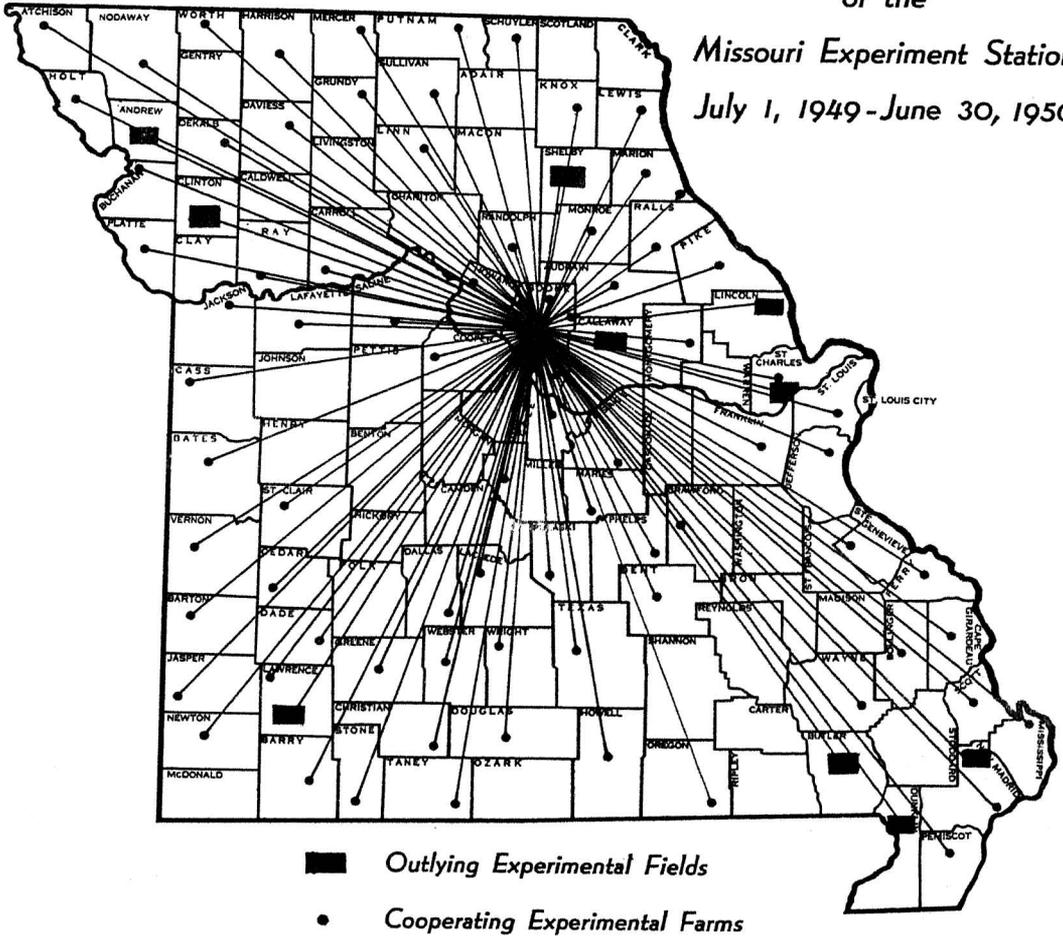


Serving Missouri Agriculture

J. H. Longwell and S. B. Shirky

Annual Report
of the
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LETTER OF TRANSMITTAL

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

Sir:

I am submitting herewith the report of the Agricultural Experiment Station for the year ending June 30, 1950. This report is submitted in accordance with the Federal law requiring such a report, a copy of which is to be submitted to the Governor of the State and to the Secretary of the Treasury of the United States.

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

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Front Cover: This illustration with the lines from the Missouri Experiment Station to the Outlying Experimental Fields and the Cooperating Farms shows that "Serving Missouri Agriculture" is truly the purpose and function of the Missouri College of Agriculture and the Experiment Station.

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

Serving Missouri Agriculture

J. H. Longwell and S. B. Shirky

INTRODUCTION

This is a report on the research program of the Missouri Experiment Station which is basic to the resident teaching and extension work in the State. Few people realize that no substantial amount of agricultural information was available until the Experiment Stations were organized in 1888, and had conducted a number of investigations that provided information of value to Missouri people. Since agricultural research is of little value until the results are received and applied by farm people, the Extension Service was organized in 1914 to provide an effective means of getting the information to the farmers.

The application on Missouri farms of this information developed by the research program of the University of Missouri Agricultural Experiment Station has increased farm income tremendously. Here are just a few examples of the results of the application of research:

Much of the research which demonstrated the importance of riboflavin and choline in poultry feeds was done by the Department of Agricultural Chemistry. These two vitamins are commonly not present in poultry feeds in sufficient amounts to meet the needs of poultry, and it has been estimated they have increased the poultry income in Missouri from \$90,000,000 to \$100,000,000, or a total increase of \$10,000,000 annually.

An important development in the whole water management program in Missouri was the Missouri thin-section low-cost concrete structure to conduct water down a steep bank to a natural waterway without erosion. This structure and the morning-glory tube, especially adapted to high overfalls, were developed by the Department of Agricultural Engineering. In 1949 alone, 270 thin-section dams and morning-glory tubes were constructed at a cost of about \$150 less per structure than a heavier structure. Besides saving the farmers more than \$40,000, they made possible and practical the use of terraces that would otherwise not have been built. And the increased value of \$20 an acre on the 10,000 acres put under water management would give a total value of \$200,000. There are now terraces on about 750,000 acres in the state which have increased the value of the land by about \$15,000,000.

It has been estimated that the practices developed in the Missouri research program emphasizing the degree to which pasture can be used to produce beef in Missouri would make a saving of \$13,000,000 on the cattle on feed January 1, 1950. The research programs on pasture, breeding, management, and parasite and disease control in swine have provided information which, if applied to the hogs produced in Missouri in 1949, would have saved \$1,500,000.

Research in dairy husbandry at the Missouri College of Agriculture, has as its objective the finding and correlation of facts concerning the production of milk, the growth and development of dairy cattle, the physiology of life processes in cattle, and the processing and distribution of high quality dairy products. Production of Missouri cows has increased during the last 10 years from 164 pounds of fat per cow to 205 pounds per cow or a total increase to producers of over \$7,750,000 annually.

In 1916, the Hessian Fly destroyed wheat valued at \$9,000,000 in Missouri. Since 1916, the Entomology Department has developed methods to control this insect and the control program has netted Missouri farmers an annual saving of \$5,000,000 to \$8,000,000, or a total of \$170,000,000 since 1916. This is about the sum the state has paid to establish and maintain the College of Agriculture since 1870.

The use of lespedeza, discovered by the Missouri Agricultural Experiment Station has completely revised Missouri agriculture. In 1923, a handful of Korean lespedeza seed was received from the United States Department of Agriculture. Now more than 10,000,000 acres of Korean lespedeza are grown in Missouri. There was none of this kind of lespedeza in Missouri before the research program brought it here.

Applying the percentage to the state gain in bushels resulting from all hybrid varieties of corn used in Missouri, the research work in breeding hybrid corn can be credited with 22,500,000 bushels increase in production.

In 1938, in the area around Campbell, Missouri, about 20 acres of peach trees were in production with an average total annual return of about \$1500. Since that time, Station workers in the Department of Horticulture have carried on work which has resulted in a present planting of about 56,000 trees with an average annual production worth \$350,000 to \$400,000.

Fertilizer tonnage has increased in Missouri from 54,000 tons in 1939 to over 364,000 tons in 1949 and this phenomenal increase in the use of fertilizers is closely associated with the development of improved analytical methods by the Department of Soils. The number of soil tests increased from 5,850 in 1939 to 45,369 in 1949, and all Missouri farmers now have a soil testing laboratory in their own or an adjoining county.

These examples of the value of research are just a few of the many and are cited to indicate the various ways agricultural research can benefit not only the farmers but all of the people.

Service Program

In addition to the research program, the Agricultural Experiment Station renders a large amount of service which requires the expert knowledge of the specialists on the staff and the equipment and facilities available in the Station laboratories. Examples are: the fertilizer control program, soil testing, limestone testing, pure seed program, blood testing, post-mortem examinations, and numerous others.

Among the most valuable services are the thousands of letters written annually in reply to inquiries, and the bulletins and circulars containing information of value to farmers which are printed and sent to anyone requesting them in the state.

AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

Effect of Fertilizers Upon the Vitamin Content of Vegetable Crops (A. G. Hogan, Laura M. Flynn and Robert Grainger). Fertilizer treatments were not reflected in the vitamin content of the vegetables used in this test. With both Snap beans and Lima beans the concentration of each vitamin increased with increasing maturity of the vegetables (increasing dry matter) so that the content of each vitamin was correlated with the maturity of the sample.

Test vegetables included (1) New Zealand spinach (a leafy vegetable), (2) Snap beans [pods (modified leaves) and seeds used], and (3) Lima beans (only seeds used) and were produced by the Department of Horticulture on plots of three grades of fertilizer treatment: (1) Plot I, poor soil with 45 pounds of Nitrogen, 80 pounds of Phosphorus and 112 pounds of Potassium added per acre; (2) Plot II, same soil with 45 pounds of Nitrogen, 80 pounds of Phosphorus, and 224 pounds of Potassium added per acre; and (3) Plot III, same soil with 300 pounds of Nitrogen, 300 pounds of Phosphorus, and 448 pounds of Potassium added per acre.

The leaves of New Zealand spinach were an excellent source of carotene and ascorbic acid, a good source of riboflavin, but a relatively poor source of thiamine and nicotinic acid. The stalks contributed little carotene, and thiamine, and less ascorbic acid and riboflavin than the leaves. There were no significant differences, on a fresh basis, in concentrations of the vitamins assayed in either the leaves or the stalks of spinach from the three plots.

Snap beans were found to be a good source of carotene and ascorbic acid and a fair source of thiamine, riboflavin, and nicotinic acid. Lima beans were a poor source of carotene and only a fair source of riboflavin, but an excellent source of ascorbic acid, thiamine, and nicotinic acid.

Complete data on the vitamin content of Snap beans on each of the three plots is given in Table 1.

TABLE 1.--VITAMINS IN SNAP BEANS (FRESH BASIS).

Plot and Classification	Yield gms/plot	Fraction of Crop (Fresh Basis) %	Dry Matter %	Carotene mcg/100gm	Total Ascorbic Acid mg/100gm	Thiamine mcg/100gm	Riboflavine mcg/100gm	Nicotinic Acid mcg/100gm
Plot I								
Small	525	6.60	9.18	430	23.6	64.7	103.7	588
Average	4578	57.63	11.40	320	24.0	81.7	85.5	855
Large	2842	35.77	13.40	230	28.6	82.5	88.2	964
Total (or weighted Avg.)	7945	100.00	11.97	295	25.6	80.9	87.7	876
Plot II								
Small	425	6.20	8.10	364	21.1	61.0	85.5	520
Average	3728	54.34	13.30	326	27.7	80.0	86.9	891
Large	2707	39.46	13.80	307	24.7	78.4	91.0	1000
Total (or weighted Avg.)	6861	100.00	13.18	321	26.1	78.2	88.4	911
Plot 18								
Small	865	9.55	9.43	390	23.2	69.0	91.0	564
Average	6818	75.27	10.54	254	23.3	73.2	86.2	636
Large	1375	15.18	13.62	267	26.2	77.9	76.0	815
Total (or weighted Avg.)	9058	100.00	10.90	269	23.7	73.5	85.1	656

Effect of Frozen Storage on Vitamin Retention in Broccoli, Kale, and Cabbage (A. G. Hogan, Laura M. Flynn, and Robert Grainger). Less than a third of the ascorbic acid in raw broccoli remained after frozen storage at 10° F. for a year. Carotene, nicotine acid, and riboflavin in processed broccoli were retained well during frozen storage, but there was an appreciable loss of thiamine. However, even after a year's frozen storage, broccoli was a good source of ascorbic acid and carotene, and a fair source of riboflavin because the content of these vitamins in the vegetable at time of harvest was very high.

Blanching caused a large loss of water-soluble vitamins. Approximately a third of the thiamine, half of the nicotinic acid, and half of the riboflavin were lost from broccoli in blanching.

The kale as harvested was an excellent source of ascorbic acid, carotene, riboflavin, and folic acid, and a relatively poor source of nicotinic acid and thiamine. The ribs, stems, and center stock, while almost half of the weight of the plant, contributed only a small portion of each of the vitamins. The oldest, coarsest leaves were lowest in vitamin concentration, and in contrast the smallest, fastest growing leaves were highest in vitamins.

Vitamin retention was lower in the leaves than in the stems, and possibly thiamine and riboflavin were retained to a higher degree than nicotinic acid. Losses of nicotinic acid and thiamine were not important, however, since raw kale was low in these vitamins.

Less than a fifth of the ascorbic acid left after blanching was retained, after storage for a year at 10° F. Since further losses of this vitamin would

be expected in cooking, stored kale was regarded as a poor source of ascorbic acid. The amounts of thiamine and nicotinic acid furnished by stored kale also were unimportant. Since carotene and riboflavin were high in kale at time of harvest, frozen kale was an excellent source of carotene and at least a fair source of riboflavin, even after in frozen storage for a year.

Cabbage was an excellent source of ascorbic acid at the time of harvest, but was unimportant as a source of the other vitamins. Most of the small supply of carotene, riboflavin, and thiamine left in cabbage after processing was retained after storage for a year at 10° F. Only about a fourth of the ascorbic acid remaining in the vegetable after processing was retained after one year of frozen storage. The amount of ascorbic acid fell even lower when the stored cabbage was cooked. Cooked frozen stored cabbage therefore, was only a fair source of ascorbic acid, and other vitamins were negligible in amount.

Effect of Vitamin B₁₂ in Poultry Rations (A. G. Hogan, and J. E. Savage). A comparison of the effects of Vitamin B₁₂ and liver fraction supplementation of casein and soybean meal rations indicated that there was a sex difference in the response of chicks to liver residue supplements. The addition of Vitamin B₁₂ to the ration of males had very little effect. The addition of liver residue, or whole liver, accelerated the growth rate in males. The addition of both Vitamin B₁₂ and liver residue accelerated the growth rate still more.

Females did not show the acceleration in growth rate when liver fractions were added, but more data are needed for positive proof. When Vitamin B₁₂ and liver fractions were included in soybean meal, and casein rations, it was found that the Vitamin B₁₂ supplementation was much more effective with the soybean meal rations. In most trials neither liver extract nor liver residue supplements were more effective than Vitamin B₁₂ alone.

When highly purified diets were used in chick growth studies, the majority of the chicks grew at a satisfactory rate. The purified diets used were presumed to be complete with respect to the known amino acid and vitamin requirements. However, in some diets where casein and lactalbumin were the source of protein, some chicks exhibited characteristic abnormalities thought to be of nutritional origin.

The affected chicks weighed 100 to 150 grams at four weeks of age while other chicks on the same rations weighed from 250 to 300 grams and the abnormalities present were rough broken wing features, a general deficiency in body feathering, and a variable degree of leg weakness. The birds more deficient in feather development generally had a more severe form of leg weakness. The degree of leg weakness varied from a slightly nervous "quick-step" walk to the completely crippled "spraddle-leg" state where the legs extended out from the body at a 90° angle. This condition did not resemble perosis since the tendon did not slip out of the condyle.

When soybean meal was included in the purified rations or when chicks received a practical type chick starter, feathering improved and no leg weakness developed. Further studies have been started to determine the exact nature of the deficiency.

Effect of Rations on Egg Production and Hatchability (A. G. Hogan and J. E. Savage). No difference in annual egg production was produced by supplements of APF, "Animal Protein Factor" concentrate, fish meal and dried skim milk, and protamone. These results were not in agreement with previous reports that iodinated casein reduced the decline in summer egg production. Earlier observations that an all plant protein ration was adequate for egg production were confirmed.

TABLE 2.--HATCHABILITY OF FERTILE EGGS.

Basal Ration	Supplements	No. Fertile Eggs Set	% Hatch
	None	1871	75
	Iodinated Casein	1841	74
	B-vitamins	1755	54
Plant Protein	B-vitamins + Iodinated Casein	1682	83
	B-vitamins + Vitamin B ₁₂	1296	78
	B-vitamins + B ₁₂ + Iodinated Casein	1283	75
Animal Protein	None	970	84
	Iodinated Casein	944	70

Eggs produced by hens fed protamone required about 18 hours longer for incubation than did eggs produced by hens not receiving protamone. When this extra incubation time was given, the eggs from the hyperthyroid hens hatched at a lower rate only in the group receiving fish meal and skim milk. This decrease was probably due to the excess iodine content of the ration rather than to an intensified nutritional deficiency.

The low rate of hatchability on the B-vitamin supplemented ration was improved by the addition of B₁₂, but the supplement of animal proteins gave even greater improvement. In these trials it appeared that Vitamin B₁₂ definitely improved hatchability but did not furnish all factors needed for good hatchability since supplements of fish meal and dried skim milk proved more effective than the B₁₂ supplement alone.

Unrecognized Nutrients Required for the Complete Life Cycle of the Rat and of the Hamster (A. G. Hogan, B. L. O'Dell, J. R. Whitley, and W. B. House). The relation of diet to reproduction and lactation in rats with special emphasis on the occurrence of hydrocephalus among offspring has been studied. Two variables in the diet were investigated:

1. The source of dietary protein, and
2. The addition of folic acid antagonists.

Commercially prepared "Vitamin Test" casein seemed to be lacking in a factor required for lactation which was present in casein prepared in

the laboratory, but the incidence of hydrocephalus was higher when the dams received the laboratory prepared casein.

Blood fibrin supported reproduction and lactation as well as casein, but no hydrocephalus was produced.

Egg albumin failed to support reproduction and lactation in the absence of folic acid.

Both crude and purified soybean protein supported reproduction very well, but, because of the lack of the animal protein factor lactation was subnormal and offspring did not survive.

The addition of methylfolic acid to a soybean meal diet resulted in almost complete mortality of the offspring during the first week and as high as 35 per cent of the infant rats showed symptoms of hydrocephalus at birth.

When the soybean meal diet containing the antagonist was supplemented with Merck's Vitamin B₁₂ concentrate no hydrocephalus was observed and the lactation performance was equivalent to that of the stock colony.

The strain of lactation did not cause either a decrease or disproportion of leucocytes in dams maintained on casein diets without folic acid or in dams on a soybean meal diet.

It has been found that the nutritional requirements of hamsters were more complex during pregnancy and lactation. For example, when Vitamin K and inositol were deleted from the diet, the animals grew quite well; however, they did not produce living young unless these two vitamins were included.

Past experiments have shown that about 25% of the young hamsters have died by the end of the first three days and 50% by the end of ten days. There was some indication that lactation partially failed during this period because the young were not able to eat the mother's feed rations until the 12th to 14th day of age. When the mothers consumed carrots, the losses were reduced greatly. Only 16% were lost in the initial three-day period and 25% at the end of ten days.

Abnormal Increases in the Mineral Content of Body Tissues in Relation to Age and Nutrition (W. B. House and A. G. Hogan). Previous research has shown that an arthritis-like syndrome can be produced nutritionally in guinea pigs by giving them a diet that is high in phosphorus or has a low calcium-phosphorus ratio. The symptoms are soreness and stiffness in the wrist joints followed by calcareous deposits in the soft tissues.

The objective of this investigation was to investigate various natural products as sources of an active factor which will prevent or cure the abnormality. A preliminary investigation was made to evaluate two dry feedstuffs (alfalfa leaf meal and wheat germ) and one fresh vegetable (tomatoes) as possible sources of an organic factor for this purpose.

The animals were stiff on all the diets used by the end of eight weeks, with the exception of those on the normal stock diet of natural feedstuffs.

The guinea pigs on the synthetic basal ration developed deposits in seven weeks. The animals on a diet of natural feedstuffs with an equivalent phosphorus level developed deposits after a much longer period, 17 weeks.

Fifty per cent of the animals on the synthetic basal diet supplemented with fresh tomatoes, wheat germ and alfalfa leaf meal did not develop deposits and never became stiff. Unfortunately, the tomato diet was quite liquid and the guinea pigs did not do well, since half of them died by the end of 12 weeks.

These results indicated that natural feedstuffs did partially arrest the syndrome and possibly a higher concentration of activity may be found in fresh materials.

When the phosphorus content of the ration was raised from 0.5% to 1.4% the growth rate of guinea pigs was reduced practically 50%. This contrast was even more striking with the stock rations. When the phosphorus level was raised to 0.4% from 0.9%, all other factors being the same, the daily growth rate of the guinea pigs was reduced from 6.1 gms. to 3.0 gms. for the males and for the females from 4.2 gms. to 2.3 gms.

The manual method of detecting soreness and stiffness of the wrist joints was not a satisfactory assay method. Therefore, a study of the blood for hematological abnormalities has been started in an effort to provide a more precise assay. A method has been devised for analysis of inorganic blood phosphorus by micro-techniques. Work has been initiated on a semi-micro analysis for calcium and alkaline phosphates. Since the sedimentation rate of the blood has been found to be a useful clinical measure of the severity of rheumatic fever in humans, work has been undertaken on an adaptation of this procedure for microscale use on the guinea pig.

Chemical Analytical Service (Charles W. Gehrke, E. W. Cowan, Jacqueline Hearne, Edward Martin, Lewis Fergason, Jack Browne, Roscoe Pearce, George Garner, Philip Acuff, and Charles Runyon). The number of fertilizer samples analyzed in 1949-1950 was nearly double the number for the previous year. A summary of samples analyzed follows:

Total number of samples analyzed.....	5,717
Total number of analyses.....	24,588
Total moisture analyses.....	675
Total nitrogen analyses.....	6,076
Total fat analyses.....	740
Total phosphorus analyses.....	8,287
Total calcium analyses.....	81
Total ash analyses.....	175
Total potash analyses.....	2,619

The time required for the analysis of fertilizers has been reduced so that results are available within two to three weeks after the receipt of sam-

ples from the fertilizer inspectors. This, in turn, permitted the earlier distribution of results to fertilizer manufacturers and dealers and the prompt publications of the fertilizer inspection report.

Service to all departments of the Agricultural Experiment Station has been developed to:

- (1) Give rapid, accurate routine analyses,
- (2) Help all departments improve their use of chemical methods, and
- (3) Develop new chemical procedures where needed and possible.

Adding Folic Acid to Synthetic Rations (A. G. Hogan; and W. B. House). The addition of folic acid to synthetic rations containing all the known crystalline vitamins allowed the guinea pig to survive and grow reasonably well. On an average, the male and female guinea pig gained 4.0 and 3.3 gms. per day, respectively. If folic acid was removed from the diet and Vitamin B₁₂ added at a level of 2.2 mcg. per 100 gms. of ration, the guinea pigs failed to survive.

A study was made of the value of gum arabic in combination with potassium and magnesium salts. It appeared that gum arabic definitely contained a substance that promoted growth over and above all known crystalline vitamins.

The added response in growth obtained from the K. and Mg. salts was in agreement with the results published by Wisconsin research workers. A ration was formulated resembling the Wisconsin diet in all respects with the exception of the salt mixture and the niacin content (5 mg. instead of 10 mg. per 100 gm. of ration). The potassium and magnesium contents were adjusted to equal those of the Wisconsin ration. The results were striking in that the males gained 5.3 and the females 4.5 gms. per day. These gains were equal to, if not better than, Missouri stock colony records. (5.0 gms. and 4.5 gms. per day for males and females respectively).

A synthetic ration containing Cellu Flour produced a rate of growth of 4.3 and 2.5 gms. for males and females. When the Cellu Flour was replaced with 15% gum arabic, the growth rates rose to 5.0 and 3.7 gms.

Spectrographic Laboratory (E. E. Pickett). One of the most outstanding moves made at the University of Missouri in recent years to aid in scientific research was the establishment of a general spectrographic service laboratory. Outstanding equipment in this laboratory includes elaborate spectrographic and spectrophotometric apparatus.

Extensive work is being done with trace elements through the use of a grating spectrograph to determine extremely small amounts of the biologically important trace elements in very small samples. Semi-quantitative spectrographic methods of analysis have been used to conduct surveys of the trace element composition of Missouri soils, forage plants, and limestones. Studies to develop methods for the more accurate, fully quantitative determination of

trace metals in aqueous soil extracts and plant ash have been started. The analysis of the soil extracts have been designed to provide information about the available amounts of the trace elements in the soils for use by plants.

Methods have been developed for the determination of trace elements in animal tissues, such as liver and blood.

Flame Photometer

A flame photometer consisting of a solution atomizer, burner, and extremely sensitive light measuring device has been constructed for measuring the amounts of sodium, potassium, magnesium, and other common metals in water solutions. Samples of limestones, ash of forage plants, soil extracts, and others converted into the form of water solutions, have been analyzed for the more common metals very rapidly and conveniently by this apparatus.

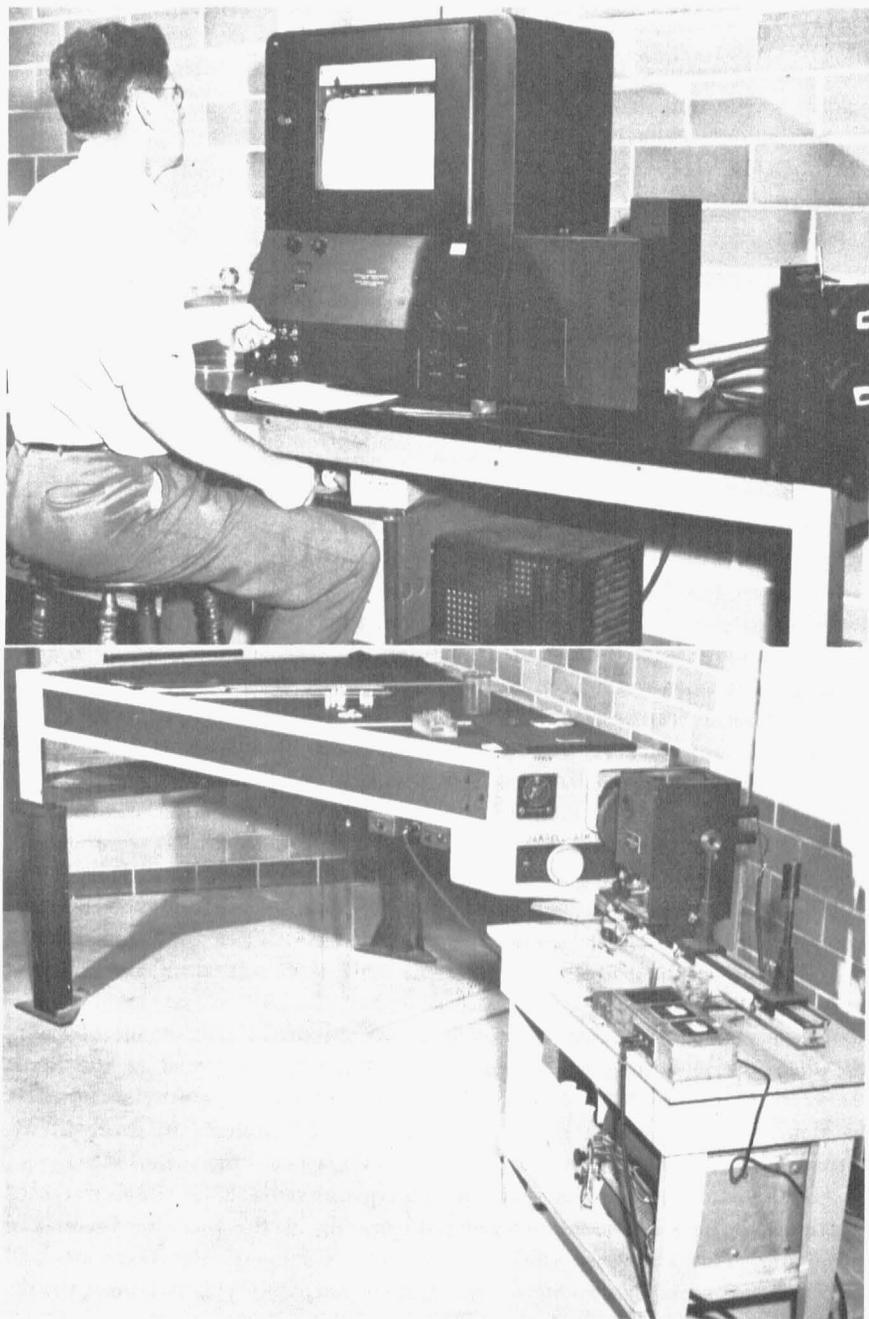
Measuring Color in Agricultural Products

A Cary spectrophotometer has been installed to measure precisely and rapidly the color of the light refracted and reflected by a wide variety of materials important in agricultural research.

Through the use of a Beckman infrared spectrophotometer and the Cary instrument mentioned above, the identity of samples of minerals and organic substances of unknown composition which have been submitted to the laboratory have been determined.

The Quantitative Determination of Chromic Oxide in Feeds and Feces (Charles W. Gehrke, Dennis T. Mayer, Edward E. Pickett, and Charles V. Runyon). An improved method, applicable in digestibility studies with farm animals, for determining the chromic oxide (Cr_2O_3) in feeds and feces using the chromic oxide ratio technique has been developed.

Known quantities of "purified" chromic oxide were added to samples of feeds and feces and analyses were made of the Cr_2O_3 content. Analyses were also made of samples of "purified" chromic oxide for the Cr_2O_3 content. The statistical analysis of the results of these chemical analyses indicated the precision and accuracy of the "chromic oxide" method developed.



The Cary Recording Spectrophotometer (at top) measures ultraviolet and visible spectra. A Grating Spectrograph (below) photographs emission spectra of metallic elements—new equipment added to the University's Agricultural Chemistry laboratory, making it one of the outstanding laboratories of the Midwest.

AGRICULTURAL ECONOMICS

O. R. JOHNSON, *Chairman*

Inequities in the Assessment of Property for Tax Purposes (Frank Miller, Walter E. Chryst). In Missouri, the cost of government at the local level rests heavily upon the property owner. Prior to the 1921-22 biennium, taxes on property also provided most of the revenue for the support of the State government. Since that time other sources of income have been used and the property tax has dropped to eighth place as a source of State revenue. The general property tax remains the principal support for the county, school district, and all other local units.

Taxes have been levied on two general classes of assets—real estate and personal property. The cost of government cannot be fairly distributed without equitable assessment. The problem has two parts; (1) to get all of the property listed, and (2) to assign comparable and equitable values to the holdings of each owner.

The law governing the listing of property for tax purposes in Missouri states that each class shall be assessed at its true value. However, analysis of yield records on farm land showed that the best soils in the State were more than eight times as productive as the poorest soils. Location with respect to roads, schools, churches, power lines, telephone services, milk routes, and other service facilities influenced the value of farm land materially. Location was even more important in the case of town and city lots. No formula that includes all of the factors that influence real estate values is available.

In 1940, the total assessed value of 62 farm properties that were sold in Audrain County was \$247,130. Receipts from sales of the farms amounted to \$193,240. The assessed valuation was 127.9 per cent of the amount received. The range in ratio between assessed value and selling price for the difference makes it appear evident that considerable inequity existed in the assessed valuations.

Inequities in assessment also exist between counties. In Pemiscot County, where the land was regarded as the most productive found in the State, the average assessed value was only 44.0 per cent of the sale value in 1940. In Monroe County, which ranks 55 among the 114 counties in productivity, farm land was assessed at 129.2 per cent of the market price in 1940.

Examination of similar data in subsequent years since 1940 revealed the fact that assessed valuations had not gone up as the price of farm land advanced. This situation would cause no difficulty if the tax rate and the level of bond issues were not limited and the original assessments were made on an equitable basis. The assessments, however, were not closely related to the productivity of the land. Old valuations have been carried forward from year to year causing the variations within counties and between counties to persist.



Inequitable valuation of farm real and personal property is common in every Missouri county because there is no uniform method of assessment. Sheep like these were recently valued at \$1.65 a head in Pemiscot County, and \$10.92 a head in Bollinger County.

The situation with regard to the assessment of personal property was even worse than for real estate. In this classification, wide variations occurred in the assessment of items that should have essentially the same value and a considerable part of the property did not appear on the tax roll. In 1940, the number of cattle assessed in Pike County as of June 1 was only 26 per cent of the number recorded by the census enumerator on April 1. The census showed that the animals were worth an average of \$43.55 a head. The assessed value was \$25.72 a head or 59 per cent of the census value. In 1944, only 34 per cent as many cattle were listed by the assessor as were recorded

by the census taker. The assessed value per head was only 54 per cent of the census value.

In Carter County, the number of cattle assessed in 1940 exceeded the number recorded in the census by 13 per cent, but the assessed value was only 53 per cent of the census value. Numbers recorded by the assessor and the census enumerator were almost the same in 1945. The assessed value per head, however, was only 58 per cent of the census value.

The situation was similar in other counties and for other species of livestock. The assessed value of horses varied from \$12.03 per head in Stone County to \$45.94 in Adair County. Cattle varied from \$22.33 per head in McDonald County to \$61.23 in Caldwell County. Sheep were assessed at \$1.65 a head in Pemiscot County and \$10.92 a head in Bollinger County.

The following conclusions were made:

1. A considerable quantity of tangible property is not being assessed.
2. Much of the property that appears on the tax list is assessed far below its true value, the legal standard, while some of it is assessed above the true value.
3. These difficulties grow out of assessment procedures. There are 91 county assessors, more than 300 township assessors and almost as many standards of assessment. No schedule of values giving a range for specific kinds of property is prepared for the guidance of these assessors.
4. Property that is listed is not uniformly valued, either within a county or between counties.
5. No effective program of equalization appears to exist.
6. The fact that property of the same value is not uniformly assessed causes tax payers to bear unequal shares of the cost of government in relation to their property holdings.
7. This unequal sharing of the tax load leads to disrespect of government.
8. Unequal assessment causes inequitable distribution of state aid money such as the state school fund.
9. Low assessed valuations restrict bond issues and keep improvements from being made in communities where the true value of property and the flow of income would support better facilities than are available to the people at the present time.

Investigations are needed that will provide factual material on which to build a good tax structure. When this information is available a comprehensive program that will lead to equitable assessment can be developed. Both legal and administrative action will be required to get the program into effect.

The Use of Missouri Lands For Crops, Pasture and Forest (Frank Miller and Hugh Denney). Reports were secured on conservation measures that were being used. Some reasons for slow progress in adopting these measures on all farms were obtained from 52 farm operators in Cooper, Moniteau, Harrison, and Mercer counties. This survey was designed to determine obstacles to rapid expansion of conservation measures in Missouri.

All of these farmers were using one or more conservation practices. The most common were lime, commercial fertilizer, terraces, grassed waterways, contour cultivation, and ponds. An overwhelming majority were of the opinion that the advantages of using such structures as terraces, grassed waterways, and ponds, and such practices as contour cultivation far outweighed the disadvantages. The principal handicaps to rapid expansion of these measures were: (1) cost of doing the work, (2) failure of farmers to realize the need for erosion control and water management, (3) reluctance of farmers to change their methods of farming, and (4) the inconvenience of short, crooked rows.

The following measures were suggested to help overcome these difficulties:

- (1) Increase payments for desirable conservation structures.
- (2) Show that net benefits from the use of conservation measures do accrue to the farm operator.
- (3) Decrease the cost of building structures by using farm machinery designed for this purpose.
- (4) Make special machinery available to farmers at low cost.
- (5) Use an intensive educational program to make farmers realize the need for erosion control and water management.

Productivity Classification of Land in Missouri (Frank Miller and Buel Franklin Lanpher, Jr.). Land in Missouri has been divided into seven general classes on the basis of productivity and desirability for agricultural use. The distinguishing characteristics of the land in each of the seven classes were described by the Department of Soils and outlined as follows:

CLASS 1 LAND.

All conditions of soil and topography are highly favorable. The land is permanently first quality and produces dependable yields of crops. The soil does not deteriorate easily; it is adapted to a variety of crops; it has good drainage and safety from erosion and flooding; it occurs in large areas, and it is easily tilled.

CLASS 2 LAND.

It is less desirable in one or more respects than class 1, but is very good farm land. It may have a wider range of soil conditions—mainly of texture and structure and for this reason may not have as wide a range of crop adaptation as class 1 land; rolling areas rarely have slopes of more than

10 per cent; under good care, its permanent productiveness is assured, and it should not include more than 10 per cent of non-tillable land.

CLASS 3 LAND.

Land in this class is rarely above medium in fertility; it requires good management for best results in crop production; it is subject to deterioration under continuous cultivation; the hazard of erosion or incomplete drainage is nearly always present; crop adaptation is generally limited because of some unfavorable soil feature; soil improvements such as liming, fertilization, and erosion control are necessary for maximum yields; rolling areas do not have slopes above 15 per cent, and the included non-arable land should not represent more than 20 per cent of the total area.

CLASS 4 LAND.

This is the lowest class of land suitable for producing cultivated crops; it is land of insurmountable limitations, due either to low fertility or to unfavorable physical properties; frequent cultivation usually results in rapid deterioration; fields may be irregular, but slopes are not greater than 20 per cent; the non-arable land included cannot be more than 30 per cent of the total area; crop yields depend upon tillage practices and weather conditions; only the exceptional operator gets a fair return; and hazards are always present because of some soil condition. Undeveloped areas should be left so.

CLASS 5 LAND.

This land should be kept in permanent pasture because of one or more of the following conditions: low fertility, steepness of slope, deterioration because of erosion, poor drainage, stone content or rock outcrop, less than 30 per cent of arable land. In general, the fertility of the soil is such that bluegrass will grow.

CLASS 6 LAND.

Land in this class may have similar physical features—slope, erosion, stone content—to class 5, but the fertility of the soil is lower; much of this class land is in forest, and its use for pasture or forest depends upon local conditions; the fertility of the soil is so low that bluegrass does not thrive; and most of the acreage in this class is found in the Ozark region.

CLASS 7 LAND.

All of the land for which tree production is the best use is placed in class 7. It includes steep slopes, gullied areas, and non-arable stony lands, either cleared or forested. The most rugged land in the Ozark region is placed in this class.

The purposes of this study were two: (1) to measure the physical productivity of land in Missouri by areas and sub areas where the crops grown and the yields that could be expected under customary farming practices were similar, and (2) to determine the relationship between the level of pro-

ductivity found in these areas and sub areas and some economic and social factors that influence the general welfare of farm people.

In order to reach these objectives, the land in the State was divided into fifteen areas and sub areas for which separate determinations of productivity were made.

Productivity in each of these areas and sub areas was based primarily upon the energy and protein equivalents of all primary products of the land. The procedure was to select townships that were representative of each land class; find the acreage and average yield of crops as shown by data from the United States census; correct the yield determinations to the 1937-1946 ten-year average yields; reduce all feedstuffs, including pastures, to corn and cottonseed meal equivalents, and then to apply the 1928-1947 twenty-year average price of these two commodities to the total. The value of cotton lint in the sections of the State where this crop is important was added to the dollar value of other products to get the total productivity. The productivity values which were obtained by this procedure were designed as productivity units per acre.

Productivity in the different land class areas and sub areas varied greatly. The range when calculated on the basis of total acreage in farms was from 49.60 units per acre in sub area 1SE to 5.96 units in class 7.

When analyzed on a per farm basis, the range in gross productivity was also wide. It varied from 4,716 units on the average farm in sub area 1NW to 979 units in class 7. In the cotton section the range was from 3,776 units in sub area 1SE to 1,375 in 4SE.

On a county basis, Pemiscot, with a relatively large acreage of class 1 land, was first in productivity. Reynolds and Taney counties with most of their acreage in land class 7, stood last.

Significant positive relationships were found between the following factors:

1. Productivity per acre and the value of land and buildings per acre.
2. Productivity of land and the value of buildings, except in southeastern Missouri.
3. Productivity and the value of machinery per acre. This relationship was less significant in southeastern Missouri than in other parts of the state.
4. Productivity per acre and the percentage of farms operated by renters, except in southeastern Missouri.
5. Productivity per farm and the percentage of farms rented.
6. Productivity per acre and the amount of gross product per person on farms. This relationship was also significant in the delta cotton and corn area, but the number of units of productivity per person on farms was smaller than for other land classes in the state.
7. The proportion of farms equipped with telephones, running water, and electricity showed some tendency to vary with the productivity of the land.

A significant inverse relationship was found between the productivity of land and the percentage of owner operators. The land low in productivity was largely owner operated while a considerable amount of better land was farmed by tenants.

The analysis presents objective proof of the need for adjustments in land use and the size of operating units, particularly in the low producing classes. The findings should aid the following people:

1. Prospective buyers of land.
2. Rural appraisers, fire insurance companies, banks and other financial institutions that provide services or make loans to farmers.
3. Action agencies charged with the task of aiding low income farmers.
4. Research workers in crops, soils, credit, farm organizations, and tenure who want to make their work applicable to specific conditions that influence the welfare of farm people.
5. Government officials and business executives whose task it is to frame policies that will lead to large expenditures for adjustments in agricultural production, or public service facilities such as roads, telephones, electric power lines, school buildings and marketing facilities.
6. Business men who are planning sales campaigns for farm equipment, household appliances and other goods used by farmers.

The accompanying table shows the average in relative productivity of all land and farm in each land area and sub-area.

TABLE 3.--AVERAGE AND RELATIVE PRODUCTIVITY OF ALL LAND IN FARMS IN EACH LAND CLASS AREA AND SUB AREA.

Land class	Average productivity per acre of land in farms (units)	Relative productivity per acre of land in farms (1NW = 100)	Acreage required to equal the productivity of one acre of 1NW land (acres)
1 NW	22.37	100	1.00
1 C	22.65	101	.99
2 WC	16.72	75	1.34
3 NW	12.97	58	1.73
3 SW	14.54	65	1.54
3 NE	13.16	59	1.70
4 SW	11.41	51	1.96
4 EC	9.52	43	2.35
5	10.51	47	2.13
6	7.96	36	2.81
7	5.78	26	3.87
1 SE	49.60	222	.45
2 SE	39.68	177	.56
3 SE	31.51	141	.71
4 SE	18.95	85	1.18

A complete report of this research will be found in Missouri Research Bulletin 465, "Productivity of Farm Land in Missouri."

Pricing Non-Fat Powder Milk at Country Points in Missouri (A. R. Conley). This project was part of the regional studies on the problem of disposal of skim milk. Eight plants producing non-fat dried milk are located in

Missouri—three are in Northwest Missouri, four in Southwest and one in Central Missouri. Most dried milk is sold to the bakery trade. Much of the product of Missouri dried milk plants is believed to be sold for use in Missouri and nearby states. It was found that meat packing plants sometimes purchase and distribute considerable quantities. In 1949 one-fourth of Missouri's output of dried milk was sold to the Federal Government and in November 1949 the Government was taking about half of Missouri's output.

Due to the fact that Missouri has a problem in the disposal of skim milk in a very brief surplus season and government support prices have been so significant in determining the prices of dried milk, no significant conclusion can be drawn concerning prices under free marketing circumstances. It was found that a study of seasonal variation in price cannot be made with any satisfaction with government support prices in effect.

Pricing of Missouri's Butter (A. R. Conley, and Brice Kirtley). This study was conducted in cooperation with the Regional Dairy Committee. The study included the examination of data from Missouri creameries which would tend to provide information on the prevalence of down-grading, refusal of central market to accept seller's weights, amount of overage required, trade discount practices, commissions, terms of sale, cost of shipment, and other pertinent items. At one time Missouri had approximately 125 creameries. There are now only a fraction of this number in operation.

The peak of butter production was in 1935, but since then production has declined with the expanding demand for whole milk. Until 1939 Chicago was the major market for Missouri butter, but by 1949 most Missouri butter was going to Eastern Markets. About three-fourths of Missouri's butter was sold through regular trade channels; 10% of it was marketed locally; and about 15% has been sold to the Government during the past few years.

Missouri has a long butter making season. Most butter made in the United States is made in the months of May, June, and July, with June being the heaviest month. In Missouri, May is almost as important as June, and a heavy manufacture of butter continues until October. The smaller creameries sell more of their butter locally. Larger creameries either ship their product to the normal trade channels or sell to the Government. The best grade of butter was packaged for local trade.

It was found that prices were generally based on the Chicago market. Eighteen of the 28 creameries analyzed used Chicago quotations for setting their own local prices. The St. Louis and Kansas City markets were used by 5 creameries. Butterfat quotations as a basis for butter values were used by two creameries. The most frequently used price was the price of Chicago 90 score butter plus 2 cents for butter packed by quarter-pound sticks in one-pound packages. Chicago received nearly one-fourth of Missouri's butter and was the largest single market customer. New York received 13 per cent

of Missouri's butter in 1949. Local Missouri markets received approximately 15%. The remainder went to various markets. The only complaint concerning grade of Missouri butter from these creameries occurred during the flush season when amounts to be marketed were above the normal flow. Usually surpluses above normal marketings have been sold to the Government.

The increased demand for whole milk for consumption as liquid milk has reduced the importance of butter manufacture in Missouri to a point where problems associated with butter marketing were not as significant as once was the case.

Marketing Livestock by Carcass Grade and Weight (James W. Reynolds and Elmer R. Kiehl). A total of 593 hog carcasses were measured, weighed, and data recorded in this experiment on marketing livestock by carcass grade and weight. This is a cooperative project between the Departments of Agricultural Economics and Animal Husbandry, University of Missouri; and the Bureau of Animal Industry and the Production and Marketing Administrations of the U. S. Department of Agriculture.

Relationships of four possible objective criteria of carcass merit were computed. Simple average of correlations of backfat measurements to the following were:

- | | |
|--|---------|
| 1. Per cent of four lean cuts..... | — .8353 |
| 2. Per cent of four lean cuts, plus belly and lean trim..... | — .8457 |
| 3. Per cent of four lean cuts, plus belly..... | — .8469 |
| 4. Per cent of four lean cuts, plus lean trim..... | — .8284 |

The differences in the correlation as determined above of the various measures of carcass merit were considered insignificant. The use of (1) above or four lean cuts was considered more practical under commercial conditions and was chosen for subsequent analysis. The correlation indicates that as backfat increases the proportion of lean cuts decreases. The correlation of — .8353 indicates that the variation in backfat thickness accounts for 70 per cent of the total possible variation, or 70 per cent of the variation. The value of the carcass is explained by the single measurement of backfat thickness.

An economic study of the cost of marketing feeder livestock at auctions and public stockyards markets showed that the costs of performing the service of selling feeder livestock at auctions were higher for all species when compared to shipments arriving by truck at public stockyards markets. These costs were greater for cattle by 127%; for sheep by 33%; and by 91% for pigs. Selling costs on shipments arriving by rail at public stockyards markets were lower than shipments arriving by truck and were considerably lower than costs at auction markets.

Commission charges represented 89 to 96 per cent of total selling costs at auctions; the remainder were inspection and insurance charges. At public

stockyards markets commission charges were the largest component item of expense, ranging for the various kinds of feeder livestock from 52.68 to 60.61 per cent for truck shipments, and from 34.36 to 45.22 per cent for the rail consignments. Yardage was the next most important cost component, ranging from 32.19 to 40.05 per cent on truck shipments, and from 35.22 to 55.07 per cent on rail shipments. Feed cost at the market was the third largest component. Fire insurance, inspection, and miscellaneous deductions together were minor, representing less than 2 per cent of total selling costs.

This study suggests a commission rate schedule at auctions based on charges per head with provision for a relatively higher charge per animal for single animal lots compared to larger lots. A rate schedule on a graduated per head basis would result in a more equitable distribution of charges among producers.

AGRICULTURAL ENGINEERING

M. M. JONES, *Chairman*

Dairy Loafing Barns (R. E. Stewart, Carl Reaves and K. B. Huff). Field studies have been conducted in a number of Missouri counties for the purpose of establishing an estimate of the present practice of Missouri dairy farmers who use the loafing barn type of housing.

The field study phase of this project has now been completed. The studies were conducted on 36 Grade A dairy farms located in the following counties: Newton, Morgan, Lawrence, Boone, Greene, Warren, Webster, Lincoln, Wright, and St. Charles.

The field studies consisted of visiting each farm, filling out a 110-item questionnaire, sketching, and photographing the dairy structures, and, in some cases, making time and motion studies of the milking and feeding operations. The following facts were established:

1. The typical dairy farm contained about 200 acres.
2. The herds averaged 23 mature milking cows, together with heifers, but in many cases, no bull.
3. Jerseys were the breed used most frequently.
4. The loafing barn was frequently converted from some previous type of enterprise; usually a two-story barn, with hay and bedding stored overhead.
5. The loafing area allowed about 54 square feet of space per cow, and was usually long and narrow in shape rather than approaching a square.
6. The milking barn, or milking parlor, was a floor-level type, attached to the loafing barn by one end or one side.
7. There were 6 or 8 stalls in the floor-level type milking parlor, and about 4 to 5 cows were milked per stall.
8. If an elevated stall type milking parlor was used, (and their use is increasing), about 10 to 12 cows were milked per stall.

9. In either type milking parlor, the cows were milked at a rate of about 10 cows per man-hour.

10. Hay and silage were fed in the loafing area of the loafing barn in the same manger.

11. Manure usually was removed from the loafing area twice yearly, using power equipment.

12. The loafing area was needed during the months of December, January, February, and March, primarily, and bedding was used at an average rate of about 6 pounds per cow per day. The bedding consisted of straw, poor-quality hay, or sawdust.

13. The typical Grade A dairy farm is a family enterprise. It is operated most often by the father and son, but also father and daughter, husband and wife, or other members of the family or relatives. Rarely is a hired hand employed to help regularly with the dairy work.

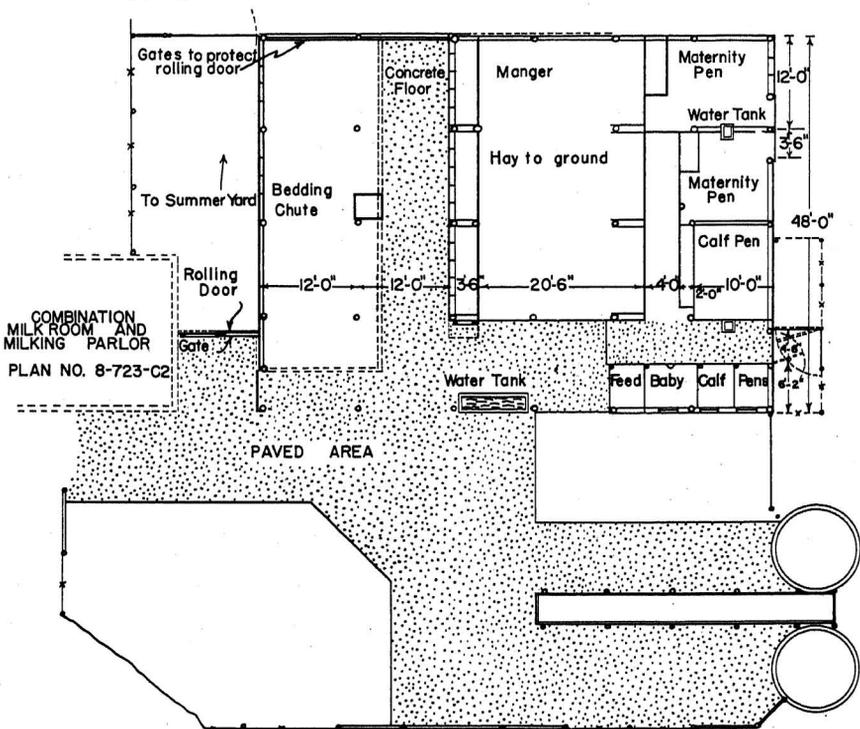
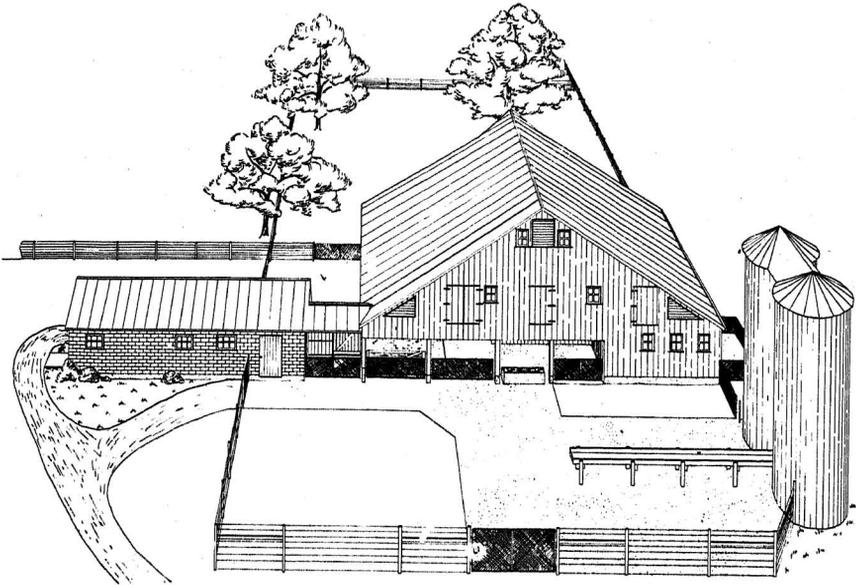
The results of the field studies have formed a basis for preparation of the specifications for loose or loafing dairy barn housing.

The Economic Use of Power, Labor, and Machinery in Crop Production (B. J. Butler, C. L. Day, and M. M. Jones). During the past year records have been obtained by personal survey on the use of more than 100 farm machines, including tractors, pick-up hay balers, mowers, rakes, forage harvesters, forage blowers, and hay wagons.

Studies on the use of different implements and methods have been continued in preparing seedbeds for wheat following lespedeza. The following methods were included in the trials this year: (1) Plowing, harrowing, discing, harrowing; (2) Field cultivating three times, harrowing; (3) Field cultivating three times, harrowing, but applying the fertilizer deeper with the field cultivator instead of with the grain drill; (4) Using heavy-duty field cultivator-plow three times, discing, and harrowing.

The season was rather poor for wheat production, so all yields were lower than normal. The yields by methods 1 and 2, plowing and field cultivating, were practically the same, 12.7 and 12.8 bushels per acre respectively. Method 3, applying the fertilizer deep with the field cultivator instead of with the grain drill depressed the yield from 12.8 to 9.3 bushels per acre. Method 4, using the heavy-duty field cultivator-plow, gave the highest yields, 16.6 bushels per acre.

Design of Loafing Barns for Dairy Cows (J. C. Wooley). Work on this project this year was devoted to designing four types of loafing barns to be used with the combined milk and milking room building previously designed by the departments of Agricultural Engineering and Dairy Husbandry in cooperation with the State Department of Health and the Missouri Sanitation Advisory Council. This plan has been made a part of the Building Plan Service as Plan 8-723-C1 and has had wide adoption throughout the state. In this plan, the floor level type of milking, with cows standing



Loading barns, one of which is illustrated here, have been among the projects of the Agricultural Engineering Department in cooperation with other agencies. Farmers may secure these plans for their own use.

abreast is used. For the small herd, where one man does most of the work, this type, built with 4, 6 or 8 stalls has been found to be quite satisfactory. For larger herds the elevated stall type offers some advantages.

Loafing Barn Requirements

A considerable amount of attention has been given to the requirements for handling milk, care of milking rooms, equipment, etc., but those for the loafing barn have not, as yet, been so well defined. The Research Project on Dairy Housing in Wisconsin and several of the Wisconsin dairy farms using the loafing or loose housing type of management were visited. Also a number of farms and farmers were contacted in the Springfield and Versailles areas in Missouri to inspect buildings in use and secure operators' opinions on their use. Results from tests in the Psychroenergetic Laboratory indicated some requirements useful in the design of housing for dairy cows.

The requirements considered to be most important in the design of loafing barns were selected with four points of view in mind: (1) The well-being of the cow; (2) The production of sanitary milk; (3) Efficiency in the use of labor; and (4) Economy in construction and maintenance.

Floor plans of loafing barns were designed and the blue prints are available free to farmers upon request from the Agricultural Engineering Department at the University of Missouri.

Loafing and Young Stock Barn

(PLAN 5—POLE FRAME)

Plan 5, a combination loafing and young stock barn, has been designed with a pole frame with hay to ground storage and holds enough hay to supply the animals housed for one season. The hay manger for the cows has the V notch (hay saving) openings and extends up to the plate level. Girts at 4 foot intervals make it possible to fill with hay from any level in the mow. It can be used for daily feeding or filled once each two weeks as a calf feeder.

Bedding storage for one season's supply of baled straw is provided in the loft over the hay feeding space. Bales may be broken and chutes filled to be available in the bedded area. The bedded area is 16' x 43' and the hay feeding area adjacent 8' x 48'. An earth floor is used in the bedded area and this provides 67 square feet of floorspace per cow in the loafing shed. The loft over the feeding area is floored and the space above the manger openings boarded up to prevent drafts from the hay storage space. Extra width is secured in the loafing shed by extending it into the central hay storage area.

Maternity and calf pens utilize the opposite shed in this plan and a watering tank located to be accessible from the loafing barn or yard. It supplies small tanks built level with it in maternity and calf pens. A metal roof with either wood or metal siding may be used.

An added suggested feature is the twin silos and paved lot with a feed bunk extending from between the two silos. Silage can be thrown directly from each silo into one end of the feed bunk.

The combination milk room and milking parlor (Missouri Plan No. 8) can be attached.

(PLAN 14—POST FRAME)

Plan No. 14-723-C3 specifies a post frame on a concrete foundation. This plan provides an alternate arrangement for the milk and milking room building.

Loafing Barn Only

(PLAN 13—POST FRAME)

Plan No. 13 is for a loafing barn only. Provision for maternity and calf pens, and for storing and processing concentrated feed must be made in other buildings. Two-thirds of the mow space is for hay and the remainder for storing straw to be used for bedding.

The manger extends into the mow and may be used for daily or self feeding of hay. Chutes are provided to make bedding available in the bedded area. If desired, poles or gates may be used as a barrier across a part of the open front to keep cows from using the bedded area as a traffic way.

Silos and the silage feeding area are located on the protected side of the barn for winter feeding. The foundation and roof area are much less per cow housed than with the hay to ground type.

This plan lends itself to use of power equipment in cleaning and both winter and summer yards are accessible to the milking room. The open front combined with ventilating type windows can be regulated to give ventilation needed.

Wood or metal siding and metal roofing are used in the design.

**Loafing Barn With Hay Overhead and
Built-in Milking Room**

(PLAN 12—POST FRAME)

Plan No. 12-723-C4 specifies post frame construction on a concrete foundation and has a milking room built on one end of the loafing barn. Loafing area, milking room, and feed processing room are on the ground floor. The hay, bedding, oats, and feed supplements are stored on the second floor and hay saving, self feeding manger, and bedding chutes similar to those used in other plans are recommended. Provision is made for storage of sufficient hay, bedding, corn, oats, and supplements for one season's needs.

Two 10' x 28' silos can be used for either summer or winter feeding and the covered silage bunk in the yard serves as a protective barrier for the feeding year.

The milk room which provides space for twenty-four cows at one time is built on and extends into the service court for purposes of sanitation and convenience. Cows may be routed from the summer yard on the north into the milking room without use of the loafing area if desired.

Farm Water Management (R. P. Beasley and J. C. Wooley). In this study a survey was conducted to determine the effect of water management practices on power, labor, and machine costs of crop production, and on yields and net income. Information was also secured on the method and costs of building terraces, outlets, and overall structures with different types of equipment and observations were made to determine the method of farming and type of equipment best suited to farming terraced land. To date 20 farmers have been interviewed and records secured from 10 of these.

All available runoff records applicable to Missouri conditions were analyzed and runoff tables were prepared. D. D. Smith of the U. S. Soil Conservation Research Division made available data on runoff from Soil Conservation experiment stations and assisted in analyzing the data and in the preparation of the tables. Runoff tables that have been used previously were not based on actual runoff records but on assumptions. A revision was indicated by the following comparison of the runoff to be expected from 40 acres of cultivated terraced land.

Runoff (cubic feet per second) to be expected on 40 acres an average once in time indicated in table as follows:

	½-yr.	1-yr.	2-yr.	5-yr.	10-yr.	25-yr.	50-yr.
Old Tables	62	72	83	98	112	126	144
Revised Tables	18	33	50	73	90	112	130

Observations in the field have indicated that values of runoff given by the old tables were too high. The revised tables bear out this observation. Mimeograph copies of the revised tables have been prepared by the Agricultural Extension Service and copies have been distributed. These new values are to be used in place of the runoff tables in the present water management bulletins.

To further aid workers in the field, revised grass terrace outlet tables were prepared based: on the revised values of runoff; on the flow characteristics of the various grasses and channel types as determined in the experimental outlets at the Midwest Claypan Soil Conservation Experiment Farm and other soil conservation experiment farms; on a revised channel cross section using 3 to 1 side slopes instead of the 1½ to 1 side slopes previously used; and on observation of the past performance of existing outlets.

To avoid laborious mathematical computations in the determination of outlet size required for different conditions curves to be used in outlet design were prepared which materially reduced the time required to prepared outlet tables for use in the field. These tables were also mimeographed and sent out by the Agricultural Extension Service to replace existing tables.

Models of different types of overall structures were constructed. Hydraulic tests will be conducted on these models to determine the flow characteristics and effectiveness of control.

Arrangements are being made with a farmer cooperator to conduct trials to determine irrigation procedures, methods, cultural practices, and soil treatments which will give the greatest returns from the irrigation of field crops and pastures.

Temperature Distribution in Dwellings (Carl Reaves, J. C. Wooley, R. E. Stewart and K. B. Huff). During the winter of 1949-50, temperature tests were conducted in a farm house using fuel oil circulators with various heat distribution systems. This test indicated that oil fired circulating heaters can be used satisfactorily to heat small homes in Missouri if the cold weather conditions are not too severe. This house was loosely constructed, uninsulated, one-story, without a basement and had a very high ceiling. It was typical of many rural Missouri homes.

Temperature data were obtained with automatic recording potentiometers. These instruments were used to record dry bulb temperatures at 16 locations by the use of copper-constantan thermocouples. The temperature at each point was recorded every eight minutes on a continuous strip chart. Fifteen of these thermocouples were distributed throughout the house in locations that would give representative room temperatures, 3 inches above floor, 30 inches above floor, and 3 inches below ceiling. The sixteenth thermocouple was used to record outside air temperature.

Human-hair element type hygrothermographs were used to record relative humidity and Fahrenheit dry bulb temperature. Two to four hygrothermographs were used in each house and were located about 12 inches above the floor in extreme corners of the house.

A direct reading velometer of the air-actuated pointer vane type was used to obtain air velocities in feet per minute for the various tests. Velocities were taken at 12 points in each inside door opening that remained open during tests and readings were also taken at duct and register openings.

Heating System

The test was made for a range of outside temperatures of 20 to 50 degrees F. A twin burner oil fired circulating heater was located in the living room and fuel was piped directly to the heater carburetor from a large storage tank located outside the house. A commercial centrifugal type fan was integral with the heater and was located at the top and back of the heater jacket in such a way that it blew air down and across the top of the burners.

In an effort to attain a continuous and positive circulation of air from living room, to northwest bedroom, to southwest bedroom, to kitchen, to either southeast bedroom or dining room and back to the living room, a duct was located next to the dining room ceiling and connecting transom openings in the living room and northwest bedroom walls.

This test did not maintain temperature throughout the entire house as high as the minimum acceptable (60 degrees F. at 2 inches above the floor) but it was believed that more elaborate tests would go beyond the low-cost range.

It was concluded that to provide optimum temperature conditions in this house with an oil fired circulating heater as the heat source it would be mandatory to eliminate most of the infiltration and heat loss and also to make alterations of the interior arrangement. It would be very desirable to lower the ceilings.

Interior temperature differences varied almost directly with heat output.

ANIMAL HUSBANDRY

L. A. WEAVER, *Chairman*

Lamb Production (A. J. Dyer, C. V. Ross, and P. Q. Guyer). Although grain feeding of ewes prior to parturition resulted in heavier birth weight of lambs, especially in the case of twin early lambs and for both single and twin late lambs, there seemed to be no advantage from grain feeding of ewes. This was true for fleece weight of ewes, lambing percentage, time of reaching market finish, carcass grade, and dressing percentage.

One objective of this investigation was to determine the extent to which roughage and pasture could be used for early and late lamb production.

Sixty range bred ewes, 4 years old, originating in the Northwest area of the United States were divided into two equal groups. The same purebred Hampshire ram was used on each group, one to raise early lambs and the other to raise late lambs. Six weeks prior to the average lambing date for each group, a grain mixture of shelled corn, 6 parts, wheat bran, 3 parts, and soybean oil meal, 1 part, by weight was fed to half of the ewes comprising each group. Partitioning of the ewes was based on weight, lambing date, and past performance.

All ewes in the early lambing group were fed grain after they lambled and all lambs were creep fed grain. None of the ewes in the late lambing group were fed grain after they lambled and none of the lambs received grain. Half of the late lambs were shorn on July 11 and half were left in full fleece to study the effect on gain during hot weather in pasture. The early lambs were marketed when they reached a market grade of "Good."

It was found that fleece weights for late lambing ewes were greater than for early lambing ewes. The cause for this difference was thought to be attributable to greater nutritional requirements of the early lambing ewes: that is, the early lambing ewes produced much of their fleece growth during lactation whereas the late lambing ewes were sheared either in early lactation or before they had dropped lambs.

Shearing late lambs before the onset of hot weather proved advantageous.

Only 1 bushel of grain was required to finish late lambs, and they sold at 100 pounds average weight in January. The lambs shorn in July had fleeces long enough so that no discount was made in price paid for them.

The results on the group of ewes which were fed no grain in winter and none during lactation and their lambs grazed until late November, then finished on full feed in dry lot, indicated a system of economical production utilizing large amounts of roughage and pasture, mostly the latter.

The early lambs were dropped over a period of 10 to 12 weeks and ninety-three per cent of the ewes bred for late lambs settled to the first service making possible lambs of uniform age and size.

Swine Breeding (G. E. Dickerson, K. E. Gregory, R. L. Arthaud, J. F. Lasley, W. E. Neville, L. A. Weaver, L. Tribble, Cletis Craig, Maynard Vaughn Jr., and Lewis E. Smith). This research is in cooperation with the Regional Swine Breeding Laboratory and Bureau of Animal Husbandry. Line II Polands have been inbred for 11 years at the Missouri Station and are now nearly as highly inbred (42%) as progeny from three generations of full brother-sister mating. Line VI Polands and Line V Hampshires have been inbred for only 5 years and now are little more highly inbred than progeny from one generation of full brother-sister mating. Since most of the litters have been from gilt dams, the average of 5 to 6 pigs weaned has been considered satisfactory. The two Poland lines were below the Hampshire line in size of litters farrowed, but the Poland pigs were heavier at birth and a larger proportion survived to weaning. Growth rates of inbreds were superior in the Poland strains, particularly in the less highly inbred line VI.

Performance of Inbred Lines in Crosses

For several years, test-crosses have been farrowed in the fall to determine the usefulness of inbred strains for improving the efficiency of market hog production. Factors studied were size of litters, rate and economy of gain, and desirability of carcasses produced. The lines were tested in linecrosses (e. g. inbred line II Poland boars x inbred line V Hampshire sows) from 1946 through 1949, and in topcrosses on Duroc sows with non-inbred purebred Duroc litters as "controls" in 1948 and 1949. Data on litter size and pig weights to 154 days of age have been completed through 1949 and are given in Table 4. Rate and economy of gains from weaning to a market weight of 200 pounds, in dry lot, together with information on carcass desirability are given in Table 5.

Topcrosses on Duroc Sows

Topcrosses of Poland boars (lines II and VI) on non-inbred Duroc sows maintained size of litters and increased weight of pigs at weaning, compared with purebred Duroc litters (Table 4). However, litter size was re-

TABLE 4.--COMPARISON OF LINECROSSES, TOPCROSSES ON DUROCS WITH PUREBRED DUROCS IN PERFORMANCE TO FIVE MONTHS OF AGE (1948-49, ADJUSTED TO 2nd LITTER BASIS).

Breeding	No. Litters	Litter Size			Pig Weight (Lbs) at				Litter Weight (Lbs) at		
		Birth	21 Day	56 Day	Birth	21 Day	56 Day	154 Day	Birth	56 Day	154 Days*
Purebred Durocs	10										
	1948-49	9.1	7.6	7.4	3.0	10.2	29.4	148	27.6	218	1100
II Px Duroc	7										
Sows	1948-49	-0.4	-0.1	-0.2	+0.4	+9	+2.4	+0	+1.7	+12	-30
VIP x Duroc	8										
Sows	1948-49	+0.4	+0.2	+0.4	+0.2	+1.1	+3.0	+20	+3.3	+34	+205
VH x Duroc	8										
Sows	1948-49	-1.1	-1.1	-1.0	+0.2	+1.0	+0.8	-1	-2.5	-24	-153
Dx (I x VI) P	6										
Sows	1949	-0.4	+1.0	+1.3	+0.3	+1.3	+1.2	+8	+1.3	+48	+256
II Px VH	13										
	1946-49	+0.7	-0.9	-1.2	-0.15	+1.3	+4.2	+4	+0.2	-10	-159
VH x II P	7										
	1947-49	-2.6	-2.6	-2.4	+0.8	+2.8	+5.3	+9	-2.6	-46	-321
Average	20	-0.9	-1.7	-1.8	+0.3	+2.0	+4.7	+6	-1.2	-28	-240
VIP x VH	8										
	1947-49	-1.6	-1.8	-1.9	+0.3	+1.7	+3.9	+6	-2.5	-36	-253
VH x VIP	5										
	1947-49	-2.3	-2.1	-2.3	+0.9	+2.2	+8.6	+20	-1.4	-25	-250
Average	13	-1.9	-2.0	-2.1	+0.6	+1.9	+6.2	+13	-2.0	-31	-252
II Px VIP	13										
	1946-49	-1.1	-1.6	-1.5	+0.7	+4.2	+9.2	-4	+2.1	+10	-248
VIP x II P	7										
	1947-49	-1.9	-1.0	-0.8	+0.9	+2.0	+6.1	0	+0.3	+18	-117
Average	20	-1.5	-1.3	-1.2	+0.8	+3.1	+7.7	-2	+1.2	+14	-183

* Litter size at weaning multiplied by average weight per pig at 154 days.

duced and rate of growth was not improved in the line V Hampshire-Duroc cross. Line VI Poland-Duroc crosses were superior in weight at 154 days. Rate of gain from weaning to market weight in dry lot (Table 5) was better for

TABLE 5.--RATE AND ECONOMY OF GAIN FROM WEANING TO MARKET WEIGHT AND CARCASS DESIRABILITY FOR LINECROSSES, TOPCROSSES ON DUROCS AND PUREBRED DUROCS.

Breeding	Rate and Economy Gains			Carcass Desirability (1948 only)**				
	No. Pigs	Daily Gain (Lbs)	Feed/100 Gain (Lbs)	No. Carc.	Dressing* %	Equiv.** Yield Loin - %	Score of Cuts#	Carcass** Index (Yield x Score)
Purebred Duroc	24 ('48)	1.47	328	8	71.5	43.9	.92	40.4
II Px Duroc Sows	16 ('48)	1.52	339	8	71.9	45.6	1.03	47.0
VI Px Duroc Sows	16 ('48)	1.50	330	6	72.0	45.6	1.02	46.6
V Hx Duroc Sows	16 ('48)	1.43	329	7	72.6	45.8	1.01	46.2
II Px V H	48 ('46-'48)	1.43	338	8	70.7	45.5	1.03	46.9
VI Px V H	24 ('47-'48)	1.42	349	5	71.1	45.5	1.06	48.1
V Hx VI P	63 ('46-'48)	1.36	348	7	71.4	45.8	1.04	47.5

* All carcass yields are given as percentage of live weight on feed, and dressing percentage is for chilled carcass with head off and leaf fat left in.

** Yields of all cuts are expressed as equivalent yield of trimmed loin, using relative values of 1.0 for trimmed loin, 0.9 for skinned ham, 0.8 for skinned shoulder, 0.7 for lean trimmings, 0.2 for fat-back, leaf fat and fat trimmings, and 0.1 for spare ribs, neck bones, feet, tail, and kidneys.

On basis of worth per pound to consumer, considering composition and quality of trimmed cut.

topcrosses of both Poland lines on Durocs, but was inferior for the Hampshire-Duroc cross, compared with the purebred Durocs. Although the difference in dressing percentage was small, the yield of lean cuts expressed as equivalent yield of trimmed loin was two per cent higher and the scores for consumer desirability of the cuts was markedly higher for the topcrosses than for the Durocs. The carcass index, expressed as equivalent percentage yield of trimmed loin of average quality was 6 or 7 per cent greater for the topcrosses.

Carcass dimensions which indicate conformation, fatness, and muscle development are given in Table 6. Topcrosses were longer legged, less fat, and much thicker in muscling than Durocs.

Previous research has shown that crossbreds generally equal the *better* parent breed in each character and thus surpass *either one* of the parent breed in over-all performance. In the present example, litter size and economy of gain were excellent in the purebred Duroc stock, but growth rate was not exceptionally good, and carcass composition was poor. In the crossbreds, carcass quality was markedly improved to nearly the level of the Poland-Hampshire linecrosses, and growth rate was improved by the Poland-Duroc cross, particularly by the line VI boars.

TABLE 6.--CARCASS CHARACTERISTICS OF STRAIN CROSSES, TOPCROSSES ON DUROCS AND OF PUREBRED DUROCS.

Breeding	No. Pigs	Slaughter Wt. - Lbs.	Length of		Avg. Back-Fat Thickness Ins.	Area of Lean in cross-section	
			Carcass Ins.	Leg Ins.		of Loin Sq. Ins.	of Ham Sq. Ins.
II x VI Poland	7	205	28.7	21.8	1.6	4.9	10.4
II x V Pol.-Hamp.	8	204	28.5	21.8	1.6	4.6	9.0
VI x V Pol.-Hamp.	5	212	28.8	21.8	1.6	4.9	9.3
II Pol. x Duroc	8	202	27.9	21.5	1.7	4.4	9.3
VI Pol. x Duroc	6	206	28.3	21.5	1.8	4.6	9.6
V Hamp. x Duroc	7	204	27.6	21.6	1.7	4.4	8.8
Duroc	8	201	27.6	20.9	1.9	3.6	7.1

Crosses Between Inbred Lines

In this part of the test, the crosses between inbred lines were at a disadvantage in comparison with the Durocs or topcrosses on Durocs because the linecross litters were farrowed and raised by *inbred* sows. In these experiments (Table 4), linecross litters were noticeably smaller at birth and weaning, particularly in crosses of Hampshire boars on inbred Poland sows. However, when the non-inbred Poland linecross (II x VI) sows were mated to Duroc boars, size of litters weaned was over one pig larger than in the Duroc or topcross litters. The same Poland lines (II and VI) were represented in the sows in both cases—the difference was entirely due to the effect of inbreeding on sow performance.

In all linecrosses, birth and weaning weights of pigs were superior to the Durocs, the advantage being greater when the litters were from the Poland inbred sows than when the dams were inbred Hampshires. The smaller litter size from inbred dams was undoubtedly responsible for much of the advantage of linecrosses in pig weights at birth and weaning, since pig weights at these ages were lower in the larger litters from the Poland linecross (II x VI) dams and Duroc boars.

Carcass desirability (Table 5) was similar for all three linecrosses and for the three topcrosses on Durocs, all being much superior to the purebred Durocs. However, the linecrosses were slightly longer in body and leg, less fat and thicker muscled than the topcrosses from Duroc sows (Table 6).

Daily gain and feed requirements were found to be slightly poorer for linecrosses, particularly of Poland lines II and VI, than for the topcrosses on Durocs or purebred Durocs.

Nine New Stocks

Beginning with the 1950 spring litters, tests were begun on nine new stocks in reciprocal crosses with the II and VI lines of Polands. Two unrelated stocks in each of the Poland, Duroc, Hampshire, and Danish Landrace breeds and one stock of Yorkshires have been placed on test. Each stock lot has five or six sows and one boar in it. Matings have been made reciprocally with both lines II and VI, so that comparisons can be made among the nine new strains and also a much more extensive comparison between lines II and VI.

Restricted vs Full Feeding

The effect of heterosis on growth rate, feed utilization, and carcass composition, under restricted and full feeding was studied. The 1949 fall pigs from each of the three inbred lines, three linecrosses, three topcrosses on Duroc sows, purebred Durocs, and Duroc x (II x VI) Poland linecrosses were divided into full and limited feeding lots.

Digestion trials were made in all 22 lots during two 5-day periods about one month apart, using the "chromium ratio" technique to obtain digestion data on all pigs simultaneously and under normal conditions of the feed lot. Feed intake of full fed crosses has averaged about 25 per cent higher than for the inbreds. Comparison of full-and-limited-fed pigs of the same cross will permit an estimate of the part increased appetite plays in causing superior gains of crosses.

Fertility in Sows

Beginning in 1947 a study has been made of (1) number of ova shed per estrus, (2) percentage of ova fertilized and (3) embryonic mortality during pregnancy. Gilts and sows from the two inbred lines of Polands, one line of Hampshires, non-inbred Durocs and their cross combinations have been used.

Ovulation rate for 277 gilts with a mean age of 225 days averaged 11.4, and strain and cross differences were significant with a range of age corrected means from 9.7 for line II inbreds to 13.5 for the line V Hampshires x Duroc cross. Ovulation rate of every cross equalled or exceeded the average for the two line crosses and crosses averaged 1.2 more ova per estrus than the lines themselves. Ovulation rate for 72 older sows averaged 15.3, ranging from 14.6 for inbred line II Polands to 16.1 for outbred Durocs.

Left ovaries shed 1/6 more eggs than right ovaries in gilts, but were no more active in sows. Variation between sows in activity of right and left ovaries was much greater than in total ovulations per sow, indicating alternation in activity levels between the right and left ovaries.

Of all ova shed, 80 per cent were recovered at 24 hours. In gilts having any ova cleaved, 95 per cent of all ova were fertilized. Total mortality to 25 days averaged 35% for gilts, consisting of 5% unfertilized ova, 23% very early mortality and 7% partially decomposed embryos (Table 7). Total mortality was also 35% in sows but only 5% was accounted for by regressive embryos. In absolute terms, 11.3 ova were shed in gilts and 7.3 pigs were present at 25 days. The discrepancy of 4 pigs was accounted for by .6 ova nonfertilized, .8 regressive embryos, and 2.6 very early mortality.

TABLE 7.--SOURCES OF MORTALITY OF OVA FROM OVULATION TO THE 25th DAY OF PREGNANCY.

Age	No.	No. Ova	No. Embryos	Total Mortality		Source of Mortality					
				No.	%	Unfertilized		Ova Decomposed		Remainder	
				No.	%	No.	%	No.	%	No.	%
Gilts	147	11.3	7.3	4.0	35.4	.59	5.2	.80	7.1	2.61	23.0
Sows	65	15.3	10.0	5.3	34.6	.80	5.2	.70	4.6	3.80	24.8

Both ovulation rates and embryonic mortality were found to be related to age in gilts and the combined relationship accounted for an increase of $\frac{1}{2}$ pig for 10 days increased age at breeding. Age was more closely associated with percentage of ova lost before 25 days than with actual numbers of ova lost, because of the variation in numbers of ova shed by different sows. For each additional ovum produced, litter size at 25 days increased 0.6 of a pig and 0.4 more ova were lost. These relationships were remarkably alike for gilts and sows. However, the ovulation rate appeared to be independent of factors influencing the percentage of ova surviving. Also, differences in degree of inbreeding among sows of the same breeding group were too small to influence ovulation rate.

Fertility in Boars

Reports on the use of inbred boars on farms have indicated that their reproductive performance was less satisfactory than that of non-inbred boars. For this reason an investigation of the nature of inbreeding effects on reproductive performance of boars was initiated.

There was no distinct difference between boars or lines of boars in efficiency of fertilization after the first fertile mating. Forty-three of 60 matings gave 100 per cent fertilization as judged by ova recovered from the females. The average for all matings was about 95 per cent.

It was concluded that the boar had little, if any, effect on proportion of ova fertilized if any fertilization occurred. That is, the boar's influence on fertility appears to be largely an all or none influence. Of course the boar may affect embryonic mortality through his genetic contribution to the embryo. However, studies of a large volume of data have failed to demonstrate a boar influence on size of his litters at birth.

Vitamins Required by Swine (G. C. Anderson and A. G. Hogan). Investigations at the Missouri Experiment Station with the factor known as "Animal Protein Factor" from which one fraction has been isolated in pure form and designated as Vitamin B₁₂ have shown that pigs require this Vitamin B₁₂ for maximum growth and well being. Calculations from the data gave a tentative requirement of 1.5 mcg. of Vitamin B₁₂ per 100 gms. of diet.

In this experiment the effects of Vitamin B₁₂ did not seem to make any appreciable difference in the daily gain of pigs during the first six weeks of growth. After the first six weeks, however, the pigs which had received the injections of Vitamin B₁₂ grew at a more rapid rate, ate more feed, and required less feed per pound gained than did the pigs that received no Vitamin B₁₂ supplement. These pigs were on a synthetic diet and another lot was fed fortified cow's milk to see how this ration compared with Vitamin B₁₂. This fortified cow's milk contained 60 gm. sucrose, 2.5 gm. ferrous sulphate, 0.2 gm. cupric sulphate, 0.2 gm. manganous sulphate, and 0.02 gm. potassium iodide per liter of whole milk. The data in Table 8 shows that the pigs on the fortified cow's milk gained better than the pigs on either the control ration or the Vitamin B₁₂ ration. Since the pigs which received Vitamin B₁₂ did not grow as rapidly as those fed fortified cow's milk, apparently the list of vitamins was still incomplete and the pigs required at least one additional vitamin not yet discovered.

TABLE 8.--EFFECT OF VITAMIN B₁₂ ON THE GROWTH RATE OF PIGS (AVERAGES).⁽¹⁾

Group	A ⁽²⁾	B ⁽³⁾	C
Ration	327 + Vitamin B ₁₂	327	Fortified Cow's Milk
No. of Pigs	3 females	2 females	2 males
Age, Weeks	lbs.	lbs.	lbs.
0	2.5	2.9	2.8
5	15.2	14.5	19.1
8	32.6	28.4	50.4
21	159.0	109.0	----

(1) All pigs were hand fed seven times daily.

(2) Injections of Vitamin B₁₂ given from 2 to 38 days. Total injected was 50 mcg. for one pig, 100 for another, and 200 mcg. for the third.

(3) Weights to eighth week include 3 pigs, one pig died in tenth week.

The Value of Whey and Liver Extract as a Source of Unrecognized Vitamins for the Pig

Pigs two days old farrowed by sows which had been maintained on practical rations deficient in Vitamin B₁₂ and the "Animal Protein Factor" were used as experimental animals. During the first week of the trial all pigs died from an undetermined cause except the pigs which received fortified cow's milk, with injections of an antipernicious anemia (A.P.A.) liver extract. Six pigs of similar breeding and nutritional background were used as replacements. Four of these pigs were offered the fortified cow's milk ration. Two of these pigs received injections of an anti-pernicious anemia liver extract and the remaining pigs were given injections of Vitamin B₁₂. Two other pigs received a ration identical with the fortified cow's milk ration except that it was homogenized in whey instead of water. The pigs were kept in wire mesh cages in a room maintained at 75° F. or above and they were fed seven times daily from open containers. The data indicated that the anti-pernicious anemia liver extract and the whey used in this trial were not effective in stimulating a growth rate above that observed when Vitamin B₁₂ was administered.

The value of Vitamin B₁₂ for brood sows was tested on 18 Duroc gilts which were divided into three equal groups. All gilts received a corn-soybean ration until they weighed approximately 200 pounds at which time the gilts were bred. One group was continued on the corn-soybean ration, which contained only small amounts of Vitamin B₁₂. A second group received this basal ration supplemented with a Vitamin B₁₂ concentrate so as to add 10 mcg. of the vitamin to each pound of ration. The third group received a ration containing fish meal and fish solubles, which contained adequate amounts of Vitamin B₁₂ as well as unknown factors required for efficient production.

The gilts in the first group, which received the corn-soybean ration, farrowed more and larger pigs than did the gilts in the other two groups. The gilts in the Vitamin B₁₂ and the fish meal groups, however, lost fewer pigs and their litters were heavier at weaning. Pigs farrowed by sows on the corn-soybean ration suffered from severe diarrhea during the first four weeks and they were uneven in size and thrift. On the other hand, pigs farrowed by sows receiving the Vitamin B₁₂ concentrate and fish meal rations did not suffer from diarrhea and were even in size and thrift.

Three trials with weanling pigs were conducted to determine the value of a Vitamin B₁₂ concentrate when added to rations composed of commonly used feedstuffs. In each trial the largest and most thrifty pigs resulting received a basal corn-soybean ration which contained only small amounts of Vitamin B₁₂. On the other hand, the smallest and least thrifty pigs received a similar ration except that a Vitamin B₁₂ concentrate was added so as to supply

10 mcg. of the vitamin per pound of ration. Pigs intermediate in size and thrift received the fish meal ration which had been believed to be nutritionally complete.

In one trial pigs were farrowed by sows in dry lot; in a second trial the sows and pigs were on pasture; and in a third trial the pigs were dry-lot pigs from sows fed the corn-soybean ration.

The results indicate that:

- (1) Vitamin B₁₂ is a nutritional requirement for rapid and efficient growth in swine.
- (2) Such commonly used feedstuffs as corn and soy-bean oil meal are poor sources of Vitamin B₁₂, and that tankage is only a fair source of the vitamin.
- (3) Pigs which have access to a good pasture along with a protein supplement containing some tankage and fish meal do obtain adequate amounts of Vitamin B₁₂.

Production of Beef by the Maximum Use of Pasture and Other Roughage and the Minimum Grain Requirement (A. J. Dyer, Paul Q. Guyer, L. A. Weaver, J. E. Comfort, and John M. Landers). It was shown that the forage and grain from about 3 to 3½ acres of 30-bushel corn land in Missouri in a good growing season will produce a fat yearling steer. This finished steer will grade "good" and the approximate amounts of feed required are: 1½ tons of legume hay, 1 acre of good pasture, 30 bushels of corn, and 100 pounds of protein supplement. A total of 630 pounds of beef gain will be made or 210 pounds of beef per acre.

The amounts of feed required to produce fat yearling cattle under this system of management are shown in Table 9.

"Good" to "choice" feeder steer calves divided into 5 lots, weighed an average of 475 pounds in December, 1948, and were fed various rations in winter, grazed comparable pasture in summer, and finished in dry lot on the same ration. All lots of cattle were marketed in January, 1950 at weights ranging from 1083 to 1129 pounds. Each lot was sold when it was thought to be fat enough to grade "good" in the carcass. Total gains required to make cattle grade good varied from 607 to 654 pounds.

From 60 to 65 per cent of the total gain required to develop fat yearlings was produced from roughage and pasture combined (Table 10). From 33 to 42 per cent of the total gain was made from pasture alone. Gains made from pasture were low cost gains and thus reduced the cost of production. When feeder cattle are high in price in relation to fat cattle, economical production is extremely important because profits must come from cheap production rather than from wide margins.

TABLE 9.--WEIGHTS, GAINS, AND FEED REQUIRED TO PRODUCE FAT YEARLING CATTLE.
Summary of data on gains and feed consumed. (All figures represent pounds unless otherwise stated.)

Lot No.		I	II	III	IV	V
1948-49	Average Weight Dec. 14, 1948	476	476	475	477	475
Winter	Average Total Gain in Winter	136	175	163	137	191
A	Average Weight April 13, 1949	612	651	638	614	666
	Average Daily Gain	1.1	1.5	1.4	1.1	1.6
	Average Total Feed Consumed (per head)					
	Corn Silage	2694	2427	1375	none	2088
B	Clover Hay	736	750	1305	2006	767
	Soybean Oil Meal	none	120	120	none	44
	Shelled Corn	none	none	none	none	436 (7.8 bu.)
1949	Average Weight April 13, 1949 when					
Summer	turned to pasture	612	651	638	614	666
C	Average Weight Sept. 30, 1949	848	866	862	869	897
	Average Total Gain in Summer	236	215	224	255	231
	Average Daily Gain in Summer	1.4	1.3	1.3	1.5	1.4
D	Feed Consumed	Wheat Lesp. Pasture	Wheat Lesp. Pasture	Wheat Lesp. Pasture	Wheat Lesp. Pasture	Wheat Lesp. Pasture
1949-50	Average Weight Oct. 1, 1949 in Dry Lot	848	866	862	869	897
Dry Lot	Average Gain in Dry Lot	252	255	221	215	232
Feeding	Average Weight Jan. 7, 1950	----	----	1083	1084	----
E	Average Weight Jan. 28, 1950	1100	1121	----	----	1129
	Average Daily Gain	2.1	2.1	2.3	2.2	1.9
	Average Total Feed Consumed (per head)					
	Shelled Corn (bu)	29.6	29.6	27.2	26.5	31.3
F	Soybean Oil Meal	98	98	100	88	104
	Clover Hay	1056	1063	962	973	1131

TABLE 10.--DISTRIBUTION OF GAINS MADE BY YEARLING CATTLE FROM
ROUGHAGE, PASTURE, AND FULL FEEDING.

	Lot 1		Lot 2		Lot 3		Lot 4		Lot 5	
	Am't	%								
Winter Gain	136	21.8	175	27.2	163	26.8	137	22.6	191	29.2
Summer Gain	236	37.8	215	33.3	224	36.8	255	42.0	231	35.4
Winter & Summer Gain Combined	372	59.6	390	60.5	387	63.3	392	64.6	422	64.6
Gain in Dry Lot on Full Feed	251	40.4	255	39.5	221	36.4	215	35.4	232	35.4
TOTAL	623	100.0	645	100.0	608	100.0	607	100.0	654	100.0

Heifers and Steers Compared

Medium weight heifer and heavy steer calves of good to choice feeder grade were developed into good fat yearlings weighing 967 and 1165 pounds, respectively. The total amounts of feed required to produce gains of 621 pounds on steers and 499 pounds on heifers in dry lot were:

Steers and Heifers:

		Steers	Heifers
Corn	(bu.)	31.6	18.6
Soybean Oil Meal	(lbs.)	227.0	181.4
Legume Hay	(ton)	.9	.7
Corn Silage	(ton)	1.1	1.0
Small Grain, Bluegrass and Lespedeza Pasture	(days)	172.0	172.0

Of the total weight increase, steers and heifers made 62 and 70% respectively from roughage and pasture.

Heifers gained more economically, (largely a result of the higher percentage gain from roughage and pasture), fattened more quickly, and were marketed one month earlier than steers. Steers were smoother in conformation, sold higher, and returned more profit than heifers. Summary of the final results of the steers vs. heifers test is given in Table 11.

TABLE 11.--STEERS VS. HEIFERS (SUMMARY OF FINAL RESULTS).

		Steers	Heifers
Average Initial Weight (Dec. 14, 1948)	(lbs)	544	475
Average Final Weight * (Dec. 9, 1949)	(lbs)		967 **
Average Final Weight (Jan. 6, 1950)	(lbs)	1165	
Average Total Gain	(lbs)	621	499
Average Daily Gain	(lbs)	1.6	1.4
Average Total Feed Consumed:			
Shelled Corn	(bus)	31.6	18.6
Soybean Oil Meal	(lbs)	227	181
Legume Hay	(ton)	.9	.7
Corn Silage	(ton)	1.1	1.0
Pasture	(mos)	5.7	5.7
Dressing % (warm wt.)	(%)	58.8	56.9
Shrink to Market	(%)	2.7	3.7
Initial Cost Per Cwt.	(\$)	28.67	26.25
Selling Price Per Cwt.	(\$)	27.00	22.75

* Cattle were sold when a committee from the Animal Husbandry Department considered them fat enough to grade "good."

** One heifer sold at end of winter because of pregnancy.

Factors Influencing Efficiency of Beef Production (James E. Comfort, G. E. Dickerson, A. J. Dyer, and L. A. Weaver). Thirty yearling Hereford heifers from six different herds and seven yearling Hereford bulls from seven different herds were purchased for this project.

These heifers were wintered on corn silage and legume hay and bred (half-sib matings) so as to calve during the winter of 1950-51 when they will be 27 to 30 months of age. Half-sib matings were made for the first generation in order to obtain additional information on the relative merits of the different foundation families or related groups. Information on the progeny within each family should be more reliable than on their parents since the calves will be developed under similar conditions.

A group of 5 Hereford heifer calves and 1 bull calf from Spring Creek Ranch, Greencastle, Missouri, were purchased for the project in November, 1949. Four heifer calves from the University herd were added to the project in the fall of 1949.

Four hundred acres of pasture at the Weldon Springs Experimental Farm were fertilized and seeded during the fall of 1949 using the following legume and pasture grass combinations: Brome grass, alfalfa and Ladino clover; wheat, timothy, birdsfoot trefoil and Kentucky bluegrass; tall fescue and Ladino clover; wheat and lespedeza; and rye and lespedeza.

Work With Identical Twins

A detailed procedure has been prepared for using identical and fraternal beef cattle twin heifers to investigate the nature and importance of (1) genetic and environmental variation in economic characters; (2) genetic environmental interactions, and (3) genetic physiological associations between different characters.

A circular letter was sent to 1500 beef cattle breeders in Missouri explaining briefly the proposed work with identical twin heifers and asking that cases of apparently identical twin heifers be reported to the Department of Animal Husbandry. Replies were received from 60 breeders and to date 11 pairs have been blood tested. Three pairs were definitely fraternal, one pair undetermined, and 7 pairs were probably identical twins. Three pairs of identical twins have been purchased to start some exploratory work.

Physiology of Reproduction in Farm Animals—Biochemical, Physical and Physiological Aspects of Natural and Artificial Breeding (Dennis T. Mayer, Ralph Kampschmidt, Harry Herman, Wells Farnsworth, Lloyd E. Thomas, and C. D. Squiers). This is a cooperative project between Animal Husbandry, Agricultural Chemistry and the Dairy Husbandry Department.

Previous research at this station has shown that a high concentration of sodium ions in the diluting medium were detrimental to spermatozoan viability during storage and that sugar (glucose or sucrose) could be used to replace sodium salts for the maintenance of osmotic equilibrium. Egg yolk was shown to protect stallion spermatozoa from drastic changes in osmotic pressure and pH, and from certain toxic substances added to the diluting medium.

This year's work has been primarily concerned with the physical, chemical, biochemical, and metabolic requirements of bull spermatozoa during prolonged storage periods at low temperatures. The end in view is the development of the "ideal" diluter which will maintain the fertilizing potentialities of a semen specimen during storage or shipping at or near the level present in the same specimen at the time it was collected from the bull. Additional sugar over that previously reported resulted in the production of more acid during a storage period and the protective sodium-containing buffer salts were reduced in quantity; therefore, it was necessary to find a more efficient buffer salt than the sodium citrate or the sodium phosphate mixture.

Sodium bicarbonate (common baking soda) proved to be a very efficient buffer. The final diluting medium composed of 1 part of egg yolk and 4 parts of an aqueous mixture comprised of sodium carbonate (1.3%) and glucose (5%) gave better spermatozoan survival, maintenance of the pH of the diluted semen and better maintenance of motility during a prolonged storage period.

For a number of years it had been noted by inseminators in the field that in many of the diluted semen samples received by them the diluter solids

had settled to the bottom of the tube, with a clear amber supernatant in the upper portions of the tube. That the settling of the diluter solids resulted in a reduction in fertility was an accepted opinion.

These studies indicated that:

1. Sodium ions in the aqueous medium caused the precipitation of the diluter solids. If the sodium salts in the diluter medium were reduced in concentration, settling or precipitation no longer occurred.
2. The method whereby the constituents were mixed in the preparation of the diluting medium also affected the rate of settling.
3. Contrary to the general opinion of the inseminators the settling of diluter solids had no effect upon the viability of the spermatozoa during a storage period.
4. Both dead and live spermatozoa behaved as inert particles in a diluting medium and sediment rapidly during shipping or storage. Therefore, all diluted specimens should be thoroughly mixed prior to the withdrawal of a portion from the shipping or storage tube for insemination. Failure to mix thoroughly may explain the poorer results with specimens in which settling had occurred because the upper layers contained very few spermatozoa.

Proteins of Mammalian Spermatozoa

This project on the proteins of mammalian spermatozoa and of cellular nuclei is in cooperation with the department of biochemistry. When this work was started all available information regarding spermatozoa was that obtained in studies with fish spermatozoa prior to 1900.

It was found, in general, that the chemical constitution, especially that concerned with the protein constituents, of mammalian spermatozoa resembled that of cellular nuclei of other mammalian tissues more closely than that of the fish spermatozoa mentioned previously.

Studies with boar spermatozoa and the nuclei of liver cells, bird erythrocyte nuclei, and the nuclei of cells from the calf thymus gland led to the following conclusions:

Nuclei, in general, contain nucleohistones or nucleoproteins extractable with water of NaCl solutions. This was also a characteristic of fish spermatozoa. Boar and ram spermatozoa contained no proteins soluble in water or NaCl solution. However, these substances may be present in an altered form with different solubility characteristics in mammalian spermatozoa.

Mammalian spermatozoa and the nuclei of the cells of the mammalian tissues studied, contained two alkali-soluble proteins. The first protein, present in appreciable quantities, was soluble in 0.1 N NaOH solution and precipitated from the alkaline solution at pH 6.0 upon the addition of acid. The second protein, present in somewhat smaller quantities, was soluble in N NaOH and precipitated from solution at a pH between 10 and 11 upon

addition of acid. These proteins have been further characterized by analyses of their amino acid content.

A highly insoluble residue remained after removal of the above proteins. The residue contained nucleic acid, a protein or proteins high in arginine and possibly a keratin-like protein. This residue retained the shape of the spermatozoan head so that the residual material was characterized as "ghost heads."

Reproduction in the Sow

Previous investigations on reproduction in the sow has indicated that approximately 95 per cent of all ova shed were fertilized, yet only a small fraction of these resulted in the birth of pigs. This work suggested that litter size might be determined by one or both of two factors, (1) the percentage of fertilized ova implanted and, (2) the number of pigs surviving the gestation period—especially the first 30 days.

Work has been started on rats in which data similar to those obtained with sows and gilts can be obtained on larger numbers of females and on which more specific knowledge can be gained by slaughtering and studying animals at desirable stages.

The results obtained thus far on a limited number of females showed that the presence of the ovaries was unnecessary for implantation and early embryonic survival if the female was supplied with the two hormones, estrogen and progesterone, which are normally produced by the ovaries at this period in the reproductive process of the female. Pregnancy has been maintained in an ovariectomized female rat with a daily injection of 5 mgm. of progesterone plus 7 gamma (micrograms) of estrone.

These results suggest two important questions: (1) Is there an optimal level of these two hormones which provides the necessary environmental conditions in the uterus for implantation and embryonic survival to occur? In this case other factors would limit litter size. (2) Does each zygote implanted or each developing embryo have a definite hormone requirement, thus making the total amount of hormone available the limiting factor in determining litter size?

The Chemical Determination of Urinary Pregnanediol and Its Application to Reproductive Processes in the Sow: Progesterone is apparently the most important hormone in the reproductive physiology of the pregnant female. Numerous investigators have reported that progesterone is excreted in the urine as pregnanediol and that the urinary concentration of pregnanediol is a measure of the rate of progesterone production in the corpora lutea tissue in the ovaries.

Urine samples were collected from pregnant sows from the first day to the 39th day of gestation. Data were obtained on the number and weight of corpora lutea present, the number and weight of embryos, the relative numbers of live and dead embryos, and ovarian weights.

In order to shorten the lengths of analytical procedures a reliable and accurate colorimetric method for the quantitative determination of urinary pregnanediol was developed. While some species of animals do not excrete pregnanediol in the urine, the sow was found to excrete appreciable quantities of pregnanediol in the urine. The pregnanediol excretion in pregnant sows ranged from 5 mg. per liter of urine to 45 mg. per liter. Lower figures were obtained in several sows with regressive corpora or other abnormalities.

The average urinary concentration of pregnanediol per liter of urine was 8.4 mg. for the first 25-day period of gestation and from the 25th day to the 39th day of gestation, an average of 17.2 mg. These results indicated that progesterone production and pregnanediol excretion increased during the gestation period.

The correlation between pregnanediol concentration and the percentage of live embryos was highly significant. The percentage of live embryos is based on the number of corpora lutea found in the ovaries. Each corpus luteum represents an ovulated ovum. Previous work showed that 95 per cent of the ovulated ova were fertilized. Hence, the number of live embryos on the 25th day of gestation was dependent upon the number of placentae present and, as indicated by pregnanediol secretion, upon the amount of progesterone available from the placental tissue. This was further proof of the importance of progesterone in the reproductive processes of the pregnant female.

Food Preservation and Utilization and the Effect of Temperature Changes on the Quality of Frozen Foods (D. E. Brady, L. N. Tucker, Carl Emerson, Henry Ballou and Hugh Naumann). This project is in cooperation with the departments of Horticulture, Home Economics, Poultry Husbandry, Agricultural Economics, Agricultural Engineering, Agricultural Chemistry and Dairy Husbandry. The products studied this year were meat, poultry, fruits, and vegetables.

In studies with beef a total of 18 prime ribs, 8 rounds and 4 loins were used to secure 72 round steaks, 72 rib roasts, 12 porterhouse steaks, 12 T-bone steaks, 90 one-pound packages of ground beef and 72 packages of short ribs.

In addition to studying the effects of temperature changes on the quality of frozen foods the studies also included a comprehensive study of the influence of packaging materials. The packaging materials studied were:

- a. Coated cellulose film, 300 MSAT-83 cellophane, (DuPont) over-wrapped with 30 pound bleached kraft.
- b. Waxed paper consisting of 35 pound basis weight raw stock 24 x 36 - 500, on one side of which 18 pounds of microcrystalline wax reenforced with additives had been applied.
- c. Aluminum foil, .0015 gauge.

- d. Laminate *A* which consisted of wet strength cream tint kraft laminated to wet strength, high gloss, plasticized glassine with a special low temperature laminant.
- e. Laminate *B* which consisted of wet strength bleached kraft laminated to plasticized glassine.

The effects of the following storage temperatures for 6 and 12 months periods were studied: 0°F., 10°F., 0° to 10°F. (alternate weeks where the room temperature was at each of these temperatures), 0°F. with wide temperature fluctuations (evaporator temperatures varying from approximately -24°F. to plus 11°F. and the air temperature around the packages varying from approximately -4° to plus 8½°F. with each cycle) for 1, 2, 3, 4, 5, and 6 months followed by constant temperature storage at 0°F. and 0°F. storage following from one to six defrostings.

- a. Defrosting and refreezing has a determinable effect on the intensity and desirability of aroma and flavor when compared with the same cuts stored at 0°F. The differences were significant when comparing intensity of flavor and aroma and highly significant when comparing desirability of flavor and aroma.
- b. There was no relationship between the number of defrostings and the intensity of aroma although there was a high correlation between the number of defrostings and the desirability of aroma. In the case of flavor there was a low correlation in intensity of flavor but a high correlation in desirability of flavor.
- c. The length of storage period, regardless of storage temperature, had a highly significant effect on both the intensity and desirability of aroma and flavor.
- d. On an average, the aluminum foil was found to be the most satisfactory packaging material for the various treatments while the waxed sheet was the least satisfactory. Where meat had been defrosted a number of times the differences attributable to packaging material were greatly minimized.



The effect of different packaging materials on the quality of frozen meats at 10°F. From left, aluminum foil, laminate *A*, laminate *B*, coated cellulose film, and waxed paper. Aluminum foil was found to be most satisfactory, waxed sheets least suitable.

In studies with pork a total of 600 one-pound packages of ground pork, 120 pork chops, and 40 pork loin roasts from 20 hogs of varying feeding history were used. A study of the effects of a good oxygen-moisture barrier and a poor oxygen-moisture barrier as packaging materials was included in this work in addition to studying the effects of temperature changes on the quality of frozen foods. One-half of the pork used was packaged in laminated paper and one-half was packaged in a waxed sheet using the confectioner's method of packaging.

The temperatures studied were 0°F. storage, 10°F. storage, 0° to 10°F. storage (alternate weeks where the room temperature was at each of these temperatures), one defrosting followed by 0°F. storage and three defrostings followed by 0°F. storage. The storage periods studied were 3, 6, 9, and 12 months.

Analysis of the data showed highly significant effects were attributable to the character of the feed, the temperature of storage, the type of packaging material, and the length of time the meat was stored. 0°F. storage was not found to be superior to 0° to 10°F. (alternating weekly). 0°F. and 0° to 10°F. (alternating weekly) were superior to storage at 10°F., one defrosting followed by 0°F. storage, and three defrostings followed by 0°F. storage. One defrosting followed by 0°F. storage was superior to 10°F. storage. No differences were observable between 10°F. and three defrostings followed by 0°F. storage and no differences were found between one defrosting followed by 0°F. and three defrostings followed by 0°F. storage.

In studies with poultry forty-five fryers were stored at 0°F., 10°F., 0° to 10°F. (alternate weeks where the room temperature was at each of these temperatures), one defrosting followed by 0°F. and three defrostings followed by 0°F. and 0°F. with wide temperature fluctuations (evaporator temperatures varying from approximately — 24°F. to plus 11°F. and the air temperature around the packages varying from approximately — 4° to 8½°F. with each cycle) for 1, 2, 3, 4, 5, and 6 months followed by constant temperature storage at 0°F.

No discernible differences were found between free fatty acid values for the various treatments. The average peroxide values for the samples held at 0°F., 10°F., and 0° to 10°F. (alternating weekly) was 1.64 while samples of the birds which had defrosted one time had an average peroxide value of 3.13, and defrosted three times, 6.35. The palatability committee was unable to determine any consistent effect as far as storage temperature was concerned at the end of the six months period.

In studies with fruits and vegetables the effects of storage temperatures on quality were determined.

In the Vitamin C determinations there was a very sharp decrease from the freshly frozen product to the end products of the various treatments (18 mg

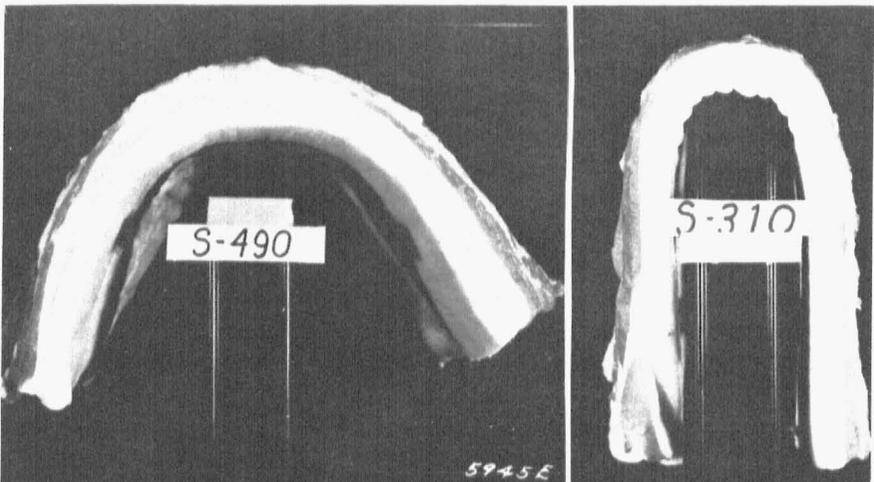
to 12 mg "C" per 100 grams of corn) and defrosting the product three times had a very marked effect, reducing the "C" content to about 4.5 mg per 100 grams.

Strawberries which were defrosted three times had a noticeable change in color and showed definite deterioration. Due to the extreme effect upon these berries they were rated poor on overall quality.

Effect of the Fat Composition of Stored Meat on Rancidity Development in Frozen Pork (D. E. Brady, L. N. Tucker, A. Z. Palmer, H. D. Naumann and Carl Emerson). One of the purposes of this experiment was to test the effect of fat composition on rancidity development in frozen pork and to determine the relationship between odor, flavor, and peroxide values as measures of rancidity in frozen ground pork.

In Missouri, as well as other states, hogs frequently have been fed a considerable amount of soybeans. This has resulted in an increase in the softness of the fat. When the amount of soybeans fed was limited, the change in the character of fat was not sufficient to cause an apparent reduction in quality, but perhaps there was sufficient change to affect the keeping quality of this pork when frozen. It has been customarily assumed that the amount of unsaturated fat was related to the total quantity of beans consumed, the proximity of the feeding of the beans to the time of slaughter, and the average rate of gain.

To study the effect of increasing amounts of unsaturated fat of frozen pork, 20 fall farrowed cross-bred pigs averaging 103 pounds in weight were divided into four uniform lots. Two rations were fed: (1) a "hard ration"



At left, typical fresh side from lot which received a ration conducive to firm pork; at right, typical fresh side from lot which was fed a ration conducive to soft pork.

composed of 80% ground yellow corn, 10% digester tankage, 5% soybean oil meal and 5% alfalfa leaf meal, and (2) a "soft ration" composed of 70% ground yellow corn, 25% ground soybeans, and 5% alfalfa meal. This gave both rations approximately 16½% protein content and 79% total digestible nutrients. The principle variation was in the percentage of fat in the ration which amounted to 4.4% fat in the "hard ration" and 7.1% fat in the "soft ration." It should be pointed out that soybean oil has an iodine number that is somewhat higher than corn oil due to the higher percentage of linoleic acid. The corn oil is somewhat higher in oleic acid.

Ground pork samples from the twenty hogs that had been fed to produce four degrees of hardness in the carcasses were wrapped in two packaging materials, frozen, stored under five temperature treatments, and tested for rancidity by chemical (peroxide value) and organoleptic (odor and flavor) determinations after six and nine months storage.

A total of six hundred one-pound packages of ground pork, 120 pork chops, and 40 pork loin roasts were used. One half of the meat was packaged in a laminated paper and one half in a waxed paper using the confectioner's method of packaging.

The following summary and conclusions were made from this experiment:

1. Rancidity development was a function of time. All of the criteria used indicated more rancidity in samples tested after nine months storage than after six months. This factor had the most consistent influence on the development of rancidity of the various factors considered in this study.
2. Samples tested at 0°F. continuous and 0° and 10°F. alternate weekly for 1 year were similarly efficient in the preservation of ground pork and were often in sharp contrast to samples at 10°F. and the one and three defrosting treatments. All defrostings were to approximately 40°F. The latter treatments were relatively inefficient in preventing the development of rancidity.
3. Prolonged storage above 0°F. and defrostings followed by 0°F. storage increased rancidity development of ground pork as much as 50 per cent as measured by peroxide values. The 10°F. was the poorest storage treatment involved in this study.
4. Defrostings to approximately 40°F. had a pronounced immediate effect upon rancidity development in frozen ground pork but this effect did not seem to be progressive in nature.
5. The feeding of soybeans to hogs definitely reduced the potential freezer life of pork.

6. Wide differences existed between packaging materials in the amount of protection provided against rancidity development.
7. Unsatisfactory relationships existed between odor, flavor, and peroxide values as measures of rancidity in ground pork. The relationships were much greater between odor and flavor than between either odor or flavor and peroxide values.
8. Hogs varied individually to different levels of peroxide values and to organoleptic rancidity development. The peroxide value associated with a particular level of organoleptic rancidity and the rate of peroxide accumulation varied with the individual rather than according to the type of feed-lot gain or freezer treatment.

The feeding of a twenty-five per cent soybean ration in producing the last seventy pounds or more gain prior to slaughter reduced the potential freezer storage life of ground pork from these hogs. Increased rancidity development was found in pork from soybean-fed hogs when compared to pork from hogs fed on a standard corn-belt ration.

The least rancidity development of ground pork was found in samples from corn-fed hogs that have been wrapped in laminated paper and stored at 0° F.

The relationship found between odor, flavor, and peroxide values as measures of rancidity in frozen ground pork was too low to be of utility.

Individual variation in hogs, regardless of feeding treatment, had a great influence upon eventual rancidity and peroxide value development during freezer storage.

Deterioration in Frozen Beef as Affected by Packaging and Storage Treatment

Progress has been rapid in the field of frozen food packaging materials, but there still is a definite need for further improvement and recognition of good materials and methods. Also, the thawing and refreezing of frozen foods has been studied only to a minor degree and more definite information is needed on this subject. It is known that the thawing and refreezing process must be held to a minimum, but it is important to interpret more fully the maximum and minimum times this can occur and still yield an acceptable product.

In addition to 90 one-pound packages of ground beef and 72 packages of short ribs, this package study included 18 prime ribs, 72 round steaks, 72 rib roasts, 12 porterhouse steaks, and 12 T-bone steaks, which were studied in this test.

The following summarizes the results found:

1. Temperature and storage treatments had only slight effect on the palatability, the rate of autolysis, and moisture losses of rib roasts and top round steaks. Ground beef, receiving identical treatment was materially affected.
2. Ground beef samples stored at 0°F., 0°-10°F., and 10°F. for twelve months had significantly lower palatability ratings than those stored six months at the same temperatures.
3. There was a marked lowering of acceptance for ground beef after being defrosted four times. Those defrosted six times were rated as undesirable.
4. Ground beef samples stored for twelve months at 10°F. or for six months after four or five defrostings received the same palatability ratings.
5. High frost losses occurred during the initial six months storage. High evaporative losses occurred during the extended six months period. Total moisture losses were approximately the same for the six and twelve months periods.
6. The ability of the various types of packaging materials to retain moisture was in direct proportion to their ability to prolong the desirability of the flavor.
7. Aluminum foil, cellulose film, and Laminate *A*, in the order named were the higher in the moisture retention factor.
8. Aluminum foil, cellulose film, and Laminate *A* were superior to Laminate *B*, and waxed paper in their ability to prolong a desirable aroma and flavor, and to maintain the original appearance of the product.

Storage of frozen beef for periods up to six months at temperatures of 10°F., 0°F., and fluctuating temperatures between these ranges did not materially affect the palatability, moisture losses, or the rate of autolysis when a good moisture vapor-proof packaging material was used. Extended storage up to twelve months, or the employment of a less efficient type of packaging material lowered the acceptance of the product. A temperature of 0°F., for extended storage was imperative. This observation is in agreement with results reported by Finnegan (1939), Pennington (1943) and Sims (1947).

Defrosting from one to six times apparently did not markedly affect the palatability of cuts of beef when the meat was not allowed to remain above 32°F., for more than eighteen to twenty hours on each defrosting.

Waxed paper was very inefficient as a protective wrap for frozen beef.

BOTANY

C. M. TUCKER, *Chairman*

Identification of Plant Diseases (C. H. Kingsolver and C. M. Tucker). The 1949 season, with its abnormally wet early summer, was very favorable to the development of diseases of the foliar blight, rust, and root rot types.

A bright pink to red spot frequently appeared on apples, particularly the variety Golden Delicious. Spots occurred most frequently on the side exposed to sunlight, and on the stem half of the fruit. The spots originated at lenticels, possibly as the result of injury to lenticel tissue by heat or drying following the cool rainy period of early summer. In early stages, no organism could be obtained consistently. In later stages the spots were apparently invaded by a fungus which caused a wet rot which invaded the fruit very rapidly. Spotted fruit placed in common storage rotted quickly.

Wheat mosaic was found causing damage in St. Charles and Carroll counties. Symptoms of wheat mosaic have been observed in 15 other counties in Missouri, but this was the first report of extensive damage. Continuous wheat culture in bottom land areas and use of susceptible varieties contributed to its damaging effects.

Barley (B400) growing in Sikeston plots was found to be infected by *Sclerospora macrospora*. This was the first report for Missouri and believed to be the second published report for the United States.

A disease on tobacco similar in symptomology to black shank was observed in Platte County. Attempts to isolate the black shank fungus were not successful, and the identity of the disease remains in doubt.

Specimens of *Setaria* were found to be infected with *Sporotrichum peribebuyense*. Comparison with herbarium material revealed that the fungus had been collected only once previously in Missouri.

Scab (*Gibberella* spp.) was unusually prevalent in Missouri during the season on wheat and barley. Races of crown rust of oats which attack Bond derivatives were present in epiphytotic amounts in some areas of the State. Several specimens of bacterial stalk rot of corn were received, (*Erwinia dissolvens*).

A large number of specimens of wilt in cotton were examined. In a few cases *Verticillium* sp. was the casual fungus, but in the majority of specimens, *Fusarium vasinfectum* was found. The wilts caused by these two fungi were difficult to differentiate and constituted a serious problem to the cotton farmer, since the means of control are not the same.

Investigations on Diseases of Forest and Shade Trees (T. W. Bretz, W. G. Long, C. M. Tucker, and R. H. Westveld). This was a cooperative project with the Forestry Department and the United States Department of Agriculture. Investigations on the control of juniper blight in nursery beds were

continued in cooperation with the Soil Conservation Service Nursery at Elsberry, Missouri, and replicated field trials were conducted with several spray materials in uninfected seedling beds and on plots of 1-0 stock in which the disease was already established. Spray applications were made at 10 and 30 day intervals, extending from early May to late September, with mist blower and hydraulic equipment. Fungicides tested were Ferric dimethyl dithiocarbamate, Bordow (copper sulfate and magnesium hydroxide), Puratized 111-5 (mercury copper quarternary ammonium complex); and Phygon XL (2, 3-dichloro-3, 4 naphthoquinone).

Initial applications of the Phygon and Puratized formulations used caused severe phytotoxicity to both cedar and *Rosa multiflora* and were discontinued for the remainder of the season. No injury occurred in either hydraulic or mist blower plots of Ferbam or Bordow.

No practical degree of control of juniper blight was obtained with any material or treatment tested and no significant differences were obtained between sprays applied at 10 or 30-day intervals. Spray applications at 10-day intervals did not give adequate protection to new growth and in infected beds the amount of disease continued to increase during the spray season.

Observation on the development of juniper blight in plot areas revealed a marked decrease in the amount of blight that developed in new beds as the distance increased from the 1-0 beds which were heavily infected. Studies were therefore undertaken to determine the degree of control that might be obtained by the elimination of possible infection sources. These studies included the use of seed disinfectants, soil treatments both before and after seeding, the use of various mulches, and the establishment of seed beds on new ground well isolated from other juniper plantings.

Supplemental studies also included the inoculation with the juniper blight fungus of other plant species commonly grown in the nursery to determine if they may serve as sources of infection. Results are not yet available.

Laboratory studies undertaken on the juniper blight fungus have shown that under high moisture conditions, spore discharge occurred from pycnidia within 12 to 24 hours; spore tendrils disintegrated rapidly in water; and over 50% of the alpha type spores germinated within 4 hours at a temperature of 25 degrees centigrade.

Disease Resistant Elms

Studies to determine the most satisfactory method of rooting vegetative cuttings of disease-resistant elms were continued. The Christine Buisman elm (*U. carpinifolia*) has been rooted most successfully from root cuttings collected during the dormant period and planted in a light soil-rooting medium. Continued attempts to root the Buisman elm from leafy softwood cuttings have not given satisfactory results. The root-cutting method has been used

to propagate stock for distribution to commercial nurseries. A total of 2117 cuttings have rooted by this method, averaging 82.6% successfully-rooted cuttings in 8 trials. The use of chemical treatments have not proved beneficial in rooting cuttings of the Buisman elm. Over 500 Christine Buisman elms were distributed to 53 commercial nurseries in 17 states in 1949 and approximately an equal number in 1950.

Rooted Cuttings

Ulmus americana, including our phloem necrosis resistant selections which have been unusually difficult to propagate, has been rooted most successfully in greenhouse trials from leaf-bud cuttings subjected to constant misting. Leaf-bud cuttings, consisting of a leaf blade, axillary bud, and a shield of stem tissue taken from current year's growth of 8-year-old trees in May and June, have produced 83.5 and 88.5 per cent rooted stock, respectively, when treated with Hormodin Powder #24 (indol butyric acid). Similar material produced 60 and 58.5 per cent rooted cuttings without chemical treatment. Rooted cuttings were obtained from four to six weeks after planting. Rooted stock obtained was superior to that obtained from either root or softwood stem cuttings and gave better survival after transplanting.

Outdoor Propagation

Outdoor propagation trials with leaf-bud cuttings of 8-year-old, field-grow *U. americana* under constant misting have been conducted in a lath-covered propagation frame. Results were promising although inferior to greenhouse trials; rooted cuttings obtained were 46% with Hormodin Dust #2 and 50% when no chemical treatment was used.

Experimental DDT spray plots for the control of elm phloem necrosis have been continued in Kansas City, Missouri, and Columbus, Ohio. During the past year, 2 of 82 sprayed trees or 2.4% died of phloem necrosis in the Columbus plots as compared to 53 (18.2%) of the 291 unsprayed check trees. In Kansas City plots, 3 of 1663 sprayed trees or 0.18% became diseased as compared to 9 (0.59%) of the 1509 unsprayed checks. In the general plot area at Columbus, phloem necrosis continued to cause a heavy elm mortality and the experimental results were considered to be encouraging. In Kansas City, however, the incidence of disease in the general plot area has been low and no significant data has been obtained.

Further experiments conducted on the disease causing the necrotic bark rings have demonstrated its virus nature. Elm mosaic, which has become a serious disease problem in some areas, has been found to occur in some trees as a latent virus.

The virus has been found to be carried in seed from mosaic-affected elms, 31½% of the seedlings obtained from one lot of such seed were found to be affected by mosaic. Evidence has also been obtained that the virus may persist in seed for at least 18 months.

Attempts to transmit the mosaic virus to a number of herbaceous or succulent plants by mechanical methods failed.

Virus Diseases of Stone Fruit (D. F. Millikan, A. D. Hibbard, and C. M. Tucker). This research was carried on in cooperation with the Department of Horticulture. The use of flowering cherry, *Prunus serrulata*, seemed to offer considerable promise as a test plant for the detection of stone fruit virus diseases. However, it was found that flowering cherry failed to make satisfactory union with virus-infected *Prunus avium* seedling understocks, and this fact can be used to advantage in selecting virus-free sweet cherry (*Prunus avium*) trees in the nursery row. Accordingly, individual nursery trees were budded with one bud each of Kwanzan and Shirofugen flowering cherry. In the event that either or both of the buds failed to make normal union the tree was discarded. However, if both buds formed normal unions the tree was preserved. Confirmatory studies are now being made, and it is hoped that this method will provide a means for selecting ringspot-free trees from a clone believed to be infected.

The search for ringspot-free clones in sweet cherries was accelerated during the 1948 season. Studies conducted during the 1948 season revealed that the parent trees of the Windsor, Seneca, Early Honey Heart, Bing, Black Tartarian, Schmidt, and Deacon varieties were all infected.

One of the practices ordinarily used by nurserymen is propagation with budwood removed from one-year-old nursery trees. This suggested the possibility of selecting ringspot-free trees within the nursery row since the parent tree may have become infected after the period when it was the sole source of budwood. As a result individual trees of superior vigor and growth were selected within the nursery rows during the growing season and indexed in 1949 on Montmorency cherry in the greenhouse. Two trees of Seneca, one of Early Honey Heart, five of Schmidt, four of Windsor, three of Deacon, and two of Black Tartarian were found to be free from ringspot.

The Lambert, Governor Wood, Seneca and Schmidt clones being propagated at the present time are apparently the only ringspot-free selections of these varieties reported to date.

The presence of virus in seed trees of *Prunus mahaleb* and seed transmission of this virus presents a previously unconsidered source of virus spread. Seed transmission of both ringspot and cherry yellows has run as high as 20%.

An investigation was started to determine the extent of ringspot present in the parent seed trees and rogue out those found to be infected. Through indexing conducted in the greenhouse one planting of twelve trees was found to be entirely free from both ringspot and yellows. Additional plantings are being indexed and the planting previously found to be free from ringspot is being re-indexed. Seed from ringspot-free planting will be used for the establishment of other ringspot-free plantings.

The Development of Tomato Varieties for Resistance to Fusarium Wilt and Other Diseases (C. M. Tucker, and R. A. Schroeder). This project is in cooperation with the Department of Horticulture. Continued selection of tomato lines with high resistance to Fusarium wilt was carried on both in the field and greenhouse. In the field, favorable conditions for wilt development occurred during May, when varieties without the *pimpinellifolium* type of resistance were completely destroyed. Lines in which this type of resistance has been incorporated were, in most cases, completely resistant. In others, small percentages of infection occurred.

In St. Louis County three wilt resistant lines on plots of cooperators planted where soil infestation by the wilt fungus was not a factor in yield, gave results sufficiently favorable to warrant some extension of their use. In southwest Missouri, with heavy soil infestation, one of the lines has largely superseded the previously grown varieties, in spite of the fact that this line is slightly later than the susceptible variety it has supplanted.

In crosses made to improve the earliness of lines developed for staking, there was some evidence of a linkage between factors for earliness and susceptibility. Since in greenhouse tests a number of early selections from F2 progenies proved susceptible, some of these were backcrossed to the resistant parent. F2 progenies from these crosses will be tested.

A number of lines adapted to greenhouse culture were grown at Columbia in the spring of 1949, and also in the fall. Complete yield data and information on resistance to Fusarium wilt and leaf mold were obtained for both crops. Among the commercial varieties, which were not inoculated with the wilt fungus, Michigan State had the best yield record, ranking 11th among 24 lines in the spring, and 3rd among 20 lines in the fall crop. Break o' Day and Bay State were low yielders in both crops.

Varieties involving Bay State as a parent usually produced fruit somewhat smaller in size, but the decrease in size was often offset by their more prolific bearing habit.

Studies on the Mechanisms of Resistance or Immunity to Infection by the Wilt Fungus, *Fusarium Lycopersici* (A. M. Finley, and C. M. Tucker). Since the discovery of a physiological race of *Fusarium oxysporum f. lycopersici* capable of causing some infection of *Lycopersicon pimpinellifolium* and hybrids possessing the *pimpinellifolium* factor for resistance to wilt, an attempt has been made to determine, if possible, the mechanics of resistance to both Races 1 and 2.

During the past year a histological study has been made of the differences in host response to the two races. For this study the progenies of two sister plants from the F2 generation of a *Lycopersicum esculentum* X *L. pimpinellifolium* cross were selected as the hosts.

These hybrid lines showed marked differences only in their resistance to Race 1. One of the lines was completely susceptible while the other was highly resistant to Race 1. Both lines were susceptible to Race 2.

This study has shown that both races of the organisms were strictly vascular parasites, and that they infected the plant only through a vascular wound. Consequently, anatomical differences such as thickness of cell walls or the degree of cutinization or suberization cannot account for resistance or susceptibility. Resistance, then, must be due to a physiologic response on the part of the host, and the evidence obtained indicated that the difference in time required for the initiation of wound healing processes was the most important factor.

DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

Official Testing of Dairy Cows in Missouri (J. W. Cobble). In cooperation with the National Dairy Cattle Breed Association, 2,932 cows per month were officially tested in the herds of 165 Missouri Breeders. This constitutes the largest number of herds as well as the largest number of cows ever tested in the Official Testing program in one year in Missouri. Of the two forms of Official Testing, Advanced Registry and Herd Improvement Registry, more than 95 per cent of the herds were tested under the Herd Improvement Plan. Throughout the year, fifty-three breeders entered their herds in the Official Testing Program while thirty-three breeders discontinued this work.

The highest butterfat and milk producing cow for the year, in the Advanced Registry Program and winner of the 1949 Missouri State Dairy Council Trophy, was the Guernsey cow, Seco I Faith 1047030, owned by Seco Farms, Inc., Arcadia, Missouri, with a 365 day record on 14,188 lbs. milk and 705 lbs. butterfat as a senior two-year-old.

The Guernsey cow, Rosalee of Cloverdale 869896, owned by J. J. Griesemer. Billings, Missouri, was the leading butterfat producer of her breed on Herd Improvement Registry test, with a record of 12,645 lbs. milk and 674 lbs. butterfat in 365 days with 2 times a day milking.

The Jersey cow, Coronation Spot Royal Pearl, owned by Walter H. Kollmeyer, Springfield, Missouri, led all cattle of the Jersey breed in Herd Improvement Registry test with a record of 11,450 lbs. milk and 710 lbs. butterfat in 365 days with 2 times a day milking.

The State leader in Herd Improvement Registry test in the Holstein Breed was Paganok Magda Posch Perfection 2106225, owned by Scott Meyer, Palmyra, Missouri. Her record was 20,962 lbs. milk and 790 lbs. fat in 365 days with 2 times a day milking.

The Holstein herd owned by Clyde Hill Farms, Clyde, Missouri, was leader in Herd Test with an average of 14,299 lbs. milk and 533 lbs. butterfat for a total of 43 cows all on three times a day milking.

Improvement of Dairy Cattle Through Breeding (H. A. Herman, A. C. Ragsdale, Donald B. Anderson, J. H. Edmondson, R. C. Lagen, Donald B. Roark, and Chase Wilson). Dairy cattle breeders have many differences of opinion over the time that cows first come in estrus following parturition. In order to get more information on this subject, the breeding records of 347 cows with 968 parturitions in the Missouri Station herd were studied.

It was found that the average length of interval from parturition to the first estrus period was 57 days with a standard deviation of 28 days. Of the 968 estrus periods studied, 59 per cent were within 60 days following freshening, 30 per cent between 60 and 90 days, and 11 per cent between 90 and 150 days.

The level of milk production or the season of the year was not a factor in determining the length of time from calving to the first estrus period.

Studies were made on the histology of the reproductive organs of sterile cows. Over a 2 year period 20 dairy cows from the Station herd were sold for slaughter to a local packing plant. Fourteen were classed as non-breeders and the six others served as normal controls. Immediately after killing, the reproductive tract was removed and examined, and tissue sections were taken from the vagina, cervix, uterus, oviducts, and ovaries. Sections were fixed in Bouins solution, imbedded in paraffin, and cut at 8 to 10 micra. Hematoxylin, hemalum, eosin, and erythrosin were the routine stains used.

A study of the reproductive records of the 14 non-breeders revealed the following:

Their average age at first calving was 33 months. Their 14 dams and 113 half sisters averaged 30 months.

Their lifetime reproductive records showed an average of 2.2 services per conception. The 125 relatives averaged 1.9 services per conception.

The reproductive efficiency (after the method of Williams i. e., 1 calf per 12 months after puberty equals 100%) of the non-breeders at the time of last calving was 76 per cent. By sale time it had dropped to 57 per cent. The efficiency of their dams was 86 per cent and of 105 paternal half sisters, 81 per cent.

Ten of the 14 had produced 2 or more previous calves and one had not calved. They averaged 3 previous calves. (Two of these animals were in their 11th year of age, one had dropped 6, the other 8 calves). Their average age was 6 years 9 months.

The non-breeders had an average of 7 infertile services prior to disposal and eight of the 14 showed a record of one or more abnormally long estrus periods prior to sale. There were 4 recognized abortions and 43 normal calvings for the 14 non-breeders. Brucellosis, or Trichomoniasis were not involved. but several cases of vaginitis had been treated and recorded.

Gross examination of the reproductive tracts revealed: 3 cases of ovarian adhesions, 4 cases of tubal obstructions, 3 cases of severe uterine and cervical infection, 9 cases of evident ovarian cysts, 2 cases of double external cervical os. In 5 of the 14 cases there was evidence of a definite physical barrier to fertilization. In the remaining 9 cases, 8 showed ovarian cysts. (Histological study of these ovaries revealed some normal, evidently functional ovarian tissue), one showed no gross, or histological abnormalities.

Increasing the Effectiveness of Artificial Insemination as a Means of Improving Dairy Cattle (H. A. Herman, A. C. Ragsdale, Donald B. Roark, K. L. Tallman, Howard J. Weeth, Ralph Kampschmidt, Glenn Pursley, Maurice Dickensheet and J. E. Edmondson). In studies completed this year a total of 4,692 semen samples involving over 154,000 inseminations were studied. A comparison of diluents under field conditions was also included in this study. Generally, the relationship between survival time of spermatozoa, and the sires breeding record has been found to be very highly correlated.

Inter-breed and inter-month variations in longevity and percentage non-returns were highly significant. The most consistent trend in longevity was a maximum in June for Holstein semen and in July for Jersey and Guernsey semen, followed by a sharp decline to a minimum in September; and then a significant increase in October. A delayed, detrimental effect of high environmental temperature was suggested.

A 20-hour increase in longevity occasioned a 1 per cent increase in percentage non-returns and some factor associated with the summer season appeared to have limited the fertility of the cows inseminated at this time.

One of the problems in artificial insemination is to develop diluting fluids for dairy bull semen that will maintain spermatozoa longer and with a better degree of fertility under storage conditions. Through cooperation with the Department of Agricultural Chemistry a comparison of the various diluting fluids used at present including the phosphate egg yolk, citrate egg yolk, and the "pabulum diluters" suggested by various workers were compared.

In the diluted samples of semen spermatozoa survived from 109 to 190 hours with a 20 to 50 per cent survival of sperm as the lowest measure of motility. Undiluted semen had a sperm survival of only 83 hours. Since all diluters were made up to have approximately the same osmotic pressure and agreed closely in pH the variation in livability of the spermatozoa for storage conditions was apparently due to physiological differences brought about by the chemical make-up of the medium.

The results indicated that the substitution of sodium citrate in place of sodium and phosphate salts, and the use of an animal source of lecthin was of value in increasing the longevity of spermatozoa. Further investigation of this modified diluter is under way.

A study was made on some of the effects of hypertonic and hypotonic solutions on bovine spermatozoa livability and morphology, and freezing point depressions were determined on the semen and likewise on the hypertonic, isotonic, and hypotonic solutions. Solutions from 12½ to 100 per cent hypertonic, and from 12½ to 75 per cent hypotonic were studied. Semen samples in the various diluents were retained as long as 20 per cent or more of the spermatozoa remained progressively motile.

It was found that there was a gradual decline in motility of spermatozoa stored at 40° Fahrenheit with increasing hypertonicity. Sperm stored in hypertonic solutions with a freezing point depression of -1.05° Centigrade survived only 10.9 hours.

Hypotonic solutions were found to be very little or non-detrimental to spermatozoa. A hypotonic solution with a freezing point depression of -0.19° Centigrade was as satisfactory as the isotonic solution with a freezing point depression of -0.57° Centigrade.

It was determined that a freezing point depression of -0.69° Centigrade would be the uppermost limit in formulating diluters. The optimum range for spermatozoa survival was -0.44 to -0.61° Centigrade in terms of freezing point depression or 2.3 per cent to 3.5 per cent sodium citrate solutions.

Neither the hypertonic nor the hypotonic solutions produced abnormalities in spermatozoa head dimensions. It was concluded that bovine spermatozoa have a very low permeability for salts.

Factors Affecting the Conception Rate Where Artificial Insemination of Dairy Cattle Is Practiced Under Field Conditions

A survey was made of 308 selected dairy herds in 56 of the 85 counties of Missouri, where artificial insemination service is available in an effort to determine some of the factors affecting conception rate.

The herds studied consisted of 145 breeding herds classed as efficient averaging 1.75 services per conception and 163 herds classed as inefficient in conception rate with 3.27 services required per calf.

Thirty-four per cent of the inefficient and 10 per cent of the efficient breeding herds were considered poorly managed. The conception rate of the efficient herds that were considered poorly managed was 1.90 services as compared to those with satisfactory management with 1.74 services.

The prevalence of genital disease, particularly Brucellosis, was characteristic of many of the less efficient breeding herds. Of the efficient herds, 62.8 per cent were reported as disease free. The average conception rate of these herds was 1.69 services. Only 36.7 per cent of the inefficient breeding herds were reported as disease free, but averaged 3.22 services per conception. Brucellosis was present in 22.1 per cent of the inefficient herds and 13.7 per cent of the efficient herds. Thirty-nine per cent of the inefficient Brucellosis

infected herds and 20 per cent of the efficient Brucellosis infected herds kept reactors in the herd; some vaccinated the remainder of the herd as adult cattle. Both groups practiced calfhooed vaccination rather heavily but the owners of the inefficient breeding herds practiced adult vaccination to a greater extent than owners of the better breeding herds.

Poor feeding did not seem to be a major cause of breeding failures in the two groups of herds studied. The efficient breeding herds were slightly better fed on the average and used more temporary pastures, silage, and a slightly better grain mixture. They were grazed on more improved permanent pastures than the inefficient herds. Satisfactory cooperation between the herd owner and the inseminator existed in 95.2 per cent of the efficient breeding herds and in only 80.4 per cent of the poorer breeding herds.

The quality of semen used and inseminator techniques were not adjudged to be important factors at fault in these herds where breeding failures resulted.

No single factor in feeding and management could be charged as responsible for lowered breeding efficiency in the herds surveyed, but it was believed highly significant that the more efficient breeding herds had less disease, were better managed, used more improved pastures, had better owner-inseminator cooperation, and were operated by more progressive dairymen than the less efficient herds.

Properties of Vaginal-Cervical Secretions

In order to better understand some of the factors associated with maximum breeding efficiency where artificial insemination is used the properties of bovine vaginal-cervical mucus were studied. It was believed that the viscosity and properties of mucus during various stages of the estrual cycle were associated with spermatozoa movement and survival.

A study of physiological and histological phenomena during the bovine estrual cycle was made on more than 100 cows of the Guernsey, Holstein, and Jersey breeds in the Missouri Station herd. Particular attention was given the properties of vaginal-cervical mucus at varying stages of the estrual cycle.

The beginning and end of estrus were sometimes abrupt and in other cases gradual and could be distinguished by the character and consistency of the mucus secretions. Data on 1503 estrual periods on 1182 cows showed that the majority of the periods began in the A. M. The average length of 504 estrual cycles was 21.41 days with a range of 11 to 35 days. Eighty per cent of the cycles was within the range of 18 to 24 days.

Vaginal temperatures and heart rates were slightly higher during estrus than during diestrus and pregnancy.

The volume of mucus secreted, its flow elasticity, surface tension, and water content decreased as estrus progressed, but the number of leucocytes increased. Mucus was collected from the cervix and vagina of 10 cows at slaughter. In all cases, the cervical mucus was more acid than vaginal mucus; the former averaged pH 6.89 and the latter 8.01.

A Study of the Use of Dehydrated Culture in Ice Cream (W. H. E. Reid, J. H. Gholson, C. B. Agee, and R. M. Hanckel). This investigation involved a study of the use of dehydrated culture in ice creams and its relation to the processing, freezing, hardening, and consumer acceptance. Special attention was given to the effect of variable amounts of culture upon the flavor, body, texture, color, and meltdown of the ice creams.

The data definitely indicated that when variable increments of the dehydrated culture were used the conventional procedure of calculating, processing, and freezing of the mix and hardening of the ice creams was applicable in every instance. The desirable cultured flavor became more apparent with each additional increment of the dehydrated culture. As the amount of culture was increased the body of the ice cream became more mellow and smooth and the texture became finer and closer with increased resistance to melting. However, these properties were not impaired even when using the maximum quantity of the dehydrated culture except for a slight excessive retarding of the melt down of the ice creams.

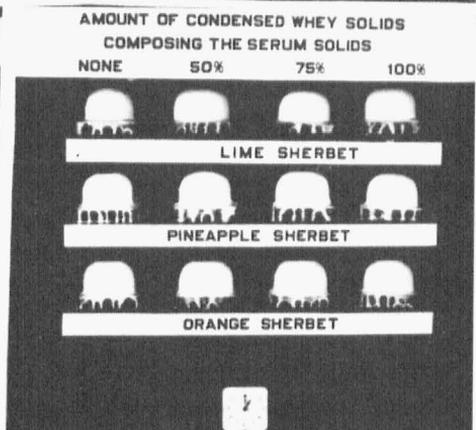
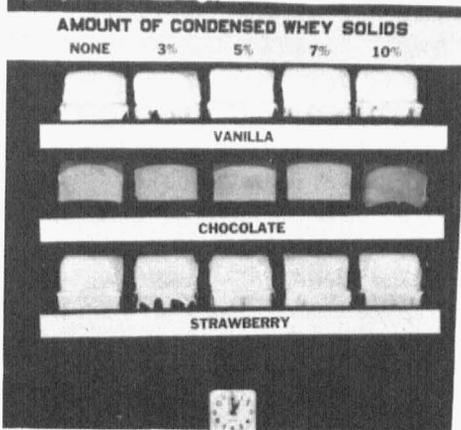
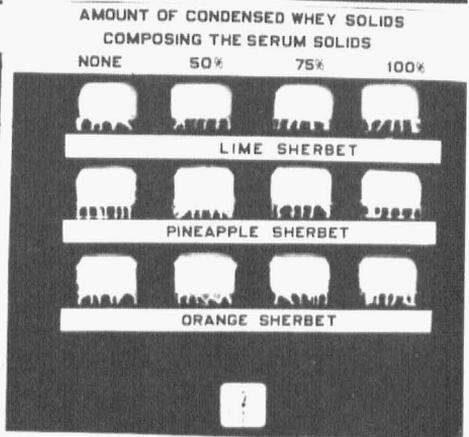
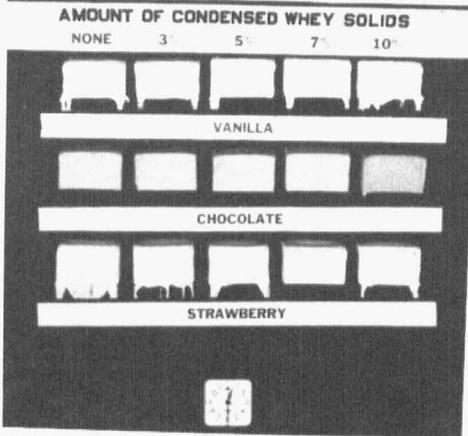
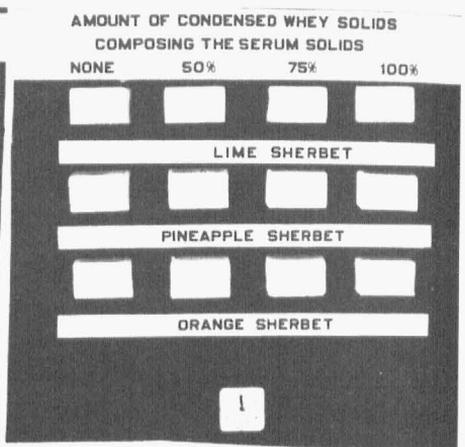
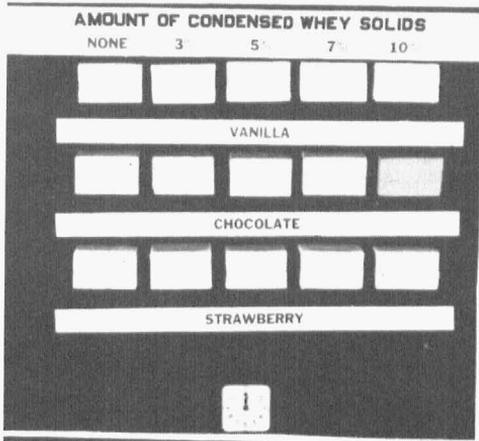
The ice creams perfected as a result of the conduct of this study possessed splendid physical qualities and presented to the ice cream industry a new and distinctive flavor.

In addition, 800 feet of educational motion picture entitled "The Melt Down Qualities of Culturized Ice Cream" and 800 feet of colored educational motion picture entitled "Factors Affecting Melt Down of Different Flavored Ice Cream and Sherbets in Several Different Markets" were produced.

The Use of Dehydrated Whey Solids in Ice Cream and Sherbets (W. H. E. Reid, J. H. Gholson, and R. C. Combs). This investigation consisted of a study of the use of condensed processed whey solids in the manufacture of different flavored ice creams and sherbets, with special attention directed to its effect upon processing, procedure, freezing, hardening, and dipping of the ice creams. Its effect upon the physical properties of the ice cream was included.

The results showed that condensed processed whey solids may be used in different flavored ice creams and sherbets without altering the processing, freezing, or hardening procedure commonly applied in commercial ice cream plants. As much as ninety per cent of the serum solids may consist of condensed processed whey solids in the manufacture of ice cream and sherbets and produce a desirable flavor, body, texture, and meltdown. Ninety per cent of serum solids in chocolate and strawberry ice creams may also consist of whey solids. Pineapple, orange, and raspberry sherbets containing as much as ninety per cent whey solids were very desirable in every respect.

The data showed that condensed whey solids when used in ice creams increased their stability in direct ratio to the amount of whey solids used.



Melt-down properties of condensed whey solids used in ice cream (at left) and in sherbets, shown at 30-minute intervals.

This is an important factor from the standpoint of the melt down properties of each differently flavored ice cream.

High quality condensed whey solids may be used in ice creams and sherbets thereby offering a new use of these important milk nutrients. Previously, large volumes of these vital food nutrients have been discarded at cheese factories because there was no important demand for them.

Studies in Milk Secretion (C. W. Turner, Gene Kauffman, Syed Kamal, and T. Y. Liu). It has been shown that the feeding of thyroprotein increased the production of milk for variable periods, then declined. In order to determine whether the feeding of a combination of estrogen and thyroprotein would maintain lactation at a higher level than thyroprotein alone, two groups of milking goats were compared, and the group fed thyroprotein and estrogen maintained their lactation for a more extended period than did the group fed thyroprotein alone. This experiment is being continued.

The inheritance of the capacity for high milk production depends upon the rate of secretion of the hormones which influence the growth of the secretory tissue and the initiation and maintenance of milk secretion. It was shown that milk secretion was depressed when the thyroid hormone was available in insufficient amounts, and that mild replacement therapy stimulated milk secretion up to the point where some other hormone limited production.

It seems reasonable to believe that in the selection of cows for high milk and fat production high thyroid secretion rate is essential and when combined with high secretion rate of other hormones outstanding cows are bred. However, since selection at this time is not based upon the secretion rate of the various hormones, in many cases cows are bred with an inheritance for milk production considerably above their actual production simply because of a deficiency in the cow's thyroid hormone secretion rate. By this simple process of feeding thyroprotein, this deficiency is overcome and the full inherited potentialities of the cow are then realized. It should be emphasized that the feeding of thyroid hormone has exactly the same effect upon the cow as the secretion of optimum amounts of hormone by the animal's own thyroid.

Increased Milk and Fat Production

It was found that thyroprotein increased the appetite resulting in an increase in feed consumption ranging up to 25 per cent for most cows. On the average this meant about three pounds more grain per cow per day was required. In those cows in which the thyroid hormone secretion rate was below normal, increased milk and fat production ranging from 10 to 30 per cent above the otherwise normal rate usually resulted. Some cows did not respond favorably in milk production and fat test probably because they were normally secreting thyroid hormone at a level adequate for their capacity.

Increased Energy Metabolism

High producing cows normally have very active thyroid glands stimulating all the cells of the body to a high rate of activity. Energy metabolism in a high producing cow may be double that of a dry non-pregnant cow. However, if thyroxine was secreted, or thyroprotein was fed in excess, metabolism was increased beyond the ability of the animal to utilize the feed for milk production, and the amount of heat produced which must be eliminated by the cow was greatly increased.

When thyroprotein feeding resulted in greater feed consumption and milk production, more heat must be eliminated. If prolonged, high temperatures were encountered, and it usually was necessary to reduce or eliminate thyroprotein feeding.

Heart Rate Increased

Heart rate was closely associated with feed consumption and the metabolism level. When thyroprotein was fed and the cow consumed more feed, an increased heart rate resulted. An increase in the heart rate caused more blood to be pumped to all parts of the body including the udder, making possible the conversion of more nutrients into milk.

When a cow was in good condition at calving time, nutrients were taken from the body and converted into milk resulting in a normal loss in body weight during the period of heavy production. The feeding of thyroprotein during the declining phase of lactation increased milk production and demanded more feed nutrients for both milk production and maintenance of body weight. If a cow receiving thyroprotein and all the feed she will consume, loses more than 10 per cent of her body weight, the rate of thyroprotein feeding should be reduced or if necessary stopped.

Affect Longevity

Will speeded up metabolism tend to shorten the life span? Possibly. On the other hand, thyroid hormone secretion decreases with advancing age and there was evidence, in the case of chickens, that the maintenance of a uniform level through thyroprotein feeding prevented some of the senescent changes associated with advancing age. In any event, most cows are eliminated from dairy herds for economic, health, or other reasons before they are seven years of age, or one-half or less of what might otherwise be a normal life span. Any effect on longevity, while of interest scientifically, would then not seem important from a practical standpoint.

A Quantitative Study of the Precursors of the Constituents of Milk and the Energy Requirements of Milk Secretion (C. W. Turner, G. W. Pipes, R. A. Monroe, Syed Kamal, G. Kauffman, and L. Karroll). This study was a continuation of previous research. An investigation was conducted to gain an insight into the fate of thyroactive substances in the organism, with special reference to compounds administered preorally to the chick. The problems studied included the absorption of thyroidally active compounds fed to the

chick and the goat; excretion of thyroxine injected subcutaneously in the goat; the rate of disappearance of orally administered thyroxine in the chick; and the effect of several factors on the rate of disappearance of thyroxine in the chick.

In a study on the comparative oral effectiveness of crystalline D, L-thyroxine and its mono- and disodium salts it was found that male White Plymouth Rock chicks, three weeks of age, required 0.000074 per cent of the crystalline compound, 0.000035 per cent of the disodium salt of thyroxine in the feed to maintain the thyroids at a normal weight when thiouracil was fed. Comparable figures for the female chicks were 0.000078 per cent crystalline, 0.000036 per cent monosodium, and 0.000039 per cent disodium thyroxine, respectively.

On this basis, it was calculated that crystalline D, L-thyroxine was 20 per cent, and the salts 45 per cent, as effective orally as by subcutaneous injection in the form of the disodium salt of thyroxine.

In a similar study it was found that 0.009 per cent desiccated thyroid in the diet was sufficient to maintain normal thyroid weight in thiouracil-treated White Plymouth Rock chicks. This amount of desiccated thyroid is equivalent to about 2.5 micrograms D, L-thyroxine per 100-gram chick per day. Thus, it was concluded that desiccated thyroid is about equally as active preorally as parenterally.

Thyroprotein (iodinated casein, Protamone) was fed to goats and its absorbability calculated by comparing the crystalline D, L-thyroxine equivalents (relative activities) of the feed and the feces. On this basis, it was calculated that thyroprotein was absorbed to the extent of 78 to 88 per cent.

Only 1 per cent of the thyroxine injected could be accounted for in the feces during the period of ten daily injections, all of this amount being excreted during the second five days of injections. Even in the period following the cessation of thyroxine injections a calculated maximum of only 5 per cent of the amount injected could be accounted for via the fecal excretion route. No thyroidal activity could be detected in the feces of normal goats or in the urine of either the normal or injected goats.

The rate of disappearance of thyroxine in the female White Plymouth Rock chick was determined by the oral administration of crystalline D, L-thyroxine in sufficient amount to depress the thyroid weight of thiouracil-treated chicks below a normal weight and then measuring the length of time necessary for a return to normal thyroid weight under the influence of thiouracil alone. When thyroxine was fed at a level of 0.00015 per cent, return to normal occurred in approximately 2.5 days. Increasing the dosage level to 0.0002 per cent prolonged this duration time to 5 days. Higher dosage levels did not increase the duration time beyond this point until the 0.00125

per cent level was fed, when the return to normal was extended to 6.5 days. This increased duration time can be explained, however, by the possibility of toxic damage, resulting in a reduced capacity to dispose of the hormone, or by the fact that, due to the toxicity of this level of thyroxine, the dosage had to be increased gradually, with the result that thyroxine was fed to this group for three days longer than for other groups. The mechanism(s) for hormone disposal is probably one of destruction rather than simple excretion.

At the 0.00015 per cent level, thyroxine disappeared in half the time (2.5 days) in the female chick than was required for the male chick (5 days). At the 0.0002 per cent level, however, the duration time was 5 days for both sexes. These observations were taken to indicate that while the male chick can dispose of excess amounts of thyroxine equally as well as the females, the males do not normally use up the hormone as rapidly.

The administration of Vitamin A in massive amounts did not affect the rate of disappearance of thyroxine (0.00015 per cent level) in the female chick. Whatever the antagonistic effect of Vitamin A for the thyroid, as reported in the literature, it apparently is not through an effect in thyroxine metabolism.

Calcium pantothenate administration was found to hasten the disappearance of thyroxine. It was postulated that calcium pantothenate may exert its effect through an influence on acetylation reactions.

Niacin and thiamin hydrochloride were found to prolong the duration of action of thyroxine.

Neither riboflavin nor pyridoxine affected the rate of disappearance of thyroxine in the chick.

Thyroxine was found to aid in the regeneration of liver tissues. Other effects noted, although their significance is not clear, tend to indicate a correlation between thyroid and liver functions.

Thyroxine injected directly into the spleen showed no difference in duration time from thyroxine injected subcutaneously or intraperitoneally, indicating that no appreciable amount of thyroxine is destroyed in its first passage through the liver. Despite the above observations, it is felt that the liver plays an important part in the metabolism of thyroxine.

Groups of White Leghorn chicks fed Vitamin B₁₂ and fish meal supplements, respectively, in diets free of protein from animal sources, and hatched from hens on identical diets, were able to metabolize thyroxine more rapidly than were similar chicks without these supplements. The latter chicks also showed symptoms of thyrotoxicosis. Apparently Vitamin B₁₂ or the factor(s) in fish meal (possibly identical in this case) are necessary factors in the metabolism of thyroxine. Thyroprotein feeding in hens caused thyroid enlargement in their chicks. Moreover, this enlargement was accompanied by a decrease in metabolic rate.

Missouri Bulletin 446 "The Metabolism of Thyroxine," gives a report on this project.

The Endocrinology of Milk Secretion (C. W. Turner, R. A. Monroe, T. Y. Liu, and J. I. Raeside). Further research was made of the effect of hypothyroidism induced by the feeding of graded amounts of thiouracil and of mild hyperthyroidism induced by the feeding of thyroprotein upon the spermatogenesis of White Plymouth Rock cockerels and upon the endocrine activity of the interstitial tissue.

Thiouracil was fed at levels of 0.1, 0.3, and 0.6 per cent of a complete starter ration from one-day to 16 weeks of age. Groups of birds were examined starting at six weeks of age and at two week intervals. Body, testes, comb, thyroid, and pituitary weights were recorded.

The feeding of thiouracil at the 0.1 per cent level depressed the testis weight slightly up to 8 weeks of age following which period there was a marked reversal so that by the 14th week, the testes of the experimental birds exceeded the normals by about 10 times in weight. Histological examination indicated a slight precocious development of spermatogenesis during the period from 10 to 14 weeks of age. However, some of the spermatids showed defective attachment with the Sertoli cells and a few spermatids were sloughing off in clumps.

In contrast to the precocious spermatogenesis induced, the cells of Leydig showed delayed development from the 10th week on, but in place of normal interstitial tissue the presence of increased intercell fluid was observed. Depression of the endocrine activity of the cells of Leydig was indicated by the reduced rate of comb growth in these birds.

The feeding of thiouracil at the higher levels reduced body growth more drastically. The marked increase in testis weight was not observed, but on a body weight basis the experimental birds exceeded the normals. Spermatogenesis was in progress but there was considerable disorganization of the process with spermatids frequently sloughing off into the lumen of the tubules which appeared to contain an abnormal amount of fluid. The cells of Leydig were abnormal in appearance and non-functional as indicated by the lack of comb growth and birefringent crystals in the interstitial tissue zone.

When 12-week-old cockerels were fed 0.3% thiouracil in the feed for a period of 4 weeks, the testes and comb weights were reduced. However, spermatogenesis was not delayed.

The feeding of 0.04% thyroprotein with the above amount of thiouracil stimulated above average growth of the testes and combs and precocious spermatogenesis.

When 20 mg. testosterone per kg. feed was added to the thiouracil ration, the testis weight was about normal, but histological examination showed retardation in spermatogenesis.

These observations indicated that the hypothyroidism induced by the feeding of graded amounts of thiouracil up to 0.6% was without effect upon the secretion of the pituitary gonadotrophic hormone FSH (Follicle stimulating hormone) but progressively depressed the secretion of ICSH (Interstitial cell stimulating hormone).

Hyperthyroidism was induced by the feeding of thyroprotein at levels of 0.04 and 0.08% of the ration from one day until 14 weeks of age. At the 0.04% level there was slightly faster growth in the 8 and 10-week-old groups but the 12 and 14-week-old groups were about the same as the controls. While spermatogenesis proceeded at approximately a normal rate the average comb weight of each group throughout the experiment was markedly increased over their control group indicating that the rate of secretion of male hormone was increased. At the 0.08% thyroprotein level slight stimulation of spermatogenesis was observed associated with marked stimulation of comb growth.

It would appear that mild hyperthyroidism in cockerels has only a slight stimulating effect upon the secretion of FSH by the pituitary but has a more pronounced effect upon the secretion of ICSH.

Considering the overall influence of the thyroid hormone upon the secretion of the gonadotrophic hormones in cockerels, these data indicate only slight influence upon the secretion of FSH but very marked influence upon the secretion of ICSH. The favorable influence of the thyroid hormone appears to be due chiefly to the stimulation of increased secretion of male hormone which acts upon the final stages of spermatogenesis.

Effect of Androgens

It was observed that the administration of the male hormone, testosterone, at 10 mg. per kg. feed or more, depressed the secretion of FSH. Without the support of this hormone, the secondary and primary spermatocytes involuted, leaving only the spermatogonium.

The administration of lower levels of male hormone in cockerels eight weeks old or less was ineffective, but when the secondary spermatocytes have developed in the 10-week-old birds, then the administration of the male hormone stimulated a marked increase in testis weight due to the stimulation of an increase in spermatid formation.

It was concluded that the gonadotrophic hormone, FSH, was essential for the growth of the primary spermatocytes and the meiotic or reduction division involved in the production of secondary spermatocytes. When this stage was reached, the male hormone normally secreted by the interstitial cells of Leydig played a role in the transformation of the secondary spermatocytes into spermatids.

Thyroprotein-feeding to 7-year-old Hens

A group of 13 White Leghorn hens in their seventh laying year were continued on a ration containing 10 gm. of thyroprotein per 100 lbs. of feed. The seven surviving hens laid an average of 67.7 eggs during the year as compared to 116.3 eggs laid the previous year.

In comparison were a group of 8 control hens of similar age. Only three hens survived the year and laid an average of 39.3 eggs. If two hens which died May 1, and September 22, 1948 are included, the average production of the five hens was 31.6 eggs. The 39.3 eggs laid by the control hens was 58.1 per cent of the 67.7 eggs laid by the thyroprotein-fed hens.

The average body weight of the controls was 5.9 pounds as compared with 5.0 pounds for the experimental group.

It was concluded that if the maintenance of a mild hyperthyroid condition as a result of the continued feeding of thyroprotein were a serious factor in limiting the life span of fowls, it should have begun to show itself before this time.

Nutritional Studies on Growth and Milk Production (H. A. Herman, O. T. Stallcup, A. C. Ragsdale, J. W. Cobble, J. H. Edmondson, C. P. Merilan, G. W. Graham, K. L. Tallman, and G. W. Harlan). Research was continued on raising dairy heifers on the maximum roughage with varying amounts of gain. These studies showed that dairy heifers of normal body weight and size can be reared from 6 months to 24 months of age with not more than 900 pounds of grain concentrates provided that good roughage and pasture were provided in abundance.

The growth and feed consumption of 14 Jersey and 36 Holstein heifers raised on a maximum roughage feeding program between 6 and 24 months of age was recorded. Both non-legume and legume hays provided the dry roughage and silage was fed in varying amounts. Pasture was utilized from 262 to 334 days during the 6 to 24 month period of all heifers. They were raised on low, intermediate, and very high planes of nutrition.

Although the mean body weight of all groups was slightly below normal standards at age 24 months, the height at withers was only slightly below normal for all groups and the circumference of the chest was slightly above normal in the first group and slightly below normal in the other groups. A fourth group of heifers fed on hay, silage, pasture, and a mixture of steamed bone meal and salt from 15 to 24 months of age were slightly below normal in weight at age 24 months. None of the deviations from normal were statistically significant.

Normal growth was secured where approximately 55 per cent of the total crude protein and digestible nutrients were secured from pasture. A complete report on this work will be found in Missouri Experiment Station Bulletin 523, "The Growth of Dairy Heifers Raised Chiefly on Roughages."

The Influence of Diet on Growth, Lactation, and Reproduction in Dairy Heifers

In a continuation of studies begun over 10 years ago a total of approximately 50 Holstein heifers have been raised on low, intermediate, and very high planes of nutrition. The objective of this study was to compare the economy of rapid growth with normal growth rates and the subsequent effects on lactation and reproduction.

It has been found that heifers grown very rapidly (20 to 30 per cent above normal) are 5 to 30 per cent heavier in body weight, from 5 to 10 per cent larger in skeletal growth, and may be bred from 3 to 5 months earlier than usual. However, such heifers are more expensive to raise from a feed cost standpoint and produced no better the first lactation than heifers raised mostly on roughages after 8 to 9 months of age.

The heifers raised on an intermediate or more normal plane of nutrition with whole milk and skim milk fed the first few months after birth, adequate grain and roughage to 6 months, and from 6 to 24 months largely on roughages with normal grain consumption were the most satisfactory producers. They were likewise the most economical in growth cost when total nutrients and time involved in growth are considered.

Limited Whole Milk Feeding Plan

The trend in milk marketing in Missouri is away from maximum cream production and less skim milk is available on farms for calf raising purposes than was true 10 years ago. Hence, the "limited whole-milk-dry calf starter" plan of raising calves is becoming more useful.

In order to measure the economy of growth and general thriftiness of calves raised by the two plans a group of 13 heifers were fed whole milk 21 to 30 days and skim milk thereafter to 4 to 6 months of age. A like number of heifers were fed whole milk 6 to 8 weeks of age and thereafter a dry concentrate "calf starter" ration containing 18.6 per cent crude protein. The skim milk group received grain supplement. Both groups were fed fine leafy legume hay. At 6 months the calves fed on the limited whole milk, were below normal weight standards, while the skim milk group averaged 5.2 pounds heavier than normal. There was no significant difference in skeletal development of the two groups, but the skim milk group had a sleeker hair coat.

At 12, 18, and 24 months of age there were no significant differences in the body size of the two groups and at freshening time the groups were comparable in every respect. The limited whole milk feeding plan saved an average of 346 pounds of whole milk and 2186 pounds of skim milk per calf. However, this saving was offset to some extent by an average greater grain consumption of 101 pounds and 121 pounds more hay than the average heifer in the skim milk fed group.

The Site of Conversion of Carotene to Vitamin A In the Dairy Calf

As a result of studies on the site of conversion of carotene to Vitamin A in dairy calves, which were conducted by *in vitro* studies on 10 calves it was concluded that both the intestinal wall and liver were capable (probably by enzymatic action) of converting colloidal carotene to Vitamin A in the calf, but that such a conversion was not a function of blood plasma.

Sections of intestine, and minced liver tissue, collected from Vitamin A depleted calves were incubated in a colloidal carotene solution of known standards. In 8 or 9 calves studied the intestinal wall was found to be the site of conversion of carotene to Vitamin A. Likewise the incubation of minced liver tissues from 10 calves (4 Jersey, 3 Guernsey, and 3 Holstein) showed the liver capable of converting carotene to Vitamin A.

The incubation of blood plasma revealed that carotene was not converted to Vitamin A in this medium.

Losses of Carotenoids and Tocopherols in Hays and Silage During Storage

Studies were made on the losses of carotenoids and tocopherols in hays and silage during storage, especially to see if tocopherols reduced the losses of carotene and Vitamin A.

After a 6 month storage period the micrograms of carotenoids per gram of air dry material were as follows: alfalfa silage 47.4, 1st cutting alfalfa hay 10.1, 2nd cutting alfalfa hay 13.9, 1st cutting red clover hay 7.0, 2nd cutting red clover 8.0, early cut Korean lespedeza hay 35.1 and late cut Korean lespedeza hay 23.0

Tocopherols in hays were lost in storage in amounts of the same order as carotenoids. Red clover hays were higher than alfalfa hays, and alfalfa hays higher than lespedeza hays in this substance. Tocopherols did not appear to prevent the loss of carotenoids in hays during storage.

The Effect of Environmental Temperatures on the Composition of Milk

The effect of environmental temperature on the solids-not-fat content and the chemical composition of milk was studied on 42 cows maintained under varying temperatures (105° F. to 4° F.) in the "climatic laboratory." Over 3200 samples of milk were collected and analyzed for percentage of solids-not-fat, butterfat, lactose, chlorides, and total nitrogen. Changes in the freezing point were also measured.

Under the conditions of this experiment, as the temperatures increased above 80 to 85° F., there was a tendency for slightly lower solids-not-fat, the percentage of butterfat increased, milk production was lowered, lactose and nitrogen levels decreased, and the chloride content increased.

Where lower temperatures (0 to 50° F.) prevailed the percentage of butterfat increased and there was a slight decrease in total milk production, but in general, the composition of the milk remained more stable than under conditions of high temperatures.

Mastitis

This study covered a 10-year investigation of the incidence, causative organisms, reliability of diagnostic tests, and effectiveness of various therapeutic measures in mastitis control in the Missouri Station dairy herd.

The most commonly found organism was *S. agalactiae* and the Hotis test and the microscopic examination of the milk proved to be the most reliable diagnostic test. It was found that penicillin, sulfanilamide, and tyrothricin administered as udder infusions were about 70 to 80 per cent effective in freeing the udder of *S. agalactiae*. About 38 per cent of all infected quarters made "natural recovery" whether treated or untreated.

The results have been summarized in Research Bulletin 454, "The Reliability of Various Diagnostic Tests and the Efficiency of Certain Therapeutic Measures in Control of Mastitis."

Additional studies have been made on 3 cows (11 quarters) using aureomycin ointment and 3 cows (8 quarters) using penicillin ointment. In no case did the infected quarters appear to be free of mastitic organisms and remain negative over a two-week period following treatment.

The Effect of Environmental Temperature on the Incidence of Mastitis

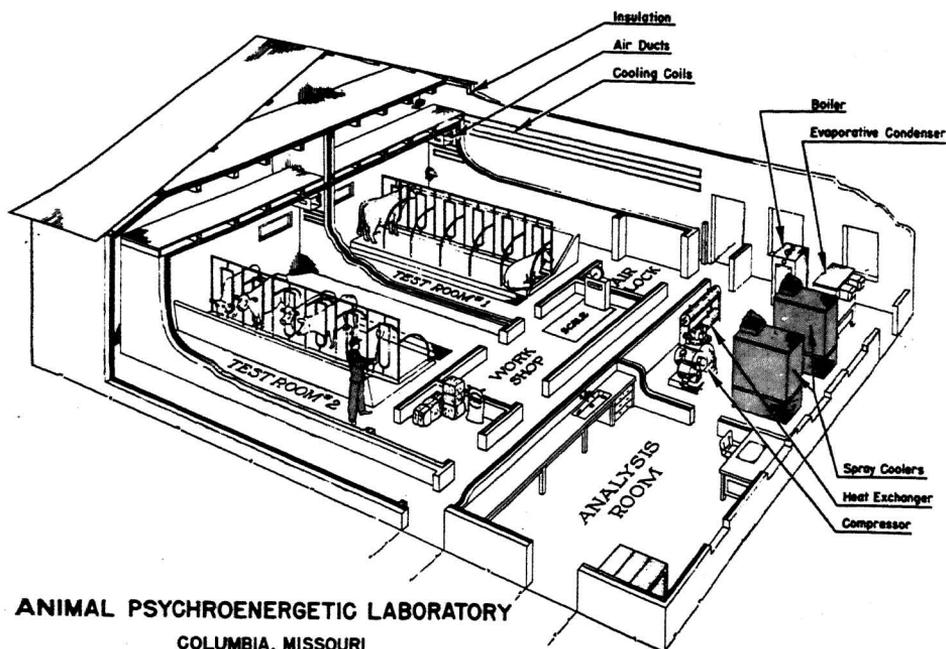
A study of the incidence of mastitis in 11 cows maintained at varying temperatures over a 3 month period was made. Six of the cows (2 Holsteins, 2 Jerseys, and 2 Brahman) were housed in an experimental chamber of the "climatic laboratory" in which the temperature was increased from 50° F. to 105° F. by 5° intervals at weekly stages while five cows served as controls and were maintained at a uniform temperature of 50° F.

Milk samples were examined for mastitis at each temperature level, and total bacteria count as well as the type of organisms present was studied.

The Brahman cows were found to consistently produce milk with a lower bacteria count than the other breeds. No significant relationship between environmental temperature and the incidence of mastitis was established.

Periodic tests for mastitis have been made on the entire milking herd in an effort to determine possible relationships between udder injuries and infections and the histamine content of the milk as a means of early diagnosis of mastitis.

Influence of Climatic Factors on Productivity and Physiological Reactions of Farm Animals With Specific Reference to Dairy Cattle (Samuel Brody, H. H. Kibler, A. C. Ragsdale, C. R. Blincoe, Gloria Burge, Orley Miller, M. M. Jones and Assistants; H. J. Thompson, D. M. Worstell and Associates)—This is a continuation of previous research and Indian (Brahma) cows and Brown Swiss cows were added to the experiment.



ANIMAL PSYCHROENERGETIC LABORATORY
COLUMBIA, MISSOURI

Experiments to determine the influence of climatic factors on productivity of dairy cattle were carried on in this laboratory during the year.

Thermoneutrality—the temperature zone in which animals are most comfortable and produce maximally—was found to be between 40 and 60° F. for European (Jersey and Holstein) lactating cows. The rate of decline in milk yield and increase in *heat stress* with increasing environmental temperature *above thermoneutrality* is very much greater than the rate of decline in milk yield and increase in *cold stress below thermoneutrality*. In fact, the cows did not show serious stress, and produced fairly satisfactorily near 0° F., but they began to suffer serious heat stress and rapid decline in milk production and feed consumption on increasing air temperature above 80° F.

The zone of thermoneutrality for Indian (Brahma) cows reached out to much higher environmental temperatures, perhaps to 80° F. instead of 60° F. and serious heat stress was not attained until 90° or even 95° F. For instance, under the conditions of this experiment appreciable changes occurred at the following temperatures: *rectal temperature*, 75° F. in European and 95° F. in Indian cows; *pulse rate*, 85° in European and 95° F. in Indian; *respiration rate*, 65° F. in European and 80° F. in Indian; *hay consumption*, 75° F. in European and 85° F. in Indian. The water consumption above 85° F. increased in the Indian cows and in Jersey cow No. 212, but decreased

in the other Jersey and Holstein cows. While rising temperatures above thermoneutrality profoundly affected the physiological reactions of the cows, declining temperatures below thermoneutrality to about 0° F., increased the heat production about 30 per cent (more in small than large cows and more in the Indian than European cows), but did not affect rectal temperature and but slightly increased the pulse rate and decreased the respiration rate. Blood analysis likewise showed no appreciable changes below thermoneutrality but considerable changes, especially in creatinine and cholesterol, above thermoneutrality.

While *rectal* temperature showed no change between 0° and 70° F. environmental temperature, *skin* temperature showed profound changes. The *skin* (under the hair) of *Jersey* cows increased from about 75° F. at 0° F. air temperature, to 93° F. at 70° F. air temperature, and to 105° F. at 105° F. air temperature; of *Holstein* cows from about 80° F. at 0° F. air temperature, to 93° F. at 70° F. air temperature, and 105° F. at 105° F. air temperature. The *hair* surface temperature (measured with the Hardy radiometer) increased in both breeds from about 50° F. at 0° F. air temperature, to 90° F. at 70° F. air temperature, and to 105° F. at 105° F. air temperature. In the absence of fever, man's skin temperature does not increase above about 94° F. because of the compensatory effect of increasing sweating rate in man but not in cows. Man breaks out in a sweat at about 84° F., but cows do not.

The moisture vaporization rate is proportional to surface area, not to body weight; that is, per 1000 lbs. live weight, small animals (*Jersey*) vaporize more moisture than large animals (*Holstein*).

The greatest changes in blood composition occurred in creatinine (rise with increasing temperature) and cholesterol (decline with increasing temperature). Other blood constituents showed minor trends. There was considerable individuality in the blood pictures of the cows.

Unlike man—a sweating species—whose rectal temperature, respiration rate, and “resting” metabolism are not affected by changes in temperature from 60 to 105° F., these cows were profoundly affected by these changes in temperature; the rectal temperature rose from the original 101° F. to 106° F. (*Jerseys*) and 108° F. (*Holsteins*); the respiration rate increased 300 to 400 per cent in *Holsteins* and over 500 per cent in *Jerseys*; with some exceptions, the pulse rate declined at the 95° F. to 75 per cent of the 50° F. level, and at temperatures above 95° F. it continued to fall in *Jerseys*, but rose in *Holsteins*; the heat production declined—while the rectal temperature increased—to 60 to 70 per cent of the 50° F. level (in man the heat production rises with rising rectal temperature).

The greater the water consumption (the temperature of the water was about 60° F.) the less the rise in rectal temperature and the less the depression of milk production and feed consumption.

Lowering of temperature from 50° to 4° F. increased feed consumption and butterfat percentage, but decreased somewhat the milk yield. Increasing temperatures from 80° to 95° F. depressed milk production, feed consumption, and body weight.

The optimal temperature zone—quantity and efficiency—for milk production appears to be not far from 50° F., a statement that has to be substantiated. The critical high temperature is apparently 80° F.; whereas, no critical low temperature is evident, a gradual effect was observed. Rising temperatures are more detrimental to the Holstein cows and declining temperatures to Jersey cows. The effect of lowering temperatures below 50° F. is much less for both breeds than the effect of rising temperatures above 50° F.

The ratio curves of heat dissipation by evaporation to heat production in cow and man cross at 92° F. ambient temperature when about 75 per cent of the heat production is dissipated by vaporization. The ratio of heat dissipation by vaporization to heat production becomes unity (100 per cent) at ambient temperature 94° F. in man and about 102° F. in cows. Prior to about 90° F., the heat dissipation by vaporization in cattle is higher than in man (at 80° F., cows dissipate by vaporization 70 per cent of the heat produced, but man dissipates by vaporization only 25 per cent of the heat production; at 70° F., man dissipates about 18 per cent and cows 50 per cent of the heat produced).

Cows were affected by these temperature differences where man—a sweating species—was not. These differences were undoubtedly associated with differences in evaporative cooling. In man about two-thirds of the moisture vaporization in hot weather is from the skin and one-third from the respiratory passages. This partition of evaporative cooling has not yet been determined in cows, but judging by their apparently dry and hot skin (as contrasted to man's damp and cool skin) and by their panting in hot weather, the vaporization from the skin in cows is relatively slight, not sufficient to keep down the rectal temperature.

The increase in rectal temperature and respiration rate in cows is no surprise; this was long known from practical experience and from the reports of Kleiber, Regan, and associates. The big surprise of this study is the decline in heat production—a 30 to 40 per cent decline with increase in room temperature from 80 to 100° F., or with increase in rectal temperature from about 101° F. to about 106° F. This is most unexpected because: (1) it contradicts the van't Hoff-Arrhenius rule to the effect that increasing the temperature of a physico-chemical system increases its reaction rate; (2) it runs counter to the observations of McConnell that increasing man's rectal temperature from the normal 98° to 102° F. (by a hot environment) more than doubles the rate of heat production (raises it from 35 to 75 Cal./sq.m./-

hr.); and of DuBois *et al.*, that a rectal temperature in man of 104° F., associated with many categories of "fever," increases the metabolism about 40 per cent.

How should one explain this decrease in heat production in cows with increasing rectal temperature? First, there is rapid decline above 80° F. in feed consumption and milk production with consequent decline in their heat increments, which may amount to 25 per cent of the total heat production: second, as demonstrated by Dempsey and Astwood, increasing environmental temperature profoundly depresses thyroxine production, at least in the rat (a non-sweating species).

The decline and eventual elimination of the heat increments of feeding, milking, and thyroid activity with increasing temperature seem to account fully for the decline in heat production with increasing rectal temperature. In other words, feed consumption, milk production, and thyroid activity function within the given limits as mechanisms of body temperature regulation; that is, increasing difficulty in heat elimination with increasing temperature automatically reduces the rate of heat production.

This is a cooperative project between the departments of Dairy Husbandry and Agricultural Engineering of the Missouri Agricultural Experiment Station, and the United States Department of Agriculture, Bureaus of Plant Industry; Soils and Agricultural Engineering; Animal Industry and Dairy Industry.

An open-circuit apparatus (mask type) was developed for measuring the respiratory exchange (O_2 , CO_2 , CH_4 , H_2O vapor).

Respiratory exchange data were obtained by open- and closed-circuit methods at various chamber temperatures ranging from 50° to 105° F.; simultaneous measurements were also made of rectal temperature, respiration rate, pulse rate, tidal air, and pulmonary ventilation.

ENTOMOLOGY

LEONARD HASEMAN, *Chairman*

Influence of Soil Minerals on Insects (Leonard Haseman, Philip C. Stone, and Harry E. Brown). This investigation was a study of the influence of the major soil minerals and other plant nutrients on the well-being of various insect pests of field crops and garden crops. The experiment has been designed to endeavor to control insect pests by using properly formulated crop fertilizers in place of some of our present powerful insecticides.

Black Cricket Feeding Experiments

A number of cricket rearing experiments have been in progress in which they were fed lettuce, cerophyl, commercial alfalfa meal, and ground alfalfa. The ground alfalfa was supplied by the Soils Department and had been grown on nine different soil plots which had been supplied with varying amounts of the different soil minerals. The initial results showed a striking difference in weight and size of the adult insects as well as the length of time required

to reach the adult stage. These experiments are being continued and will include a variety of mixtures of known chemical composition and a study is being made of the influence that the ground alfalfa diet may have on the fecundity and the progeny of the test crickets.

Fertilizer Test on Garden Insects

An insect test garden was established on the University South Farm to study the influence of fertilizers on the insects attacking the cabbage, cauliflower, eggplant, potato, tomato, and sweet corn. All of the common insects which normally attack these plants were quite abundant in this garden except the Colorado potato beetle which has been scarce in the Columbia area for the last two years. Some of the insects attacking cabbage and corn were less abundant on certain fertilizer plots than on others.

Although no insecticides were to be used in this garden, the potatoes and eggplants were treated twice with DDT to prevent the flea beetles from completely killing them before they had a chance to get started. Both of these varieties of plants were severely infested with native insects and the potato plants were all killed by leaf hoppers and tipburn before they made a good crop. Although the solanum plants, with the exception of the tomato, were heavily infested by native insects some of them had much less damage on a part of the randomized fertilizer plots.

Some work has been reported on soil mineral test with cabbage aphids. However, further work with aphids must be done before a definite conclusion can be made on how they respond to different levels of the soil minerals.

Control of Flies on Dairy Animals and in Dairy Barns (Leonard Haseman; Philip C. Stone, Curtis W. Wingo and Roland W. Portman). In cooperation with the division of insects affecting man and animals of the Bureau of Entomology and Plant Quarantine, a series of experiments were carried out from June 1 to September 1 to determine the effectiveness of four of the newer insecticides against horn flies on dairy cattle and house flies in dairy barns. These studies were made in an effort to find an effective substitute for DDT (dichlorodiphenyl dichlormethane) which is no longer approved for use on milking animals and in dairy barns.

Eight commercial herds were treated and included about 320 cattle and all barns and nearby outbuildings on the farms. The results on the dairy herds show that residual protection against horn flies lasted an average of 14.9 days with a 0.5% methoxychlor spray; 16.9 days with a 0.5% toxaphene (chlorinated camphene) spray; 7.9 days with 0.025% lindane (pure gamma isomer of hexachlorocyclohexane) spray and 4 days with a spray of pyrethrum-piperonyl butoxide (1 to 10 emulsifiable concentrate "Pyrenone") 0.1% pyrethrins plus 1.0% piperonyl butoxide.

In the dairy barns residual protection against the house fly lasted an average of 8.7 days with 1.0% methoxychlor spray, 24.5 days with 1.0% toxaphene spray; 22.8 days with 0.25% lindane spray and 6.5 days with a spray of

pyrethrum-piperonyl butoxide (1 to 10 emulsifiable concentrate "Pyrenone") 0.1% pyrethrins plus 1.0% piperonyl butoxide.

These results showed clearly that none of these materials were as effective as DDT in controlling blood sucking flies on animals or in controlling flies in dairy barns. However, spraying every two weeks with Methoxychlor, one of the most effective new insecticides, which is approved for use on milking animals, proved to be satisfactory. It is to be hoped, however, that with care in protecting feed and feeding and watering troughs it may eventually be found that DDT can safely be used in dairy barns when the animals are out on pasture or in the lot.

The Departments of Entomology and Dairy Husbandry, in cooperation with one of the insecticide manufacturers, ran an experiment to see if it is possible to spray the interior of dairy barns with DDT for controlling flies without having any DDT later appearing in milk from cows housed in the barn. These tests indicated that, when the feed and feeding and watering troughs are properly protected from contamination, DDT will not appear in the milk later.

Biology and Control of the Hessian Fly, Corn Earworm and European Corn Borer (Harry E. Brown, Philip C. Stone, and Leonard Haseman).

Hessian Fly

Studies on this insect included (a) standard stubble survey, (b) establishment of a fly nursery for the study of wheat resistance to fly and (c) some preliminary studies on insecticide control.

The population survey was made in the usual manner in cooperation with the Bureau of Entomology and Plant Quarantine. Stubble samples were collected from 59 counties, taken from all parts of the state, and fly flaxseed (egg) counts were made during July. The results of this survey briefly summarized showed.

Northwest counties had a maximum average of 20 flaxseeds per 100 stubbles.

West Central counties had a maximum average of 35 flaxseeds per 100 stubbles.

Southwest counties had a maximum average of 29 flaxseeds per 100 stubbles.

Northeast counties had a maximum average of 19 flaxseeds per 100 stubbles.

East Central counties had a maximum average of 32 flaxseeds per 100 stubbles.

Southeast counties had a maximum average of 2 flaxseeds per 100 stubbles.

From these data it may be seen that there was a fair sprinkling of Hessian fly over all Missouri in the fall of 1949 and that favorable conditions for the fly and failure of communities to observe the "fly free date" might result in serious infestations.

During the summer of 1949, in cooperation with the Field Crops Department and the United States Department of Agriculture, the Hessian fly resistance study nursery was moved from Springfield, Missouri, where it had been located for over thirty years, to Columbia.

Preliminary studies to determine whether or not insecticides offered any promise for use in the control of Hessian fly were undertaken. Clarkan wheat was planted very early (September) and heavily infested stubble was brought in and distributed over the plots so as to insure a heavy fall infestation of fly.

As soon as the wheat was well up, two sprays of toxaphene (chlorinated camphene) and chlordan (1, 2, 4, 5, 6, 7, 8, 8-octachloro-4, 7-methano-3a, 4, 7, 7, a-tetra-hydroindane and related active compounds) were applied to small test plots. On October 8, after most of the flies had disappeared, counts were made to see what effect the insecticides had had on the fall infestation with the following results:

HESSIAN FLY—INSECTICIDE TESTS

Treatment	Number of Plants in Sample	Number Plants Infested	Average No. of Maggots per Plant
Control	36	35	5.0
Toxaphene	20	6	.9
Chlordan	20	6	.5

The insecticides plainly reduced the infestation of Hessian fly materially, but large amounts of material were required (8 pounds per acre) to get the results attained. There are still many points which require further attention in this study such as timing, rate of application, etc., and this research will be continued.

Corn Earworm

During the summer of 1949 the entomology department began testing the use of the chlorinated hydrocarbon mineral oil emulsion applied as a spray for the control of corn earworm. Research workers soon realized that they had had the most satisfactory and practical control for the earworm in corn that they had ever experienced.

The following table gives a set of typical results from one of the tests:

CONTROL OF EARWORM ON MARCROSS SWEET CORN DDT—MINERAL OIL EMULSION

Number of Sprays	Percentage Infested	Percentage Clean
1	27	73
2	0	100
None	100	0

European Corn Borer

During 1949 the European corn borer made very substantial gains in population in the northern counties of Missouri. The following table records 18 counties for which survey data is available for both the years 1948 and 1949 and shows plainly this build-up.

European corn borer abundance in Missouri corn, fall of 1949, compared with data for 1948:

County	Average number of borers per 100 plants		County	Average number of borers per 100 plants	
	1948	1949		1948	1949
Adair	22	58	Marion	29	170
Atchison	23	136	Mercer	19	199
Clark	31	125	Montgomery	48	56
Clay	7	80	Nodaway	26	145
Gentry	20	360	Platte	6	114
Grundy	28	145	Ralls	11	63
Knox	0	32	Ray	19	84
Lewis	37	101	Warren	8	0
Livingston	12	150	Worth	0	237

In all but one of these counties the 1949 population showed an increase over those recorded in 1948. The average number of borers per 100 plants in these 18 counties for 1948 was 22, while the average for the same 18 counties jumped to 129 in 1949, an increase in numbers of almost six times.

Even with these gains the European corn borer continued to be of but small importance as a corn insect in Missouri except in a few northern counties, and, in these most heavily infested counties, it is still in too low numbers to justify recommending insecticide control measures. Missouri producers, however, should begin to utilize such control measures as sanitation, spring plow-down of stalk refuse, and avoidance of excessively early or late planting which helps to keep borer numbers as low as possible without resorting to expensive chemical control.

During the 1949 season, additional releases of parasites were made in St. Louis County, continuing the work started in 1947 in cooperation with the Bureau of Entomology and Plant Quarantine. Investigations are being completed using parasitic flies and wasps as a natural control of the borer. These insects attack the borer during the summer and as it harbors over the winter in the larva stage. Both insects show promise of helping control the borer. Further investigation is necessary.

Codling Moth and Other Fruit and Vegetable Pests (Lee Jenkins, Wilbur R. Enns, and George W. Thomas). This research was a continuation of work on insects and their control. Fruit insect problems during the 1949 season were very similar to the previous season except that some insects were more numerous. These insects were the plum curculio, red-banded leaf roller and Forbes scale on apples. There was some damage to peaches by the red-banded leaf roller.

Mealy bugs were reported on grapes in Missouri for the first time and there was some indication that DDT in the grape spray program might be causing a build-up of grape scale.

Apple Insects

The plum curculio was very destructive to apples during July and August in some orchards where no insecticide was used for its control in the calyx and first two cover sprays. Fruit growers who used lead arsenate in the calyx and first two cover sprays avoided serious injury from curculio. Methoxychlor gave better control than lead arsenate but caused some russetting on Golden Delicious when applied in the calyx spray.

The red-banded leaf roller was controlled most effectively by the use of TDE (1, 1-Dichloro-2, 2-bis [p-chlorophenyl] ethane) either as a wettable powder or as a 25% emulsion. The emulsion was the more effective and less expensive than the wettable powder per 100 gallons of spray. Parathion and toxaphene were somewhat less effective than TDE.

Forbes scale was controlled by two or three summer applications of $\frac{3}{4}$ pounds of 15% wettable parathion per 100 gallons and was more effective than a dormant oil spray. Summer oil at $\frac{3}{4}$ per cent was not as effective as the parathion. DN-289 (Triethanol amine salt of dinitro-o-sec-butyl phenol) gave better control as a dormant at 2 quarts per 100 gallons than a 2% dormant oil.

Mites were controlled by the use of $\frac{3}{4}$ to $1\frac{1}{4}$ pounds on DN-111 (Dinitro-cyclohexylphenol, dicyclohexyl amine salt) per 100 gallons applied when the mites appeared. Parathion at $\frac{1}{2}$ pound of 15% wettable powder per 100 gallons was about the same as DN-111 as listed above.

A new material known as EPN (Ethyl p-nitrophenyl thionobenzene phosphonate) gave about the same mite control as parathion.

Karathane and Aramite (B-chloroethyl-B- (p. tert. butyl phenoxy) L-methyl ethyl sulfite), two newer materials, also gave promising results for mite control.

Extensive experiments were conducted to perfect a general purpose spray, suitable for all fruits grown in the small home orchard. Two satisfactory formulations were developed. The work, results, and recommendations are given in detail in Missouri Station Bulletin 530, "General-Purpose Sprays for Home Fruit Plantings."

Peach Insects

Experiments were continued on peach insect control in southeast Missouri. The principal pest was the plum curculio so most of the tests were aimed at the control of this one insect but included observations on cat-facing insects and the Oriental fruit moth.

In tests at Cape Girardeau four insecticides were used and found to be effective in the following order: BHC (benzene hexachloride (6% gamma), methoxychlor, toxaphene, and lindane. In tests at Campbell two insecticides were compared with BHC. Results indicate parathion was equal to BHC and toxaphene was also effective but too slow to prevent "stinging" of fruit by curculios. Lead arsenate proved to be inferior to all the insecticides above and its use resulted in arsenical injury to the foliage. DN-111 and parathion were equally effective in controlling mites on peach trees at Campbell.

At Turner Station, benzene hexachloride and chlordane were tested for peach tree borer control used in fall applications to trunks and ground around the peach trees. BHC (6% gamma isomer) at 20 pounds to 100 gallons of water was highly effective and the odor was still markedly present six months after application. Chlordane, 1 gallon of 48% emulsion to 100 gallons of water also was effective. Check trees showed 56 borers present in 5 trees; the chlordane-treated block had 1 borer per 5 trees; and the BHC block showed no borers in 10 trees.

Grape Insects

Due to rather serious damage caused by the grape berry moth (*Polychrosis viteana* Clem) in 1948 to grapes in the Concord areas around Rosati, Missouri, arrangements were made to conduct insecticidal experiments on about two acres of Concord grapes owned by Joe H. Piazza, Rosati, Missouri.

The three insecticides tested were: (1) DDT applied at the rate of 1½ pounds per 100 gallons, (2) Methoxychlor applied at the rate of 1½ pounds per 100 gallons, and (3) Lead arsenate applied at the rate of 3 pounds per 100 gallons. Each block received four applications beginning April 28 and repeated May 11, May 27 and June 17. Results were checked at the beginning of harvest on August 29. The results were calculated on the percentage of injury and were as follows: DDT—2.2%; Methoxychlor—3.2%; Lead arsenate—1.7%. The blocks receiving the lead arsenate were also moderately damaged by the grape leaf-hopper. As harvest continued, the damage by the berry moth increased greatly as the fourth brood larvae began feeding on the ripe berries at this time. Damage ran as high as 17% in some few vineyards. With this observation, it was evident that four or five sprays, as was then recommended, were not sufficient to control this pest. The "Suggested 1950 Grape Spray Programs" recommended the application of a sixth and seventh spray for the control of this pest.

The appearance of a grape mealy-bug, for the first time in Missouri, in the vineyards at Campbell and at Mountain Grove, was discovered in September. This insect practically ruined the grapes for table use due to the presence of a sooty mold that develops on the excrement of this pest. Control investigations of this insect have been started.

Strawberry Insects

Tests at Monett indicated toxaphene was effective in controlling cutworms and tarnished plant bugs in strawberries. DDT was more effective than toxaphene for tarnished plant bug control but not satisfactory for cutworm control. Tests at other places indicated chlordane was very effective for strawberry weevil control and TDE was effective for strawberry leaf roller control. Chlordane also effectively controls crickets.

Vegetable Insects

Five insecticides were tested at Campbell for insecticidal efficiency on snap beans. They included CPR dust (a pryenone compound), methoxychlor spray, "Hydronox" (a hydrogenated rotenone) spray, cryolite dust, and toxaphene dust. Of these, methoxychlor, CPR, and toxaphene were satisfactory. The Hydronox and cryolite were much inferior, hardly better than an untreated check, and caused some injury to the plants.

A dust diluent containing a phosphorus fertilizer was used in formulating the toxaphene dust. It proved to be satisfactory and shows promise for its fertilizer value.

In informal tests at Columbia, parathion, "Pycrocel" (a pyrethrum compound), piperonyl cyclonene, and piperonyl butoxide, the two latter containing also certain fractions of pyrethrum and rotenone, were found to be non-toxic to vegetable crops such as eggplant, tomato, cabbage, kale, broccoli, and peppers. Results were inconclusive on their insecticidal effectiveness except that parathion was highly effective for aphid control.

Injurious Insect Pests of Melons and Related Crops (W. R. Enns, L. Hase-man, and L. Jenkins). This project was a continuation of previous research on insect control on melons and related crops and various plots of cucurbits were laid out in the Campbell, Missouri, fields on which controlled insecticides tests were run. Separate blocks consisted of (1) watermelons, (2) cantaloupes, (3) cucumbers and (4) squash. Objectives included (a) to determine insecticidal efficiency of the sixteen materials available and (b) to determine the phytotoxic effects of those materials.

The following materials and combinations of materials were tested: parathion, cryolite, rotenone, pyrethrum, aerosol grade DDT, lindane, piperonyl cyclonene plus pyrethrum plus rotenone, methoxychlor, chlordan, toxaphene, DDT, and three combinations consisting of parathion plus methoxychlor, lindane plus methoxychlor, and toxaphene plus lindane. All plots received the same fungicides, namely, zinc dimethyldithiocarbamate.

All insecticides were effective to some degree but ordinary DDT, toxaphene, and chlordan were too phytotoxic for further experimentation. These three killed the plants outright or so stunted them as to eliminate the production of a crop. The aerosol, or purified, grade of DDT, however, was among the least phytotoxic and most effective. Parathion proved to be very effective in low concentrations but it is too hazardous to the operator for general use at this time. The three most effective and least phytotoxic are lindane, methoxychlor, and purified DDT, with lindane preferred because it will also control melon aphids, whereas, the other materials will not. The rotenone, pyrethrum, and piperonyl compounds are not phytotoxic but are less effective as insecticides or lack residual insecticidal toxicity.

In the light of the foregoing results, the preferred insecticides for melon insect control in 1950, in order of preference, are lindane, methoxychlor, and purified DDT followed by the rotenone and pyrethrum organics. Missouri Folder No. 6, "Controlling Garden Insect Pests" was prepared for distribution. It gives complete directions for spraying and dusting the various garden insects.

Service Project (G. D. Jones, R. W. Portman, Lee Jenkins, P. C. Stone, H. E. Brown, W. R. Enns, G. W. Thomas, V. F. Burk, and L. Haseman). As in former years every effort was made to help people. This was done by means of circular letters, publications, phone calls, radio talks and on-the-spot



Control of insects through ground spraying, as is being done in this corn field, is a part of the extensive experiments being carried on by the Entomology Department.

interviews and talks. Timely weekly letters went out to the some 400 producing fruit growers about spraying and other care of the orchards and fruit crops.

As in former years state-wide surveys were made to determine the abundance of Hessian fly in the summer stubble as a guide to our early fall advice to wheat growers on the delaying of seeding. Summer grasshopper abundance and fall grasshopper egg abundance surveys were made with the help of one federal worker. A chinch bug survey was completed to determine their abundance in winter clump grass and reports on these findings have been made available to farmers, county agents and others. Some airplane application of insecticides was done in controlling the army worm.

FIELD CROPS

W. C. ETHERIDGE, *Chairman*

The Improvement of Pastures (E. Marion Brown, Joe B. Baldrige, and O. Hale Fletchall). This study on pasture improvement is divided into five different phases.

I. The Testing and Improvement of Pasture Species

The progeny testing of 290 selected plants of orchard grass was continued, and seed of the 10 better hybrids of *Poa arachnifera* x *Poa pratensis* was harvested for testing in northwestern Missouri.

Preliminary results of interstrain hybridization to induce variations in *Lespedeza stipulacea* indicated that this breeding procedure was possible, but slow because of the small flower size.

One hundred pounds of foundation seed of Climax, a late maturing variety of Korean lespedeza that will outyield other varieties by 25 per cent or more in southern Missouri and that is highly resistant to bacterial wilt, was produced for further increase.

Two strains of *Lespedeza striata* (F. C. 31852 and F. C. 31057-5) were found to be much superior to other lespedeza for use with grass in permanent pastures. These strains are now ready for increase.

The large birdsfoot trefoil breeding nursery, to which 2600 new plants from widely divergent sources were added during 1949, was screened for superior strains selected for vigor, seed yield, disease resistance, and survival of unfavorable weather.

It was found that one generation of inbreeding reduced greatly the vigor of birdsfoot trefoil.

II. Interaction Between Species in Mixtures

This experiment on interaction between species in mixtures was started in the spring of 1945 to test the persistence of each of 9 legumes when planted in sods of each of 4 grasses: bluegrass, brome grass, orchard grass, and red-top. The following results have been observed:

Ladino clover, which had thinned badly early in its fourth year, 1948, made a partial recovery during 1949 without being resown. It was best under moderate mowing.

Birdsfoot trefoil which had maintained its stand undiminished from 1945 to July 1948 in 4 grasses under 3 mowing treatments and then deteriorated in stand late that summer, almost disappeared from sods of all 4 grasses during 1949. An unidentified disease is believed to have been the cause.

Bacterial wilt killed most of the Korean lespedeza under semi-monthly lawn-mowing and stunted its growth under less severe clipping. Kobe maintained better stands and made more growth than Korean with all 4 grasses under all 3 mowing treatments.

Alfalfa, red clover, alsike, and hop clover had been eliminated from all grasses prior to 1949.

Bromegrass has thinned badly in stand on this clay-pan nitrogen-deficient soil, and the stand of orchard grass has not been maintained. Bluegrass still forms a dense turf and redtop has thinned only a little.

Under moderate mowing—three inches above ground level at monthly intervals—ladino-grass mixtures produced 3940 pounds dry matter per acre during 1949, second-year sweet clover-grass mixture produced 3809 pounds, and birdsfoot trefoil-grass mixtures 2513 pounds. The 4 grasses growing without legumes, other than volunteer lespedeza and white clover, produced an average yield of 1687 pounds of dry herbage an acre.

Ladino clover drilled April 22, 1949, in disked and in untilled sods of redtop, tall fescue, orchard grass, bromegrass, and bluegrass established medium to good stands during this wet season which was unusually favorable for ladino. The clover was best in bromegrass and poorest in bluegrass. By October there was twice as much Ladino in disked as in untilled sods of bluegrass, but disking did not improve clover establishment in sods of the 4 other grasses.

III. Pasture for Southeast Missouri Lowlands

At Sikeston, cattle gained 385 pounds an acre on bromegrass and alfalfa, 385 pounds an acre on wheat and lespedeza, 302 pounds an acre on bromegrass and ladino clover, and 267 pounds an acre on winter oats and lespedeza. Each acre of rye carried from 1 to 2 steers and produced 61 pounds gain from March 19 to April 19, after which the field was plowed and planted to soybeans which yielded 27 bushels an acre.

Twenty steers purchased March 19 from a local trader at 26 cents a pound and sold September 22 to a local feeder at 22½ cents a pound gained enough on Southeastern Missouri experimental pastures to pay \$35.99 for each acre of pasture used.

IV. Managed Grazing of Kentucky Bluegrass

Supplemented grazing of bluegrass returned more pounds of beef per acre on Missouri Bluegrass pasture land than unsupplemented. Three pastures on the University South Farms occupied land which had never been plowed and which Kentucky bluegrass had invaded many years ago. Bluegrass thrives in all three pastures and white clover volunteers abundantly when weather is favorable.

One of the pastures was initially the most productive, but during the 4-year period, 1945 through 1948, one of the other pastures produced a 12 per cent larger beef cattle gain an acre under supplemented grazing. The 60 per cent larger gain obtained during 1949 from this pasture was due in part to the greater efficiency of supplemented grazing and in part to lespedeza, which was sown that spring.

Cattle gains made on the third pasture during the 3-year period 1945 through 1947, when grazing was deferred each year in that half in which sweet clover reestablishment was being attempted, were 25 per cent less an acre than gains made on the check pasture, where grazing began April 15 on the entire pasture. When, however, supplemented grazing was applied to this third pasture, cattle gained 32 per cent more an acre during 1948 and 55 per cent more during 1949, than on the check pasture under continuous grazing.

V. Improving Permanent Pastures With Legumes

At Lathrop steers gained 240 pounds an acre on wheat and lespedeza, but only 71 pounds of this gain was made after June 23, as contrasted with 163 pounds gain made on the same pasture after July 1, 1948. It was believed the poor gain made on lespedeza during the wet summer of 1949 was due to severe infection of lespedeza by bacterial wilt.

A pasture seeded to Alta fescue in August, 1948, and to ladino clover in March, 1949, was pastured only when grazing was expected to be beneficial to the clover. This 2½-acre pasture carried 3 steers from April 18 to May 25, and 5 from August 2 to August 30. When the grass threatened to smother the clover it was mowed and raked off June 23. In spite of limited use, steers gained 210 pounds an acre and none bloated. The 5 steers gained 2 pounds per head daily during 29 days of August.

Bluegrass fertilized with 200 pounds of ammonium nitrate per acre annually in March, supplied earlier grazing and produced a larger total gain (322 pounds an acre) than any other Lathrop pasture. In order to obtain this large production it was necessary to carry 10 steers on the 5 acres from April 14 to May 25 and to remove 5 steers May 25 and 2 more June 23. although weather was unusually favorable for summer growth of grass. For those farms that can provide supplementary pasture during the summer for

70 per cent of cattle carried on permanent pasture during the spring, heavy spring applications of nitrogen fertilizer were shown to be profitable.

Five acres of brome-grass-ladino-lespedeza carried 5 steers continuously from April 25 to September 30, and they gained 298 pounds an acre.

The bluegrass pasture renovated with sweet clover produced more dry matter than the bluegrass pasture renovated with lespedeza, but less beef-cattle gain an acre (183 pounds and 201 pounds respectively) because the grazing management required to preserve the stand of first-year sweet clover did not make efficient use of forage that was available in that half of the pasture.

Although soil tests showed the untreated soil to be moderately low in phosphorus, the phosphate fertilized bluegrass and lespedeza pasture has produced no larger gains over a 4-year period than the unfertilized bluegrass-lespedeza pasture. It appears that in order to obtain a profitable increase in beef production from an application of phosphorus to soil fertile enough to support a 75 per cent stand of bluegrass before treatment, some legume other than Korean lespedeza must be sown in the grass.

Improvement of the Missouri Soybean Crop (Carl V. Feaster). This soybean improvement project is conducted in cooperation with the U. S. Regional Soybean Laboratory, United States Department of Agriculture and the value of this research is proved by the practical benefits received from the project by Missouri farmers. One of the two varieties lately released, S-100, released four years ago, occupied approximately fifty per cent of the acreage of soybeans in southeast Missouri in 1949. The production of Wabash reached 30,000 bushels last year, and all of it will be planted in 1950. When seed is available, Wabash should replace Boone and Macoupin everywhere, and replace Chief on the more fertile soils.

Row width and rate-of-planting studies were continued at Columbia and Sikeston. Soybeans were planted at 15, 30, 45 and 60 pounds per acre in rows 24, 32 and 40 inches apart. Maximum yields were obtained from planting 30 and 45 pounds in rows 24 inches apart.

Regional uniform group tests were grown at Columbia, Laddonia, Norborne, Elsberry, Sikeston, and Wardell. These compare the best strains developed by the different states in cooperation with the U. S. Regional Soybean Laboratory. Several were superior to the check varieties in yield, oil content, and lodging resistance. One strain from uniform group IV has performed well and is approaching multiplication and release. The Wabash soybean, a variety released in 1949, was introduced into Missouri through the uniform testing program.

In addition to the uniform tests, approximately 275 strains were tested at one or more of the locations listed above. Strains from Chief x (Chief x Macoupin) were most outstanding in central Missouri. Selections from the cross Lincoln x Ralsoy continued to show promise in southeast Missouri.

These selections yielded higher than S-100 and contained about two per cent more oil. Four thousand plant rows from nineteen hybrid combinations were grown at Columbia and Sikeston. The best were selected for further testing.

F₂ seed from sixteen hybrid populations were grown at Columbia and Sikeston. Approximately four thousand plant selections were taken from the best populations. Ten new combinations were made and fifteen hybrid combinations were grown in the F₁ generation.

The breeding of strains resistant to bacterial pustule was continued. Multiple and backcross methods are being employed, since it was learned that the resistance carried by Clemson Nonshatter is conditioned by a single recessive factor.

Missouri Seed Testing Laboratory (Viola Stanway, W. C. Etheridge, and C. A. Helm). The Missouri Seed Testing Laboratory in 1949 analysed representative samples from 4000 lots of farm seeds and this required a total of 6106 tests.

About one-fourth the total number of samples analysed were received from farmer seed growers who produce certified seed under the auspices of the Missouri Seed Improvement Association, for sale to other farmers. The amount and market value of this seed tested together with the farm acreages which it planted, are listed in Table 12. The total value of the farmer seed grower's seed tested reached nearly one million dollars. Estimated on the same basis, the total amount of seed tested by the laboratory would exceed three million dollars in annual value.

Current cash value, however, is not the best measure of the importance of seed testing. The continuing expert scrutiny of seed quality, whereby those who plant crops may be informed of the relative purity and vitality of the seed used, is the most important service rendered.

TABLE 12—FARMER SEED GROWER'S CERTIFIED SEEDS TESTED
AT THE SEED TESTING LABORATORY, 1949-50

<u>Crop</u>	<u>Amount</u>	<u>Market Value</u>	<u>Acres</u>
Wheat	16,159 bu.	\$36,357.75	10,773
Barley	1,952 bu.	4,880.00	976
Rye	1,170 bu.	2,925.00	780
Oats	23,214 bu.	40,624.00	11,607
Corn	75,264 bu.	526,848.00	530,000
Soybeans	58,781 bu.	176,343.00	57,781
Cotton	1,434 tons	186,420.00	89,625
Sorghum	25.4 tons	3,556.00	6,350
Total		\$977,953.75	889,200

Breeding Better Oats for Missouri (J. M. Poehlman, William P. Sappenfield, and L. E. Cavanah). Missouri's new variety of oats, Mo. 0-200, was grown by 77 certified growers in 57 counties of Missouri in 1949. This is the first "Columbia type" disease resistant variety of oats yet distributed, and it is also high in yield and well adapted to most areas in Missouri. In 1949, 0-200 was the highest ranking named variety of oats in the USDA uniform red oat yield nursery.

New Strains

Four new strains from a Columbia x Victoria-Richland cross were increased on a five-acre plot. Two of these strains were further increased by Missouri farmers in 1950 for possible release in 1951. These Columbia x Victoria-Richland strains were not only high in yield, but were the only early maturing oats strains now available with combined resistance to crown rust race 45 and Victoria blight.

Approximately 4000 nursery rows were grown in addition to four yield tests. These were advanced selections and head selections from new crosses. All seed was inoculated with collections of loose and covered smut before planting and epidemics of crown and stem rust were established by artificial inoculation to aid in selection of disease resistant lines.

Seven new crosses were made and in addition to the Spring oats work, a winter oats variety test was grown at Perryville, Sikeston, Bates County, and Pierce City.

Breeding Winter Barley (J. M. Poehlman, C. K. Cloninger, and William P. Sappenfield). Yield tests were continued in cooperation with Bureau of Plant Industry, Soils and Agricultural Engineering, United States Department of Agriculture, and three winter hardy nursery yield tests were grown during the year. No. 1 consisted of 30 standard varieties and elite strains grown at six locations: Columbia, Bethany, Bates County, Perry County, Pierce City, and Sikeston. No. 2 contained 50 new strains and check varieties grown at Columbia and Bethany. No. 3 was a United States Department of Agriculture uniform variety test of 21 varieties and strains at Columbia only. Drill plots were also grown at Columbia and Sikeston.

New Variety, Mo. B-400

A new variety identified as B546, a selection from Ky. 5 x Early Beardless, was named Mo. B-400 and 25 acres were grown in 1949. This new variety was high in yield, was winter hardy and early, and had moderate resistance to mildew, loose smut, and spot blotch. Other selections, outstanding in yield and disease resistance are being obtained from Admire x Early Beardless; Ky. 2 x Early Beardless; and Michigan Winter x Early Beardless.

In addition to the yield tests, 1735 nursery rows of advanced strains, introductions and selections from new crosses were grown for observations

on maturity, height, strength of straw, and disease resistance. The F_1 generations of 49 crosses were grown and one new cross was made.

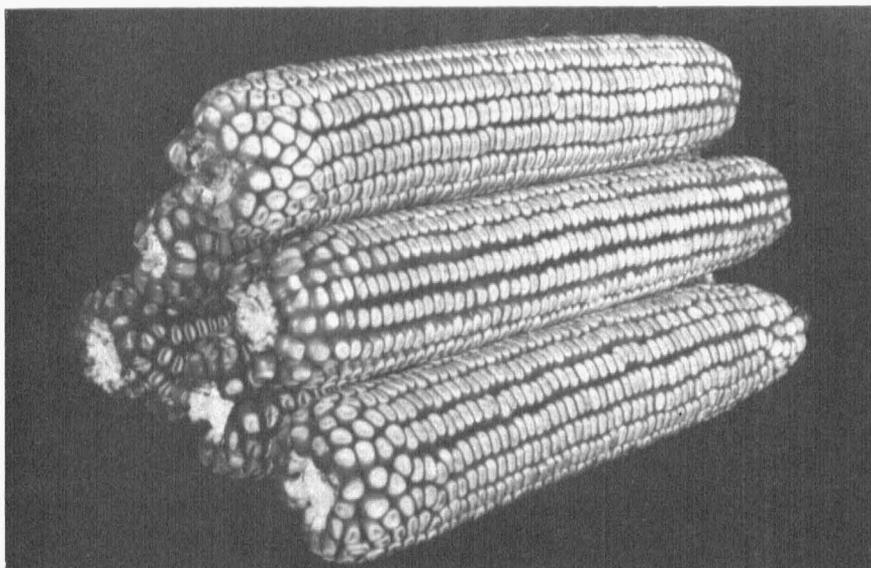
Considerable information on comparative hardiness and disease resistance of many winter barleys originating in the United States as well as the USDA World Collection, was summarized in Missouri Research Bulletin 442 and should prove useful to research workers in the selection of parent material for barley breeding.

Special Disease Studies

In special smut nurseries, strains and varieties of barley have been checked with individual races or collections of the three smut organisms. Known races of *Ustilago nigra* and *U. hordei* obtained from USDA are used to inoculate selected varieties. Studies are being made to determine the possible existence of races of *U. nuda* since this information is needed before proper selection of breeding material can be made.

Breeding Hybrid Corn in Missouri (Marcus S. Zuber, Wm. A. Crane, and L. J. Gundy). In 1949 a total of 96.5% of the total corn acreage in Missouri was planted with hybrid corn. The 3.5% planted to open-pollinated varieties was located in widely scattered areas in the southern part of the State.

One of the immediate objectives of the corn breeding project was to develop white hybrids of similar maturity as U. S. 13 and Missouri 8. Progress has been made in the development of the midseason white hybrid, but it will be several years before a suitable hybrid of this maturity will be ready for



The new late white hybrid U. S. 523W is an outstanding performer in Missouri, has good standing ability, husk cover, and mills well.

commercial production. A new late white hybrid, U. S. 523W, was released for double-cross seed production in 1949. So far, this hybrid has had an outstanding performance record for a 3-year period in Missouri, Kansas, and Kentucky. It is an excellent yielder with good standing ability and husk cover and it has a grain type that is suitable for milling purposes. Approximately 2600 bushels of double-cross seed were produced in 1949. The demand for this seed greatly exceeded the supply.

Progress has been made in the development of a late yellow hybrid of Missouri 8 maturity. Two new hybrids, Missouri 800 and 804, have given good performance records for the two periods they have been tested in Missouri. Both hybrids were more desirable than Missouri 8, not only in higher yields, but also there was considerable less stalk lodging. Seed stocks for both hybrids were increased in 1950.

Several hundred new white and yellow lines developed from open-pollinated varieties were selected and selfed from 3 to 5 generations. Some of these lines have been top crossed and were tested in 1950, while for the remaining groups, top-cross seed produced in 1950 will be tested.

One of the diseases, which caused considerable yield reduction in Missouri some years, is bacterial wilt. A few inbred lines showed some resistance to this disease, and in 1949 crosses were made between 16 of these selected lines with the intention of making a synthetic. It will require several years of crossing before a synthetic will be available, but it should give a good source for the possible extraction of lines having more resistance to this disease. Similar synthetics are being made up with lines having resistance to ear worm, stalk rots, and the *Helminthosporium* leaf blights.

Improvement of Soft Red Winter Wheat in Missouri (J. M. Poehlman, W. P. Sappenfield, and L. E. Cavanah). Nine wheat yield tests totaling 241 varieties and strains were compared at Columbia, Lathrop, Elsberry, and Sikeston.

The high yielding ability of Vigo and Royal were again confirmed in these tests. These two soft wheat varieties are now recommended along with Clarkan for Missouri. Most promising new selections were from Clarkan x Vigo, which combine good straw, quality and high yield with resistance to the leaf rust and loose smut diseases.

New Selections

Approximately 4000 nursery rows were grown in addition to the yield tests. These included reselections from outstanding strains previously grown, new introductions, and new selections from crosses. Outstanding were reselections from W5400, Kawvale x Currell² and selections from crosses between Kawvale and Purplestraw-Chinese-Michigan Amber. The latter selections were early, stiff-strawed, and resistant to leaf rust and loose smut diseases.

New Crosses

Fourteen new crosses were made in the greenhouse to combine high yield, earliness, and good straw, with resistance to leaf rust and loose smut and to Hessian fly.

Quality Studies

Seventeen samples composited from drill plot tests at Columbia, Lathrop, Elsberry, and Sikeston were submitted to the Department of Home Economics for baking studies. These wheats were milled by the Scott County Milling Company, Sikeston, Missouri. Six samples were submitted to the Federal Soft Wheat Laboratory, Wooster, Ohio, for quality studies.

Field Crops Outlying Experiment Fields (C. A. Helm, W. R. Langford, Hale Fletchall, Lloyd Cavanah, and W. C. Etheridge). A wide range of experimental studies of crops and pastures were conducted on four outlying fields in 1949-50 in cooperation with the departments of Animal Husbandry and Soils.

Northwest Missouri Field

This field of 75 acres, near Lathrop, Clinton County, is located on the farm of C. L. Van Buren. The soil is Sharpsburg silt loam, merging with the regular Marshall type in places. Studies include grazing management, pasture treatment, testing of grass-legume mixtures, testing of pasture species, and testing of improved cereals and hybrid corn. A summary of this study is given under the different projects.

Mississippi River Bottomland Field

A 30-acre field on the land of T. L. Remley, near Elsberry, Lincoln County, is used for the study of crops and cultural methods specially adapted to Wabash clay (gumbo), a soil type widely found in bottomlands along the upper Mississippi River in Missouri. On this field in 1949-50 were tests of varieties of hybrid corn, wheat, oats and soybeans.

There were also tests of a crop succession of wheat and soybeans, and the treatment of corn with 2-4D as a cultural supplement in the control of weeds. Varieties of rice were tested on the fields of cooperative growers near Elsberry and Palmyra. The effects of hulling and fungicidal treatment upon the germination of seed rice, were observed in the greenhouse at Columbia.

The crop succession of wheat and soybeans on the same land was not completed in 1949-50 because wet weather prevented the planting of the beans designed to follow the wheat. Wheat itself was damaged by abnormal wetness all winter and its yield was low. These results are in marked contrast to those of 1948 when wheat made 40 bushels per acre and soybeans sown immediately after wheat made 33 bushels. However, even in 1949, a farmer on better drained though less fertile land nearby produced 20 bushels of wheat and 20 bushels of soybeans by this "double-crop" practice.

Test 22 Varieties of Rice

Twenty-two varieties of rice were tested for yield near Elsberry and near Palmyra. Nine varieties maturing fully (119 to 135 days) gave individual yields of 68 to 96 bushels per acre. Three leading varieties were Kinai (195 days) 90 bushels; Cody 89 bushels; Zenith 82 bushels. Nineteen other varieties, from Texas, were observed for climatic adaptation and other agronomic qualities.

It was found that removing the hulls from seed rice reduced the germination by more than 50 per cent. But treatment of the unhulled (natural) seed with new improved cerasan further increased germination by 22 per cent.



Rice is not regarded commonly as a Missouri farm crop, yet this field on the J. L. Cook farm, near Palmyra yields 135 bushels an acre. Forty-one varieties of rice were tested in Missouri last season.

Pre-emergence Spraying

The high fertility and normal wetness of Wabash clay produces an extremely heavy growth of weeds. Seasonal tillage of corn is difficult and though often running to a costly total of four or five times in the season, is usually inadequate. In 1949-50 a single pre-emergence spraying with 2-4D supplemented with one regular cultivation kept the corn ground very clean. Acre yields in this instance were approximately double those resulting from untreated ground and from a single post-emergence spraying also supplemented with one cultivation. Even the best of these yields, however, was low. Excessive rains delayed planting and later swamped the ground to delay growth. The season as a whole was bad for corn on this extremely heavy and wettish soil.

Southeast Missouri Field

This 100-acre field is located on highway 61 in New Madrid County, near the Scott County line and very near the geographical center of the whole area generally known as Southeast Missouri. The soil is Lintonia fine sandy loam, moderate in natural fertility and very responsive to treatments.

The broad purpose of this field is (1) to find or create and continually improve the varieties of crops and pastures best adapted to the delta soils and other lands surrounding them within the limits of the area called Southeast Missouri, (2) to develop for these varieties the most profitable efficiencies in production and use, and (3) to maintain or improve the fertility of the soil. The field is supplemented by numerous cooperative tests with farmers on the more important soil types of the southeastern area.

Crops studied, improved and tested during the year include cotton, hybrid corn, soybeans, cereals, pasture species, alfalfa, peanuts, and several species of winter legumes. There were also studies of pasture production and management.

Cotton

Research with cotton during the season centered on varieties, fertilizers, defoliation, and chemical weed control. The improvement of cotton varieties for Missouri was started this year.

Varieties: Tests of cotton varieties were conducted on the Southeast Missouri Experiment Field and also in cooperation with farmers at Hayti, Gideon, Marston, and White Oak.

The test on the experiment field consisted of 24 varieties. Delfos 9169 led in the yield of seed cotton with 2600 pounds per acre but Deltapine 15, which has a very high lint percentage, produced the most lint per acre. Deltapine 33 and Deltapine-Fox ranked third and fourth respectively in line production. Of all varieties on the experiment field, Rowden and Paula 5-46-6D, two late maturing varieties were the least productive.

Ten leading commercial varieties were grown at Gideon on highly fertile silt loam. Deltapine-Fox and Deltapine 15 were the most productive, with a yield of 758 and 722 pounds of lint respectively. Rowden failed to mature under conditions of this test. It made a low yield of poor quality fiber.

Fifteen varieties and new strains were tested at White Oak on light sandy soil heavily infected with *Fusarium* wilt fungus. The yield of lint in this test ranged from 130 to 714 pounds per acre. Deltapine 15, Paula C and Stoneville 2B, the three most prominent varieties in Missouri, made the lowest yields. These varieties are not wilt resistant and should not be grown on soils where wilt occurs. Coker 100-Wilt was the highest yielding commercial variety. It produced 593 pounds of lint. Coker 100-Wilt 47-70, a new strain, made the highest yield of all varieties.

Coker 100-Wilt 47-70 also produced the most lint at Hayti in a test with twenty other varieties. This was on fertile silt loam soil that was not fertilized. In addition to Coker 100-Wilt 47-70, other high yielding varieties were Deltapine-Fox, Delfos 9169, and Stoneville 62. Rowden and Stoneville 2B-5325 made the lowest yield of lint.

The test at Marston was on Sarpy silt loam soil infected by both *Fusarium* and *Verticillium* wilt fungi. Yields were lower here than in any other test. None of the varieties were resistant to *Verticillium* wilt and those varieties resistant to *Fusarium* made the best yields. Coker 100-Wilt 47-70, Coker 100-Wilt and Empire led in production of lint while Rowden, Stoneville 2B-2492 and Paula C were the least productive.

Fertilizers: The response of cotton to different rates of nitrogen, phosphorus and potash was studied at five locations during the 1949 season. Nitrogen was the most consistent element in raising the yield and absence of nitrogen at any location caused a reduction in yield below plots receiving a complete fertilizer. Absence of phosphorus had little effect at Wardell and Deering and no effect at Gideon and Caruthersville. Absence of potash reduced the yield somewhat at Wardell but had no effect on it at Deering, Caruthersville, and Gideon. At these four locations 40 pounds of nitrogen produced the largest yields. Eighty pounds of nitrogen on these heavy soils so delayed maturity that the yield was below that of the forty pound rate.

At White Oak on light sandy soil the absence of any element from a complete fertilizer reduced the yield sharply. The yield was increased from 234 pounds of seed cotton an acre without fertilizer to 1439 pounds by using 80 pounds of nitrogen, 60 pounds phosphorus and 40 pounds potash. Leaving out potash lowered the yield to 626 pounds an acre. The absence of phosphorus reduced it to 736 pounds, and without nitrogen but with phosphorus and potash the yield was only 382 pounds.

Defoliation: Pulverized calcium cyanamid, ammonium thiocyanate, Shed-a-Leaf, Sharples E. C. 3740, and two forms of Sodium cyanamid, were applied to cotton at three rates each to determine their efficiency in defoliation. Ammonium thiocyanate caused severe spot-burning of leaves, but many of the leaves remained on the plant. All rates of Sharples E. C. 3740 (four to nine pounds an acre) and the higher rates of Shed-a-Leaf (10 and 14 pounds an acre) were much too high and caused severe and sudden burning of leaves, stems and bolls. The abscission layer failed to develop and the dead leaves adhered to the plant. Many bolls opened abnormally and the cotton was difficult to pick. Shed-a-Leaf and Sharples E. C. 3740 should be tested at much lighter rates.

Under conditions of this test calcium cyanamid was the most effective material used. Furthermore, it gave good defoliation over a wide range in the rates of application. Fifty pounds per acre was somewhat more effective than lower rates. A form of sodium cyanamid, X-10 dust, was applied

at comparatively lighter rates than the calcium cyanamid. The highest rate used, 22 pounds per acre, approached calcium cyanamid in efficiency. Heavier rates of X-10 might prove as effective for defoliation as calcium cyanamid.

The effect of time of defoliation on the yield and quality of cotton has a pronounced influence on the yield, the quality of seed, and the quality of fiber. Previous results showed that blooms opening 29 days or less prior to defoliation produced seed with lower than normal oil content. Yield from bolls opening 23 days or less prior to defoliation was reduced, and blooms that opened only 17 days or less before defoliation produced fibers shorter than normal and seed with a low germination percentage.

Cotton was defoliated 15, 23, and 31 days after the last blooms opened, and the yield of seed cotton was reduced 25, 14, and 5 per cent respectively below that of untreated plots. Cotton defoliated September 7 (23 days after the last blooms) had 18 per cent more cotton open by September 15 than the untreated plots. It was found that cotton was easier to defoliate early in the season than after the leaves became tough and leathery. These results suggest that cotton matures slower under Missouri conditions and defoliation must be delayed longer after the last blooms, than in areas where temperatures are higher.

Chemical Weed Control: Granular calcium cyanamid, ester formulation of 2,4-D, and Dow Selective (Dinitro), were applied at several different rates for pre-emergence weed control in cotton. Soil moisture was inadequate to activate fully the calcium cyanamid prior to planting and it had little control over early weed growth. This does not agree with results in the previous year, when moisture was plentiful prior to planting and 400 pounds per acre of calcium cyanamid sharply reduced weed growth and increased the yield of cotton. All rates of 2, 4-D applied three weeks prior to planting were too heavy and even the lightest rate, one pound per acre, reduced the crop stand. Four to six gallons per acre of Dow Selective gave fair to good weed control early in the season and had little effect on the stand. However, nine gallons per acre of Dow Selective caused irregular stands. During the two-year period Dow Selective was more consistent than cyanamid in reducing weed growth.

Improvement of Cotton Varieties in Missouri: Cotton in Missouri is produced along the northern limit of the cotton belt and present varieties fail to reach their maximum performance under Missouri conditions. The yield of high grade cotton can be increased with varieties that are disease-resistant, mature early, and lend themselves to mechanical harvesting.

Hartsville 7, a variety resistant to *Verticillium* wilt, Delta Smooth leaf, and Coker 100-Wilt were crossed with eight leading commercial varieties, Deltapine 15, Deltapine-Fox, Delfós 9169, Coker 100 Staple, Empire, Paula, Stoneville 2B, and Stoneville 62. F₂ seed from several of these crosses was

produced in the greenhouse at Columbia during the winter and will be planted in the field for segregation and selection in 1950.

Alfalfa

Alfalfa Varieties: Fourteen varieties of alfalfa, ranging from the northern hardy to the southern non-hardy varieties, were established on the Southeast Missouri field in September 1947. During the first season there was no appreciable difference in their yields. In 1949, the second year after establishment, the Atlantic variety was highly superior to any other in the test. It produced an average of 2390 pounds of hay at the first cutting while Oklahoma Common, the second highest yielding variety, produced 1650 pounds. Ranger and Buffalo produced 1420 and 1400 pounds respectively. Soon after the first cutting army worms defoliated the plants and weakened them to the extent that the stand of all varieties was sharply reduced.

Vetch

This study was started two years ago to determine the possibilities of growing vetch for seed in Southeast Missouri. Hairy Vetch was planted alone and in mixtures at different rates with rye, wheat, oats, and barley. During the two-year period the mixture of ten pounds of vetch and one bushel of rye produced the highest yield, 483 pounds of vetch seed per acre. Furthermore, this combination made a good yield of rye.

The lowest yield of vetch seed, 183 pounds per acre, was harvested from vetch planted without a companion crop. Wheat ranked second to rye as a companion crop. Oats and barley lodged badly and much vetch seed was on the ground at the time of harvesting.

Winter Annual Legumes

Winter annual legumes lend themselves well to the type of farming now followed in Southeast Missouri. Hairy vetch is grown on more acres than any other winter legume but the total acreage of it is small. The cost of seeding is high and many seedings have failed.

In 1947 a number of species, including five of *Vicia*, three of *Medicago*, three of *Trifolium*, and one each of *Pisum* and *Lathyrus*, were planted in nursery rows for comparison in seed production, winter hardiness, vegetative growth, and time of maturity. All were allowed to mature seed in the spring of 1948, and some species produced volunteer crops during the 1948 and the 1949 season.

Among the species studied, Dixie Crimson Clover, Manganese bur clover, and woolly pod vetch appeared to be the best adapted to Missouri conditions. Manganese bur and Dixie Crimson clover produced an abundance of seed, matured early, and on undisturbed soil returned excellent volunteer stands.

Manganese bur is not as winter hardy and does not produce as much vegetative growth as crimson clover or woolly pod vetch. Woolly pod vetch equals hairy vetch in winter-hardiness, produces more seed and matures a few days earlier. Neither hairy nor woolly pod vetch volunteered successfully during the two-year period and all species of Lupines were winter killed. Singletary pea, button clover, and subterranean clover matured late and do not lend themselves to cropping systems in Southeast Missouri.

Southwest Missouri Field

The broad purpose of this field is to learn and to demonstrate the means of improving in quantity and quality the production of feed for livestock on lands of meager fertility generally prevailing in Southwest Missouri. The field, located near Pierce City, is 120 acres in size and is composed mainly of Lebanon gravelly loam, one of the more extensive soil types in the southwestern area. It is near the average of the area in natural productivity or a little below average.

Crop yields on Lebanon gravelly loam and similar southwestern soils are generally low and inadequate for the support of the large numbers of livestock on which the economy of the area is mainly based. Imports of feed are very heavy. A much larger proportion of home grown feed is essential for better profits from livestock and dairy farming, and for the improvement of the soil.

First procedures on this field towards the larger production of feed were the control of soil erosion and weeds, the improvement of drainage, the build-up of organic matter in the soil, and the treatment of the soil with lime and fertilizers. These betterments along with considerable renovation and clearing were mostly worked out at minimum cost with the small force of labor employed since the field was established two years ago.

Forty varieties of legumes and grasses were seeded in 1949 for initial observation of their value for forage and pasture. Experimental pastures of tall fescue-ladino clover and of orchard grass were seeded in early fall. Uniform nurseries of winter oats, barley and wheat were fall sown in 1948, and spring oats in 1949.

Eight varieties of castor beans were tested for yield and other agronomic qualities. The best of these were Illinois No. 1, Conner, and Nebraska 108-3.

Ten acres were seeded in 1948 to B-400, a new variety of winter barley bred at Columbia for winter hardiness, earliness, disease resistance and total productivity. The yield of re-cleaned grain, 266 bushels, was distributed to 9 special growers of improved seed, who sowed it on 171 acres in 1949 for seed increase in 1950. This rapid multiplication of a superior new variety in the area where it should be greatly increased as a crop, is an important service in line with the purpose of the outlying experiment field.

Genetic Studies With Crop Plants (J. G. O'Mara, E. R. Sears and L. J. Stadler)—This is a cooperative project carried on by the Department of Field Crops and the Division of Cereal Crops and Diseases, United States Department of Agriculture. Through the use of monosomics and nullisomics (which are deficient, respectively, for one and two members of a pair of chromosomes) several genes for disease resistance have been located on particular wheat chromosomes. The following chromosomes have been found to carry resistance to one or more physiologic races of black stem rust: Chromosomes VI and X of Red Egyptian, chromosome XVII of Thatcher, and chromosome X of Timstein. In addition, chromosome XI of Axminster has been shown to carry a dominant gene for mildew resistance. In oats, the number of different nullisomics identified has been brought to nine.

Wheat plants resistant to leaf rust because of an added pair of chromosomes from *Ae. umbellulata* have been crossed with the monosomics in an effort to obtain substitutions of the Aegilops chromosome for known wheat chromosomes. It is hoped that one or more of the substituted types may be of more nearly normal vigor and fertility than the simple addition type.

Research was continued on the mechanism of heredity in corn, and the analysis of spontaneous mutation was continued.

Evidence bearing on the possibility of crossing over within the R complex a cause of the apparent mutations of R^r to r^r or to R^g has now been secured, using as markers the gene g , about 15 units to the right of R , and the heterochromatin appendage described by Longley, about one unit to the left. The results show that neither seed color mutation nor plant color mutation is dependent upon the occurrence of crossing over between these markers. This study was made in collaboration with M. G. Nuffer.

Mutation of the allele r^r : Belt yields an unstable mutant designated r^g , which appears to be an r^g giving very frequent somatic mutation to the r^r level. This mutant has important advantages for the study of the mutation process, and rather extensive study of its behavior is in progress.

FORESTRY

R. H. WESTVELD, *Chairman*

Christmas Trees as a Crop (R. B. Polk, R. E. McDermott, and L. K. Paulsell). Christmas tree research continues to show that much of Missouri's demand for Christmas trees could be met by Missouri farmers.

Work on the Christmas tree project was carried on in two different locations—the Weldon Springs Experimental Farm and the Ashland Wildlife Area.

The work done on the Ashland Area was of two different types (1) the establishment of new Christmas tree plantations which involved the use of fertilizers and (2) the pruning of established trees for the purpose of improving form. Twenty 1/20-acre plots of jack pine involving approximately 1700 trees and seven 1/25-acre plots involving Virginia pine were planted in the fertilizer experiment. Five different fertilizer treatments and a check plot which received no fertilizer were included. The fertilizer treatments were as follows (all values are on a per-acre basis):

Treatment A—2 tons lime, 300 lbs. ammonium nitrate, 500 lbs. raw rock phosphate, and 200 lbs. of 0-20-20 commercial fertilizer.

Treatment B—300 lbs. ammonium nitrate, 500 lbs. raw rock phosphate, and 200 lbs. 0-20-20 commercial fertilizer.

Treatment C—2 tons lime, 500 lbs. raw rock phosphate, and 200 lbs. 0-20-20 commercial fertilizer.

Treatment D—2 tons lime, 300 lbs. ammonium nitrate, and 500 lbs. raw rock phosphate.

Treatment E—2 tons lime, 300 lbs. ammonium nitrate, and 200 lbs. 0-20-20 commercial fertilizer.

The original plan called for the plowing in of the fertilizer on some of the plots, but weather conditions interfered, and as a result all fertilizers were applied to the surface. The only work done on these plantings subsequent to their establishment was the making of a survival count and the mulching of one-half of one of the jack pine plots. On one quarter a one inch layer of sawdust was applied and to another quarter three inches of sawdust was applied.

The pruning work on the Ashland Wildlife Area was concerned with full grown trees of poor form. These were pruned with various degrees of severity in an effort to determine the extent to which the form of such trees could be improved. A total of 125 trees were so treated.

Prior to March 1, 1949, new sites were prepared for the establishment of additional Christmas tree plantings during the planting season of 1950. The main part of this year's project was concerned with development forms of site preparation. These included (1) complete plowing, (2) plowing of furrows, (3) scalping, and (4) no site preparation. Jack pine was planted on these site preparation plots. In addition to this work, a test including species of Arizona cypress, Douglas-fir, and Fraser fir is being made.

Plans were made for the establishment of a series of Christmas tree plantations at the Weldon Springs Experimental Farm. All plots to be used for this purpose were laid out prior to March 1, and all site preparation and fertilization was also done prior to that time. The work at Weldon Springs will involve the planting of approximately 12,000 jack pine, 3000 Scotch pine, 200 Arizona cypress, 200 Douglas-fir, and 200 Fraser fir. The

experimental plots are concerned with the following cultural practices in Christmas tree production: (1) mulching, (2) spacing, (3) pruning, (4) initial site preparation and subsequent cultivation, and (5) species comparison.

The Value of Woodland Management in Missouri (Paul Y. Burns). The forests of Missouri occupy one-third of the area of the state, and almost half of the commercial forest area is owned by farmers, with an average of about 30 acres of woods per farm. Surveys have shown many of these farm woods are in a run-down condition, producing little or no income because of unwise cutting practices, frequent fires, and heavy grazing. This neglect has resulted in smaller incomes to farmers than could be realized under good management and a shortage of high-quality wood for the people of Missouri.

If a farm woodlot is managed for the production of wood as a crop, with annual or periodic partial cuttings, it will contribute substantially to the owner's income, just as wise management with his other crops increase his financial return. The value of woodlot management to the farmer is well illustrated by an analysis of the actual woodlot income which five Missouri farmers have made in different parts of the state. These cases show that the financial returns have been and indicate what returns can be expected in the future by farm woodland owners who manage their woodlots as part of their farm enterprises.



The J. M. Sneed farm woodland in Pettis County has yielded timber profitably for 40 years. Timber management is an important Missouri farm activity.

The following two conclusions are obvious from a study of the woodlot management of these farmers:

(1) Missouri farmers can obtain substantial permanent incomes from sales and home use of wood products when they bring their woodlands into their farm enterprises and produce timber as a crop. The average annual yield of sawlogs from managed woodlots can be approximately 100 to 150 board feet per acre on average sites and 200 to 250 board feet per acre on good sites. In addition to this sawlog harvest, minor products such as fence posts and fuelwood may be cut and sold or used on the home farm. The net value of the wood crop to the farmer can approximate \$100 to \$700 per acre per year, depending mainly upon the volume and condition of the woodlot and the time which the farmer spends in harvesting his own products.

(2) Considering the time, expense, and effort on the farmer's part, the income received from timber management is high. The farmer need not spend money for fertilizer or expensive machinery to produce his wood crop, nor devote time to planting or sowing. The management practices required are simple, requiring little effort—protection of the timber from fire and grazing, and careful selection of trees to be cut so that the woodland will be maintained in productive condition. If in addition to these practices the farmer will devote from one to four weeks of his off-season time to harvesting his own wood products, he will substantially increase the revenue from his woodlot, and the income from this work will be relatively high per day of labor.

A complete summary of this study is found in Missouri Experiment Station Circular 349, "Value of Farm Woodlot Management in Missouri," published this year.

Rehabilitation of Missouri Forests (J. M. Nichols, R. H. Westveld). Research is being centered on the control of inferior species and the following treatments were applied to sassafras, persimmon, and hickory; 5% solution of Esteron 245 in kerosene, 5% solution of Esteron 245 in water, 1% solution of Esteron 245 in kerosene, 4 pounds Ammate crystals per gallon of water, 1 pound Ammate crystals per gallon of water, 1 tablespoon Ammate crystals applied to fresh stump, and no treatment check.

Ten trees per species per treatment were used in this test and applications were made to freshly cut stumps.

Resulting sprouts were tallied and measured at the end of the 1949 growing season. Best results were secured from the 5% solution of Esteron 245 in kerosene and it was found that the solution of 1 pound Ammate per gallon of water was insufficient.

Treatments Being Made

The following tests are now in progress:

1. Monthly stump treatment of persimmon. Three hundred sixty trees

ranging from 2 to 4 inches in diameter at a point 6 inches above the ground were tagged and treatments randomized. Ten trees for each of the following three treatments were used each month in the year.

- a. Fresh stump saturated with a solution of 5% Esteron 245 in kerosene.
 - b. Fresh stump saturated with a solution of 4 pounds Ammate crystals per gallon of water.
 - c. No treatment applied to fresh stumps.
2. Monthly stump treatment of hickory. This test is a duplication of No. 1 above, stump diameters ranging from 2 to 4 inches.
 3. Monthly stump treatment of sassafras. The same procedure was followed as on numbers 1 and 2 above with one additional treatment. On an additional 10 trees per month the stems were saturated to a height of approximately 18 inches with a solution of 5% Esteron 245 in kerosene and the trees were not cut.
 4. Monthly stump treatment of oak. This test is roughly the same as those above, except that it is being done on a plot basis. The black and white oak sprouts average one inch in diameter at a 6 inch stump height. Forty-eight circular plots 30 feet in diameter were randomized on a 5 acre area. The additional treatment of saturating the stems with a 5% solution of 245 in kerosene was used on one plot per month.
 5. Four different concentrations of Ammate solution were used in another test on black hickory. It was being used in a solution with water at the rates of 1 pound, 2 pounds, 3 pounds, and 4 pounds per gallon to determine the approximate breaking point in its effectiveness.
 6. Eight plots on an electric line right-of-way, each 20 feet by 40 feet have been surveyed and all stems tagged and measured. These will be used for spray treatments and tests.
 7. The following tests are being made on blackjack oak, average DBH 12 inches: notch treatment using Ammate crystals, notch treatment using a solution of Esteron 245 in kerosene, axe girdling and chair saw girdling. Twenty trees for each treatment were tagged and the treatments along with time studies will be made.

In the three direct seeding plots both germination and survival were satisfactory for all three species—white oak, black oak, and scarlet oak. Extreme drought conditions did not occur during the growing season which was one factor in the good survival, particularly on the one dry site. Survival was best on the plots which were kept raked clean of all litter apparently because the rodent population was heavier where there was more litter.

Missouri Forest Plantations (R. H. Westveld, R. W. Dingle, Ross Hortin, and R. B. Polk). In the forest plantation survey, approximately 230 farms in 18 counties were visited and 28 species of trees on 225 plots were investigated.

Geographically the work has been well distributed over the State. Preliminary work has been finished in Atchison and Nodaway counties in the northwest corner of the State; while in southwestern Missouri, Barry and McDonald counties have been finished and some work has been done in Lawrence county. Work done in Howell, Douglas, and Wright counties is representative of conditions in the south central part of the state, and southeastern Missouri is represented by work done in Dunklin county. Central Missouri is represented by work done in Boone, Callaway, Audrain, Howard, Cooper, Miller, Moniteau, and Maries counties; and eastern Missouri is represented by work done in Pike county.

Of the ten major soil areas, designated from the standpoint of the influence of soils on forest growth by H. H. Krusekopf, only one soil area is not represented by plots. The soil area which lacks representation is the smallest one both insofar as total area and number of forest plantations located within its limits are concerned.

Forest Management and Utilization (Weldon Springs) (Lee K. Paulsell, T. B. Martz, and R. H. Westveld). Since this is a new experimental area, an inventory of the entire forested area of the Weldon Springs Experimental Farm was made by the resident forester.

This was accomplished by first interpreting aerial photographs covering the area and separating the forest into 134 stands according to size and stocking of the growing stock. Following this 452 individual one-fifth acre plots were examined in the field. In addition to the actual timber measurements, a large number of other factors and conditions were considered which are important in placing the area under strict forest management.

Data were arranged and processed and gross volumes by species and diameter classes were computed for each stand and for the total forested area. Stand and stock tables were prepared for each stand.

A study was made of growth and form classes of the timber on the area. A large number of plots located by a systematic arrangement were examined across the area and the past growth rate of every tree on each plot was recorded from examining increment borings taken from the tree. This method permits growth calculations on an area basis.

Preservation of Posts and Farm Timbers (Lee K. Paulsell and K. C. Compton). This research is being done in cooperation with the Monsanto Chemical Company and the first treatments were miscellaneous species, mostly ash, elm, and hickory, for the experiment on farm fences.

The experimental posts include sixty ash and thirty hickory. Each of three groups of 15 ash posts was treated with pentachlorophenol for 24, 48, and 96 hours respectively. One set of 15 hickory posts was treated for 24 hours. Fifteen posts of each species were retained as checks.

HOME ECONOMICS

STARLEY M. HUNTER, *Chairman*

Nutritive Requirement of Older Women—The Retention of Calcium, Phosphorus and Nitrogen by Healthy Older Women; Thiamin, Riboflavin and Niacin Content of the Diets of Healthy Older Women in Relation to Blood Levels and Urinary Excretion (Adelia E. Weis, Inez Harrill, Mary Holke Jenkins, Jean Huston, and Dorothy Lewis). The purpose of this study is to measure quantitatively the important nutrients in the diets customarily consumed by healthy older women (50-70 years of age) and to study the relationship between consumption, and excretion of some of these nutrients.

Data obtained from this study are to be added to those being accumulated by the North Central Cooperative Group on the Nutritional Status and Dietary Needs of Older People.



Experiments in human nutrition are being carried on by students and staff personnel in the Home Economics department laboratory.

Blanks and questionnaires for use in obtaining data from the women who cooperate in this study have been assembled and prepared for the physical examination, the dental examination, the case history, the 3-week measured dietary record, and the two 5-day balance period (weighed dietary record).

Directions have also been prepared for these women so that they will understand how the food, urine, and feces samples are to be collected during the two 5-day balance periods, and for the 10th day of the balance period when the test dose of thiamin and riboflavin is given.

Samples for the nitrogen, calcium, and phosphorus content of the food, urine, and feces have been sent to the Department of Agricultural Chemistry for analysis.

Techniques have been developed for the determination of: (1) thiamine in food and urine; (2) riboflavin in food and urine; (3) niacin in food; (4) tryptophane in food; and (5) creatinine in urine.

The Improvement of Soft Red Winter Wheat in Missouri—Flour Studies (Leta G. Maharg and Jeanne Vinyard). Cakes baked from flours obtained from seven varieties of wheat which have been grown for three consecutive years gave the following average scores and volumes.

Wheat Variety	Scores			Index of Volume		
	1946 %	1947 %	1948 %	1946 Sq. In.	1947 Sq. In.	1948 Sq. In.
Clarkan	92	93	93	10.5	10.2	9.7
Early Premium	93	94	93	10.5	9.9	10.0
Kawvale	81	84	83	9.7	8.8	9.3
W 5253	93	90	87	10.3	10.3	10.3
W 5477	84	87	87	8.9	9.6	9.5
W 5478	86	86	88	9.1	9.6	9.8
W 5488	92	87	92	10.4	10.0	9.9

These baking results indicated that the variety of wheat was a controlling factor in the quality of a cake flour. In general, cakes which were scored the highest, were also highest in volume. The flours showed fairly consistent qualities in baking performance for each of the three years. The softer wheat produced cookies with a higher spread factor.

The Serviceability of Some Staple or Common Household Textiles as Measured by Laboratory Tests and Home Service (Adella E. Ginter and Berniece Blue). Some results of this experiment have been reported in previous annual reports. The tests for this problem have now been completed and a complete analysis of the data has been published in Research Bulletin 448, "A Serviceability Study of Kitchen Towelings of Various Fiber Contents."

HORTICULTURE

T. J. TALBERT, *Chairman*

Factors Affecting Fruit Setting of the Apple (A. E. Murneek). Extensive field investigations were continued and conducted in several commercial and three Experiment Station orchards on the practical value of chemical thinning of apples and peaches. Almost all standard varieties of apples grown in the State were involved, though special attention was paid to the Jonathan and Golden Delicious varieties. Elberta peaches were thinned extensively in the Experiment Station orchard at Campbell.

The three chemicals, used at various concentrations and definite periods of flower and fruit development, were: Naphthaleneacetic acid ("hormone spray), sodium dinitrocresylate ("Elgetol 20") and dinitro ortho-cylohexylphenole ("DN-1"). The results showed that for "flower thinning" of apples either DN-1, at $\frac{3}{4}$ to 1 lb. to 100 gallons, or Elgetol 20, at .125% to .37% were satisfactory materials. For annually bearing varieties the weaker concentrations are desirable and for biennially bearing varieties the stronger concentrations.

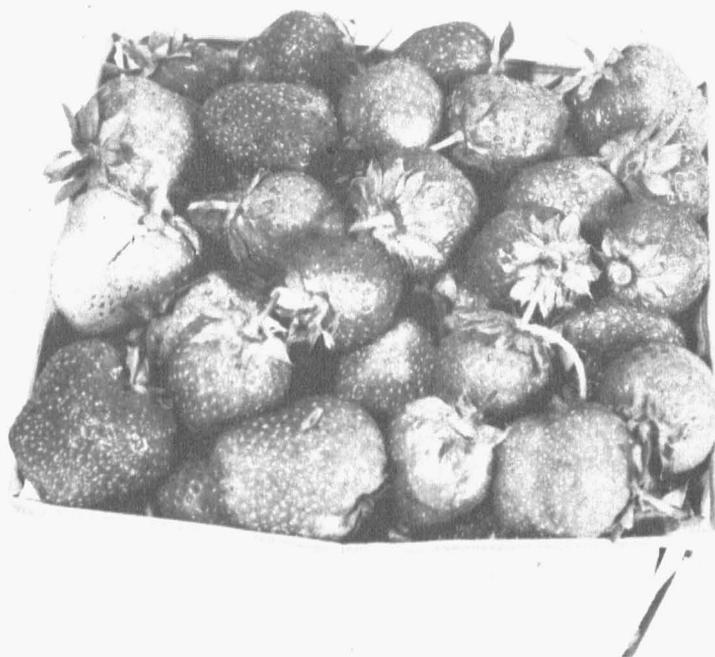
For thinning apples in the early fruiting stage (1-2 weeks after full bloom), the hormone spray was very satisfactory. The best concentration of this spray was found to be 10 parts per million for the annual bearers and 20 parts per million for the biennial bearers.

Peaches can be thinned most successfully and economically with the hormone spray applied 30-35 days after full bloom. The best concentration for this purpose was 30-40 parts per million for trees of high vigor and a heavy fruit set.

Recommendations and directions have been issued to fruit growers throughout the State, and elsewhere, for chemical thinning of apples and peaches to improve fruit size, color, and quality in general.

Marketing Fruits and Vegetables (R. A. Schroeder, D. D. Hemphill, and A. R. Conley). This project on marketing fruits and vegetables was a new study. Apples on the retail store shelf are all too frequently of extremely poor quality. To determine where the damage causing such poor quality occurs, apples were inspected at the following stages in the marketing procedure: (1) At packing shed immediately upon receipt from orchard; (2) in packing shed as soon as packaged in the container in which they were to be moved to market; (3) as they were being removed from cold storage; (4) in the "back room" of the retail store just prior to their being placed upon the shelf.

A total of 210 samples were taken and the data has been recorded in IBM cards and currently is being studied for its significance and proper interpretation. The project was conducted as part of the North Central Regional Fruit and Vegetable Marketing Project.



The "Armore" strawberry has good commercial qualities, and was among the best of more than 20 varieties tested by the Horticulture Department.

The Horticulture Experiment Fields (A. D. Hibbard, H. G. Swartwout, Victor N. Lambeth, and R. A. Schroeder). **The Monett Field**—Final tests were made on the Missouri 164 strawberry and because of its superior yielding ability, season of maturity, and good commercial qualities, the Seedling Missouri 164 was named and introduced as the "Armore." Of twenty-three varieties fruited this year, the new Armore was among the best. The commercial varieties which were the most productive and which showed considerable promise were Armore, Temple, Tennessee Beauty, Tennessee Shipper, and Blakemore.

It was found that a weed killing spray of $\frac{1}{2}$ (500 p.p.m.) strength 2,4-D combined with summer mulches resulted in a saving of about one-half of the labor normally required for hand cultivation. The application of 2,4-D did not adversely affect strawberry yield although there was some suppression of summer plant development. A number of growers who have adopted the practices which were developed at the Monett Experiment Field claim they have been able to reduce production costs by 50%. Such practices as fall setting, contour planting, and summer mulching, while reducing the costs of production, also insured a better row and increased yields.

The Campbell Fruit Field—The value of hormones to thin peaches was again confirmed. Alpha-naphthaleneacetic acid when sprayed on the developing fruit at a concentration of 40 to 60 p.p.m. 35 days after full bloom gave good thinning on mature Elberta trees. The cost of the operation was only the cost of the chemical, since this material was combined with the regular spray mixture. This offered a way to reduce materially the cost of this expensive practice in peach production.

Studies were continued on the systems of pruning peaches, soil management for peach orchards, and fertilizer practices. About one hundred peach varieties produced fruit. Comparison of the resistance of peach varieties to certain diseases were made since the season was favorable for their development. Additional information was secured on the response of peach trees to fertility elements, other than nitrogen.

A young peach orchard planted in 1946 bore an average of one bushel per tree in 1949. This orchard planted on contours and terraces has been handled uniformly since it was planted.

Work was continued on breeding a wilt resistant watermelon of solid dark green color suitable for commercial production under Missouri conditions. Neither the Missouri Queen nor any of the wilt resistant varieties in the trade meet the present market requirement for a cylindrical, large size, dark green, early melon with good commercial qualities.

Studies on sidedressing the watermelon crop with nitrogenous fertilizers were made. Both the time and rate of application were shown to influence earliness, marketable size, and quality of the crop. This work indicated that it was practical to apply a moderate amount of nitrogen fertilizer when the crop was planted, or just before planting, since the benefits derived from sidedressing were not great enough to justify the added expense and may be detrimental if applied too late and in too large quantities.

The Speas Horticultural Farm—The present soil management system in all blocks is to grow sweet clover and corn in alternate tree row middles. In the contour and square plantings, the alternate strips of sweet clover are to slow water runoff and thus reduce soil movement. In the terrace blocks the alternate sweet clover strips permit greater convenience in spraying.

After there had been more than the usual amount of washing, the number of places where water had cut over terraces or through sod strips were counted with the following findings:

1. Northwest terrace block with 1 inch fall—3 cutovers, all by trees. None were great. All were due to loss in effective height—less than 8 inches.
2. Southeast terrace block with 3 inch fall—1 cutover on lower end of berm below a double spacing between terraces. A fairly large break due to the silting in of the channel near the mouth.

3. Level contour block—6 cuts through vetch and rye strips. Only one was very long and it did not result in any great amount of soil movement.

4. Graded contour block—49 cuts through the low ridge thrown up at each tree row as a result of cultivation.

5. Square planting block—4 ditches of appreciable size and one wash of large size. By far a greater amount of soil loss than in any of the other blocks.

Lima Bean Production

Campbell Field and Columbia—Commercial lima bean production in the United States at the present time is limited to a relatively few sections possessing ideal growing conditions. Even in these sections, consistent satisfactory yields of varieties of the large-seeded lima type are uncertain. Low yields are always associated with profuse dropping of the buds, flowers and developing pods. Many of the earlier investigators have considered the inconsistent yields solely from the standpoint of unfavorable weather with little consideration being given to the physiological response of the plant, and of the specific plant characteristics involved in the breeding and adaptation of new varieties. This preliminary investigation by Victor N. Lambeth was an attempt to determine more specifically the morphological and physiological factors associated with pod set in the lima bean with particular reference to the newer varieties of the large-seeded type.

The problem of securing better pod set in the large-seeded lima types is one of great practical importance to the vegetable industry. The large-seeded varieties have met with a greater demand on the fresh and frozen market (especially in the North) because they possess better flavor, color, size, and texture. The southeastern section of Missouri has for many years profitably produced annually several thousand acres of lima beans, principally the small-seeded varieties, for canning. The problem now arises as to whether or not the large-seeded varieties are adapted to this section, and if so, what cultural practices will contribute to satisfactory, consistent yields. To accomplish these objectives an extensive investigation of the morphological and physiological characteristics of representative varieties together with a consideration of their interactions with specific climatic and edaphic factors was started.

The preliminary investigation included both greenhouse and field experiments. The latter were designed to test and apply the findings of the more detailed greenhouse experiments. The pod-setting characteristics of lima bean plants of representative large-seeded varieties were compared in thermo-regulated growth chambers maintained at different air temperatures and soil moisture levels. The pod set under these carefully controlled conditions was correlated with detailed pollen studies *in vivo* and *in vitro*, and by critical histological examination in order to determine the reason for set or failure to

set pods. Other greenhouse experiments were designed to correlate pod set and yield with leaf area of the plants, and to determine the effect of applications of soluble boron sprays to the blossoms and leaves of the plants.

The first field experiments were designed to correlate under natural conditions on a statistical basis the basal pod set with mean daily temperature and with the mean daily relative humidity. One variety of green snap bean (Tendergreen) and two varieties of bush limas (Henderson and Fordhook 242) were used in these studies in order to compare species and varietal differences. A study of the effect of nitrogen fertilization was superimposed upon the weather pattern. Additional field experiments were conducted to investigate the effect of increased light, shading, plant spacing, and boron sprays.

This data indicated that the frequent failures to obtain satisfactory pod set with lima varieties of the large-seeded type can be attributed directly to inadequate fertilization of the ovules. In order to prevent abscission of the flower itself, it was found necessary that at least one ovule in the ovary be fertilized. The histological evidence from this study supported the contention that poor fertilization most frequently resulted from a failure of the microgamete to reach the egg while the latter was receptive.

The following facts attested to the very sensitive nature of the pollen grains of lima species: (1) very exacting requirements for pollen germination *in vitro*; (2) remnants of ruptured pollen grains frequently abound on the stigmatic surface; (3) germination of pollen prior to release from the anther; and (4) frequent occurrence of partially-filled pods.

It would appear, therefore, that the lima bean plant, especially the large-seeded type, is limited ecologically to a narrow environmental complex by reason of its sensitive pollen. Since the climatic and edaphic factors are exposed through the pollen, the results on pod set can now be interpreted on this basis. However, pod set and yield of beans are not necessarily comparable, since once the "capacity set" for the plant is reached, floral and pod abscission may occur due to competition among the developing pods for essential metabolites. But once the "capacity set" is obtained yields would then depend primarily upon the photosynthetic activity of the plant. Sunlight duration and intensity, and plant leaf area then become very important factors.

From these results, the factor in the environmental complex found most frequently to limit pod set to the greatest degree was the available soil moisture. This was true both from the standpoint of excesses and deficiencies. The results indicated that under field conditions, frequent heavy rains at the beginning of the blossoming period seriously limited and sometimes almost completely prevented basal pod set, evidently by favoring rupture of the pollen grains during germination. The difficulty was enhanced by close plant spacing and by vigorous plant growth.

Air temperature was found to be an important factor limiting pod set near the upper and lower temperature limits for satisfactory vegetative growth for warm season crops. The minimum night temperature may be as important as high daytime temperatures. However, considerable varietal difference was found in this respect. The Fordhook 242 variety was considerably more tolerant of low night temperature than regular Fordhook. Other than this factor, differential response of varieties to the environmental complex may be attributed largely to relative ability of the plants to maintain an adequate water supply to the tissue and hence to the stigmatic surface. The small-seeded bush lima varieties such as Henderson are apparently more drought tolerant for this reason. The specific plant characteristic desired in parent stock for use in breeding new varieties for increased yield is more tolerant pollen.

So far as the fertilizer treatments were concerned, timely application was the important problem. The results indicated that heavy side dressing applications of soluble nitrogenous fertilizers during the blossoming period inhibited pod set. There was some evidence in the preliminary field experiments, that applications of some of the trace elements increased pod set.

For a more practical application of the problem, extensive field experiments have been outlined for the southeastern Missouri section. The experiments include planting dates, soil treatments, and a cooperative variety-strain testing project in cooperation with the U.S.D.A. The planting date study was based upon a forty-year survey of climatological data in this section. Plantings are to be made regularly at one-week intervals so that the plants will blossom under both favorable and unfavorable pod-setting conditions.

Vine Crop Insecticides

The Entomology and Horticulture Departments studied the effectiveness of various new organic insecticides in the control of vine crop insects. Lindane and Marlate were the two most successful from the combined standpoint of insect control and freedom from plant injury. Toxaphene proved highly toxic to cantaloupes and cucumbers and parathion, aside from its potential danger to the operator, was highly promising.

Sweet Corn Ear Worm Control

Working with the Entomology Department, the use of several insecticides separately and in combination were tried for their effectiveness in sweet corn ear worm control. The combination giving the best control, both at Campbell, and at Columbia, was the DDT and Oil emulsion.

An emulsion containing 1% DDT and 10% oil gave 100% control when checks showed 100% infestation. The application of two sprays was superior to that of one. The first spray was applied when approximately 25% of the silks were showing. The second was applied 3 days later and DDD was equally effective as DDT when used in the oil emulsion spray.

New Sprays and Spraying Methods (H. G. Swartwout). Evaluation studies were continued on the newer organic fungicides and spray schedules. A bulletin, Missouri Bulletin 530, "General-Purpose Sprays for Home Fruit Plantings" was published.

Grapes

Several different fungicides were tested for their effectiveness against black rot of grapes. The tests were conducted in three vineyards with different black rot infection potentials as shown by the incidence of black rot on unsprayed check vines. In vineyard No. 1 where Ferbam, SR406, Arathane and CR305 were used, SR406 at 4-100 gallons was essentially equal in effectiveness to Ferbam at $1\frac{1}{2}$ -100 gallons. SR406 at 2-100 gallons was somewhat less effective while CR305 and Arathane gave poor control. In vineyard No. 2 where only Bordeaux 6-8-100 formula and Dithane D-14 plus zinc sulfate at 2 qts. plus 1 lb. to 100 gallons were used, the Dithane combination was a little more effective than the Bordeaux. In vineyard No. 3 comparisons were made between Ferbam and SR406. The SR406 at 4-100 was almost as effective against black rot as Ferbam at $1\frac{1}{2}$ -100 but SR at 2-100 was distinctly less effective. In a vineyard at Rosati Ferbam at $1\frac{1}{2}$ -100 gave better control than 6-8-100 Bordeaux formula.

At Rosati tests were conducted on different methods of spraying grapes for the control of black rot. The methods used were (1) 2-nozzle rods, spraying down and up from underneath; (2) 2-nozzle rod, spraying down only; (3) 2-nozzle rod, spraying up from underneath only; (4) 4-nozzle rod from the ground; (5) 4-nozzle rod, riding the tank; (6) 4-drive nozzle rod riding the tank; (7) gun riding the tank; and (8) gun from the ground. Comparable amounts of material were applied by each method and all methods gave good control of black rot with no significant difference between the various methods.

Apples

No sprays were applied to Rome Beauty and Arkansas (Black Twig) trees until May 13, the time when the first cover was due. By that time scab was abundant on the foliage and some was showing on the fruit. Wet weather prevailed the remainder of the season favoring late scab infection. This provided the condition necessary for measuring the effectiveness of the organic mercurials in checking further spread of the disease.

Four special sprays were applied on May 13, May 20, June 5 and June 15. A general spray of Ferbam, 1-100 gallons, was applied on June 28 to all trees, except the unsprayed check. This was the last fungicide spray of the season.

Both Puratized Agricultural Spray and Tag were highly effective in inactivating established scab lesions, thus preventing further spread of the disease. There was no significant difference in the effectiveness of the two materials at comparable concentration of toxicant. The addition of sulfur to

Puratized and Tag reduced their efficiency in "burning out" scab. The combination was quite effective, however, where the number of scab lesions was not great. Counts of scab lesions on the fruit showed that a large number of infections occurred in the sulfur block after spraying was discontinued, that a small number occurred where sulfur was added to the Puratized and Tag and that there were very few late infections where the Puratized and Tag were used alone.

Pesticide Combinations

Tests were conducted with a number of pesticide combinations to determine the safety with which they might be used on apples. A summary of the results with the brands and formulations used this year is as follows:

1. Rhothane emulsion was used with parathion, Toxaphene, DDT, Methoxychlor (Marlate) sulfur and DN-111 on Jonathan and Golden Delicious without injury due to the combination. There was some spotting on Jonathan from the Rhothane-parathion combination but it was the same type as produced by parathion not in combination with Rhothane. With high temperatures there was sulfur burn on fruit and foliage from the sulfur-Rhothane combination but there was no indication of injury from the combination itself.

2. Diatox, another brand of DDD emulsion, was used in combination with DDT, Fermate and DN-111 also without injury.

3. Arathane in combination with parathion, methoxychlor (Marlate) Rhothane emulsion, Rhothane wettable powder and Fermate caused no injury.

4. No injury resulted from DN-111 used with Rhothane emulsion, methoxychlor (Marlate), Toxaphene and Fermate.

5. A summer spray oil, Superla with DDT caused severe injury and heavy leaf drop on Golden Delicious followed closely in severity of injury by Superla with Rhothane powder. Injury was somewhat lighter from a Superla-methoxychlor (Marlate) combination and no injury to a mere trace occurred where Superla and Toxaphene were used together.

Apple Foliage Injury from Chlorinated Insecticides

Severe apple foliage injury of the DDT type—a bronzing and yellow mottling occurred with certain chlorinated insecticide programs during the year. The season was unusually rainy and humid during late spring, summer, and early fall. Injury showed first on Golden Delicious about the middle of August. Within a few weeks much of the foliage had fallen and this was followed a little later by the premature dropping of most of the fruit. By early September, Jonathan trees showed definite symptoms of injury. Later the same injury appeared on all other varieties in the orchard including such varieties as York, Winesap, Rome, and Ben Davis. Golden Delicious was the most severely affected.

Economic damage occurred where DDT, Rhothane (powder), methoxychlor, lindane, parathion, and certain combinations of these materials were used as the insecticide in the calyx, first and second cover sprays in combination with wettable microfine sulfur followed in all cases by five summer applications of DDT and two TDE. Damage was most intense with methoxychlor followed closely by TDE and DDT and then by lindane. It was somewhat lighter with parathion. Where lead arsenate was used with sulfur in the calyx, first and second cover sprays in the place of the other insecticides, followed by the summer sprays of DDT and TDE, injury was very late in appearing and was of little consequence. Where Ferbam (Fermate) was used in the place of sulfur-lead arsenate combination, injury was late in appearing and was light in all cases. Injury was intermediate in severity where Tag was used as the fungicide. Lead arsenate and Ferbam and to a lesser extent Tag greatly delayed and lessened the development of a DDT type of injury from chlorinated insecticides.

Nutrition of Vegetables (R. A. Schroeder, V. N. Lambeth, E. R. Graham, and G. E. Smith). Approximately three acres were devoted to soil fertility studies upon cantaloupes at the Campbell Vegetable Experiment Field. The work was based upon the making of rather detailed soil tests and then calculating the degree to which each cation saturated the total exchange capacity of the soil. The experimental levels of 2.7, 5.4 and 8.1% of potassium; and 4.7 and 8.4% of magnesium were decided upon and the required amount of either potassium chloride or magnesium sulfate added to give the desired level. Nitrogen levels maintained were 66, 166 and 316 pounds per acre. Phosphorus was held constant at 265 pounds per acre while calcium was constant at 70.7% of the total exchange capacity of the soil. Trace elements in the form of Es-Min-El were added to $\frac{1}{2}$ of the treatments at the rate of 50 pounds per acre. The various levels of N, K, Mg and trace elements were combined in all possible combinations making a total of 30 treatments. Each treatment was replicated 5 times.

The results indicated that the balance of plant nutrients in the soil was of considerable significance in crop performance. In general, the higher level of K gave increased yields while the higher magnesium and nitrogen levels decreased yield. The single fertility treatment resulting in the greatest increase was the addition of trace elements. In gross terms, the yield in both number and weight of fruit was doubled.

Nutrition of Fruit Plants (A. E. Murneek). Effects of straw and hay mulches, as compared to sod culture, on the chemical and physical state of Grundy silt loam soil planted to Jonathan apples, were studied for two years by periodic sampling and analyses of the soil.

The mulched soil contained 2-10% more moisture in the 12-18 inch layer than sodded soil in adjoining plots. Largest differences in this respect

were after a relatively dry period. Under the mulch, the soil was cooler in summer and warmer in winter. The sodded soil warmed up more rapidly in the spring and was 7-9°F. warmer than mulched soil in summer.

Differences in available nutrients between the mulched and sodded soils were as follows:

- a. *Total nitrogen*: No significant difference.
- b. *Nitrate nitrogen*: Three times higher, in 0-6 inch layer, under hay and twice as high under straw as under sod.
- c. *Available phosphorus*: In 0-2 inch layer about 25 p.p.m. more under mulch than sod, in 2-6 inch layer 9 p.p.m. more, but little difference in available phosphorus under the three soil treatments at greater depths (down to 24 inches).
- d. *Replaceable potassium*: In 0-6 inch layer, about 15 mg. per 100 grams of soil more in mulched than sod soil. Even the 6-24 inch layer of the mulched soil contained about 4 mg/100 grams more replaceable potassium.
- e. *Replaceable calcium*: The sodded soil contained approximately 30 mg/100 grams of soil more replaceable calcium in the 0-6 inch layer than the mulched soil. At the greater depth of 12-18 inches, this was reversed, for the mulched soil was found to contain 65 mg/100 grams soil more replaceable calcium than soil under sod.

Physiology of Reproduction of Horticultural Plants (A. E. Murneek, and D. D. Hemphill). Research work was continued on the use of synthetic growth-regulating chemicals (plant hormones) to improve the set and size of greenhouse-grown tomatoes. Hormone sprays, if properly applied, can increase fruit yields 15-40% on greenhouse tomatoes. Likewise the set of fruit can be improved on the first two clusters of field-grown plants, which are planted in April for early fresh fruit production, when the weather is cool and hormones are effective.

Studies have been continued with the "Missouri Method" of pruning staked tomatoes, by means of which the leaf area per fruit is increased, which helps to augment the yield. The use of "hormone sprays" together with this new pruning method has increased greenhouse tomato yields as much as 50%. This pruning method alone usually increases yield 15-25%.

Para-chlorophenoxyacetic acid, first used and recommended by the Missouri Experiment Station, is now the most widely used of the fruit-setting hormones. New growth-regulating chemicals are being tested, but so far none have proven superior to p-chlorophenoxyacetic acid.

Fruit from hormone-treated plants have been reported in some cases to be softer than from untreated plants. Results obtained to date indicate that the time of application of hormone sprays is an important factor in their

use. Softness appears to be correlated with seed content of the fruit and time of treatment with the hormone in relation to stage of flower development. The important factor is the forming of as many functional seeds as possible in the fruit. Hormones, therefore, must be used only as supplements to the process of pollination and fertilization, not as substitutes for these natural processes, as has been emphasized repeatedly by the Missouri Experiment Station. When applied before pollination and fertilization they tend to interfere with embryo formation and development with the result that few viable seeds will be present in the fruit. The tomato flower cluster should not be treated with the hormone until 3-5 flowers have been pollinated.

Previous work has shown that extracts of young corn kernels will set seedless fruit of tomatoes and peppers. Research was continued at Missouri to investigate the exact nature of this substance "syngamin" in the young seed. It is a natural occurring hormone. Further purification of it is in progress.

Relation of Temperature Precipitation and Light Intensity to Fruit Pollination, Fruit Setting, and to the Influence of Hormone Sprays on Horticultural Crops (A. E. Murneek, D. D. Hemphill, Jack F. Ellis, and Wm. D. Treese). Studies were conducted to determine the relation of total solar radiation to yields of tomatoes grown during different seasons of the year. This investigation was initiated to further explore the reason why yields of fall and winter crops are noticeably smaller than those of spring and summer crops. Low yields of fall and winter crops are usually attributed to poor set of fruit. However, when this is increased by hormone sprays, yields never equal those of spring and summer crops. This suggested sunlight as an important factor, and it was decided to determine how closely yields are correlated with total solar radiation during the fruiting period.

Four crops of field grown tomatoes and several crops of greenhouse tomatoes which fruited at different seasons of the year were included in this study. Solar radiation determinations were made with an Eppley pyrheliometer, an official U. S. Weather Bureau instrument, which was located at the horticultural greenhouse.

Results of the study showed that as total radiation increased, the fruit yield increased, and the efficiency of utilization of the available light was lowest also. Plants which were fruited during the period from November 21 to April 14 required 2.8 gram calories for each gram of fruit produced by ten plants whereas plants fruited during the period February 26 to June 12 required 2.0 gram calories for each gram of fruit produced by ten plants.

In the production of greenhouse tomatoes, where optimum nutrient supply, moisture supply, and temperatures were maintained, it was found that light became the most important factor in determining yields. As the total amount

of sunlight during the fruiting period increased yields correspondingly.

For field grown tomatoes an excellent correlation was established between yields and total solar radiation.

POULTRY HUSBANDRY

H. L. KEMPSTER, *Chairman*

Maintaining Quality in Fresh Eggs (E. M. Funk, Martha Lorah, and James E. Forward). These tests were to determine the cause of stuck yolks and spoilage in stabilized eggs stored at 55°F. and short-held. Missouri Agricultural Experiment Station Research Bulletin 426 "Experiments in Cleaning Soiled Eggs for Storage" has been published. Eggs were treated as follows:

- a. Thermostabilized in water (15 minutes at 130°F.)
- b. Thermostabilized and oil-processed in sterile oil, cooled immediately at 32°F. before casing.
- c. Stabilized and oiled, held at 100°F. for 24 hours before casing.
- d. Natural eggs.
- e. Soiled eggs washed on washing machine.
- f. Soiled eggs washed and then stabilized.

After treatment the eggs were short-held at 55°F. and weekly observations by candling and breaking were made. The eggs were scored by the Cornell score.

In general, the eggs of better quality at time of treatment kept best in storage. The treated eggs which were immediately cooled after treatment kept better than did those cased immediately after treatment or those held at 100°F. for 24 hours after treatment. Washed eggs possessed inferior keeping qualities and the soiled eggs of better quality kept longer after washing than did the eggs of lower grade.

It appeared from these tests that eggs for stabilizing should be of good grade and that the warm eggs following stabilizing should be cooled before casing.

It was found that the lower the grade of the eggs the greater the number of bacteria in the eggs. Stabilization of the eggs at 130°F. for 15 minutes, and at 130°F. for seven minutes plus 136°F. for seven minutes, reduced the numbers of bacteria but did not completely pasteurize the eggs.

Oil processing maintained higher egg quality but increased the incidence of mold penetration.

Escherichia coli, *Aerobacter aerogenes*, *Alcaligenes faecalis*, *Proteus mirabilis*, *Bacillus subtilis*, and *Mycoides* were the predominant bacteria causing the spoilage. *Pseudomonas fluorescens* caused a great part of the loss in the eggs that were not stabilized.

The *Penicillia* and *Aspergilli* were the predominant molds present. Species of *Mucor*, *Rhizopus*, *Streptomyces*, *Alternaria*, *Cladosporium*, *Tricothecium* and *Oidium* also were isolated.

Rations for Growing Chicks (Quinton B. Kinder and Frank Murray, Jr.) Eight rations were arranged to test the need for riboflavin where alfalfa leaf meal was omitted from the ration, and also, to see how the addition of proteins of animal origin affected this need and promoted chick growth.

The eight rations were developed from a basal ration containing an all vegetable protein (soybean meal) by the addition of riboflavin, fish meal, meat scrap, and combinations of these. These rations were:

Basal, all soybean protein ration.

Basal, + 120 mg. riboflavin per 100 pounds.

Basal, + 2% fish meal — 2½% soybean meal.

Same as 370 + 120 mg. riboflavin.

Basal + 4% fish meal + riboflavin (— 5% soybean meal).

Same as 372 with no riboflavin.

Basal + 2% dried milk + 2 % fish meal (— 4% soybean meal).

Basal + 7% meat scrap (— 7% soybean meal) + 100 mg. riboflavin.

The following results were observed from the 50 chicks on each ration:

The basal ration was discontinued after four weeks as the riboflavin deficiency was very marked as shown by poor growth rate, curled toe paralysis, and nervous conditions of the chicks. However, crystalline riboflavin added to this ration at four weeks allowed the birds to make a recovery of most of their growth rate by eight weeks of age. Fish meal at 2% levels only delayed onset of curled toe paralysis 2 - 4 days. This group was carried to eight weeks without supplement of riboflavin to the ration and showed that the incidence of curled toe paralysis increased throughout the entire period. Four per cent fish meal and no additional riboflavin showed similar results; in fact, a slightly lower growth rate may indicate a greater need for riboflavin where fish meal is fed. The ration containing dried milk and fish meal gave the best results. This may indicate a value in milk when fed with fish meal that cannot be attributed to riboflavin alone. On the other hand, the ration with meat scrap and riboflavin showed very little superiority over the all soybean protein ration with riboflavin.

Another series of rations used in tests during the year was a comparison of crystalline riboflavin and fermentation solubles (BY21) in all vegetable protein rations and in rations with animal protein and Animal Protein Factor (A.P.F.) supplements. Ten rations were selected using a wide range of combinations, and duplicate lots of 25 each of heavy breed chicks were used on each trial. A summary of the results showed that:

Very little difference was noticeable in growth rate between soybean rations and rations where part of soybean meal was replaced by meat and bone scrap regardless of source of riboflavin.

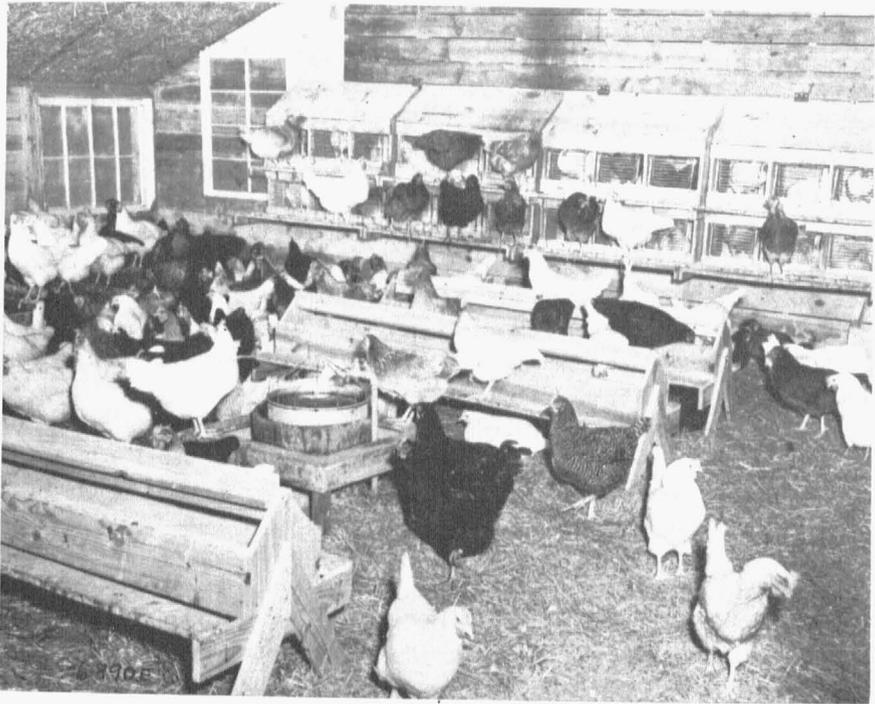
The efficiency of feed per pound gain was higher where some animal protein was used (except a 1% level of a commercial vitamin supplement to supply the riboflavin and Vitamin D apparently was not sufficient for efficient gains). This was more pronounced where fish meal and A.P.F. supplement was used than where meat scrap alone was used.

There was no advantage of distillers' solubles (BY21) on this group of rations over the crystalline form of riboflavin.

Rations containing animal protein that contains B₁₂ or the Animal Protein Factor showed greater efficiency in feed per pound of gain than rations that were deficient in these growth factors.

Systems for Breeding for Performance in Poultry (G. E. Dickerson, H. L. Kempster, Q. B. Kinder, W. F. Krueger, Frank Murray, Jr., Bertha Jean Shaffer, and Claude P. Howard). This experiment of the Poultry and Animal husbandry departments was in cooperation with the Regional Poultry Breeding Project including the United States Department of Agriculture and the experiment stations of the North Central Region.

The objective is to develop more effective methods of breeding for maximum performance in poultry. The methods used are: (1) Intra-flock selec-



The Poultry Husbandry Department is seeking more effective methods of breeding for maximum performance in poultry. This year nearly 800 crossbred test-progeny from 21 lines were utilized for experiments.

tion with minimum inbreeding; and (2) Recurrent selection for maximum performance in strains. In addition, a control flock of outcrosses and cross-breeds was maintained.

A total of approximately 300 pullets have been used in the outcross and crossbred part of the experiment.

A new 40-pen breeding house (20' x 126') for 480 birds was completed and is in use. Also, a new laying house (104' x 24') with 4 pens, 24' x 24' was completed and now houses 800 crossbred pullets. Nine new range shelters also were constructed for rearing the spring hatch.

Comparison of Breeds in Linecross Matings

In the intra-breed matings, hatchability of fertile eggs was highest for Leghorns and poorest for Reds with Hampshires and White Rocks intermediate. Viability from hatching to 22 weeks was highest for Hampshires and lowest for Reds. Total viability to 22 weeks of fertile eggs was highest for Hampshires and Leghorns with White Rocks slightly lower and Reds much lower. In chick weight and growth to 22 weeks, Hampshires excelled with Reds and Rocks intermediate and Leghorns lowest. In egg production and viability from 154 to 300 days, the Leghorns and New Hampshires were tied for top place. The Rhode Island Red families were low in viability and the White Rocks low in egg production, so that Reds and White Rocks were similar in egg production.

Breed-Crosses and Inter-breed Crosses

Performance of each breed-cross has been recorded for all families and with reciprocal combinations combined. The mean for each breed-cross has been compared with the mean of the two parent breeds in within-breed linecrosses. Crossbred superiority was indicated in hatchability and viability to 22 weeks, as well as in body weight at all ages and in conformation scores at 12 and 22 weeks. In crossbreds, keels were slightly longer and shanks slightly shorter at 22 weeks, and the ratio of body weight to shank length was slightly higher than in the purebred birds.

Up to 300 days of age, the Leghorn-Hampshire cross was slightly superior to the Leghorn-Red cross in egg production; the former was better in egg production but the latter was better in adult viability. The Leghorn-White Rock crosses were lower in both respects.

Heterosis in pullet performance to 300 days (production per hen housed) averaged 11-12 per cent in the Leghorn crosses with New Hampshires and Rhode Island Reds, but only about 4 per cent in Leghorn-White Rock crosses since viability in this cross was poorer than in the parental breeds and production of survivors was only 6 per cent above parental breeds. Exceptional pullet performance was obtained from exploratory crosses of 2 Leghorn lines on Delaware hens. The 112 eggs in 146 days amounted to 77 per cent production from 154 days of age for the 9 pullets surviving. Some individual

combinations of Leghorn-Hampshire and Leghorn-Red lines also have given pullet performance at about this level.

The fact that crossing relatively unrelated strains of the same breed produces some heterosis was demonstrated by the higher pullet performance obtained from the average of all linecrosses within each breed using pullet breeders as compared with that from regular flock matings of older breeders which were carefully selected on the basis of full-year individual and family performance records and part or full-year progeny tests. The difference favoring intra-breed linecrosses was greatest (about 20 per cent) in New Hampshires and White Rocks but was important (about 10 per cent) in Leghorns and Rhode Island Reds.

Selection Between Families

Of the 21 Leghorn lines tested in breed crosses the best 5 lines in each breed cross have been retained for retesting and for intercrossing among themselves to provide segregating progeny for the next cycle of selection between individual breeders on the basis of progeny performance in a given breed cross. A total of 9 Leghorn, 4 Hampshire, 3 Rhode Island Red, and 2 White Rock lines have been retained and have been mated to produce the test-crosses, intra-breed crosses of selected lines, and inbreds of these lines. In addition, 6 new Leghorn lines, 2 new Rhode Island Red lines, and 1 new White Rock line have been included in the test-crosses. Also, a number of additional Red, Hampshire, Delaware, and Leghorn lines have been introduced through imported hatching eggs.

Carcass Desirability

Crossbred males were slaughtered at 12 weeks and carcass data obtained. Differences between crossbred combinations were small in dressing percentage, score, and carcass quality. Small numbers of Hampshire X Barred Rock and Rhode Island Red X Barred Rock indicated somewhat higher dressing percentages but prevalence of black pin feathers reduced the carcass score. Rhode Island Red X White Rock crosses were similar in these respects. Family crosses within the Leghorn breed, although lighter in weight, compared favorably with crossbreds in most respects.

Egg Quality

Data on exterior and interior quality of eggs produced by breeding hens were obtained. In egg weight Hampshires were highest followed by Rhode Island Reds, White Rock, and Leghorn. Hampshire and Red eggs were definitely longer than those from Leghorn and White Rock while New Hampshire eggs were characteristically long and narrow compared with eggs of the other three breeds. Rhode Island Red eggs were inferior in shell texture grading only 63% as compared with about 80% for most of the other three breeds. New Hampshire eggs were inferior in albumen characteristics compared with the other breeds. In yolk there was little difference between the breeds.

In blood and meat spots the Leghorns were strikingly superior having only 9% of all eggs affected compared with 42%, 45%, and 61% for Hampshire, Reds, and Rocks, respectively. The differences in the number of blood and meat spots on the affected egg were not so large but again Leghorns were superior. The number of medium or large spots which would be detected by candling was quite similar for all four breeds.

RURAL SOCIOLOGY

C. E. LIVELY, *Chairman*

Effective Methods of Assisting Low Income Farmers (C. E. Lively, Herbert F. Lionberger). This study has been concerned with the contacts which low-income farmers have with potential sources of farm and home information and the factors which appear to condition them. The farmers surveyed had fewer personal than impersonal contacts with potential sources of farm and home income.

Only 31 per cent of the farm operators belonged to a farm organization and less than one-third conferred with a county agent during the survey year. Less than 9 per cent had any direct contact with the F.H.A. office and only about 3 per cent conferred with a vocational agricultural teacher. Approximately two-thirds of the farmers had participated in some phase of the Production and Marketing Administration program and the most personal contact was with this office.

On the other hand 95 per cent took one or more newspapers and 69 per cent subscribed to one or more farm magazines. About 40 per cent obtained U. S. D. A. or College of Agriculture bulletins although less than half that number received them by request. Two-thirds of them listened to radio stations from which farm and home information could be obtained.

Contacts through commercialized channels of communication were more frequent than contacts with public agencies including the College of Agriculture. Over twice as many households subscribed to newspapers as secured farm bulletins; over four times as many subscribed to newspapers as secured farm bulletins by request. The number taking farm journals exceeded the number getting bulletins by 29 per cent. Radio contacts were far more prevalent than contacts with the county agent or with farm bulletins.

Reading and radio contacts were affected less by communicative barriers than personal contacts. Location on or off an all-weather road, ownership or non-ownership of automobile or truck, and ownership and non-ownership of telephone had little to do with the number of reading and radio contacts experienced. On the other hand presence or absence of such facilities, other than the telephone had a marked influence on the number of personal contacts. Furthermore, subscription to farm journals and listening regularly to radio stations from which farm information could be secured were less influenced by communicative barriers than contacts with farm bulletins.

In the absence of a clear-cut definition and analysis of social class in rural Missouri, there is no way of knowing to what extent such barriers restrict contacts with potential sources of farm and home information. However, since the farmers interviewed in this study had lower incomes than their neighbors and since income is a recognized correlate of social class, a certain amount of class isolation may be assumed. Diffusion of information from college to farmer via the personal contact route was subject to the limitations of class and clique-imposed associational patterns. Mass communication media on the other hand were little influenced by such factors. It is therefore possible that part of the isolation experienced by the low-income farmers is a function of social distances which restrict free and spontaneous association and which cause the so-called "little farmer" to feel that he has little in common with his "big farmer" neighbor.

Prevailing habits of contact with potential sources of farm and home information suggested that a large percentage of the survey (low-income) farmers can be most readily reached by radio, newspaper, and farm journals. About 40 per cent of them obtained farm bulletins during the survey year. Although reading and radio contacts were more common than personal contacts, a considerable number have more or less established personal contacts through which farm and home information is readily available.

In view of the close association between farm income and contacts with potential sources of farm and home information on the one hand and years of schooling completed on the other, increased effort to educate low-income farm youth seems essential. The favorable attitude of low-income farmers toward education for farming and their own desire for more information is encouraging.

A complete report of this study has been made in Missouri Agricultural Experiment Station Research Bulletin 441, "Low Income Farmers in Missouri." An analysis of the use made of farm and home information has been started.

Rural Community Trends (C. E. Lively, and Lawrence M. Hepple). The work on this investigation has consisted of two parts: (1) completion and final preparation for publication of the Shelby County study entitled, Missouri Agricultural Experiment Station Research Bulletin 456 "Social Change in Shelby County, Missouri" and (2) verification, reorganization, and revising a manuscript in cooperation with the Bureau of Agricultural Economics entitled, Missouri Agricultural Experiment Station Bulletin 458, "Rural Social Organization in Dent County, Missouri." With the publication of these manuscripts, this phase of this investigation has been completed.

Rural Population: Its Characteristics, Trends, and Implications For Agriculture, the Labor Force, and For Rural Life (C. E. Lively). A study has been made of the latest figures on the number and distribution of the aged

(65 or over) in the rural-farm and rural-nonfarm population. It has been learned that great variation occurs in the proportion of aged persons in the various counties of Missouri.

In general, the more populous counties have more old people and vice versa, but the smallest proportions of aged persons were found in the Ozark and Southeastern delta counties. The highest percentages of aged persons live in the better agricultural counties. These generalizations were true of both the rural-farm and the rural-non-farm population. The proportion of population who are aged in the rural-farm population was correlated with the proportion of aged in the rural-non-farm population. However, migration from farm to village for retirement purposes makes the proportion higher in the rural non-farm population.

In order to prepare for later field work on the circumstances surrounding the retirement of farmers and the problems encountered subsequently, a schedule was prepared and a trial run conducted in the nearby village of Ashland, Boone County, Missouri. A complete census of aged persons was taken and the number of schedules collected was 70, consisting of 29 for males and 41 for females.

Two popular bulletins "The First Hundred Years Are the Hardest" and "Eleven Million Grandparents" were prepared for the Department of Adult Education. Several thousand copies were distributed.

The Rural Social Areas of Missouri (C. E. Lively and C. L. Gregory). Core areas, which appear to be hearts of centers representing extreme positions in the culture of the State were established. This work has led to an appraisal of the surrounding area to determine the loss of homogeneity as distances away from the core areas were increased.

Another phase of the work was the establishment of a standard of variation from which can be judged the validity of a delineation. The approach has been an examination of the total variation in the State and a comparison of this total variation with that existing among and within the social areas.

From the present stage of work, it appears that considerable improvement in methods can be expected. Many of the techniques that have been loosely defined and not capable of repetition have been reduced to more exact methods that can be tested by other research workers. This should result in a more accurate description of the cultural variation in the State. Sampling should be greatly facilitated; and action programs more uniformly constructed and administered within their prescribed areas. Officials of the State Library Commission have used some of the results of this work to establish homogeneous areas for regional libraries. The State Welfare Division has used the method to establish district administrative units. In addition,

the United States Bureau of the Census utilized these results to establish census districts for more detailed tabulation and analysis of population and agricultural data collected in the 1950 census.

Rural Health Facilities in Missouri and the Factors Affecting Their Use (C. E. Lively, Robert L. McNamara, and John B. Mitchell). During the Spring of 1949, about 1600 family schedules were taken in twenty counties from two distinct socio-economic areas of the State. The families interviewed comprised an approximate six per cent of the farm families residing in the sample counties.

The first stage of the study has been planned to establish a reliable procedure so that morbidity in the farm population may be measured and related to its socio-economic correlates. The study has demonstrated, without question, that extreme variation exists with respect to morbidity as affected by the age, sex, and level of living of the population studied.

Preliminary findings revealed that much illness occurs to the farm population. Nearly one of every ten farm persons in the areas studied can be expected to be incapacitated (disabling illness) on any one day and fully one-third of the farm people included in the study were suffering to some degree from some chronic illness. During the month of March, 1949, the adult farm population lost, on the average, about three days per person because of disabling illness, that is, confined to bed or the house, or otherwise unable to do regular work.

The data showed high promise of forming a basis for determining health facilities and personnel needed to provide farm people with general health services and for establishing an index for morbidity on a continuing basis. For the first time information has become available with respect to time lost from work because of illness and how that is affected by and related to the significant measurable characteristics of the farm population.

SOILS

W. A. ALBRECHT, *Chairman*

The Relation of Climate to Important Aspects of Missouri Agriculture—Determination of Freeze Hazards for Fruit Orchards, Truck Farms, and Other Crops (Wayne L. Decker and M. F. Miller). This project is cooperative between the Missouri Agricultural Experiment Station and the United States Weather Bureau. Several departments of the Experiment Station are represented on a committee which directs this work.

A plan has been developed for the summarization of weather data affecting agriculture by months and weeks by the use of punch card methods. Using these summaries it will be possible to compare the expectancies of weather occurrences between stations and between regions.

Freeze Hazards to Tender Crops

Work designed to gain a more complete understanding of the weather hazard to the growth of tender crops in the state has been started. Several problem areas have been outlined within the state, and concentrated effort has been made on data from these areas. These problem regions include the areas around St. Louis and Kansas City, where both truck gardens and orchards are prevalent; the fruit regions of central Missouri; and the vegetable canning areas of southwestern Missouri.

The St. Louis area has been chosen for a pilot project because of the density of meteorological stations in the area, and because of the value of affected crops grown. Also, some exploratory work has been completed in the St. Louis area.

Water Utilization of Crops in Relation to Solar Radiation (C. M. Woodruff). Soil moisture measurements were made under crops of corn, alfalfa, sweet clover, red clover, lespedeza, soybeans, and bluegrass at weekly intervals from June 17 to July 29, with the expectation that during this period there would occur a two-week period without rain in which case it would be possible to evaluate the relative quantities of water removed from the soil by different crops. However, the season of 1949 was characterized by numerous well-distributed rains so that the soil remained excessively wet most of the time and in no instance did the moisture content of the soil drop below the optimum level for the growth of crops.

Improvement of the Fertility Level of Missouri Soils (G. E. Smith, C. E. Marshall, E. R. Graham, F. R. Johnson, C. M. Woodruff, and Wm. A. Albrecht). A survey of the copper and cobalt contents of some Missouri soils was made. Twenty-six different Missouri soils were selected for this test, and the copper content was determined by three different methods. These were spectographic, chemical, and biological. The cobalt content was determined with two different methods: spectrographic, and chemical.

The copper content of the soils varied widely and the results placed them within three groups. Samples of Ashe, Bates, Huntington, Cherokee, Sharky, Crawford, Grundy, Osage, and Newtonia were classified in the medium groups. Oswego, Waverly, Putnam, Memphis, Hagerstown, Knox, Union, Lintonia, Clarksville, and Lebanon were classified in the group of low copper contents. Samples of Union, Lintonia, Clarksville, and Lebanon were found to be low in both total and available copper. Samples of Memphis and Hagerstown were low in total copper, but were medium to high when examined by the biological test.

The results of the cobalt study revealed the following: Samples of Ashe, Crawford, and Tilsit were classified as of very high cobalt content; Hagerstown, Wabash, Grundy, Lebanon, Marshall, Shelby, Union, Huntington, Bates,

Cherokee, Sharkey, Lintonia, Sarpy, and Osage, were classified as medium; and samples of Lindley, Summit, Putnam, Knox, Memphis, Waverly, Oswego, and Clarksville were classified as low.

Weathering of Soil Minerals

In order to understand better the relationship which the soil minerals in the course of their decomposition have with plant growth information regarding the rates of weathering of some soil minerals and the resulting effects on the growth of specific plants is needed. A start on this problem has been made using feldspars.

Samples of a complete series of plagioclase feldspars were collected and weathered by subjecting silt size particles to the weathering action of electro-dialyzed hydrogen clay. After approximately 100 days, the ions released from the feldspars were determined. Silt size minerals isolated from several Missouri soils were studied for their content of plagioclase feldspars.

The different weathering rates of the feldspars corresponded to the content of calcium. Anorthite, the mineral of highest calcium content, weathered most rapidly and the others followed in series according to calcium content.

It was found that albite was little affected by the action of hydrogen clay. Consequently, it can be considered extremely resistant to weathering action in the soil. On the other hand, bytownite and labradorite released significant quantities of both calcium and sodium during the short weathering period.

In terms of the feldspar content of the silt fraction of Missouri soils, the Ozark Region showed a degree of weathering much higher than north Missouri.

Maintaining Fertility With Continuous Corn

It has been found that more fertility was returned to the soil in the corn stalks of a 100 bushel crop of corn than was released from a soil which was not capable of producing more than 50 bushels per acre without soil treatments. Such soil, treated to produce 100 bushels per acre, should improve under corn rather than deteriorate.

The first year of this study, 1948, was characterized by ideal conditions for the release of fertility from the soil. Corn without treatment yielded 75 bushels per acre while the fertilized corn yielded 107 bushels per acre. The year 1949 was less favorable and corn receiving moderate amounts of fertilizer (30 pounds N per acre) yielded only 46 bushels, while adequate soil treatments produced 102 bushels per acre from land in corn for the third consecutive year. A measure of the nitrate nitrogen remaining in the soil in December after the crop was harvested showed a total of only 12 pounds per acre six inches in the soil that produced only 46 bushels, and 57 pounds of nitrate nitrogen in the soil that produced 102 bushels of corn per acre.

The moderately low yields of corn that have occurred for years on Missouri upland soils have been traced to deficiencies in the fertility of the soil. When adequate amounts of fertility were supplied, phenomenal yields resulted. Corn planted the third consecutive year on the University South Farms yielded 102 bushels per acre where 300 pounds ammonium nitrate, 250 pounds 45% super phosphate, and 200 pounds 50% muriate of potash were drilled in and plowed under the first week of May. The yields on this same land dropped to 47 bushels per acre when moderate applications of only nitrogen fertilizer (100 pounds of NH_4NO_3) were used. Corn receiving 100 pounds per acre of ammonium nitrate fertilizer "fired" even though rains were ample and well distributed throughout the growing season. When nitrogen was supplied in quantities required to produce 100 bushels per acre of corn the stalks remained a healthy dark green color until the corn matured and the yields obtained were equal to expectation.

Apparently each bushel increase of corn above the normal level of production required two pounds of nitrogen supplied through fertilizers.

Minor Soil Elements (W. A. Albrecht, E. O. McLean, A. W. Klemme, and Fred Koehler). Research on minor elements and trace minerals has been receiving more attention and during the past year New Zealand rabbits were used to assay corn grain grown on Putnam silt loam: (northeast Missouri) (a) without treatment; (b) with major elements as soil treatments; and (c) with both major and trace elements in the fertilizers.

The feed intake by the animals was kept constant in all cases, and gains in weights were not significantly different. Observations of external characteristics and of the internal organs were made. There were very noticeable differences in the internal organs. In all cases where trace elements had been added to the soil on which the grain was grown, the livers appeared normal in all respects. Without the trace element treatments on the soil, the rabbit livers were smaller in size, soft and pulpy in texture and darker (approaching black) or lighter (approaching yellow) in color.

The livers were weighed, dried, and ashed at approximately 425°C. and spectrographic analyses made of the ash. No cobalt was found in any of the livers of the 14 animals sacrificed (5 each of check, and fertilizers plus trace elements, and 4 of fertilizer only). This suggests that there is less than one part of cobalt per ten million parts of liver tissue.

Evidence of changed physiology of the animal as a result of treatments on the soil on which the feed crop was grown was gathered in connection with the use of major nutrient elements. By adding lime and phosphate to the soil, the bones of the rabbits fed the forages grown on the soils so treated were significantly longer, heavier, thicker of wall and stronger under stress.

Blood samples from 14 dairy cows pastured on the Eldon and Newtonia silt loam soils of southwest Missouri were ashed and this fraction analyzed

spectrographically. In none of these was any cobalt detected. The copper content of blood varied from .07 to .172 parts per million; the manganese from .04 to 0.9, and the zinc from .43 to 4.6 parts per million.

Three cuttings of alfalfa growing on these soils as dairy feeds, with a total of 12 samplings, were also subjected to spectrographic examination. They represented different soil treatments including fertilization both with and without the trace elements in the complete treatment. In only one sample was any cobalt detected. This was a case where trace elements not including cobalt had been applied on the soil. However, no cobalt was shown by six other alfalfa samples on the soils given the same treatment of trace elements in various fertilizer combinations. The copper content of this forage varied from .16 to 15.8 parts per million; the manganese from 27 to 193; and the zinc from none to 15.5 parts per million.

Some of the soils from plots on Sanborn Field also were analyzed spectrographically to learn how the long continued treatments may have modified the total supply of trace elements.

Soil Survey and Land Classification (H. H. Krusekopf, J. A. Frieze, and C. L. Scrivner). Soil survey was continued with limited personnel and Daviess County was completed and Boone County almost completed.

In addition to detailed surveys in counties, special land classifications were made of the Wappapello Reservoir Area on the St. Francois River; levee districts in the Missouri River valley; and of the bottomland in the Grand River basin. These special surveys were made as a part of the flood control study program which is evaluating the effects and benefits from proposed and existing flood control projects.

Investigation of Nitrogen Fixation (E. R. Graham and W. H. Longstaff). Soybeans normally are high in magnesium, but often suffer because of a deficiency of this element in the soil. The necessity for adding magnesium to soils by using magnesium bearing mineral, especially dolomitic limestone, is increasingly evident.

As a consequence the following magnesium minerals were used, namely dolomite, magnesite, olivine, hornblende, and talc, of silt size mixed with electro-dialyzed hydrogen clay and allowed to weather for several weeks. After this weathering interval, nutrients other than magnesium were added to the mixture. This mixture of magnesium mineral and clay was added to acid-leached quartz sand, and allowed to dry to optimum moisture content. Inoculated soybean seeds, comparable to samples of seeds analyzed, were planted in these mixtures. After a growing interval of six weeks the plants were harvested, dry weights determined, and the plants analyzed chemically.

The test showed that magnesite, olivine, and dolomite released magnesium to the clay system in amounts sufficient for the normal growth of

soybeans while hornblende and talc were resistant to hydrogen clay weathering, and to plant root activity resulting in magnesium-deficient plants.

The magnesium contents of 50 harvested soybean plants for these mineral treatments were as follows: no magnesium mineral 16.0 mgms., hornblende 17.5 mgms. olivine 47.1 mgms., talc 21.2 mgms., magnesite 41.8 mgms., and dolomite 51.8 mgms.

Nitrogen fixation was found to be influenced by the addition of magnesium minerals. The amounts of nitrogen contained in 50 harvested soybean plants was as follows: check 304 mgms., hornblende 330 mgms., olivine 407 mgms., talc 307 mgms., magnesite 445 mgms., dolomite 410 mgms. Plants receiving no magnesium minerals, talc, and hornblende showed definite visual symptoms of magnesium deficiency while plants receiving dolomite, magnesite, and olivine were normal, healthy plants.

Release of Nitrogen by Soil Organic Matter

A study was made of changes in the organic matter level as reflected by the nitrogen content of the soil. Results showed that the average removal of nitrogen from the soil through crops amounted to the following:

Crop	Pounds Nitrogen
Corn, per bushel, in both stalks and grain	2
Wheat, per bushel, in both straw and grain	2
Oats, per bushel in both straw and grain	1
Timothy hay, per ton	20

The delivery of nitrogen from the organic matter supplies in the soil amounted to the following values as percentages of the total nitrogen present in the soil at the time of that crop.

Crop	Delivery of nitrogen (% of total in plowed soil)
Corn	2
Small grain	1
Meadow	$\frac{3}{4}$

It was found that the value of barnyard manure as a supplier of nitrogen to the immediate crop to which it was applied amounted to only 3 pounds of nitrogen per ton of manure. The principal value of manure was found to be due to the cumulative effect over a long period of years. Nearly 70 per cent of the manure applied to the land went into the organic matter reserves of the soil from which the nitrogen was released at the rates associated with the more stable humus. After 60 years of cropping land to corn with six tons manure annually, approximately half of the organic matter in the soil was that originating from the manure.

Crop Rotations and Fertilizer Experiments (G. E. Smith, E. R. Graham, Wm. A. Albrecht and C. M. Woodruff). Sixty years of soil treatments and cropping systems on Sanborn Field show that crop rotations serve only to slow the rate of depletion below that resulting from continuous planting of cultivated crops. Rotations, regardless of length, with unbalanced or inadequate soil fertility additions are producing crops at lowered levels.

Soil tests reveal close correlations between fertility reserves and crop production. Not only has exploitative rotation cropping reduced levels of the major plant nutrients but spectrographic analyses show the supply of trace elements has been reduced in some cases.

Magnesium deficiency has influenced crop yields where a high calcium limestone has been used for the last 25 years. On plots that have been in a 2 year rotation of corn, wheat, and sweet clover for this period, the available magnesium has reached a low level. In 1949 these plots produced 8.5 bushels less wheat per acre than where the soil had not been limed and no sweet clover grown.

Rock phosphate and superphosphate have been compared in a six-year rotation for a period of 35 years. In the early years of the comparison, superphosphate gave superior yields of grain. In the last rotation, however, the average yield of grain on the rock phosphate plot was 6.1 bushels larger, the yield of clover was increased 450 pounds, and the yield of timothy was 720 pounds greater.

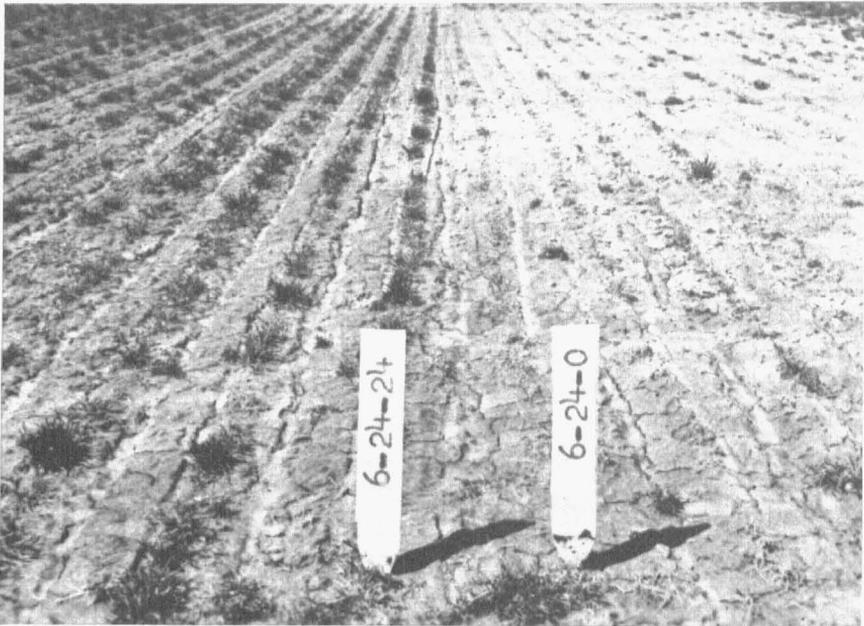
The loss of nitrogen from the soil where crops were grown continuously on separate plots is contrasted with the loss of nitrogen from the soil where the same crops were grown in rotations in the following table.

LOSS OF SOIL NITROGEN AS A RESULT OF CROPPING
ON SANBORN FIELD

Crops Grown	Cropping System	Pounds of N lost per acre	
		Untreated	Manured
Corn wheat, Timothy meadow	Continuous cropping on separate plots	1427	548
	Three year rotation	1445	690
Corn, oats, wheat and three years of timothy	Continuous cropping in separate plots.	1150	386
	Six year rotation	1335	400

Soil fertility experiments at the University South Farm are showing increasing nutrient deficiencies where plant food additions are not equal to,

or greater than, the amounts used in the crops. In experiments where potassium applications gave no response for several years, the soil reserve of this nutrient has now been reduced significantly, and applications of this element are necessary to secure a response from phosphorus. Lodging of corn has been severe from a potash shortage, particularly where the corn has received heavy nitrogen fertilizer. During the winter of 1949 there was severe winter-killing of small grain. Where the fertilizers contained no potassium, the injury included more than 90 per cent on many areas. Where adequate potash was applied the killing was much less severe. Mixed fertilizer that contained nitrogen also greatly reduced the loss from winter injury.



Deficiencies in soil fertility more than bad weather explain so-called "winter-killing" of wheat. Here is shown the difference when ample potassium (at left) is added to the soil.

The Characteristics and Development of Heavy Clays in the Soils of Missouri (C. E. Marshall, E. R. Graham and E. O. McLean). In mixed calcium-potassium clays it has been found that the mutual influences of these cations were very significant. In all the clays examined the potassium ion activity was considerably enhanced by calcium. The effect of potassium on the calcium activity varied considerably according to the clay used. These effects were natural consequences of the previously established fact that single cations were held on clay minerals with a wide range of bonding energies.

The practical aspects of these results are found in effects of liming and potash fertilization on crop response. Through them one can better understand why liming has an effect on the potash nutrition of plants and potash upon the calcium nutrition. The work is being carried out in a similar way for potassium and magnesium and a study of soil organic matter has been started similar to that carried out on the clays.

The purpose of the cataphoretic study is to learn more of the surface conditions of clay minerals in relation to such effects as coagulation, stability of suspensions, etc. In the progress of this work the treatment of clays with salts of polyvalent cations has shown very great differences between different minerals so that methods of separation can be based upon them.

Soil Management for Important Soil Types in Missouri (W. A. Albrecht, E. R. Graham, A. W. Klemme, G. E. Smith, and C. M. Woodruff). Several experiment fields are in operation at outlying locations in the State to measure the value of different systems of management and soil treatments.

Results on the heavier soils indicated that nitrogen should be plowed down for corn, while on sandy soils side dressing corn with nitrogen has given the best results. Applications of nitrogen to pasture and small grain can be made in late fall.

The need for magnesium has become apparent in several sections of the State. At one location in southeast Missouri on a sandy loam soil, high magnesium limestone produced a yield of 7.2 tons of alfalfa per acre while the yield from high calcium limestone was 6.5 tons.

Results from eight experiments with cotton have shown that the applications of fertilizers according to soil tests have given increases of as much as 1200 pounds of seed cotton per acre. It was found that mixtures of trace elements applied with the fertilizer at eight locations in southeast Missouri gave significant increases of from 42 to 625 pounds of seed cotton per acre.

Management of Permanent Pastures (Staff). This work was in cooperation with the Soil Conservation Service on the Experimental Farm at McCredie. The series of rotations using 1, 2, and 4 years of meadow or pasture must be continually fertilized for maximum production. The use of fertilizers on only the small grain crop was not sufficient.

Reclamation of Eroded Land (W. A. Albrecht and C. M. Woodruff). This problem of reclamation of eroded land has been under study for 10 years on the seven original erosion plots from which the surface soil was removed to expose the same degree of subsoil in each plot. An attempt has been made to bring the subsoil back to productivity and four plots were utilized in a system of mixed grasses and legumes while the remaining plots were planted to small grain and legumes with corn one year out of five. Soil treatments employed were held to a minimum but enough to establish a cover of vegetation to provide protection against runoff and erosion.

The grasses and legumes were divided into harvested and unharvested plots, with and without soil treatments of lime and fertilizer. The unharvested plots were included to determine the extent to which the land would protect itself with vegetation and would develop into usable land if left without disturbance over a period of years. The harvested plots received the same initial treatment but the growth of vegetation was removed as hay.

The small grains and legumes were given: (1) no treatment; (2) lime and mixed fertilizer on the small grain at a conventional rate; (3) both lime and fertilizer as on the preceding plot, but with all crop residues including the growth of legumes, returned to the land. Corn was introduced at five year intervals to measure the level of productivity attained.

Results showed that the moderate treatments of lime and other fertilizers have produced good stands of legumes while the continuous meadow without soil treatment has not produced sufficient growth to warrant harvesting the crop.

VETERINARY MEDICINE

A. H. GROTH, *Dean*

Blood Studies in Bang's Disease (Cecil Elder, and D. E. Rodabough). Six cows were used in an attempt to determine the effect of trace minerals upon the blood titer artificially produced with Strain 19 *Brucella abortus* organisms.

The elements used were manganese sulfate and copper sulfate. A single element at a time was tried on each of the six animals. The technique followed was to give the element for a period of thirty days and then let the animal rest for thirty days before the other element was given. During this entire period frequent blood tests were made and maximum titers determined. Chemical examinations for the manganese sulfate content of the blood were made before the animals were started on this treatment. The thirty day feeding period has been completed, but the results from the chemical tests and spectrographic analyses had not yet been finished when the report was made.

There was no evidence of change of blood titer.

Titer Differentiation

An effort has been made to differentiate between vaccine titer and infection titer due to Brucellosis. Two low-titer infected cows were obtained from the University of Missouri beef herd for this study and these animals were considered as field infection cases. They were given 5 cc. of *Brucella abortus* vaccine, Strain 19, which was injected intramuscularly and blood studies were made.

It was found that the blood titer of both individuals raised very materially. This was not in agreement with results reported by other experiment stations.

Service Projects (Staff of Veterinary Medicine). The laboratories of the School of Veterinary Medicine were used during the year to run a total of 34,135 tests and examinations for the people in Missouri. The breakdown on this service is as follows:

Blood tests for Bang's Disease.....	602
Rabies Examination.....	64
Blood Samples for Newcastle Disease Test.....	427
Poultry Necropsy.....	3,799
Miscellaneous Examination.....	51
Agglutination tests for Pullorum Disease.....	29,192
Total	34,135

Blackhead in Turkeys (A. J. Durant, and H. C. McDougale). The use of sodium morrhuate as an escharotic to cause the destruction and absorption of the ceca of abligated birds was studied. With records of previously treated birds and with those now under treatment and observation it appeared that it was possible to make use of this drug for the destruction and absorption of the ceca.

If the proper amount of sodium morrhuate was injected into the abligated ceca immediately after the operation, subsequent enlargement of the organs was not only prevented but the ceca were completely resorbed. During this fiscal period forty-eight hens and turkeys were under observation and treatment. It is believed that the dosage for young poults one month or two months of age, which is the most favorable time to abligate, can be greatly reduced.

Bang's Disease Vaccination (Cecil Elder, Donald E. Rodabaugh, and James E. Comfort). The value of calfhood vaccination in producing immunity against Brucellosis has been studied. A combination of blood testing, segregation, and calfhood vaccination has been tried in an effort to materially speed up the elimination of Brucellosis from a herd. The University beef cattle herd has been used for this experiment. It was not always possible to handle the herd to the best advantage due to classwork and breeding programs. Therefore, challenge doses in order to determine the amount of actual immunity produced by the calfhood vaccination have not been possible.

It will be seen from the following summary table that less trouble was observed in the negative herd than in the reactor herd. The negative herd had no animals removed because of breeding difficulties. None of the animals became reactors and only one abortion occurred during the period. The reactor herd was much less efficient, having one premature birth, 7 abortions, and 4 animals were sold because of breeding difficulties. The following table shows the complete data.

Summary of Findings March 1, 1949 to February 28, 1950

1. Total number of cattle on experiment.....	133
Total number of Bang's Agglutination tests.....	360
Total number calves vaccinated with Strain 19 during the experimental year.....	23
2. Total number non-vaccinated cows in negative herd.....	28
Delivered normal calves.....	21
Average number breedings per normal calf.....	1.75
(Exclusive of Herefords which are pasture bred)	
Becoming reactors during period.....	0
*Aborting during report period.....	1
Sold because of breeding difficulties.....	0
Sold for other reasons.....	3
**Have not delivered a calf during period reported.....	5
5. Total number calfhooed vaccinated cows in the negative herd.....	32
Delivering normal calves.....	11
Average number breedings per normal calf (exclusive of Herefords which were pasture bred).....	1.91
Becoming reactors during report period.....	0
**Have not delivered a calf during period reported.....	17
Aborting during report period.....	0
Sold because of breeding difficulties.....	0
Sold for other reasons.....	2
Died while on experiment.....	1
4. Total number vaccinated heifers under breeding age.....	26
5. Total number animals in reactor herd.....	47
Number calfhooed vaccinated adults in reactor herd.....	4
Number non-vaccinated adults in the reactor herd.....	43
Delivering normal calves.....	30
Average number breedings per normal calf.....	1.65
Delivering premature calves.....	1
Aborting during report period.....	7
Sold because of breeding difficulties.....	4
Sold for other reasons.....	1
**Have not delivered a calf during period reported.....	7

NOTE: Data on length of time it took animals to return to negative status following calfhooed vaccination was not available during this period.

*Was found negative for Bang's Disease on three subsequent tests.

**Some of these animals are now carrying a calf and have not completed the gestation period.

Some animals were intentionally not bred.

Investigation of the Pathology and Comparative Damage Done By Stomach, Nodular, and Tape Worms in Sheep (Cecil Elder, and D. E. Rodabaugh). A total of 105 sheep were on experiment and 1723 fecal examinations were made. The effect of freezing temperatures on pasture infestation was studied. In an effort to determine if winter temperatures in 1948-49 were low enough to destroy parasite eggs and parasite larvae, a specially constructed plot to prevent infestation by other animals, wild or domestic, was used.

Two parasite-free lambs were placed in this special plot April 20, 1949 and fecal examinations were collected every two weeks until August. At time of autopsy, August 22 and August 23, one lamb showed a total of 184 parasites, the other lamb a total of 196 parasites. This was considered to be a very light infestation.

To prove if the age of the parasite-free lambs had any influence on infestation, two parasite-free lambs of the same age were also placed on a pasture considered to be heavily contaminated. At time of autopsy, August 29 and August 30, one of the latter showed a moderately light infestation (1621 parasites) and one showed a moderately heavy infestation (4517 parasites). These findings indicated the age of the lambs was not great enough to produce any appreciable age resistance.

In the lambs from the special plot and the lambs on the contaminated pasture, six different species of parasites were found. It is of interest to note no nodular worms were found in the special plot but several were found in lambs on the other pasture. This did indicate that the nodular worms in the special plot were killed by Missouri winter temperatures last year. In the contaminated pasture the nodular worms found may be the result of contamination from other sheep on the same ground, and that contamination occurred after winter was over.

An attempt was made to determine if a single dose of liquid phenothiazine or copper sulfate would be beneficial during the summer months when the sheep concerned had been running on a pasture continuously for several months with free access to a phenothiazine salt mixture (1-10). Six lambs were used. Two lambs received a therapeutic dose of liquid phenothiazine, two received a therapeutic dose of copper sulfate, and two were left untreated as controls.

Careful examination of the lambs showed very little beneficial effect in the treated lambs as compared with the controls. In 1948-49, single doses of copper sulfate and nicotine sulfate mixture, and tetrachlorethylene were administered under similar conditions. The drugs used in 1948-49 seemed to be somewhat more beneficial than the ones used this past year.

The transmission of ovine gastrointestinal parasites to calves under pasture conditions was tested. On July 10, one calf, age $2\frac{1}{2}$ months; and her mother, both parasite-free, were placed in a pasture heavily contaminated by

sheep. As the experiment progressed it became apparent that the calf was not going to become more than lightly infested. Fecal samples were then collected from the calf and cultured. The infective larvae produced were given to a parasite-free lamb by means of a stomach tube. At time of autopsy only a few parasites considered to be of ovine origin were found in the calf. This indicated that transmission of sheep parasites to this calf under pasture conditions was not very great. There was no evidence of retransmission of parasites from the calf to the lamb.

Missouri Experiment Station Bulletin 527, "Internal Parasites of Sheep" was published during the year.

Pregnancy Disease in Sheep (Cecil Elder and H. H. Berrier). Curative treatment of animals showing symptoms of the pregnancy disease has not been satisfactory in the past.

Two field cases were given choline chloride. The first sheep was given 1.5 gm. choline chloride intravenously and also by mouth (1.5 gm. every six to eight hours until a total of four doses were given (total of 6 gm.) The animal died of pregnancy disease the following day. Biopsy of the liver was made before treatment was started and sections showed a large amount of fatty metamorphosis. Sections of the liver were also made at time of necropsy (after treatment was administered) and the findings seem to warrant further trials with this drug.

The second ewe showing symptoms of pregnancy disease was treated with choline chloride by mouth. This ewe received 6 gm. doses four times daily and at the time death occurred had received a total of six doses or 36 gm. of the drug.

Lukemia and Fowl Paralysis in Fowls (A. J. Durant, and H. C. McDougle). Investigations of Lukemia in fowl paralysis (neuritis of fowls) were carried on concurrently because of their close relationship, although at the present time dyscrasia in connection with Lukemia are regarded as possibly due to a virus different from that of Fowl paralysis. In the studies of those two diseases, the evidence accumulated on the two diseases indicated that they were due to separate and distinct viruses.

A poultry laboratory has been made available at the Veterinary Research farm for maintaining day old baby chicks and other birds and has added greatly to the facilities for this work.

PUBLICATIONS

A. A. JEFFREY, *Editor*

The University of Missouri Agricultural Experiment Station issued 77 publications during the year ending June 30, 1950, including 19 research bulletins, 37 popular bulletins, and 21 circulars. In addition there were Progress Reports and other printed matter. The total number of copies of publications printed during the year was 525,250. Also, a total of 62 articles were contributed to scientific journals.

In addition, the *Missouri Farm News Service* and the *Announcer* were published in cooperation with the Extension Service. The *Farm News Service* was printed weekly and mailed to newspapers, farm papers, county agents, vocational agricultural instructors and other farm leaders. It had a circulation of 1750 a week. The *Announcer* was sent monthly to farmers and others requesting it. It reached a circulation of about 26,000.

RESEARCH BULLETINS

No. Title, Series, Author, and Number of Pages and Copies.

- 442 Agronomic Characteristics and Disease Resistance of Winter Barleys Tested in Missouri, 1943 - 1948, by J. M. Poehlman, July, 1949, 28 pages, 2500 copies.
- 443 Trend in the Missouri Poultry Industry, by A. L. Perry, July, 1949, 104 pages, 2500 copies.
- 444 A Study of Bacteria in Bovine Semen and Their Effect Upon Livability of Spermatozoa, by J. E. Edmondson, K. L. Tallman, and H. A. Herman, July, 1949, 12 pages, 2500 copies.
- 445 A Survey of Factors Affecting Conception Rate in Dairy Cattle Where Artificial Insemination is Used Under Field Conditions, by Maurice Dickensheet and H. A. Herman, August, 1949, 20 pages, 2500 copies.
- 446 The Metabolism of Thyroxine, by R. A. Monroe and C. W. Turner, August, 1949, 76 pages, 2500 copies.
- 447 The Relationship Between Semen Quality and Conception Rate in Artificial Insemination of Dairy Cattle, by H. J. Weeth and H. A. Herman, August, 1949, 12 pages, 2500 copies.
- 448 A Serviceability Study on Kitchen Towelings of Various Fiber Contents, by Adella E. Ginter and Graduate Students: Kathryn Gray and Edna Bean, August, 1949, 20 pages, 2500 copies.
- 449 Environmental Physiology—With Special Reference to Domestic Animals—VI. Influence of Temperature, 50° to 0°F. and 50° to 95°F., on Milk Production, Feed and Water Consumption and Body Weight in Jersey and Holstein Cows, by A. C. Ragsdale, D. M. Worstell, H. J. Thompson, and Samuel Brody, September 1949, 24 pages, 2500 copies.
- 450 Environmental Physiology With Special Reference to Domestic Animals—VII. Influence of Temperature, 50° to 5°F. and 50° to 95°F., on Heat Production and Cardio-respiratory Activities of Dairy Cattle, by H. H. Kibler and Samuel Brody, October 1949, 28 pages, 2500 copies.

- 451 Environmental Physiology With Special Reference to Domestic Animals—VIII. Influence of Ambient Temperature, 0° to 105°F., on Insensible Weight Loss and Moisture Vaporization in Holstein and Jersey Cattle, by H. J. Thompson, R. M. McCroskey, and Samuel Brody, October, 1949, 20 pages, 2500 copies.
- 452 Forest Resources and Industries of Missouri, by D. B. King, E. V. Roberts, and R. K. Winters, December 1949, 90 pages, 5000 copies.
- 453 The Operating Experience of 24 Local Cooperative Exchanges in Missouri, 1929-1947, by S. K. Thurston, Jr., February, 1950, 40 pages, 2500 copies.
- 454 The Reliability of Various Diagnostic Tests and the Efficiency of Certain Therapeutic Measures in Control of Mastitis, by C. P. Merilan, H. A. Herman, J. E. Edmondson, K. L. Tallman and O. S. Crisler, February, 1950, 28 pages, 2500 copies.
- 455 Physiological and Histological Phenomena of the Bovine Estrual Cycle With Special Reference to Vaginal-Cervical Secretions, by D. B. Roark and H. A. Herman, February, 1950, 72 pages, 2500 copies.
- 456 Social Changes in Shelby County, Missouri, by L. M. Hepple and Margaret L. Bright, March, 1950, 36 pages, 2500 copies.

Reprints

- 261 Speed and Accuracy in Determination of Total Nitrogen, by A. E. Murneek and P. H. Heinze, February, 1950, 8 pages, 4000 copies.
- 415 Studies Concerning the Induction and Maintenance of Lactation—I. The Mechanisms Controlling the Initiation of Lactation at Parturition, by Joseph Meites and C. W. Turner, April, 1950, 68 pages, 2000 copies.
- 416 Studies Concerning the Induction and Maintenance of Lactation—II. The Normal Maintenance and Experimental Inhibition and Augmentation of Lactation, by Joseph Meites and C. W. Turner, April, 1950, 36 pages, 1000 copies.
- 371 Growth Hormone Production During Sexual Reproduction of Higher Plants, by S. H. Wittwer, April, 1950, 58 pages, 1500 copies.

BULLETINS

- 525 Budding and Grafting Standard Apple Varieties on Hardy Stocks, by T. J. Talbert, July, 1949, 24 pages, 10,000 copies.
- 526 Fertilizer Inspection and Analysis; Spring 1948, by J. H. Longwell, Homer J. L'Hote, R. C. Prewitt, July, 1949, 48 pages, 2500 copies.
- 527 Internal Parasites of Sheep, by Cecil Elder and D. E. Rodabaugh, July, 1949, 12 pages, 10,000 copies.
- 528 Missouri's Sixtieth Year of Agricultural Research, by E. A. Trowbridge and J. E. Crosby, Jr., September 1949, 72 pages, 2000 copies.
- 529 Fertilizer Inspection and Analysis; Fall 1948, by J. H. Longwell, Homer J. L'Hote, R. C. Prewitt, September 1949, 48 pages, 2500 copies.
- 530 General Purpose Sprays for Home Fruit Plantings, by H. G. Swartwout and Lee Jenkins, November 1949, 8 pages, 10,000 copies.
- 531 More Efficient Use of Fertilizer, by A. W. Klemme, W. A. Albrecht and R. C. Prewitt, December 1949, 20 pages, 10,000 copies.
- 532 Wheat in Missouri, by J. M. Poehlman, December 1949, 36 pages, 15,000 copies.
- 533 1949 Yield Trials with Corn Hybrids in Missouri, by M. S. Zuber, L. J. Gundy, and W. E. Aslin, December 1949, 36 pages, 4000 copies.
- 534 0-200 A New Early Variety of Oats for Missouri, by J. M. Poehlman, December 1949, 16 pages, 10,000 copies.

- 535 Research for Farm and Home, (1949 Experiment Station Report) by J. H. Longwell and Sam B. Shirky, December 1949, 104 pages, 2000 copies.
- 536 Coccidiosis in Chickens and Other Birds (Rev. 512), by A. J. Durant and H. C. McDougle, January 1950, 12 pages, 10,000 copies.
- 537 Cotton Variety Tests in Southeast Missouri, by W. R. Langford, February 1950, 3 pages, 6000 copies.
- 538 Fertilizer Inspection and Analysis; Spring 1949, by J. H. Longwell, Homer J. L'Hote, and R. C. Prewitt, May 1950, 54 pages, 10,000 copies.
- 539 Effect of Holding Temperatures on Hatchability of Eggs, by E. M. Funk, James F. Forward, and H. L. Kempster, May 1950, 20 pages, 15,000 copies.

Reprints

- 336 Growth Standards for Dairy Cattle, by A. C. Ragsdale, July 1949, 12 pages, 6000 copies.
- 425 Fattening Early and Late Lambs, by A. J. Dyer and L. A. Weaver, July 1949, 16 pages, 8000 copies.
- 346 The Secretion of Milk and the Milking Process, by C. W. Turner, July 1949, 20 pages, 6000 copies.
- 451 Korean Lespedeza Seed As a Protein Supplement for Milk Production, by H. A. Herman and A. C. Ragsdale, July 1949, 8 pages, 6000 copies.
- 519 Use of Commercial Plant Foods on Missouri Farms, by A. W. Klemme, H. J. L'Hote, and J. R. Breuer, August 1949, 20 pages, 2500 copies.
- 398 Wheat in Missouri, by W. C. Etheridge, C. A. Helm, and J. M. Poehlman, September 1949, 44 pages, 1000 copies.
- 517 The Multiflora Rose, by T. J. Talbert and J. E. Smith, September 1949, 12 pages, 10,000 copies.
- 473 Common Internal and External Parasites of Poultry, by H. C. McDougle and A. J. Durant, October 1949, 24 pages, 10,000 copies.
- 324 Soil Fertility Losses Under Missouri Conditions, by H. Jenny, November 1949, 12 pages, 6000 copies.
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- 466 Good Pasture and Roughage in Fattening Cattle, by E. A. Trowbridge and A. J. Dyer, November 1949, 12 pages, 4000 copies.
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- 458 Sanborn Field—Fifty Years of Experiments with Crop Rotations, Manure and Fertilizers, by G. E. Smith, March 1950, 64 pages, 5000 copies.

- 533 1949 Yield Trials with Corn Hybrids in Missouri, by M. S. Zuber, L. J. Gundy, and W. E. Aslin, May 1950, 36 pages, 750 copies.
- 384 Factors Influencing Production of Clean Eggs, by E. M. Funk, March 1950, 12 pages, 5000 copies.
- 507 Terracing for Erosion Control, by J. C. Wooley and M. W. Clark, May 1950, 48 pages, 10,000 copies.
- 492 Alfalfa in Missouri, by W. C. Etheridge, May 1950, 16 pages, 10,000 copies.

CIRCULARS

- 339 Using Phosphate Fertilizers for Better Crops, by A. W. Klemme, July 1949, 16 pages, 15,000 copies.
- 340 Hog Lice and Mange Affect Pork Production, by L. Haseman, August 1949, 2 pages, 10,000 copies.
- 341 Sulfathiazole Control of American Foulbrood, by L. Haseman, September 1949, 8 pages, 10,000 copies.
- 342 Home Pasteurization for Safe Milk, by J. E. Edmondson, November 1949, 12 pages, 20,000 copies.
- 343 Propagation of Fruit Trees by Budding and Grafting, by T. J. Talbert, March 1950, 12 pages, 10,000 copies.
- 344 Wabash Soybeans for Missouri, by C. V. Feaster, March 1950, 8 pages, 10,000 copies.
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- 348 Protecting Man and Livestock from Ticks, by L. Haseman, May 1950, 4 pages, 8000 copies.

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- 304 Major Soil Areas of Missouri, by H. H. Krusekopf, July 1949, 4 pages, 10,000 copies.
- 307 Cherry and Plum Culture in Missouri, by T. J. Talbert, July 1949, 16 pages, 8000 copies.
- 322 Lawn Culture in Missouri, by T. J. Talbert and E. M. Brown, September 1949, 12 pages, 10,000 copies.
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- 285 Improve Permanent Pastures with Lespedeza, Phosphate, Lime and Supplementary Grazing, by E. M. Brown, December 1949, 8 pages, 10,000 copies.
- 232 Plow Adjustment and Operation, by M. M. Jones, January 1950, 24 pages, 10,000 copies.
- 245 How To Choose Commercial Feeds, by A. G. Hogan, May 1950, 8 pages, 8000 copies.
- 315 Pruning Suggestions for Apple and Pear Trees, by T. J. Talbert, April 1950, 12 pages, 10,000 copies.
- 321 Various Grains and Other Corn Substitutes for Hog Feed, by L. A. Weaver, May 1950, 12 pages, 8000 copies.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS

- 1158 The Relation of Body Weight of Turkey Hens to Egg Production, Egg Weight, Percentage of Hatch and Viability of Poults, by E. M. Funk, submitted to Poultry Science, July 11, 1949.

- 1160 Studies in the Ionization of Magnesium, Calcium, and Barium Clays, by B. Chatterjee and C. E. Marshall. Submitted for publication in the Journal of Physical Chemistry, August 10, 1949.
- 1161 Estimating the Nitrogen Delivery of Soil from the Organic Matter Determination as Reflected by Sanborn Field, by C. M. Woodruff. Submitted August 26, 1949, to Proceedings of Soil Science Society of America.
- 1162 The Flame Spectrophotometric Determination of Sodium in Whole Blood and Plasma, by Clifton R. Blincoe. Submitted August 29, 1949, to Journal of Biological Chemistry.
- 1163 The Effects of Egg Yolk on Various Physical and Chemical Factors Detrimental to Spermatozoan Viability, by Ralph Bogart and Dennis T. Mayer. Submitted September 1, 1949 to Journal of Animal Science.
- 1164 The Structure of Chromosome I of *Secale cereale*, by Joseph G. O'Mara. Submitted September 1, 1949, to Genetics, Volume 35.
- 1165 The Plagioclase Feldspars as an Index to Soil Weathering, by E. R. Graham. Submitted September 5, 1949, to Proceedings of Soil Science Society of America.
- 1166 Interpreting Soil Features, by H. H. Krusekopf. Submitted September 5, 1949, to Proceedings of Soil Science Society of America.
- 1167 Reciprocal Effects of Magnesium and Potassium as Shown by Their Cationic Activities in Four Clays, by E. O. McLean. Submitted September 5, 1949, to Proceedings of Soil Science Society of America.
- 1168 The Calcium-Potassium Relationships of Clay Minerals as Revealed by Activity Measurements, by C. E. Marshall and S. A. Barber. Submitted to Proceedings of Soil Science Society of America.
- 1169 The Thyroxine Secretion Rate of Growing White Pekin Ducks, by H. V. Biellier and C. W. Turner. Submitted September 16, 1949, to Poultry Science.
- 1170 Electrophoretic Study of Bovine Thyroglobulin and Iodinated Bovine Gamma Globulin, by Syed Kamal and C. W. Turner. Submitted September 29, 1949, to the Journal of Biological Chemistry.
- 1171 Electrophoretic Studies of Commercial and Iodinated Casein, by Syed Kamal and C. W. Turner. Submitted September 29, 1949, to the Journal of Biological Chemistry.
- 1172 Extraction and Isolation of Gamma Globulin from the Bovine Thymus Gland, by Syed Kamal and C. W. Turner. Submitted September 29, 1949, to the Journal of Dairy Science.
- 1173 Seed Transmission of the Elm Mosaic Virus, by T. W. Bretz. Submitted October 5, 1949, to Phytopathology.
- 1174 Experimental Propagation of Disease Resistant Elm Selections by Vegetative Cuttings, by T. W. Bretz and R. U. Swingle. Submitted October 5, 1949, to Phytopathology.
- 1175 Studies on *Helminthosporium carbonum* Ullstrup on Corn, by C. H. Kingsolver and C. T. Yuan, October 12, 1949, to Phytopathology.
- 1176 Requirement of the Pig for Vitamin B₁₂, by Gerald C. Anderson and Albert G. Hogan. Submitted October 13, 1949, to Journal of Nutrition.
- 1177 Some Effects of Hypertonic and Hypotonic Solutions on the Livability and Morphology of Bovine Spermatozoa, by Glenn R. Pursley and H. A. Herman. Submitted October 14, 1949, to Journal of Dairy Science.
- 1178 A Comparison of Various Semen Diluents in Maintaining Motility of Bovine Spermatozoa, by Glenn R. Pursley, H. A. Herman, Maurice Dickensheet, and R. E. Waters. Submitted October 14, 1949, to Journal of Dairy Science.
- 1179 Growth Regulating Substances in Relation to Reproduction of Some Horticultural Plants, by A. E. Murneek. Submitted October 21, 1949, to book by University of Wisconsin Press.

- 1180 Search for a Better Preharvest Spray, by A. E. Murneek. Submitted October 21, 1949, to Proceedings of American Society for Horticultural Science.
- 1181 Light and Tomato Yields, by D. D. Hemphill and A. E. Murneek. Submitted October 24, 1949, to Proceedings of American Horticultural Society.
- 1182 The Present Known Distribution of Oak Wilt in Missouri, by T. W. Bretz. Submitted October 24, 1949, to Plant Disease Reporter.
- 1183 Leaf-Bud Cuttings as a Means of Propagating Disease Resistant Elms, by T. W. Bretz. Submitted November 4, 1949, to Plant Disease Reporter.
- 1184 The Role of Plant Growth Substances (hormones) in Reproduction, by A. E. Murneek. Submitted November 23, 1949, to Proceedings of Fourth Seed Corn Industry-Research Conference.
- 1185 The Relative Value of Hormone Sprays for Apple Thinning, by A. E. Murneek, November 23, 1949, to Proceedings of American Society for Horticultural Science.
- 1186 On the Origin of Gumbotil, by Yi Hseung, C. E. Marshall, and H. H. Krusekopf. Submitted November 29, 1949, to Proceedings of the Soil Science Society of America.
- 1187 The Electrochemistry of the Clay Minerals in Relation to Pedology, by C. E. Marshall. Submitted November 29, 1949, to Proceedings of the Fourth International Congress of Soil Science, Amsterdam, 1950.
- 1188 Rhizome Rot of White Calla Caused by *Phytophthora erythroseptica*, by C. M. Tompkins and C. M. Tucker. Submitted November 29, 1949, to Phytopathology.
- 1189 How Successful is Chemical Thinning of Fruit? by A. E. Murneek. Submitted November 29, 1949, to Proceedings of Kansas State Horticultural Society.
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- 1191 Downy Mildew on Barley in Missouri, by C. H. Kingsolver. Submitted November 30, 1949, to Plant Disease Reporter.
- 1192 Control of Apple and Peach Insects in Missouri for 1949, by Lee Jenkins. Submitted December 19, 1949, to Proceedings of the Kansas State Horticultural Society.
- 1193 In Vitro Studies on the Conversion of Carotene to Vitamin A in Dairy Calves, by O. T. Stallcup and H. A. Herman. Submitted December 29, 1949, to the Journal of Dairy Science.
- 1194 Disease Reaction and Agronomic Qualities of Oats Selections from a Columbia x Victoria-Richland Cross, by J. M. Poehlman and C. H. Kingsolver. Submitted January 9, 1950, to Agronomy Journal.
- 1195 Sexual Dimorphism in the Syrinx of the Pekin Duck, by H. V. Biellier and C. W. Turner. Submitted January 14, 1950, to Poultry Science.
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- 1197 The Planetree Disease and Elm Mosaic, by T. W. Bretz. Submitted January 26, 1950, to Arborist News and The American Nurseryman.
- 1198 Technique for Characterizing Mammalian Spermatozoa as Dead or Living by Differential Staining, by Dennis T. Mayer, C. D. Squires, Ralph Bogart, and Mohamed M. Oloufa. Submitted January 26, 1950, to Sterility and Fertility, New York.
- 1199 Adequacy of Synthetic Diets for Growth and Reproduction of Swine, by Gerald C. Anderson and Albert G. Hogan. Submitted January 31, 1950, to Journal of Animal Science.
- 1200 Thinning Peaches With Hormone Sprays, by Aubrey D. Hibbard and A. E. Murneek. Submitted February 4, 1950, to Proceedings of the American Horticultural Science.
- 1201 Restraint of Swine with Pentothal Sodium, by M. E. Muhrer. Submitted February 15, 1950, to Journal of American Veterinary Medical Association.

- 1202 Fertility and Soil Conservation, by Dwight D. Smith. Submitted February 15, 1950, to Soil Conservation Magazine.
- 1203 Relative Reactions of European and Indian Cattle to Changes in Environmental Temperature, by S. Brody, H. H. Kibler, and A. C. Ragsdale. Submitted March 14, 1950, to the Journal of Dairy Science.
- 1204 Estimation of the Thyroxine Secretion Rate Without Sacrifice of the Animals, by G. W. Pipes, C. R. Blincoe, and Kuang-Mei Hsieh. Submitted March 14, 1950, to Journal of Dairy Science.
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- 1206 A Preliminary Report on the Role of Progesterone in the Maintenance of Pregnancy in the Cow by James I. Raeside and C. W. Turner. Submitted March 14, 1950 to Journal of Dairy Science.
- 1207 The Biological Activity of Alpha and Beta Casein-Thyroprotein, by M. B. Behrens, G. W. Pipes, and C. W. Turner. Submitted March 14, 1950, to Journal of Dairy Science.
- 1208 Calcium Phosphate Deposits in Guinea Pigs and the Phosphorus Content of the Diet, by Albert G. Hogan and W. O. Regan. Submitted March 20, 1950, to Journal of Nutrition.
- 1209 Some Problems in Feeding Thyroprotein to Farm Animals, by C. W. Turner. Submitted April 4, 1950, to Proceedings of American Chemical Society.
- 1210 Oakwilt, by T. W. Bretz. Submitted April 7, 1950, to Journal of Forestry.
- 1211 Vegetative Propagation of Disease Resistant Elms, by T. W. Bretz and R. U. Swingle. Submitted April 7, 1950, to American Nurseryman or Proceedings of American Society of Horticultural Science.
- 1212 Maternal Nutrition and Hydrocephalus in Newborn Rats, by A. G. Hogan. Submitted April 29, 1950, to Proceedings of the Society of Experimental Biology and Medicine.
- 1213 The Validity of the Live-Dead Differential Staining Technique, by E. P. Warren, D. T. Mayer, and Ralph Bogart. Submitted May 5, 1950, to Journal of Animal Science.
- 1214 The Electrochemical Properties of Mineral Membranes IX. Membrane Characteristics of Clay Pastes, by S. K. Mukherjee and C. E. Marshall. Submitted May 5, 1950, to Journal of Physical and Colloid Chemistry.
- 1215 Studies on the Pathogenicity of Races 1 and 2 of *Fusarium oxysporum* F. *lycopersici* (Sacc.) Snyder and Hansen, by James W. Gerdemann and Arthur M. Finley. Submitted for publication in Phytopathology.
- 1216 Pattern of Caries in Relation to the Pattern of Soil Fertility (In the United States), by W. A. Albrecht. Submitted August 1950, to Proceedings of Twelfth Australian Dental Congress, Sidney, Australia.
- 1217 A Study of the Mechanism of Resistance to *Fusarium oxysporum* F. *lycopersici* (Sacc.) Snyder and Hansen in Tomato Varieties, by Arthur M. Findley. Submitted June 12, 1950, to Phytopathology.
- 1218 Methionine Synthesis According to the Sulfur in the Soil, by V. L. Sheldon, Wm. G., Blue, and W. A. Albrecht. Submitted June 15, 1950, to Science.
- 1219 Biosynthesis of Amino Acids According to Soil Fertility. I. Tryptophane, by V. L. Sheldon, Wm. G. Blue, and W. A. Albrecht. Submitted in June 1950, to Plant and Soil, The Hague, Netherlands.
- 1220 Viability of Bull Spermatozoa as Influenced by Electrolyte Concentration, Buffer Efficiency, and Added Glucose in Storage Media, by Ralph F. Kampschmidt, Dennis T. Mayer, Harry A. Herman, and Gordon E. Dickerson. Submitted in June 1950. to the Journal of Dairy Science.

RESEARCH GRANTS**U. S. Public Health Service**

For study of the project "Relation of Nutrition to Hydrocephalus in Infant Rats."

Parke, Davis and Company

For research in the field of vitamins.

American Dry Milk Institute

For research in the field of nutrition.

Merck and Company, Incorporated

In support of research work on the nutritional requirements of swine.

Abbott Research Laboratories

To study veterinary indications, dosage, and general uses of Pentothal Sodium.

Office of Naval Research

For a research on "The Relation of nutrition to the occurrence of arthritis in experimental animals."

Office of Naval Research

For research on "The Effects of Radiations, Infrared to Ultraviolet, on Animals, Beginning with Rats."

National Mineral Wool Association

For the conduct of research in connection with the project on "Psycho-energetic laboratory studies," to establish certain fundamental data relating to the housing and production of dairy animals.

American Dairy Association

For continued support of the investigations concerning "the use of whey solids in ice cream and sherbets."

American Dairy Association

For a comprehensive study of the Four-Day Grading Plan of Buying Cream in Missouri.

Cerophyl Laboratories

For continuation of the support of endocrine studies.

De-Raef Corporation

For research relating to the manufacture of cheddar cheese.

Corn Products Sales Company

For research in the field of dairy products.

Kraft Cheese Company

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

Office of Naval Research

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

Atomic Energy Commission

For a research project pertaining to "The Determination of Thyroid Activity in Farm Animals by the Use of Radioactive Tracers."

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

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

American Cancer Society

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

Quaker Oats Company

For research in the breeding of white hybrid corn.

**Midwest Regional Turf Foundation and the Green Section
of the U. S. Golf Association**

For research on the improvement of fairway turf in the vicinity of St. Louis, Mo.

Missouri Conservation Commission

For farm forestry research.

Monsanto Chemical Company

Drum of material for treating fence posts.

Dow Chemical Company

For support of studies on the use of plant hormones in orchard practice.

Camp Detrick Chemical Corps

To support a research project, "seed or fruit development as affected by certain plant growth regulators."

Missouri State Florists Association

For floriculture research and service.

International Baby Chick Association

For research in connection with hatchability studies.

Institute of American Poultry Industries

For research in the use of various nesting materials in the prevention of soiled shell eggs.

College of Agriculture Foundation

For use on a project entitled "Unrecognized Nutrients Required by Laying Hens."

American Potash Institute

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

Coronet Phosphate Company

For research on the influence of plant food including "trace minerals" applied to the soil in the improvement of feed quality and animal health.

International Minerals and Chemical Corporation

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

Schrock Fertilizer Service

For research on the influence of plant food including "trace minerals" applied to the soil in the improvement of feed quality and animal health.

Spencer Chemical Company

For research in connection with pasture studies.

Middle West Soil Improvement Committee

To further extension projects in soils improvement.

Missouri Portland Cement Company

For use in the study of the application of precipitator dust from cement plants as a fertilizer material.

Missouri Farmers Association

For summarizing data on the fertility of soils in Missouri.

Ruhm Phosphate Company

For research in connection with phosphate absorption from the soil.

Soil and Health Foundation

For a study of minerals in rocks from various sources of possible value as fertilizer.

Swift and Company

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

CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1950

Appointments

Helen S. Allen, Instructor in Home Economics.

Raymond L. Arthaud, Assistant Instructor in Animal Husbandry.

Henry W. Ballou, Research Assistant in Horticulture.

Stanley C. Benbrook, Instructor in Veterinary Bacteriology.

Margaret P. Britton, Instructor in Home Economics.

B. J. Butler, Instructor in Agricultural Engineering.

Robert F. Brooks, Associate Professor of Botany.

Jack W. Browne, Assistant Analyst in the Department of Agricultural Chemistry.

Henry S. Bull, Research Assistant in Agricultural Chemistry.

Gloria U. Burge, Research Assistant in Dairy Husbandry.

W. Leon Cameron, Research Assistant in Agricultural Engineering.

Floyd B. Clark, Research Associate in Forestry.

Robert C. Combs, Assistant Instructor in Dairy Husbandry.

Albert R. Conley, Associate Professor of Agricultural Economics.

Wayne L. Decker, Assistant Professor of Climatology.

Milton Y. Dendy, Research Assistant in Poultry Husbandry.

James E. Dillion, Assistant Instructor in Agricultural Economics.
Arthur E. Gaus, Research Assistant in Horticulture.
Lewis A. Ferguson, Assistant Analyst in the Department of Agricultural Chemistry.
George B. Garner, Fertilizer Inspector.
Robert N. Goodman, Research Assistant in Horticulture.
George W. Graham, Assistant Instructor in Dairy Husbandry.
Robert B. Grainger, Research Assistant in Agricultural Chemistry.
Clarence O. Grogan, Assistant Instructor in Field Crops.
Paul Q. Guyer, Instructor in Animal Husbandry.
Inez Harrill, Research Assistant in Home Economics.
August A. Haselhorst, Fertilizer Inspector.
Ross Hortin, Instructor in Forestry.
Jean Huston, Instructor in Home Economics
Mary H. Jenkins, Research Assistant in Home Economics.
Elmer R. Kiehl, Instructor in Agricultural Economics.
Malcolm B. Kirtley, Assistant Instructor in Agricultural Economics.
John Landers, Assistant Instructor in Animal Husbandry.
John F. Lasley, Associate Professor of Animal Husbandry.
Ruh-Meo Li, Research Assistant in Horticulture.
Edward E. Martin, Analyst in the Department of Agricultural Chemistry
Frank Miller, Professor of Agricultural Economics.
John D. Miller, Instructor in Agricultural Economics.
Joseph Milligan, Research Assistant in Poultry Husbandry.
Byron S. McDaniel, Supervisor of Photo Service.
Donald M. Pappenfort, Research Assistant in Rural Sociology.
Roscoe L. Pearce, Fertilizer Inspector.
R. Brooks Polk, Instructor in Forestry.
Marlin N. Rogers, Assistant Instructor in Landscape Gardening.
John D. Schatz, Assistant Instructor in Floriculture.
George E. Smith, Associate Professor of Soils.
Yates C. Smith, Graduate Assistant in Horticulture.
Louis H. Tempel, Jr., Assistant Instructor in Agricultural Engineering.
Leland Tribble, Assistant Instructor in Animal Husbandry.
Jeanne Vinyard, Research Assistant in Home Economics
Chase "C" Wilson, Assistant Instructor in Dairy Husbandry.
Joseph Winton, Research Assistant in Agricultural Engineering.

Resignations and Withdrawals

Bertha Bisbey, Professor of Home Economics (retired).
Donald B. Brooker, Instructor in Agricultural Engineering.
Robert C. Combs, Assistant Instructor in Dairy Husbandry.
M. Y. Dendy, Research Assistant in Poultry Husbandry.

Lyle Fitzgerald, Instructor in Agricultural Economics.
 George W. Graham, Assistant Instructor in Dairy Husbandry.
 Erwin T. Hadorn, Instructor in Agricultural Economics.
 Grace Richmond Hoover, Research Assistant in Home Economics.
 Helen R. Marshall, Instructor in Home Economics.
 Virgil H. Owens, Research Assistant in Entomology.
 Donald M. Pappenfort, Research Assistant in Rural Sociology.
 Roland W. Portman, Instructor in Entomology.
 James W. Reynolds, Assistant Instructor in Agricultural Economics.
 Clarence V. Ross, Instructor in Animal Husbandry.
 William D. Shrader, Research Associate in Soils.
 Newcomb C. Smith, Instructor in Soils.
 Yates C. Smith, Graduate Assistant in Horticulture.
 Odie T. Stallcup, Instructor in Dairy Husbandry.
 George W. Steinbruegge, Assistant Professor of Agricultural Engineering.
 Willard Summers, Instructor in Landscape Architecture.
 Donald R. Warner, Instructor in Animal Husbandry.
 Victor B. Williams, Instructor in Agricultural Chemistry.
 Joseph Winton, Research Assistant in Agricultural Engineering.

FINANCIAL STATEMENT
 UNIVERSITY OF MISSOURI
 AGRICULTURAL EXPERIMENT STATION
 in account with
 THE UNITED STATES APPROPRIATION, 1950

Dr.	Hatch Fund	Adams Fund	Purnell Fund	Bankhead- Jones Fund	Research & Marketing Fund
To Balance from 1949-1950	-----	-----	-----	-----	\$5,009.01
Receipts from the Treasury of the United States as per appropriation for fiscal year ended June 30, 1950	\$15,000.00	\$15,000.00	\$60,000.00	\$89,383.63	\$106,039.24
Total	15,000.00	15,000.00	60,000.00	89,383.63	111,048.25
Cr.					
Personal Service	12,649.84	12,129.46	42,603.04	64,260.03	71,120.04
Travel	81.02	-----	962.97	1,213.38	2,725.95
Transportation of things	-----	17.56	114.27	295.81	452.16
Communication Service	-----	-----	11.05	258.40	169.20
Rents and Utility Services	5.00	37.20	137.55	1,024.44	390.00
Printing and Binding	-----	-----	180.76	258.44	231.14
Other Contractual Services	57.79	425.82	1,417.58	1,895.67	5,863.00
Supplies and Materials	1,134.23	1,699.77	8,097.27	13,649.61	8,245.63
Equipment	711.56	446.29	5,389.41	4,990.74	16,447.59
Land and Structures	15.46	-----	-----	49.70	425.00
Contributions to Retirement	345.10	243.90	1,086.10	1,487.41	1,325.91
TOTAL EXPENDITURES	\$15,000.00	\$15,000.00	\$60,000.00	\$89,383.63	\$107,395.62
Unexpended Bal. June 30, 1950	-----	-----	-----	-----	3,652.63