. Low levels of potassium, calcium, nitrogen, and particularly phosphorus all had a detrimental effect upon the growth of the older tomato plant. With the levels used, a low calcium level did not show up as reduced vegetative growth in the younger plant. Higher levels of nitrogen increased the dry weight of both the seedling and mature plants. Low potassium level gave a reduction in the yield of seedling plants but not nearly as great as for the low nitrogen and phosphorus levels.

Field studies showed that a 500 pound per acre application of a 4-16-4 fertilizer plus lime gave the best yield of both early and total fruit. Application of calcium or phosphorus separately gave yields significantly lower than where both were applied.

**Outdoor Home Planting and Commercial Production of Cut Flowers.** Under the direction of J. E. Smith, Jr., a large number of varieties of annual and perennial flowers have been grown in an outdoor planting and in a specially constructed cloth house.

The following annuals were found to be very satisfactory and can be recommended for out-door planting: *Ageratum*; *Bush Balsam*; *Celosia*; *Dahlia Unwin Dwarf Hybrid*; *Tricholaeon* (ornamental grass); *Helichrysum*; *Impatiens sultani*; *Nierembergia*; *Phlox drummondii*; *Rudbeckia*; *petunia*; *verbena*; and *Vinca* roses. The following annuals did exceptionally well in the cloth house and also did well out of doors; *Antirrhinum* (rust-proof varieties); *Calliopsis*; *Gaillardia*; *marigold*; *Pentstemon* *Sensation* vars.; *scabiosa*; and *zinnia*.

**The Use of Sub-irrigation Nutrient Culture in Growing Flowers.** The growing of plants in nutrient solution has

been employed by research workers for many years. Recently this method has been used in the commercial production of cut flowers but physical problems related to the types of mediums for use in beds for support of the plant as well as nutritional problems have shown the need for additional information.

J. E. Smith, Jr., has sown seed in river sand and sub-irrigated with nutrient solutions when moisture was needed. He has obtained a higher percentage of germination and produced a better root system more easily handled than with similar seed sown in orthodox soil mixtures. Seedling diseases, primarily damping-off, have been minimized by the use of this method.

Cuttings of many bedding plants were found to root very easily early in the fall in a relatively coarse gravel medium when sub-irrigated with nutrient solution. Later cuttings in mid-winter suffered for want of bottom heat in this same medium.

Many materials have been used as a growing or rooting medium. Pulverized brick, a local inexpensive material, has been successfully used. The pulverized material was passed through 3/8 inch, 1/8 inch, and window screens respectively to eliminate the finest powder and to give various grades for experimental purposes.

Snapdragons, grown in a nutrient culture solution began to bloom at about the same time as those grown in soil and the quality of the flower was approximately the same, but the yield was slightly lower.

Carnations were benched in December from 4-inch pots and grown in nutrient culture. The plants from which soil was not removed produced much better plants than those from which all soil was washed at the time of benching. Growth was very satisfactory and the flower stems were stiffer than those commonly found on soil-grown plants.

*Miscellaneous Investigations*

In the Department of Horticulture preliminary investigations upon the influence of soil fertility upon the value of the casing soil in mushroom growing have been started. There is some indication that the production of mushroom may be increased by the fertilization of the casing soil.

Plantings of hardy varieties of Persian walnuts and pecans have been made at the Midway orchard, at Monett, and at Campbell.

Experiments with Georgia collard plants grown in sand culture indicated that copper uniformly reduced the ascorbic acid concentration in the leaves and that manganese definitely increased the

ascorbic acid content of the leaves and of the entire plant.

In the work with virus disease of plants efforts have been made to produce a true crystallin form of the virus. The attempts have been unsuccessful.

In the Ashland area approximately 10,300 trees were planted to reforest 10½ acres. Stock was supplied by State and Federal agencies. The varieties planted were: Virginia pine, short-leaf pine, jack pine, ponderosa pine, Scots pine, eastern red cedar, southern cypress, Ozark white cedar, yellow poplar, hardy catalpa, red gum, white ash, green ash, white oak, burr oak, and red oak.

A survey of markets for farm woodland products in Missouri has been made.

**POULTRY HUSBANDRY**

H. L. KEMPSTER, *Chairman*

**Protein Supplements for Young Chicks.** During 1940 fifteen different rations were fed to young chicks. Seven different trials were conducted involving 42 different lots of chicks. The rations varied in soybean oil meal from 0 to 25 per cent; dried buttermilk from 0 to 5 per cent; and meat scrap from 0 to 13 per cent. Various combinations of these protein concentrates were employed. The protein composition of the ration varied from 17.3 per cent to 22 per cent and the calculated vitamin G content ranged from 296 units to 397.

Rations containing soybean oil meal to the extent of 25 per cent of the total ration produced gains equal to the average of the controls when fed in combination with 2 per cent or more of animal protein supplement. Under the conditions of these experiments, meat scrap proved superior to dried milk as the sole supplement used with soybean oil meal in the ration. Rations containing lower levels of dried milk than generally recommended produced rapid growth and economical gains when the alfalfa leaf meal content was adjusted

to provide 290 units or more of vitamin G per 100 grams of feed.

The results of this study suggest that combinations of proteins from various sources are more satisfactory than from only two sources. The results of trials in which the protein levels ranged from 17.3 per cent to 21.9 per cent indicated that male chicks utilize the additional protein to better advantage than female chicks fed the same ration. No appreciable differences in feather growth were apparent for chicks fed rations which varied in soybean oil meal content from 0 to 25 per cent. (H. L. Kempster.)

**Feed Purchasing Power of Eggs Laid by Hen.** The eggs from a 122-egg hen purchased 124 pounds of feed in 1940 as compared to 148 in 1939 and 133 for the 1910 to 1914 average. The egg-feed ratio in 1940 was nearly as unfavorable as it was in 1936, the ratio being 8.09 in 1940 and 8.28 in 1936. The average price of feed was \$1.13 per cwt. as compared to \$.92 for 1939 while the average price of eggs for 1940 was 13.96 cents per dozen as compared to 13.3 cents for 1939. (H. L. Kempster.)

**Time of Hatching in Relation to Egg Production.** Apparently there is a wide latitude in the selection of a hatching date for White Leghorn pullets as far as subsequent egg production is concerned, according to investigations carried out by H. L. Kempster.

The hatches were made at weekly intervals from February 4 to April 8. There was no significant difference in the winter egg production of the pullets from the various groups but the April hatched birds laid more eggs during the spring period. The February hatched birds averaged 166 eggs from November 1 to October 31 as compared to 171 for the March and 186 for the April hatched birds respectively. This was

compensated for by the fact that the February hatched pullets had averaged 36 eggs before November 1 as compared to 8 for those hatched in April. Because of the usual high price of eggs in the fall, the hatching of White Leghorn pullets in February and March may be a profitable practice.

#### *Miscellaneous Investigations*

Additional projects under investigation by the Department of Poultry Husbandry include the growth and feed consumption of capons and cockerels; the influence of diet of the hen upon the vitamin potency of eggs and tissues; the comparative value of certain grains in rations for egg production; and the effect of environment on laying hens.

## RURAL SOCIOLOGY

C. E. LIVELY, *Chairman*

**The Relocation of Missouri Families.** Methods developed by C. E. Lively and Eugene Wilkening were used to advantage the past year in relocating 400 families in the Weldon Springs area of St. Charles County to permit the building of a war plant. Also, these same methods were of help in relocating 300 families in Pulaski County for Ft. Leonard Wood. A survey was made of the needs of the families so that adjustments in the relocation process could be made as quickly as possible. Information was

furnished the families with respect to location of desirable farms, sources of credit, employment possibilities, and medical assistance. A number of agencies (federal, state, and local) cooperated in relocating the families.

#### *Miscellaneous Investigations*

The Department of Rural Sociology also has been studying the rural health facilities of Missouri and the effect of rural attitudes and folkways on soil conservation and land use practices.

## SOILS

W. A. ALBRECHT, *Chairman*

**The Mineral Organic Colloidal Complex is the Active Agent in the Soil.** Results of investigations at this Station have shown the importance of the mineral organic colloidal complex of the soil as the active agent for supplying nutrients and moisture to the growing crop.

The growth and composition of plants have been studied in relation to the amounts, kinds, and ratios of the various

nutrient elements carried on the exchange complex of colloid.

Recent investigations have shown that the supply of nutrients carried by the colloid was obtained from primary rock minerals. These minerals were broken down chemically upon contact with the colloid from which nutrients had been removed by the growing plant.

Soils from which the colloidal fraction has been extracted will not retain



moisture which the plant can use, whereas the extracted colloid will adsorb several times its weight of water. The reasons for the droughty nature of silty soils and of soils high in clay content have been found to be associated with the amount and degree of hydration of the colloids present in the soil.

The seat of plant nutrition, mineral weathering, and water adsorption have all been found to be in the colloidal fraction of the soil. (W. A. Albrecht. C. M. Woodruff, T. U. Yager.)

#### **Soil Survey and Land Classification.**

The Missouri soil survey in cooperation with the Bureau of Plant Industry and the Soil Conservation Service made detailed surveys in three counties during the year. The work by this Station was carried on by H. H. Krusekopf and M. E. Springer. In addition the State survey made a detailed soil and land classification of the Meramec River flood plain and cooperated in a reconnaissance flood control survey of the Spring River basin. The total area covered by detailed soil surveys was approximately 600 square miles.

The increased attention directed to marginal land areas because of land acquisition for forests, conservation areas, flood control, and similar projects, has increased the demand for soil information, particularly in the Ozark Region.

Supplementary laboratory studies have been made on some of the more important upland soils. The better, heavy textured soils have a maximum of 1.5 M. E. of magnesium in exchangeable form. Sandy or light textured soils have from .5 to 1.0 M. E. In general, the soils that have the highest content of calcium and organic matter also have the highest amounts of magnesium.

**In Missouri Phosphate is the Most Needed Element for Small Grains.** Trials with numerous ratios of phosphates and other fertilizers on various soil types have indicated that in most parts of Mis-

souri phosphate is the most needed element for small grains. G. E. Smith found in the tests which he has conducted that there was little difference in response from the soluble phosphates, but those in the less available forms were definitely inferior. When small grains were grown in rotations with limestone and legumes, potash in addition to the phosphate gave profitable returns. Where limestone and legumes were not used, phosphate alone was the most economical material. Except where the organic matter content of the soil was very low, the use of nitrogen for wheat has not been profitable.

In some years a fall seeded, fertilized nurse crop smothers out the legumes, or grass, seeded the following spring. This indicated a high degree of exhaustion of the soil fertility. In order to remedy this condition the fertilizer application was divided by applying half the fertilizer on the wheat in the fall, and by drilling the other half with the legume seed in the spring. The yield of wheat was reduced by about two bushels, but a much better stand of legume was secured. When the amount of fertilizer applied to the wheat was not reduced and additional fertilizer applied with the legume, the increase in the legume stand well repaid the additional expenditure for fertilizer. This extra fertilizer application gives promise of being a satisfactory method for establishing stands of legumes in competition with the nurse crop when the soil supply of nutrients is limited.

**Magnesium Deficiency in the Soil.** On some of the more highly developed and consequently more leached soils, definite magnesium deficiency symptoms have been observed in the crops and have been corrected through applications of magnesium salts. This is the first evidence of this deficiency in this State. According to G. E. Smith, these symptoms appear only after a lime and legume program has been in operation for

a number of years and were most noticeable in cropping systems where little plowing was done. The larger crop yields removed after such a program was followed have removed larger quantities of magnesium. With larger quantities of magnesium removed and with shallower rooting as a result of the soils being plowed at infrequent intervals, it appears that the magnesium content of the soil area where the plant roots feed may have become exhausted of this element.

Various soil types are being examined for their magnesium content in order

to determine the soils which may possibly develop a magnesium deficiency.

#### Miscellaneous Investigations

The Department of Soils also has in progress investigations dealing with methods of making badly eroded soils more productive; speeding up the decomposition of straw following the combining of grain; the use of fertilizers with legumes; the effect of the degree of soil saturation by fertilizers on the recovery of crops; the effect of soil treatments on yields of hybrid corns; comparisons of legumes for soil improvement; and soil treatments for permanent pastures.

## VETERINARY SCIENCE

A. J. DURANT, *Chairman*

**Fowl Paralysis.** Fowl paralysis or Neuritis of fowls is a comparatively recently recognized disease. In the last few years it has become of great economic importance not only in Missouri but in the entire United States. Fowl paralysis causes losses of from 5 to 50 per cent in affected flocks. Because of its obscure nature little is known concerning its cause and transmission.

One of the first steps in determining the treatment of any disease is the establishment of the causes and the methods of transmission.

A. J. Durant and H. C. McDougale have shown that the blood of chicks more readily transmitted fowl paralysis at 20 to 30 days of age, at 50 to 60 days, and at 110 to 120 days, than at any other times.

An effort has been made to transmit fowl paralysis from organs of birds visibly affected with the disease. A group of 7 White Rock chicks, 12 days of age, were inoculated with the diseased or affected vagus, radial, and sciatic nerves by implanting them adjacent to various nerves supplying different parts of the body. Only one bird developed any signs of fowl paralysis, showing a tumor

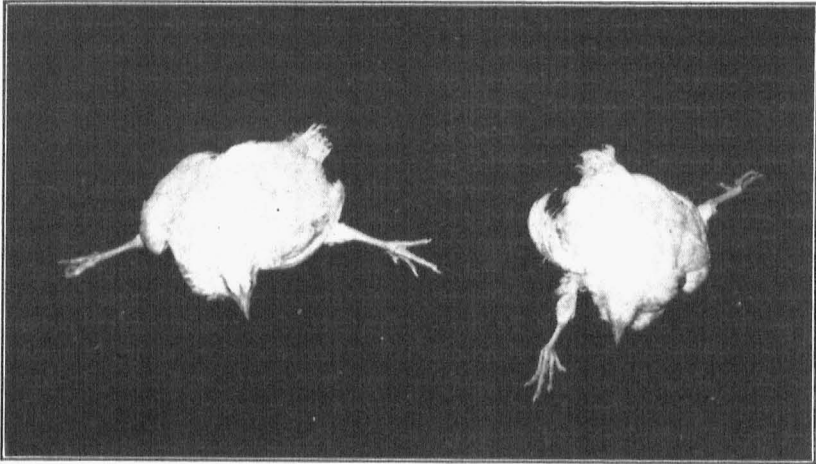
of the ovary. All seven control birds remained healthy.

In another transmission test the nerves were emulsified and inoculated into 7 Buff Leghorn chicks of 10 days of age. Of the seven birds inoculated two developed paralysis, one in 80 days and the other in 67 days. However, two of the 7 controls also developed paralysis, one in 290 days and one in 292 days.

It may be significant that the disease appeared within 3 months in the inoculated birds but did not appear in the controls until a lapse of over 9 months had occurred.

In a third transmission test, emulsions of the liver, spleen, and blood were used to inoculate 15 Buff Leghorn chicks, 10 days of age. From one-quarter to one-half cc. of the emulsion was placed in the peritoneal cavity, in the ventral cervical region near the vagus nerve, infraorbital sinus nerve, over the sciatic nerve, over the medial nerve, and subcutaneously. Of the inoculated birds, one developed a tumor of the pancreas in 285 days, and another an ovarian tumor in 104 days and an enlargement of the cervical and vagus nerves. The 15 controls remained healthy.

**Blackhead in Turkeys.** This is one of



Inoculated birds showing clinical symptoms of fowl paralysis. Both birds on autopsy showed an extensive involvement of the sciatic nerves 87 days after inoculation.

the most serious diseases of turkeys in Missouri. The sanitary programs which now are practiced by poultrymen have reduced losses materially. However, efforts to control this disease have not been entirely satisfactory. A. J. Durant and H. C. McDougale have developed a method of control by cecal abligation. In most cases if the birds withstand the operation successfully they do not develop blackhead. However, the operation is severe and abligated birds often develop an enlarged ceca which usually is fatal. Of the abligated birds available during this year, one has been abligated three years, one two years, and one ten months without evidence of enlargement of the ceca. Another bird developed an enlarged ceca after three years and seven months and died as a result of the enlargement. Three abligated birds died of blackhead during this period. One had been abligated 73 days, another 116 days, and a third three years. Apparently, lowered resistance was the cause of blackhead developing in these three birds. Two of them were affected with thrush, and one with the crop form of trichomoniasis. Properly abligated birds

kept under normal conditions have good resistance to blackhead, but other diseases, such as thrush and trichomoniasis, may lower this resistance until blackhead develops. Some success in the prevention of the enlargement of the ceca has been secured by the injection of a 4% formalin solution into the abligated ceca. Blackhead has been found in Chukar partridges, prairie chickens, and quail as well as in turkeys.

#### **Stomach and Nodular Worms in Sheep.**

The most serious internal parasites of sheep in Missouri are the stomach worm, nodular worm, the tape worm, and the small stomach worm. The general symptoms of parasitism may be very marked, especially when the infestations are heavy. They are loss of flesh, unthrifty appearance, diarrhea, and pale mucous membranes. As the infestation becomes heavier there is marked loss of weight, weakness, and in many cases death of the animal.

For a number of years Cecil Elder and O. S. Crisler have been interested in developing more timely and better methods of controlling stomach and nodular worms in sheep. The highest stomach

worm egg counts have occurred in lambs; the next highest, in yearling sheep; and, for the most part, the older sheep have had lower counts. This may indicate an age resistance or an increased immunity.

Various methods have been tried in an effort to control stomach worms. In most cases the controls had a much higher egg count than the treated animals. Nodular worm egg counts were a little higher in the controls than in the treated animals but the difference was too slight to conclude that the treatment was responsible for the reduction.

Maximum stomach worm egg counts were found in September, October, and November. The highest nodular worm egg counts were recorded in December and January indicating that the best time to treat for nodular worms probably would be late November or December. Since nodular worm egg counts were highest during the winter months, the contamination of pastures with nodular worms would be greatest during these months. However, the number of eggs which survive until spring is not known.

Methods of treatments are described in detail in Missouri Agricultural Experiment Station Bulletin No. 447.

**Can Bang's Abortion Infection Be Transmitted From Swine to Cattle?** This question is very important since *Brucella suis* (the swine infection) is more pathogenic to man than is *Brucella abortus* (the cattle infection).

Cecil Elder believes that owners of cattle herds free from Bang's disease need not have much fear of spread of infection from swine which may be running with these cattle in the same pasture even though the swine have not been blood tested. Therefore, the danger of man contracting undulant fever from milk produced by cows which have untested hogs running with them is not great. This conclusion is based on the fact that artificially infected swine have been kept with cattle in a small pasture

with no transmission of infection from the swine to the cattle. Some abortions did occur among the artificially infected swine, but none occurred in the cattle due to *Brucella suis*. Low agglutination titres developed in the cattle but in no instance were they due to *Brucella suis* infection. Neither *Brucella suis* nor *Brucella abortus* could be isolated from the cattle on experiment, even though cultural methods and guinea pig inoculations were used in all cases for making the tests. Perhaps in virulent outbreaks of swine abortion some transmission could take place, but the danger does not appear to be great.

#### *Miscellaneous Investigations*

In the Department of Veterinary Science blood studies with Bang's disease have been continued but the work has been confined primarily to methods and techniques which would be suitable for studying variations in blood titres. Comparisons between the tube agglutinations tests and the rapid or plate tests for low reacting sera have confirmed previous results in which it was found that there is a close agreement between the two methods and that the greatest difference in classification of reaction was confined to borderline cases. Results with cattle that have consistently given low titre reactions to the Bang's agglutination test have confirmed findings reported previously and indicated that apparently there was little danger of spread of Bang's disease infection from animals that have low titre reaction when such animals are kept in an otherwise negative herd. Similar results were secured with low reactors in swine. Swine owners can now be advised to retain low reacting virgin gilts in herds otherwise free from infection without danger of spread of the disease.

In the work with poultry diseases it has been found that canaries were subject to Leukosis. This may be of use in the study of Leukosis in fowls since

canaries may be used as experimental birds.

A study of Trichomoniasis of turkeys has been initiated in cooperation with the turkey growers of Missouri. Observations to date have shown that adult birds will carry the trichomonads for at least eight months and that the parasite

can be grown from these carriers at any time during this period.

The work with Toxemia in sheep has been with field cases of the disease. The treatments tried have all been unsuccessful. Also all efforts to produce experimental cases of the disease suitable for study have been unsuccessful.

## SERVICE PROJECTS

**Information Service on Agricultural Problems.** One of the most important services rendered to Missouri farmers by the Experiment Station is the answering of questions relating to Missouri Agriculture. Each year thousands of questions are answered by personal interview, by letter, by bulletin, by the Farm News Service, and by radio. Each year more and more persons call at the Station for help with individual problems. Every effort is made to handle these calls courteously and efficiently. The increased number of requests for information is an indication of the confidence of the people of the State in the Agricultural Experiment Station as a source of assistance in solving their agricultural problems.

**Seed Testing Laboratory (Clara Fuhr).** During the year 4,900 samples of seeds and plants were tested and examined by the Seed Testing Laboratory. Of these, 4,320 were tested for Missouri farmers and seedsmen, 157 samples in connection with the enforcement of the Missouri State Seed Law, and 423 samples under the Federal Seed Act.

A classified list of tests follows:

Purity and germination .....	2,366
Germination only .....	970
Identification .....	527
Approximate purity and germination .....	518
Examination and germination .....	245
Examination only .....	58
Purity only .....	37
Purity, examination, and germination .....	22
Purity and examination .....	17
Identification and germination .....	3
Identification, approximate purity, and germination .....	1
Total number of tests made .....	8,382

Number of samples received:

July 1, 1939, to June 30, 1940 .....	5,692
July 1, 1940, to June 30, 1941 .....	4,900

**Fertilizer Control.** M. F. Miller, Director; L. D. Haigh, Chemist. Collection and analysis of fertilizer samples during the past year are described in Missouri Agricultural Experiment Station Bulletin 432. A brief summary follows:

### Inspection

No. of towns and farms visited .....	272
Manufacturers, dealers, farmers, jobbers, and other handlers of fertilizer visited .....	545
Samples collected for analysis .....	488

### Chemical Analysis

Total nitrogen determinations .....	337
Water insoluble nitrogen determinations .....	320
Nitrogen activity .....	16
Total phosphoric acid determinations .....	464
Insoluble phosphoric acid determinations .....	456
Water soluble potash determinations .....	364

Purchasers of fertilizer sent 11 additional samples to be analyzed. In cooperative work with the Association of Official Agricultural Chemists, eight samples of fertilizer materials were handled in a study of methods of potash determination. In addition to the above, 2,183 samples of limestone and related materials were tested for their purity in terms of calcium carbonate equivalent. Laboratory facilities were furnished for testing 1,260 additional samples of limestone under the Grant of Aid Program of the Missouri Agricultural Conservation Association.

Missouri Agricultural Experiment Station Bulletin 432 issued in July, 1941, is a report of the results of fertilizer inspection for the calendar year 1940. A comparison of the guaranteed chemical composition of the fertilizers with that found by analyses is made. In general, farmers can rely upon the guaranteed analyses of the fertilizers offered for sale in Missouri. Analyses of the samples collected indicated that an average of 105.8 per cent of the amount of plant food guaranteed was present in the fertilizers.

**Official Testing of Dairy Cows.** Official tests were conducted for 51 Missouri breeders on 1,414 purebred cows. This represented 1,833 one-day and 351 two-day Advanced Registry or Register of Merit tests on 266 cows and 9,947 one-day Herd Improvement Registry Division tests on 1,148 cows.

The highest butterfat producing cow tested in the Advanced Registry or Register of Merit division was St. Albans Actor's Pretty Spot 559757, a Guernsey cow owned by St. Albans Farms. Her record was 17,020 pounds of milk containing 842.4 pounds butterfat during a 365 day lactation.

Pearletta Fern 924503, owned by S. R. Head, Hannibal, Mo., led all Jerseys officially tested with a yearly record of 14,175 pounds of milk. containing 859

pounds of butterfat during 365 days, at 8 years 11 months of age.

Farmington Pontiac Ormsby 1836933, a Holstein cow, owned by State Hospital No. 4 at Farmington was the leading butterfat producer of her breed with 20,715 pounds of milk, containing 751.7 pounds of butterfat during 365 days, at 4 years 1 month of age.

The leading Herd Improvement Registry record for Holsteins was made by Woodcrest Pontiac Piebe 1690914, owned by State Hospital No. 1 at Fulton, producing 28,450 pounds of milk, containing 865 pounds of butterfat during 365 days, at 6 years 7 months of age.

In the Herd Improvement Registry division, the Jersey herd of Floyd Thomas of Jasper ranked first. This herd of 10 cows averaged 9,774 pounds of milk containing 515 pounds of butterfat. The highest producing Holstein herd was that of State Hospital No. 4 of Farmington with 50 cows averaging 13,704 pounds of milk containing 467 pounds of butterfat. (H. A. Herman.)

**Locating Meritorious Dairy Sires.** Information of value to dairy cattle breeders, dairy specialists, and county agents of Missouri concerning the transmitting of high production ability of approximately one hundred dairy sires has been made available through a tabulation of progeny and their records. This information now is available on approximately 1,000 sires of the leading dairy breeds in this State. This program has assisted in recognizing sires of superior or inferior transmitting ability. The accumulated information has made it possible to recommend constructive programs to many breeders in Missouri. (H. A. Herman, M. J. Regan, Homer Cloninger.)

**Entomological Service.** During the year staff members have helped farmers with chinch bug, hessian fly, grasshopper, army worm. and corn earworm con-

trol through inspection and the completion of surveys.

Livestock farmers were aided in the control of bots, ox warbles, blood-sucking flies, and lice.

Fruit growers were assisted by weekly reports on codling moth emergence, personal conferences, and observations on fruit insects in the orchards.

Several thousand letters and informational circulars aided farmers and city people in the control of various types of pests. Also, numerous inquiries were received requesting methods to control rats, moles, and cankerworms. (L. Hase-man.)

**Identification of Plant Diseases.** (C. M. Tucker.) During the year approximately 400 letters were written in response to inquiries on the diagnosis of plant diseases and methods of their control. A total of 89 isolates of species of *Phytophthora* were received for identification and study. Among them the following were of particular interest: *Phytophthora cactorum* from peach seedlings in Connecticut; *P. citrophthora*, *P. parasitica*, *P. boehmeriae*, and *P. cactorum* from Citrus stems or fruits in Argentina; an undescribed species from Asparagus in California; *P. Cryptogea* from Carnation, Transvaal daisy, African marigold, and *Ceanothus prostratus* in California; *P. cinnamomi* from avocado and *Quercus agrifolia* in California; *P. citrophthora* from walnut in Argentina; *P. parasitica* var. *nicotianae* from tobacco in California; *P. parasitica* from papaya in Hawaii; *P. cinnamomi* from pineapple in Hawaii; *P. parasitica* from *Daphne odorata* and *Atropa belladonna* in California; *P. cactorum* from maple in New Jersey and Massachusetts; *P.*

*cactorum* from dogwood in New York; and *P. cactorum* from avocado fruit in New York.

**Agglutination Tests for Bang's Disease in Cattle and Swine** (Cecil Elder). During the past year 172,178 blood samples have been tested for Bang's disease. Of these samples 13,642 samples were tested for farmers. The tests indicated that 4.9 per cent of the animals were infected. The remaining samples were tested in cooperation with the Bureau of Animal Industry, United States Department of Agriculture and indicated that 2.9 per cent were reactors.

**Agglutination Tests for Pullorum Disease in Fowls** (H. C. McDougale). During the past year 87,777 tests were made for pullorum disease. About 13,000 specimens of blood came from turkeys and most of the remainder from chickens. The total number of infected birds found was 7.76 per cent, or 6,737.

**Distribution of Experimental Chicken-Pox Vaccine** (A. J. Durant, H. C. McDougale). During the past year 8,785 doses of chicken-pox vaccine were distributed to poultry owners in Missouri. The vaccine has continued to give excellent results in protecting fowls against this disease. The vaccine is quite as protective for turkeys as for chickens and is being used more extensively on these birds as the disease increases.

**Diagnostic Service on the Diseases of Animals and Poultry** (A. J. Durant, H. C. McDougale, O. S. Crisler). During the year 814 specimens of diseased poultry were examined and 3,174 specimens of farm animals were diagnosed. In addition 55 specimens, mainly dogs, were examined for rabies.

## PUBLICATIONS

A. A. JEFFREY, *Editor*

The publications for the Experiment Station, during the year ending June 30, 1941, reached a gross of 205,000 copies distributed between 27 new publications and 7 reprints. These publications had a total content of 1,839 pages.



During this period, distribution of Experiment Station publications through mailing reached a total of 146,003 copies, including 112,629 copies sent to residents of Missouri, 22,969 copies mailed to other states, and 10,405 copies mailed to foreign countries. Many thousand additional copies were handed to residents of the state at the mailing room.

The publications issued during the year are listed as follows:

#### Research Bulletins

No.	Title, Series, Author, and Number of Illustrations	Pages	Copies
319	The Effect of Standardizing the Acidity in the Manufacturing of Cottage Cheese and Cultured Buttermilk, by L. E. Mull, W. H. E. Reid, and W. S. Arbuckle, July, 1940; Figs. 4 .....	36	2,000
320	A Microscopic and Statistical Analysis of Texture and Structure of Ice Cream as Affected by Composition, Physical Properties, and Processing Methods, by W. S. Arbuckle, September, 1940; Figs. 9 .....	48	2,000
321	Inadequacy of the Concentrates Commonly Used in Swine Feeding, by A. G. Hogan and S. R. Johnson, September, 1940 .....	20	2,000
322	The Relation of Acidity, Solids per Gallon, and Different Sources of Serum Solids to the Physical and Chemical Properties of High Serum Solids Ice Cream, by W. H. E. Reid, C. W. Decker, and W. S. Arbuckle, December, 1940; Figs. 18 .....	48	2,000
323	Replacing Cane Sugar with Variable Increments of Dextrose and Cerelese Sugar in the Ice Cream Mix, and Its Effect Upon the Physical and Chemical Properties of Ice Cream at Different Serving Temperatures, by W. H. E. Reid, R. J. Cooley, and W. S. Arbuckle, December, 1940; Figs. 29 .....	52	2,000
324	Land and Fiscal Problems in Reynolds County Missouri, by R. J. Silkett, December, 1940; Figs. 13 .....	80	2,000
325	Ulcerative Enteritis in Quail, by A. J. Durant and E. R. Doll, February, 1941; Figs. 7 .....	27	1,500
326	Variations in Dairy Bull Semen with Respect to Its Use in Artificial Insemination, by H. A. Herman and Eric W. Swanson, February, 1941; Figs. 23 .....	82	2,000
327	Market Organization and Costs in the St. Louis Wholesale Fruit and Vegetable Market, by H. M. Haag and L. H. Schweiter, March, 1941; Figs. 2 .....	52	4,000
328	Growth and Development LII. Relation Between Organ Weight and Body Weight in Growing and Mature Animals, by S. Brody and H. H. Kibler, May, 1941; Figs. 17 .....	41	2,500
329	Estrus, Ovulation, and Related Phenomena in the Mare, by Frederick N. Andrews and F. F. McKenzie, May, 1941; Figs. 60 .....	117	3,000
330	Nitrogen Fixation and Soil Fertility Exhaustion by Soybeans Under Different Levels of Potassium, by Carl E. Ferguson and Wm. A. Albrecht, May, 1941; Figs. 11 .....	52	2,000
331	Needed Local Government Reorganization in Ozark Land Use Adjustment Areas, by Fred A. Clarenbach, June, 1941; Figs. 9 .....	132	2,000

#### Reprints

264	Types of Farming in Missouri, by Conrad Hammar, Walter J. Roth, and O. R. Johnson, Reprinted July, 1940; Figs. 41 .....	100	2,500
284	Estrus, Ovulation, and Related Phenomena in the Ewe, by F. F. McKenzie and Clair E. Terrill, Reprinted April, 1941; Figs. 27 .....	88	1,000

## Station Bulletins

418	The Walnut Caterpillar, by Leonard Haseman, July, 1940; Figs. 11 .....	14	10,000
419	The Land Grant College Movement, by F. B. Mumford, July, 1940 .....	140	6,000
420	Modern Trends in the Retail Ice Cream Store, by R. J. Cooley and W. H. E. Reid, October, 1940; Figs. 37 .....	23	5,000
421	Land Classification, by Conrad Hammar, December, 1940; Figs. 1 .....	336	2,500
422	Seasonal Variation and Economy of Basic Feeds, 1924-1940; Herman M. Haag and Norman St. John; Figs. 18 .....	43	10,000
423	The Normal Growth of Chickens, by H. L. Kempster, March, 1941; Figs. 10 .....	20	10,000
424	The Oriental Fruit Moth in Missouri, by Curtis Wingo, March, 1941; Figs. 6 .....	15	10,000
425	Fattening Early and Late Lambs, by A. J. Dyer and L. A. Weaver, April, 1941; Figs. 2 .....	16	10,000
426	Combine Harvesters in Missouri, by M. M. Jones and R. P. Beasley, April, 1941; Figs. 3 .....	27	10,000
427	Planning for Family Relocation, by Eugene A. Wilkening, and Cecil L. Gregory, April, 1941; Figs. 3 .....	51	3,000
428	Factors Affecting Size and Color of Fruit, by A. E. Murneek, April, 1941; Figs. 8 .....	19	10,000
429	Drilling Limestone for Legumes, by Wm. A. Albrecht, May, 1941; Figs. 12 .....	20	10,000

## Reprints

254	Controlling Horn and Stable Flies, by L. Haseman, January, 1941 .....	10	2,000
349	Soil Erosion in Missouri, by L. D. Baver, January, 1941; Figs. 6 .....	64	10,000
357	Actinomycosis in Cattle, by J. W. Connaway and A. W. Uren, January, 1941; Figs. 9 .....	16	10,000
364	Tuberculosis of Poultry, by A. J. Durant, June, 1941; Figs. 10 ..	22	8,000
405	Evaluating Annual Changes in Soil Productivity, by A. W. Klemme and O. T. Coleman, February, 1941; Figs. 14 .....	32	10,000

## Station Circulars

210	Management of Korean Lespedeza, by C. A. Helm, December, 1940; Figs. 7 .....	8	20,000
211	Spraying Grapes, with special Reference to Black Rot, by H. G. Swartwout, February, 1941 .....	4	6,000
212	The Hessian Fly, by Leonard Haseman, July, 1941; Figs. 1 .....	4	10,000

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

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

**Radio Broadcasts.**—Radio broadcasting stations took a larger part in spreading agricultural information during the year, with additional program directors requesting the manuscript radio service of the College. Fourteen stations received the service regularly throughout the year.

## CONTRIBUTIONS TO SCIENTIFIC JOURNALS

July 1, 1940 to June 30, 1941

- 685—Hogan, A. G., Richardson, L. R., Patrick, H., O'Dell, B. L., and Kempster, H. L., Vitamin B<sub>6</sub> and Chick Nutrition, *Poultry Science*, July, 1940.
- 686—Albrecht, Wm. A., and Smith, N. C., Calcium and Phosphorus as They Influence Manganese in Forage Crops, *Bodenkunde und Pflanzenernahrung*, Berlin, Germany.
- 687—Tompkins, C. M., and Tucker, C. M., 'Buckeye Rot of the Tomato, *Journal Agricultural Research*, July, 1940.
- 688—Reineke, E. P., and Garrison, E. R., and Turner, C. W., The Relation of Mastitis to the Level of Ascorbic Acid and Certain Other Constituents in Milk, *Journal Dairy Science*, July, 1940.
- 689—Hogan, A. G., Powell, Eugene L., and Guerrant, Ralph E., Lysine and Deminimized Casein Anemia, *Journal of Biological Chemistry*, August, 1940.
- 690—Swanson, Eric, and Herman, H. A., Variations in Bull Semen and Their Relation to Fertility, *Journal Dairy Science*, August, 1940.
- 691 Reineke, E. P., Williamson, M. B., and Turner, C. W., Use of Nembutal Anesthesia in Milk Secretion, *Journal of Physiology*, September, 1940.
- 692—Reineke, E. P., Stonecipher, W. D., and Turner, C. W., Relation Between Fat and Carbohydrate Metabolism of Lactation, as Indicated by the Respiratory Quotient of the Mammary Gland, *Journal of Physiology*, September, 1940.
- 693—Reineke, E. P., Williamson, M. B., and Turner, C. W., Utilization of Glycoprotein of the Blood Plasma by the Lactating Mammary Gland, *Journal of Biological Chemistry*, September, 1940.
- 694—Albrecht, Wm. A., Plants and Exchangeable Calcium of the Soil, *Amer. Society of Agricultural Science*, September, 1940.
- 695—Graham, Ellis R., Calcium Transfer from Mineral to Plant Through Colloidal Clay, *American Society of Agricultural Science*, October, 1940.
- 696—Smith, Luther, An Observation of the Nest-Building Behavior of the Opossum, *Journal of Mammalogy*, October, 1940.
- 697—Graham, Ellis R., Acid Clay—An Agent in Chemical Weathering, *Journal of Geology*, University of Chicago, October, 1940.
- 698—Turner, C. W., The Influence of Age, Hypophysectomy, Thyroidectomy, and Thyroxin Injection on Simple Reaction Time in the Rat, *GROWTH*, October, 1940.
- 699—Hogan, A. G., Richardson, L. R., and Patrick, H., Perosis Due to Vitamin Deficiency, *Journal of Nutrition*, October, 1940.
- 700—Andrews, Frederick N. (introduced by F. F. McKenzie), The Thermo-Regulatory Function of the Rat Scrotum. I. Normal Development and Effect of Castration, *Proceedings of Society of Experimental Biology and Medicine*, October, 1940.
- 701—Albrecht, Wm. A., Calcium Anaerobic in Gley Development in the Soil Profile, November, 1940.
- 702—Ragsdale, A. C., Dairy Herd Management Practices Affecting the Quality of Milk, *Journal of Milk Secretion*, November, 1940.
- 703—Smith, Geo. E., Photo-Period Behavior by Lespedeza Complicates its Nutritional Response, *Journal American Society of Agronomy*, November, 1940.
- 704—Sprague, C. F., Genetic Effects of Ultra Violet Radiation in Maize. V. Transmission Tests of Induced Mutants, November, 1940.
- 705—Albrecht, Wm. A., Calcium as a Factor in Seed Germination, *Journal American Society of Agronomy*, November, 1940.
- 706—Marshall, C. E., Studies in the Degree of Dispersion of the Clays. IV. The Shapes of Clay Particles, Submitted November, 1940 to *Journal of Physical Chemistry*.
- 707—Murneek, A. E., Why High Quality Fruit? Annual Meeting of Nebraska Horticultural Society, Lincoln, Nebraska, November, 1940.
- 708—Murneek, A. E., The "Preharvest" and "Crop Control" Sprays, Annual Meeting of Nebraska Horticultural Society, Lincoln, Nebr.
- 709—Marshall, C. E., A Petrographic Method for the Study of Soil Formation Processes I., Chicago Meeting Soc. Soil Science of America, November, 1940.
- 710—Effect of Stilbestrol on the Mammary Gland, Lewis, A. A., and Turner, C. W., *American Society of Animal Production Annual Proceedings*, November, 1940.

- 741—Woodruff, C. M., Soil Moisture and Plant Growth in Relation to pH, Chicago Meeting Society Soil Science of America.
- 742—Meites, J., Bergman, A. J., and Turner, C. W., Comparison of Assay Methods Using International Standard Lactogen <sup>1</sup>, <sup>2</sup>, Journal of Endocrinology, December, 1940.
- 743—Hogan, A. G., Richardson, Luther, and Long, Barbara, The Number of Vitamins Required by the Rat, Journal of Biological Chemistry, December, 1940.
- 744—Murneek, A. E., Vitamin B<sub>1</sub> vs. Organic Matter for Plant Growth, Proceedings American Society of Horticultural Science, December, 1940.
- 745—\_\_\_\_\_, Relative Carbohydrate and Nitrogen Concentrations in New Tissues Produced on Ringed Branches, American Society of Hort. Science, December, 1940.
- 746—Hemphill, D. D., and Murneek, A. E., Protection Against Loss of Moisture in Common Storage by Golden Delicious Apples, Proceedings Amer. Society of Horticultural Science, December, 1940.
- 747—Hibbard, A. D., and Talbert, T. J., Fall Setting of Strawberries in Missouri, Proceedings of American Society of Horticultural Science, December, 1940.
- 748—Schroeder, R. A., Some Effects of Calcium and pH Upon Spinach, American Society of Horticultural Science, December, 1940.
- 749—Albrecht, Wm. A., Soil Organic Matter and Ion Availability for Plants, December, 1940.
- 750—Tucker, C. M., and Tompkins, C. M., Foot Rot of Pepper and Pumpkin Caused by *Phytophthora capsici*, Journal of Agricultural Research, January, 1941.
- 751—Trowbridge, E. A., The Place of Science in Basic Training, American Society of Animal Production, January, 1941.
- 752—Lasley, J. F., Montgomery, J. T., and McKenzie, F. F., Artificial Insemination in Range Cattle, Proceedings American Soc. of Animal Production, January, 1941.
- 753—Smith, Luther, An Inversion, A Reciprocal Translocation, Trisomics, and Tetraploids in Barley, Journal of Agricultural Research, January, 1941.
- 754—Murneek, A. E., Sexual Reproduction and the Carotinoid Pigments in Plants, "Science" or "The American Naturalist," January, 1941.
- 755—Winchester, C. F., and McKenzie, F. F., Relative Metabolic Rates of Semen, Seminal Plasma, and Bacteria in Semen of the Boar, Proceedings of Experimental Biology in Medicine, January, 1941.
- 756—The Electrochemical Properties of Mineral Membranes. I. The Estimation of Potassium Ion Activities, Marshall, C. E., and Bergman, W. E., Journal of American Chemical Society, February, 1941.
- 757—Mixner, J. P., and Turner, C. W., Influence of Local Applications of Turpentine on Mammary Gland Growth and Involution, Proceedings of The Society of Experimental Biology and Medicine, February, 1941.
- 758—Trentin, J. J., Mixner, J. P., Lewis, A. A., and Turner, C. W., Qualitative Progesterone Assay of Pregnant Cattle AP and Extracts Having Mammary Growth Activity, Proceedings of the Society of Experimental Biology and Medicine, February, 1941.
- 759—Swanson, Eric, and Herman, H. A., Storage of Dairy Bull Spermatozoa, Journal of Dairy Science, February, 1941.
- 760—Ragsdale, A. C., Milk Sanitation in the Dairy Industry, Journal of Public Health, February, 1941.
- 761—Swanson, Eric, and Turner, C. W., Evidence for the Presence of Smooth Muscle Elements Surrounding the Alveolia of the Mammary Gland, Journal of Dairy Science, March, 1941.
- 762—Mertz, Edwin T., The Liberation of Ammonia from the Imidazole Ring of Histidine Carnosine and Related Compounds by Bromination, Journal of Biological Chemistry, March, 1941.
- 763—Meites, J., Bergman, A. J., and Turner, C. W., Relation of Size of Litter to the AP Lactogen Content of Nursing Rabbits, Proceedings of the Society of Experimental Biology, March, 1941.
- 764—McKenzie, F. F., Recent Reproduction Studies on Equines, Proceedings of American Society of Animal Production.
- 765—Reid, W. H. E., Edmondson, Joe, and Arbuckle, W. S., The Effect of Various Factors on Mold Mycelia in Cream and Butter, American Journal of Dairy Science, April, 1941.

- 736—Reid, W. H. E., Decker, C. W., Smith, L. E., Mintert, K. R., Arbuckle, W. S., and Edmondson, Joe, *American Journal Dairy Science*, April, 1941.
- 737—Herman, H. A., Ragsdale, A. C., and Heathman, Warren, *Trench Silos for Preserving Cereals Treated with Molasses, or Phosphoric Acid*, *American Dairy Journal of Science*, April, 1941.
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- 739—Hurst, Victor, Meites, Joseph, and Turner, C. W., *The Effect of Thyroxine on the Lactogenic Hormone in the Urine of Dairy Goats*, *American Dairy Journal Science*, April, 1941.
- 740—Garrison, E. R., and Gholson, J. H., *The Effect of Udder Infection and Late Lactation on the Methylene Blue-Borax Test for Mold Mycelia in Cream*, *American Dairy Journal Science*, April, 1941.
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- 742—Graham, E. R., *Colloidal Organic Acids as Factors in the Weathering of Anorthite*, *Soil Science*, April, 1941.
- 743—Albrecht, Wm. A., *Calcium-bearing versus Neutral Fertilizers*, *Commercial Fertilizer*, April, 1941.
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- 746—Ells, Victor R., *The Lundegardh Flame Method of Spectographic Analysis*, *Journal of Optical Society of America*, May, 1941.
- 747—Reineke, E. P., and Turner, C. W., *The Growth Response of Thyroidectomized Goats to Artificially Formed Thyroprotein*, *Journal of Dairy Science*, May, 1941.
- 748—Reineke, E. P., Bergman, A. J., Turner, C. W., *The Effect of Thyroidectomy of Young Male Goats upon Certain AP Hormones*, *Endocrinology*, May, 1941.
- 749—Lewis, A. A., and Turner, C. W., *Effect of Stilbestrol on the Mammary Gland of the Mouse, Rat, Rabbit, and Goat*, *Journal of Dairy Science*, May, 1941.
- 750—Turner, C. W., and Cooper, W. D., *The Assay of the Posterior Pituitary Factors which Contract the Lactating Mammary Gland*, *Endocrinology*, May, 1941.
- 751—Turner, C. W., and Meites, Joseph, *The Effect of Desoxycorticosterone on Pituitary and Lactogen Content*, *Proceedings of Society of Experimental Biology and Medicine*, May, 1941.
- 752—Mixner, John, and Turner, C. W., *The Biological Assay of the Mammogenic Lobule-Alveolar Growth Factor of the Anterior Pituitary*, *Endocrinology*, May, 1941.
- 753—Bergman, A. J., and Turner, C. W., *The Thyrotropic Hormone Content of the Rabbit Pituitary During Growth*, *Endocrinology*, May, 1941.
- 754—Roth, S. Y., Mayer, D. T., and Bogart, Ralph, *Pregnancy Diagnosis in Swine by a Chemical Test*, *Journal of Veterinary Research*, May, 1941.
- 755—Parker, Jesse E., and McKenzie, F. F., *Development of the Testes and Combs of White Leghorn and New Hampshire Cockerels*, *Poultry Science*, May, 1941.
- 756—O'Mara, J. G., *A Photoperiodism Accompanying Autotetraploidy*, *American Naturalist*, May, 1941.
- 757—Sears, E. R., *Amphidiploids in the Seven-Chromosome Triticinae*, *American Naturalist*, May, 1941.
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- 759—Mixner, John F., and Turner, Charles W., *Growth of the Lobule-Alveolar System of the Mammary Gland with Pregneninolene*, *Proceedings of the Society of Experimental Biology and Medicine*, May, 1941.
- 760—Marshall, C. E., and Bergman, W. E., *The Electrochemical Properties of Mineral Membranes II Measurement of Potassium Ion Activities in Colloidal Clays, 1, 2*, *Journal of Physical Chemistry*, May, 1941.
- 761—Hogan, A. G., and Muhrer, M. E., and Bogart, Ralph, *A Hemophilia-Like Disease in Swine*, *Proceedings of the Society for Experimental Biology and Medicine*, June, 1941.

- 762—Lasley, J. F., Easley, G. T., and McKenzie, F. F., A Staining Method for the Differentiation of Live and Dead Spermatozoa, *Proceedings of Society of Experimental Biology and Medicine*, June, 1941.
- 763—Stadler, L. J., and Uber, Fred M., Genetic Effects of Ultraviolet Radiation in Maize, IV. Comparison of Monochromatic Radiation, *American Journal of Botany*, June, 1941.
- 764—Stadler, L. J., The Comparison of Ultraviolet and X-Ray Effects on Mutation, Submitted June, 1941, *Symposia in Quantitative Biology*, Carnegie Institution, Washington, D. C.
- 765—Smith, Luther, Hereditary Susceptibility to X-Ray Injury in *Triticum Monococcum*, *American Journal of Botany*, June, 1941.
- 766—Robinson, Virgil B., Kays, John M., Experiments with Phenothiazine In the Treatment of Horses for Strongyles, *Veterinary Medicine*, June, 1941.

## INVESTIGATIONS UNDER COOPERATIVE PROJECTS

Study of the Wholesale Fruit and Vegetable Markets of St. Louis.  
 The Protection of Crops from Grasshoppers and Mormon Crickets.  
 Agricultural Land Use Planning.  
 Factors Influencing Quality and Palatability of Meat.  
 Methods of Beef Cattle Production.  
 Feeding Beef Calves Previous to Weaning-Fattening for Market.  
 Physiology of Reproduction of Farm Animals.  
 A Study of Beefiness and Milk Production in Dual Purpose Cattle.  
 Maintenance and Development of the Hatch Dairy Experiment Station at Hannibal, Mo.—Breeding, Feeding, and Management of Dairy Cattle.  
 Cooperative Investigations on Parasites of the Oriental Fruit Moth.  
 Seed Testing and Enforcement of the Federal Seed Act.  
 Cereal Improvement with Special Emphasis on Corn.  
 Fruit Disease Investigations in the Ozarks.  
 Agronomic, Physiologic, and Genetic Research with Soybeans.  
 Improvement of Pastures in the Corn Belt.  
 Physiology, Edaphology, and Breeding of Pasture Plants.  
 Laws and Principles Underlying the Industrial Utilization of the Soybean and Soybean Production.  
 Diseases of Orchard Fruit.  
 Soil Erosion and Its Control.  
 The Improvement of Swine Through Breeding.

## RESEARCH GRANTS

### American Academy of Arts and Sciences

For the purchase of experimental animals and feed for a study of the relation of the thyroid gland to the fat, carbohydrate and protein metabolism hormones of the anterior pituitary.

### American Cyanamid Company

For investigations dealing with the decomposition of farm residues.

### American Medical Association

For investigating the action of lactogenic hormone in cases of deficient lactation.

**De Raef Corporation**

For research in the field of dairy products.

**Ella Sachs Plotz Foundation**

For research on the endocrinology of lactation.

**International Cancer Research Foundation**

For investigations on hormones as related to mammary tumor production.

**Missouri Butter Institute**

For the study of Mold Mycelia and its relation to cream and butter.

**Cerophyl Laboratories**

For research dealing with the "effect of the fortification of ice cream mix with a vitamin rich separate" which this company is preparing.

**Corn Products Sales Company**

For carrying out a study on the use of varying amounts of cerelose in making ice cream.

**John and Mary R. Markle Foundation**

For investigations dealing with hemophilia in swine.

**Parke, Davis and Company**

For research in connection with the isolation of anti-anemic and other new vitamins from the Vitamin B complex.

**American Potash Institute**

For furthering research on the role of potassium in Missouri soils.

**Missouri Conservation Commission**

For research dealing with the utilization of Missouri timber.

**Reilley Tar and Chemical Company**

For the study of the control of the biennial bearing habit of apple trees.

**American Association for the Advancement of Science**

For the study of the organic chemical analysis of the virus of mosaic disease of tobacco.

**Quaker Oats Company**

For breeding of white corn hybrids.

**NEW EQUIPMENT**

Specialized equipment such as a fadeometer, air fog gun, 2 compressed continuous air sprayers, sprayer-atomizer, power sprayer, sprinkler system, cloth house, cultivator, photometer with DX cells, galvanometer, torsion balance, filtration extraction rack, simplex soil test outfit, laboratory mill, 2 antemp heaters and burners, sprayer with 2-wheel truck, mimeoscope and equipment, flexible shaft, small power sprayer, soil thermograph, potentiometer, 4 humidifiers, 4 atmometer spheres, thermoregulator, two 50-h.p. motors, refrigerator, temperature control chambers, freezer box, cryochem apparatus, motor driven vacuum pump, McLeod



gauge, angle centrifuge, battery brooder, gas hot plate, stop watch and holder, exhaust fan, portable hand homogenizer, Wisconsin stirrer, operating scissors, automatic float feed chamber, victor carboy trunnion perforated basket and draining chamber for centrifuge, rubber respiratory, diet scale, electric sprayer, Boston reductor, troenmer scale, 3 electric refrigerators, right angle thermometer for radiometer, rectiformer, artificial breeding equipment and glassware, 3 microscopes, special 4-battery freezer, special thermometers, 6 chatillon scales, Babcock tester, 15 milk cans, power hay hoist, one 5-h.p. motor, granite sterilization tank, electric fence controller, bacteria counter, 2 mechanical stages, colony counter, 2 sub-stage lamps, sub-stage dark field illuminator, polariscope tube, culture apparatus, hand counter talley, counting chamber, micrometer disc, Berkefeld Vand W filters, 5 desks, 3 calculators, 5 filing cases, 4 chairs, 4 desk lamps, 2 Beckman pH meters, tractor, tractor plow, tractor cultivator, 2 balances, 2 recording hygrometers, polar planimeter, 2 hygrometer and thermometer combinations, brooder, 12 hog troughs, reflectors, pot markers, stone crocks, hand sprayers and dusters, insect breeding cages, flower pots, cabinets, collecting nets, 4 glass churns, rat and mouse cages, feeding pans, water hose, fruit jars, separatory funnels, clinical thermometers, brass sieve with cover and receiver, syringes, needles, filters, Erlanmeyer flasks, 2 counters for cages, stapler, 6 hooded dairy pails, bull rings, miscellaneous glassware.

## CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1941

### Appointments

Margaret H. Blevins, Research Assistant in Home Economics  
 Glynden Easley, Research Assistant in Animal Husbandry  
 Ruth M. Flumerfelt, Research Assistant in Home Economics  
 Leonard F. Gieseke, Assistant in Agricultural Chemistry  
 John W. Hamilton, Research Assistant in Agricultural Chemistry  
 Herbert E. Hampton, Research Assistant in Soils  
 Warren W. Heathman, Assistant Instructor in Dairy Husbandry  
 Victor Hurst, Research Assistant in Dairy Husbandry  
 Kenneth Itschner, Research Assistant in Agricultural Chemistry  
 John M. Kays, Research Assistant in Animal Husbandry  
 Hudson Kibler, Research Assistant in Dairy Husbandry  
 Delvin R. Knight, Research Assistant in Veterinary Science  
 Marvin Koger, Research Assistant in Dairy Husbandry  
 Fred C. Leroux, Graduate Assistant in Agricultural Engineering  
 Wm. F. Lytle, Instructor in Agricultural Engineering  
 Margaret W. Mangel, Instructor in Home Economics  
 Nahum Z. Medalia, Research Assistant in Rural Sociology  
 Isidor Meites, Research Assistant in Horticulture  
 Edwin T. Mertz, Instructor in Agricultural Chemistry  
 Elinor Elizabeth Roth, Instructor in Home Economics  
 William C. Sechrist, Research Assistant in Forestry  
 Mildred G. Spicer, Assistant Professor of Home Economics  
 Frances E. Stiles, Instructor in Home Economics  
 Eric W. Swanson, Assistant Instructor in Dairy Husbandry

Harvey B. Vanderford, Research Assistant in Soils  
Clarence Winchester, Instructor in Animal Husbandry  
Sylvan H. Wittwer, Research Assistant in Horticulture

#### Resignations and Withdrawals

W. S. Arbuckle, Instructor in Dairy Husbandry  
Margaret H. Blevins, Research Assistant in Home Economics  
Jesse Alice Cline, Professor of Home Economics  
C. Bradford Croston, Research Assistant in Horticulture  
Gordon H. Drake, Research Assistant in Agricultural Economics  
Elizabeth Dyar, Research Assistant in Home Economics  
Ruth M. Flumerfelt, Research Assistant in Home Economics  
Kenneth Itschner, Research Assistant in Agricultural Chemistry  
Jordan Grey Lee, Research Assistant in Agricultural Chemistry  
Fred C. Leroux, Graduate Assistant in Agricultural Engineering  
Nahum Z. Medalia, Research Assistant in Rural Sociology  
Lydia Mussman, Instructor in Home Economics  
Henry Schweiter, Assistant in Agricultural Economics  
W. W. Snyder, Instructor in Dairy Husbandry  
Harvey B. Vanderford, Research Assistant in Soils  
Bertha K. Whipple, Assistant Professor of Home Economics  
Eugene Wilkening, Research Assistant in Rural Sociology  
L. L. Wiseman, Assistant in Agricultural Chemistry  
Louise A. Young, Research Assistant in Home Economics.

## FINANCIAL STATEMENT

UNIVERSITY OF MISSOURI  
AGRICULTURAL EXPERIMENT STATIONin account with  
THE UNITED STATES APPROPRIATION, 1941

	Hatch Fund	Adams Fund	Purnell Fund	Bankhead- Jones fund
Dr.				
To balance from 1939-40 .....	\$.....	\$.....	\$.....	\$.....
Receipts from the Treasury of the United States, as per appropriations for fiscal year ended June 30, 1941 ..	15,000.00	15,000.00	60,000.00	76,967.80
Total .....	15,000.00	15,000.00	60,000.00	76,967.80
Cr.				
Annuities .....	383.60	87.16	310.71	256.02
Personal services .....	14,616.40	10,014.25	38,565.73	53,378.52
Supplies and materials .....		3,477.65	9,885.60	11,696.23
Communication service .....		7.00	113.87	559.84
Travel expenses .....		9.90	1,588.81	326.95
Transportation of things .....		95.91	121.42	222.41
Printing or duplicating and illustrating publications .....			2,061.45	1,110.33
Heat, light, water, and power; and fuel .....		65.40	113.37	981.33
Contingent expenses .....				28.27
Equipment .....		1,108.95	5,603.17	5,396.81
Land (purchase and rent) .....				
Structures and nonstructural improve- ments .....		133.78	1,635.87	3,011.09
Balance .....				
Total .....	15,000.00	15,000.00	60,000.00	76,967.80