

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

AGRICULTURE EXPERIMENT STATION

BULLETIN 228

NEW KNOWLEDGE

One Year's Work, Agricultural Experiment Station

(Report of the Director; July 1, 1923 to June 30, 1924.)

"You are concerned in contributing in every possible way to making a better rural civilization. Your efforts comprehend all the problems of better farming methods, of larger and cheaper production, of conserving all resources of the soil, of more efficient marketing, of better homes, better rural schools, better places of religious worship and more intimate and helpful neighborly kindness among the people of the open country."—From address of President Coolidge delivered November 13, 1924, before the Association of Land Grant Colleges.

COLUMBIA, MISSOURI

JANUARY, 1925

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

Agricultural Experiment Station

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H. G. SWARTWOUT, B. S. in Agr.
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*In service of U. S. Department of Agriculture.

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NEW KNOWLEDGE

One Year's Work, Agricultural Experiment Station

F. B. MUMFORD, *Director*

The remarkable development of modern industry is the result of scientific research. Each forward step is made possible by the accumulated results of hundreds of investigations, often in small laboratories. New discoveries are possible only because of the laborious work of many unheralded and often unknown investigators.

Agriculture is still a new subject. Agricultural experiment stations have been organized for a comparatively short time. The accumulated agricultural knowledge, great as it may appear to be, is yet much more limited than similar knowledge in many other industrial lines.

It is however true that scientific discoveries in agriculture are succeeding one another in rapid succession. The sum total of knowledge thus developed in all the experiment stations of the world is great. Agricultural research is more effective than ever before. Pioneer days of agricultural experimentation are over. Experienced investigators of the highest training are now concentrating upon the problems of agriculture. We may even hope, and confidently expect, that at no distant date some genius will announce some great discovery that may revolutionize our methods of soil management or of crop production. If such a discovery is made it will be possible only because of the laborious research of many investigators in many experiment stations of the world.

The problems of agriculture are more difficult in the United States today than they have ever been before. The margin of profit is smaller. All the difficulties and obstacles which make farming more hazardous are increasing as our agriculture grows older. New problems and new dangers arise periodically. These handicaps to profitable agriculture can only be removed through the aid of scientific research. The farmer cannot well organize his own agencies of research as do the great corporations and manufacturing establishments. He can, however, properly call on the State and Federal Governments to aid in the solution of his problems. The production of food and clothing, which is the farmer's main task, is a prime essential of human living. Every citizen of the Republic is therefore interested in a successful agriculture, and the Government, in the interests of all the people, will continue to provide for agricultural research.

The Missouri Experiment Station has from the beginning emphasized the importance and basic character of scientific investigation. It has proceeded on the theory that good college teaching and safe extension teaching are possible only when an institution has based its work upon the most careful and reliable scientific research.

The report of one year's work at the Missouri Experiment Station, which appears in this publication, is evidence that the Station is thoroughly familiar

with the present problems of agriculture and is industriously at work in attempting their solution.

Agricultural research cannot be safely left to private enterprise. It is conceivable that research in agriculture might be conducted by great corporations for private gain. If it were so conducted the results would become the sole property of the corporation and would be used for increasing profits of the company and not directly for the public welfare. The state cannot afford to permit a monopoly of agricultural knowledge. Research in agriculture cannot be financed by the farmer himself. His operations are conducted upon too small a scale and the profits from his business are too small to justify any expenditures directly from his own business. It is also true that the benefits from the work of the agricultural experiment stations are not limited to the rural population but are of equal value to every class of citizens.

It was through agricultural research that the discovery was made that Texas fever is transmitted by the cattle tick. From this discovery came quickly the knowledge of a similar transmission in the terrible human scourges of yellow fever, bubonic plague and many other diseases. Today these diseases are under control as a result of the agricultural research on Texas fever in cattle.

Hog cholera, at one time the greatest hazard in swine production, has been brought under control, and now no farmer need have any fear of this destructive disease. The Missouri Experiment Station was one of the first in the country to popularize the use of the anti-hog cholera serum, and now maintains a modern serum laboratory for manufacturing and distributing this preventive serum to farmers at cost.

Through the researches of the Missouri Experiment Station, on its thirty outlying fields, systems of soil management have been developed which have resulted in great economic gains. By the intelligent use of fertilizers in a proper rotation it has been proven that the profits on the original investment from using limestone are 152 per cent; from bone meal, 397 per cent; from acid phosphate, 362 per cent; from potash, 46 per cent; and from barnyard manure 220 per cent.

The farmers of Missouri are protected by the Experiment Station from fraud in the sale of fertilizers. A thoroughly organized inspection service insures to Missouri farmers honest fertilizers true to the guarantee printed on the bag. This service has greatly improved the quality of commercial fertilizers in Missouri and has taught more profitable use of these essential factors in profitable agriculture.

The plant inspection service of the Station, through its inspection of nursery stock, has prevented the wide spread distribution of destructive plant diseases and saved the fruit growers of Missouri thousands of dollars.

Through its farm management investigations the Experiment Station has shown the advantages of different systems of renting and the relation which should exist between rents, land values and yields. Figures published by the Station have been used in arriving at a fair price between producers and dealers in milk in Missouri cities.

Agricultural research is essential to practical and reliable teaching in the College of Agriculture. It has made it possible to teach such methods and processes in farm operations as are known to be profitable. Agricultural

teaching is no longer a matter of opinion, or based upon one or two years' results, but is based upon long, accurate and thoroughly reliable research.

The agricultural extension work, now so important a phase of agricultural teaching, would be impossible without the help of the Experiment Station. The farmer cannot afford to experiment for himself in changing systems of agriculture; he must know that he is basing his changes upon assured fact. He is enabled to do this through the work of the Agricultural Experiment Station and the help of the Agricultural Extension Service.

Agricultural research offers the most permanent aid to the agricultural industry. It will insure a permanent system of agriculture adequate to provide for the needs of a growing population. It will promote and encourage the development of an industry of fundamental importance to the nation in time of peace or war.

COOPERATION WITH OTHER AGENCIES

Seed Testing Laboratory.—The United States Department of Agriculture cooperates with the College of Agriculture in maintaining a seed testing laboratory. During the past year we have also had the cooperation of the Missouri State Board of Agriculture.

Cereal Investigations.—Improving cereal crops is an important phase of our research work, and we are fortunate in having the full cooperation of the Bureau of Plant Industry in this project.

Soil Survey.—The Bureau of Soils of the United States Department of Agriculture is cooperating with the Experiment Station in a detailed soil survey of Missouri counties. This basic project is of great importance in connection with every phase of our investigational work.

Community Survey.—The Bureau of Agricultural Economics of the United States Department of Agriculture is cooperating with the Department of Rural Life in conducting community surveys. These surveys are of great fundamental importance in the development of rural communities.

State Board of Agriculture.—We have had good cooperation with the Missouri State Board of Agriculture in the holding of Farmers' Week, in connection with the Seed Testing Laboratory, and in other important relations.

CHANGES IN STATION STAFF

Appointments

- J. E. Hunter, Assistant in Agricultural Chemistry.
- D. R. G. Cowan, Assistant Professor of Marketing.
- M. T. Foster, Assistant in Animal Husbandry.
- R. T. Kirkpatrick, Instructor in Field Crops.
- J. B. Nelson, Assistant in Dairy Husbandry.
- E. B. Powell, Assistant in Soils.
- W. L. Witte, Assistant Professor of Rural Sociology.
- N. B. Guerrant, Assistant in Agricultural Chemistry.
- B. M. King, Instructor in Field Crops.

Resignations

- A. T. Edinger, Instructor in Animal Husbandry.
- H. D. Fox, Instructor in Animal Husbandry.
- Owen Howells, Assistant Professor of Rural Sociology.
- W. C. Boney, Instructor in Agricultural Engineering.
- O. C. McBride, Instructor in Entomology.

PUBLICATIONS

The publications of the Agricultural Experiment Station include three numbered series of reports in pamphlet form, and a weekly press service. The numbered series are the bulletins, research bulletins, and circulars. The bulletins are definite reports of specific investigations conducted by this Station, so presented that they may be readily understood by the farmer and applied in practice. The research bulletins are more technical in form and include a great mass of the original data of the investigations reported. The circulars are brief, popular reports of experiments, and frequently include a summarization of the best information on the subject covered, regardless of its source.

Within the year closing June 30, 1924 the Station has added new numbers to all three of these series as follows: eleven bulletins, six research bulletins and twelve circulars. Reprints have been made of six bulletins and four circulars. The following tabulation shows the series, number and title of each publication issued during the year, together with the number of pages in each and the number of copies printed.

Bulletins			
120	Rations for Breeding Ewes	16 pp.	3,000 48,000
136	Feeding Wheat to Fattening Swine	32	3,000 96,000
138	Farm Beekeeping.....	32	5,000 160,000
170	Insect Pests of Field Crops	32	5,000 160,000
195	Productive Methods for Soybeans in Mo.	32	10,000 320,000
196	Roup in Fowls.....	8	5,000 40,000
205	A New Method of Making Engine Oil Emulsions.....	8	5,000 40,000
206	A Comparison of Jersey Sires	12	5,000 60,000
207	Peach Culture in Missouri.....	16	10,000 160,000
208	Grape Growing in Missouri.....	36	10,000 360,000
209	Testing Fertilizers for Missouri Farmers: 1923.....	56	5,000 280,000
210	Contributions to Knowledge in Agriculture ..	80	7,500 600,000
211	Controlling Surface Erosion on Farm Lands..	24	10,000 240,000
212	Tomato Culture in Missouri.....	16	10,000 160,000
213	Cost of Family Living on the Farm	20	5,000 100,000
214	Why Build a Silo?—And How.....	16	7,500 120,000
215	Injurious Insect Pests of Strawberries.....	12	8,000 96,000
Circulars			
61	Docking and Castrating Lambs (Reprint) ..	4	5,000 20,000
89	Estimating Silo Capacities and Silage Weights (Reprint).....	4	10,000 40,000
91	Feeding Baby Chicks (Reprint).....	4	5,000 20,000
98	The Mangum Terrace (Reprint).....	12	5,000 60,000
113	Picking, Handling, and Exhibiting Fruit.....	8	10,000 80,000
114	The Missouri Fertilizer Law.....	4	2,500 10,000
115	Feeding Dairy Cows.....	12	10,000 120,000
116	Winter Rations for Dairy Heifers.....	8	10,000 80,000
117	Corn Root Rot	8	7,500 60,000
118	Self-feeders for Fattening Swine.....	8	5,000 40,000
119	Testing Milk and Cream.....	12	10,000 120,000
120	Pruning Apple and Pear Trees	16	10,000 160,000

121	Inoculation for Legumes.....	12	10,000	120,000
122	The Pickle Worm and Its Control	4	5,000	20,000
123	Strawberry Culture in Missouri.....	12	10,000	120,000
124	Apple Blotch Control in Missouri.....	8	10,000	80,000
Research Bulletins				
61	Studies in Animal Nutrition V.—Changes in the Composition of the Mature Dairy Cow While Fattening	20	2,500	50,000
62	Normal Growth of Domestic Animals.....	58	2,500	145,000
63	Erosion and Surface Runoff Under Different Soil Conditions.....	52	2,500	130,000
64	The Influence of Hydrogen-Ion Concentra- tion on the Growth of Fusarium Lycoper- sici and on Tomato Wilt.....	32	2,000	64,000
65	Silage Investigations	12	2,500	30,000
66	The Minimum Protein Requirement for Growing Dairy Heifers.....	156	2,000	312,000
			914	253,000 4,921,000

Demand for Publications.—Bulletins and circulars were in great popular demand, becoming so great at certain seasons of the year that for weeks at a stretch an average of 1,000 publications a day were mailed out in response to definite requests.

In addition to this, all publications as soon as issued were mailed to all public libraries and to all agricultural teachers and investigators in the State. Many bulletins and circulars were supplied to students in the 88 vocational agriculture high schools of Missouri, and thousands more were distributed by county agents to farmers asking for them.

ADDITIONAL INFORMATION SERVICE

The Missouri Farm News Service.—A five-column press service containing approximately 4,000 words was issued weekly, and mailed every Saturday afternoon to all newspapers and farm journals in the State. It consisted of short, timely articles designed to benefit the farmers and homemakers of the State by supplying in brief, readable form the best scientific counsel on current problems.

Special News Articles.—At frequent intervals throughout the year facts of special importance to the farming interests of the State were reported to the farm journals and to the news syndicates and thus circulated widely.

Information by Radio.—The broadcasting of timely agricultural information by radio, first inaugurated by this Station on March 7, 1922, was continued and expanded. Through the cooperation of the Missouri State Board of Agriculture and the Agricultural Extension Service a speaker was sent to Jefferson City every Wednesday night to broadcast timely information to the farmers of Missouri through Station WOS of the State Bureau of Markets.

SYNOPSIS OF NEW PUBLICATIONS

A Comparison of Jersey Sires, Based on the Average Mature Equivalent Fat Production of the Daughters.—C. W. Turner and A. C. Ragsdale (Missouri Agr. Exp. Sta. Bul. 206 (1923), pp. 3-12, fig. 1).—This bulletin

reports a comparison of 354 Jersey sires, and their ability to transmit the capacity for butterfat production as indicated in the Register of Merit records of their daughters. In order to place records made at various ages on a comparable basis the authors worked out the relation between age and fat production and used this factor to reduce all records to a "mature equivalent".

Peach Culture in Missouri, Henry D. Hooker, Jr., (Missouri Agr. Exp. Sta. Bul. 207 (1923), pp. 3-14, figs. 12).—The relation of winter injury to peach culture in Missouri is emphasized in this report. It is pointed out that pruning, cultivation, fertilizer and crop thinning increase hardiness to late winter injury. Reasons are given for delaying pruning until the trees are in bloom. The pruning recommended is a combination of thinning out and heading back. When pruning cannot be so delayed a winter heading followed by a summer thinning of the new growth is recommended. These methods of pruning are shown to favor the development of the greatest number of hardy buds. Data are given which show the value of delaying fertilizer applications until after all danger from late frosts. Directions for spraying and for the control of peach borers are appended.

Grape Growing in Missouri.—H. G. Swartwout (Missouri Agr. Exp. Sta. Bul. 203 (1924), pp. 3-33, figs. 19).—The essential factors in the successful management of a commercial vineyard under Missouri conditions are carefully set forth in this bulletin. The most desirable soils are described with reference to their character as well as their location in the State. Two commercial varieties and about a dozen home garden varieties are recommended. The successive steps in establishing and maintaining a thrifty vineyard are carefully explained, including propagation, care of vines in nursery, preparation of soil, laying out of vineyard, setting the vines, constructing the trellis, pruning the vines, cultivating, fertilizing, harvesting, packing and grading. A spraying schedule is included together with a description of spray materials and equipment.

Testing Fertilizers for Missouri Farmers, 1923. F. B. Mumford and L. D. Haigh (Missouri Agr. Exp. Sta. Bul. 209 (1924), pp. 3-55, fig. 1).—This publication is a report on the analysis of 361 official samples representing 143 brands of commercial fertilizers taken from stocks offered for sale in 109 Missouri towns. The power of limestone and similar materials to neutralize soil acidity is expressed in percentage of calcium carbonate for 446 samples tested. The brands and guaranteed analyses of fertilizers registered for sale in Missouri in 1923 are listed.

Contributions to Knowledge in Agriculture, F. B. Mumford (Missouri Agr. Exp. Sta. Bul. 210 (1924), pp. 2-77, figs. 21).—The Director of the Experiment Station in this publication reports in brief form the progress made in agricultural investigations during the year ending June 30, 1923. An account is given also of the several projects administered by the Station, as well as a review of its publications, and a statement of its receipts and expenditures.

Controlling Surface Erosion of Farm Lands, F. L. Duley (Missouri Agr. Exp. Sta. Bul. 211 (1924), pp. 2-23, figs. 17).—This bulletin seeks primarily to show the menace of sheet or surface soil erosion in depleting the fertility of Missouri soils. Results of carefully controlled experiments are given which show the relative amounts of the surface soil and fertility that have been lost from land having different tillage conditions and different crops. A growing crop on the land, particularly a small grain or sod crop is shown to

furnish the most effective means of reducing the erosion. The use of cropping systems that include sod crops like clover or other hays is shown to be the most practical means of reducing the surface erosion on rolling lands that must be cultivated a part of the time.

Tomato Culture in Missouri, J. T. Quinn (Missouri Agr. Exp. Sta. Bul. 212 (1924), pp. 3-16, figs. 5).—This bulletin opens with a discussion of the best types of soil for the production of tomatoes in Missouri. The hotbed method of starting plants is recommended for the home and market gardener. The coldframe or open bed method is best adapted to the cannery crop. Phosphorus seems to be the most important fertilizer element for tomato production on Missouri soils. The application of 400 to 500 pounds of fertilizer for the early crop, and 200 to 300 pounds for the cannery crop, is recommended. Data presented indicate that staking and pruning to one stem is unprofitable. The principal diseases and insects with their control are described.

Cost of Family Living on the Farm, O. R. Johnson (Missouri Agr. Exp. Sta. Bul. 213 (1924), pp. 2-20, figs. 8).—This bulletin reports a study of money and other costs of family living on a number of Missouri farms covering a period of eleven years, and on a farm home labor study covering four years. First a comparison is made of the relation between retail prices, farm labor incomes, and family living costs on the farms studied. The money and labor costs of maintaining the farm home are shown, together with the distribution of cash costs between groceries, clothing, household and other accounts, and the importance of other cash items compared to the value of contributions toward the living made by the farm. Next is discussed the labor demands on the housewife and just where each of her working hours is spent. The length of day, the portion of that day given to production, to indoor and outdoor work for each month in the year are all set forth.

Why Build a Silo?—And How, J. C. Wooley, E. A. Trowbridge and A. C. Ragsdale (Missouri Agr. Exp. Sta. Bul. 214 (1924), pp. 3-16, figs. 13).—This bulletin briefly sets forth the advantages of a silo under the practical conditions to be met on Missouri farms, and gives definite building instructions for each type of silo. To guide each builder in choosing the type of silo best suited to his own system of farming the authors enumerate the essential and desirable qualities of a good silo, and tabulate information on sizes of silos needed for different sized herds. Materials and details of construction are described for several types including monolithic concrete, concrete block, concrete stave, stone, vitrified block, wooden stave and wooden hoop silos.

Injurious Insect Pests of Strawberries, O. C. McBride (Missouri Agr. Exp. Sta. Bul. 215 (1924), pp. 3-12, figs. 6).—This bulletin notes the fact that strawberry growers in Missouri are beginning to realize that insect pests do much damage to the crop. In the past growers have depended largely on cultural methods, for preventing insect injury and it is still the most practical method of controlling certain insects. This bulletin, however, states that the time has arrived when growers must look to the use of insecticides for controlling serious insect epidemics on strawberries, and definitely recommends control measures for each of the more important pests and diseases.

Studies in Animal Nutrition V.—Changes in the Composition of the Mature Cow While Fattening, C. Robert Moulton, P. F. Trowbridge, and L. D. Haigh (Missouri Agr. Exp. Sta. Res. Bul. 61 (1923), pp. 3-20).—This is the fifth and final report in a series which constitutes a comprehensive analysis and interpretation of the data gathered in the "Use of Feed" experi-

ment which was started by the Station in the spring of 1907. The scope of the present report is clearly indicated by the sub-titles.

Normal Growth of Domestic Animals, C. R. Moulton, H. L. Kempster, A. G. Hogan, and Samuel Brody (Missouri Agr. Exp. Sta. Res. Bul. 62 (1923), pp. 3-58, figs. 53).—This bulletin is a first cooperative attempt to put into convenient form scattered data on growth of farm animals. In addition to the numerical data, curves are presented to show the process of growth as a whole. These curves and tables will be useful to the growers of animals and to investigators in nutrition of farm animals, as norms, or standards of growth. Growth curves and data are presented for beef steers, for the dairy cow, for draft colts, sheep, swine and the domestic fowl. A section is included also on the equivalence of age in some domestic animals.

Erosions and Surface Runoff Under Different Soil Conditions, F. L. Duley and M. F. Miller (Missouri Agr. Exp. Sta. Res. Bul. 63 (1923), pp. 3-50, figs. 22).—This publication is the first report of an investigation involving seven plots of Shelby loam soil laid off so that all the runoff and eroded soil from each plot was collected at the lower end of the plot in a concrete tank. The results of these experiments showed that grass or clover land absorbed much more water than cultivated land. Deep plowing (8 inches) was only slightly more effective than shallow plowing (4 inches) in preventing runoff and erosion. The surface inches of rainfall absorbed by uncropped land, or land in a cultivated crop like corn, was practically constant from year to year even with considerable variation in the annual precipitation. The loss of important nutrient elements from the soil through erosion was found to be more serious than the loss through the removal of crops. The use of a cropping system that includes sod crops, a considerable portion of the time is indicated as the most practical means of reducing erosion on rolling lands.

The Influence of Hydrogen-Ion Concentration on the Growth of *Fusarium Lycopersici* and on Tomato Wilt, Irl T. Scott (Missouri Agr. Exp. Sta. Res. Bul. 64 (1924), pp. 5-32, figs. 10).—This bulletin reports an investigation on the influence of the reaction on the growth of the fungous parasite *Fusarium lycopersici* and its capacity to infect the host. Four experiments where the fungus was grown in mineral nutrient solutions of varying reactions are reported and it was found that there is a limited range of acidity where the growth is at a minimum within the normal growth range of the organism. A minimum of wilting was also found to occur in soils with reaction made artificially more or less near those at which growth of the fungus was at a minimum in the cultural experiments. The results suggest a possibility of adjusting soils to reactions unfavorable for wilt by proper soil treatments, or that by using soils with natural reactions unfavorable for infections a minimum of wilt would be obtained.

Silage Investigations—Loss of Nutrients in the Silo and During the Field Curing of Corn, A. C. Ragsdale and C. W. Turner (Missouri Agr. Exp. Sta. Res. Bul. 65 (1924), pp. 3-10).—In the investigation here reported the unavoidable loss of nutrients in silage formation was compared with the loss of nutrients in the field curing of corn. The average losses in 54 silos were compared with the losses from 16 shocks of corn fodder. The loss of dry matter and of nitrogen-free extract was found to be twice as great in field cured corn as in silage.

The Minimum Protein Requirement for Growing Dairy Heifers, W. W. Swett, C. H. Eckles and A. C. Ragsdale (Missouri Agr. Exp. Sta. Res. Bul. 66

(1924), pp. 3-155, figs. 11).—This bulletin reports an investigation in which 34 purebred Holstein and Jersey heifers were kept on carefully controlled rations for an average of 14.9 or a total of 508.8 thirty-day periods, extending over approximately seven and one-half years. The rations were calculated to furnish energy equal to, or slightly in excess of, that recommended by the correct feeding standards, and adequacy of mineral salts and vitamins, while the proportions of protein were varied from very low to very high planes. The development and behavior rather than the nitrogen balance of the animals was adopted as a basis for interpreting results. The normal growth values of Eckles were used as a standard for comparison. The annual feed cost of raising to producing age a number of heifers sufficient to maintain the present dairy cow population in the United States is approximately \$400,000,000. Protein is generally the most expensive constituent in the dairy ration. The possibility of a tremendous saving is indicated.

Picking, Handling and Exhibiting Fruit, T. J. Talbert and A. M. Burroughs (Missouri Agr. Exp. Sta. Circ. 113 (1923), pp. 1-7, fig. 1).—In this brief circular the authors emphasize the importance of correct handling and preparation of fruit whether intended for sale or exhibition. Among the main divisions of the circular are the following: indications of ripeness, picking stone fruits, pears, summer apples, fall and winter apples, utensils for picking, handling between tree and consumer, exhibiting.

The Missouri Fertilizer Law, F. B. Mumford and L. D. Haigh (Missouri Agr. Exp. Sta. Circ. 114 (1923), pp. 4).—This publication outlines the purposes of the Fertilizer Law and the methods through which it is administered by the Experiment Station. The text of the law is printed in full.

Feeding Dairy Cows, A. C. Ragsdale (Missouri Agr. Exp. Sta. Circ. 115 (1923), pp. 12, figs. 4).—This circular points out the fact that the profit of milk production depends much on the selecting and buying of feeds. The requirements of a dairy ration are explained and a number of definite rations are recommended to fit different farming systems, different seasons, different breeds of cows, different volumes of milk production and different forages.

Winter Ration for Dairy Heifers, A. C. Ragsdale (Missouri Agr. Exp. Sta. Circ. 116 (1923), pp. 8, figs. 7).—Since the maintenance of a productive dairy herd requires that the calves from the best cows must be raised, this circular is issued to point out the most economical way of raising them. For this purpose rations are definitely recommended based largely on experiments by this Station previously reported in Missouri Agr. Exp. Sta. Bul. 158.

Corn Root Rot, B. B. Branstetter (Missouri Agr. Exp. Sta. Circ. 117 (1924), pp. 8, figs. 4).—Recognizing the prevalence of corn root rot throughout the Corn Belt the Station issued this circular to describe the symptoms of the disease and to recommend measures by which it may be controlled. Selection of seed ears with bright, clean tips and butts, crop rotation, and the application of lime and fertilizers are recommended.

Self-feeders for Fattening Swine, L. A. Weaver (Missouri Agr. Exp. Sta. Circ. 118 (1924), pp. 8, fig. 1).—This is a brief revision of Missouri Agr. Exp. Sta. Bul. 144 by the same author.

Testing Milk and Cream, W. P. Hays (Missouri Agr. Exp. Sta. Circ. 119 (1924), pp. 11, figs. 16).—This is a working manual for the milk and cream tester, with each step in the process described and pictorially demonstrated.

Pruning Apple and Pear Trees, T. J. Talbert (Missouri Agr. Exp. Sta. Circ. 120 (1924), pp. 16, figs. 13).—At the outset this circular notes a change in

pruning practice from the severe cutting advocated a few years ago to very light pruning at the present time. The principles of pruning are explained and the objects of the practice clearly defined. In pictures and text the practical problems of pruning are taken up and simplified.

Inoculation for Legumes, W. A. Albrecht (Missouri Agr. Exp. Sta. Circ. 121 (1924), pp. 12, figs. 5).—First explaining just what inoculation is, this circular tells why and when legumes need to be supplied with nitrogen fixing bacteria. The chief economic legumes are classified in a list showing which ones are inoculated by one another. The soil and culture methods of inoculation are then clearly explained in text and pictures.

The Pickle Worm and Its Control, K. C. Sullivan (Missouri Agr. Exp. Sta. Circ. 122 (1924), pp. 4, figs. 2).—This brief publication recognizes the economic importance of the pickle worm, *Diolophania nitidolis* (Cramer), which practically destroyed the cantaloupe crop of Southeast Missouri during the summer of 1923. The life cycle of the insect and the manner in which it damages the cucurbit crops are explained, and definite control measures are recommended.

Strawberry Culture in Missouri, T. J. Talbert (Missouri Agr. Exp. Sta. Circ. 123 (1924), pp. 12, figs. 6).—Noting the fact that Missouri produces commercially about 1000 carloads of strawberries a year and is one of the two or three chief strawberry states of the Union, this circular gives in brief form the best practices involved in each step in strawberry production. Soil, fertilization, varieties, preparation of soil, planting, cultivation, intercropping, renewal, mulching, control of insects and diseases, harvesting and selling are all carefully considered.

Apple Blotch Control in Missouri, T. J. Talbert (Missouri Agr. Exp. Sta. Circ. 124 (1924), pp. 8, figs. 2).—This circular meets a real need, since apple blotch has become the most injurious disease affecting this fruit in Missouri. Control measures are definitely outlined and the effects of spraying and pruning are explained. Directions are given for mixing and applying the sprays.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS AND PERIODICALS

Burroughs, A. M.—Some Effects of Oil Sprays on Fruit Trees. Proc. Amer. Soc. Hort. Sci. 1923, pp. 269-277. Reports on the investigation of some of the new oil sprays for the control of San Jose scale. No injurious effects were noticed following the use of engine oil sprays on apple and peach trees which were dormant. The investigations indicated, however, that oil sprays could not safely be used on green foliage.

Burroughs, A. M., and Grube, W. M.—A Simplified Method for Making Lubricating Oil Emulsions. Jour. Econ. Ent. Vol. 16, No. 6, pp. 534-539. 1923. A new method for making stock emulsions of paraffin oils to be used for spraying is described in this article.

Hooker, Henry D., Jr.—Colloidal Copper Hydroxide as a Fungicide. Jour. Ind. and Eng. Chem. Vol. 15, pp. 1177-78. 1923. Preliminary experiments indicate that copper hydroxide prepared as a colloid was fungicidal to apple scab and apple blotch in concentrations of one part of hydroxide to 5,000 of water. At this concentration it produced very slight burning. It had excellent sticking properties due to its positive charge and spreads well in dilute solution. It can be used with lead arsenate and nicotine sulphate.

Etheridge, W. C., et al.—Report of the Committee on the Improvement of Laboratory Studies in the Introductory Course in Field Crops. Jour. Amer.

Soc. Agron., Vol. 16, No. 1. This article is devoted to a discussion as to what should be the type of laboratory study for an introductory course in Field Crops whose main purpose is to give the majority of its students the only systematic training they are likely to receive in this subject.

Eyster, William H.—**A Primitive Sporophyte in Maize.** Amer. Jour. of Botany, Vol. 11: pp. 7-14. 1924. In maize, sporophytes have been found that do not become dormant in the seed stage but have a continuous development from the fertilized egg to the new plant. Such continuous growth of the sporophyte in seed plants is called *vivipary*. Vivipary in maize is inherited as a simple Mendelian character.

Stadler, L. J.—**An Experimental Study of the Variety as An Agronomic Unit.** Jour. Amer. Soc. Agron., Vol. 16, No. 4, pp. 366-372. 1924. This article reports an investigation of the fundamental assumption of the variety test—that different stocks of the same variety are similar in yield and practical value. The results showed that general varietal recommendations are frequently in error because the stock included in the variety test does not fairly represent the variety to which the conclusions are applied.

Brody, Samuel; Ragsdale, A. C., and Turner, C. W.—**The Effect of Gestation on the Rate of Decline of Milk Secretion with the Advance of the Period of Lactation.** Jour. of Gen. Physiology, Vol. 5, No. 6, July, 1923. The course of decline of milk secretion with the advance of the period of lactation in farrow cows followed the course of decline of a monomolecular chemical reaction. The decline of milk secretion due to pregnancy was related to the increase in weight of gestating animals.

Ragsdale, A. C., and Turner, C. W.—**The Effects of Underfeeding on Milk Secretion.** Jour. of Dairy Science, Vol. 6, No. 4, July, 1923. It was shown that when the ration fed to dairy cows was reduced 50 per cent there was a decided increase in the percentage of fat in milk. The quantity of milk was reduced, but the total yield of fat was not significantly changed. This effect of underfeeding should be taken into consideration when interpreting data on feeding trials of short duration.

Turner C. W.; Ragsdale, A. C., and Brody, Samuel.—**Normal Growth of the Jersey Cow.** Jour. of Dairy Science, Vol. 6, No. 5, September, 1923. It was found that the percentage of decline of growth, as indicated by body weight, with age was constant. Maximum body weight was found to be attained at approximately eight years of age, somewhat later than is generally expected.

Brody, Samuel; Ragsdale, A. C., and Turner, C. W.—**The Rate of Growth of the Dairy Cow. III. The Relation Between Growth in Weight and Increase of Milk Secretion with Age.** Jour. of Gen. Physiology, Vol. 6, No. 1, September, 1923. From 2 years, the age when milk secretion usually begins, to 9 years, the age of maximum body weight, the increase in milk secretion with age followed the course of growth in body weight. Additional data, showing the effect of age and the effect of the increase of body weight on milk secretion, are given.

Brody, Samuel, Ragsdale, A. C., and Turner, C. W.—**The Rate of Growth of the Dairy Cow. IV. Growth and Senescence as Measured by the Rise and Fall of Milk Secretion with Age.** Jour. of Gen. Physiology, Vol. 6, No. 1, September, 1923. It is indicated that growth and senescence go on simultaneously from the beginning to the end of life, and that each follows an ex-

ponential law with age. A method of predicting the future production of dairy animals on the basis of present productions is also given.

Brody, Samuel; Henderson, E. W., and Kempster, H. L.—The Rate of Senescence of the Domestic Fowl as Measured by the Decline in Egg Production with Age. The Jour. of Gen. Physiology, Vol. 6, No. 1, September, 1923. A study of the decline of egg production with age in the domestic fowl from the time laying begins up to and including 8 years showed that each year's egg production was a constant percentage of the preceding year's production (88 per cent in the group of fowls studied).

Turner, C. W.; Ragsdale, A. C., and Brody, Samuel.—How the Advance of the Period of Lactation Affects the Milk Flow. Jour. of Dairy Science, Vol. 6, No. 6, November, 1923. The percentage decline of milk secretion with the advance of the period of lactation was shown to be fairly constant. A slightly greater percentage decrease during the last two or three months of lactation was due to advanced pregnancy.

Ragsdale, A. C., and Turner, C. W.—The Minimum Milk Requirement for Calf Raising. Jour. of Agr. Research, Vol. 26, No. 9, December, 1923. Calves, weaned when 60 to 70 days old and fed thereafter a good quality of alfalfa or soybean hay and a suitable grain mixture, made approximately 70 per cent normal gains up to 6 months of age.

Ragsdale, A. C.; Turner, C. W., and Brody, Samuel.—The Effect of Gestation upon Lactation in the Dairy Cow. Jour. of Dairy Science, Vol. 7, No. 1, January, 1924. The effect of pregnancy becomes apparent in a reduced milk secretion when the period of pregnancy exceeds five months.

Brody, Samuel, and Ragsdale, A. C.—The Rate of Growth of the Dairy Cow. V. Extra-uterine Growth in Linear Dimensions. Jour. of Gen. Physiology Vol. 6, No. 3, January, 1924. The extra-uterine growth in linear dimensions and in weight of the dairy cow followed an exponential law having the same form as the law representing the course of monomolecular change in chemistry.

Ragsdale, A. C.; Turner, C. W., and Brody, Samuel.—The Relation Between Age and Fat Production in Dairy Cows. Jour. of Dairy Science, Vol. 7, No. 2, March, 1924. It was shown that fat production gradually increased up to between seven and eight years of age on the average, and then gradually decreased with the onset of old age.

No difference between the breeds as to the time of maturity was noted.

Brody, Samuel; Turner, C. W., and Ragsdale, A. C.—The Relation Between the Initial Rise and Subsequent Decline of Milk Secretion Following Parturition. Jour. of Gen. Physiology, Vol. 6, No. 5, May, 1924. Milk secretion increases for about a month after calving then it decreases steadily. Data were presented for the rising segment of milk secretion, and its relation to the declining segment determined.

Ragsdale, A. C.; Turner, C. W., and Brody, Samuel.—The Rate of Milk Secretion as Affected by an Accumulation of Milk in the Mammary Gland. Jour. of Dairy Science, Vol. 7, No. 3, May, 1924. It was shown that the speed of milk secretion in unit time was governed by the amount of milk accumulated in the udder or the interval between milkings.

Duley, F. L.—Easily Soluble Calcium of the Soil in Relation to Acidity and Returns from Liming. Soil Science, Vol. 17, No. 3, pp. 213-228. March, 1924. Determinations of the amount of calcium soluble in 0.04 N carbonated water

showed a good correlation with the returns from lime in the field. Of the soils studied those having less than approximately 700 pounds of calcium per acre soluble by this method showed good increases from liming, while those soils having appreciably more than this amount did not give very marked increases for applications of liming materials. Those soils giving low returns for lime did not vary greatly in acidity from those giving good returns. It would seem from the results that if a soil is well supplied with nitrogen, phosphorus, and a fair amount of calcium soluble in carbonated water, it will likely produce good yields of the common field crops in spite of a considerable amount of soil acidity.

Bradfield, Richard.—**The Effect of the Concentration of Colloidal Clay Upon Its Hydrogen-ion Concentration.** Jour. Phys. Chem. Vol. 28: pp. 170-5. 1924. The pH value of a series of solutions of an acid colloidal clay, ranging from 0 to 12.8 per cent in concentration, were determined electrometrically. The relation between the concentration of the clay and its hydrogen-ion concentration was found to be similar in type with that commonly obtained with ordinary weak acids like acetic. The acidity seems to be of the same type in both cases.

Bradfield, Richard.—**The Nature of the Acidity of the Colloidal Clay of Acid Soils.** Jour. Amer. Chem. Soc. Vol. 45: pp. 2669-78. 1923. Solutions of $\text{Ca}(\text{OH})_2$ and $\text{Na}(\text{OH})$ when titrated with 1% solutions of four colloidal clays by both the conductivity and the hydrogen electrode methods gave curves of the type usually obtained in titrating strong bases with weak acids. Equivalent amounts of different bases were neutralized by the same amounts of colloidal clay. The 1% solutions of the clay colloids had concentrations ranging from .0027 to .0037 N. The reaction between acid colloidal clays and strong bases seems to be an ordinary neutralization and recourse to the theory of physical adsorption seems unnecessary.

Bradfield, Richard.—**The Relation of Hydrogen-Ion Concentration to the Flocculation of a Colloidal Clay.** Jour. Amer. Chem. Soc., Vol. 45: pp. 1243-50. 1923. The effect of the hydrogen-ion concentration upon the flocculation of colloidal clay was studied by determining, the minimum electrolyte requirement with a series of mixtures of HCL, KCl and KOH in which the potassium content was kept constant and the reaction varied from a high acidity to high alkalinity. The curve obtained by plotting electrolyte requirement against pH value showed a sharp break at the neutral point, representing a ten-fold increase, then flattened in the alkaline region. With a series of acids, flocculation took place at about the same pH value in each case but the requirements varied widely when expressed in terms of milliequivalents.

Bradfield, Richard.—**The Nature of the Chemical Reactions of Colloidal Clay.** First National Colloid Symposium Monograph, pp. 369-91. An analysis of the data presented in the three articles "The Relation of Hydrogen-ion Concentration to the Flocculation of a Colloidal Clay"; "The Nature of the Acidity of the Colloidal Clay of Acid Soils;" and "The Effect of the Concentration of Colloidal Clay Upon Its Hydrogen-ion Concentration" is given. All observations made seem to indicate that the reactions resulting when colloidal clay is treated with electrolytes are due to the usual laws of chemical affinity acting at the surface of the particles.

Bradfield, Richard.—**The Importance of Hydrogen-Ion Concentration Control in Physico-Chemical Studies of Heavy Soils.** Soil Science, Vol. 17:

pp. 411-22. 1924. In a series of studies in which all other factors were kept constant and the hydrogen-ion concentration allowed to vary between wide limits it was found that the flocculating power of any electrolyte varied widely with slight changes in the hydrogen-ion concentration. Similar changes were noted in the electrical charge of the colloidal particles. In the basic exchange studies equivalent, less than equivalent, and more than equivalent exchange could be obtained at will by the proper control of the hydrogen-ion concentration.

Kempster, H. L.—Physiological Relation Between Fecundity and Yellow Pigmentation of Fowls. Profitable Culling and Selective Flock Breeding, pp. 169-170. Reliable Poultry Journal Pub. Co. Various investigations with the carotinoid pigment, known as xanthophyll, in relation to the yellow color in the skin parts of fowls and in the egg yolk are discussed.

Eyster, W. H. (with Ellis, M. M.).—Some Effects of Insulin and Glucokinin on Maize Seedlings. Science, Vol. 58, No. 1513: pp. 541-542. 1923. Weak aqueous solutions of insulin and glucokinin promoted growth in young maize seedlings. Strong solutions practically stopped growth.

Robbins, William J., and Maneval, W. E.—Further Experiments on Growth of Excised Root Tips Under Sterile Conditions. Botanical Gazette, Vol. 76: pp. 274-287. 1923. The growth of excised corn root tips under sterile conditions in the dark and in light in Pfeffer's solution containing various amounts of dextrose are reported. Extracts of corn grains, corn seedlings, corn endosperm, Canada field peas, clover, and metagen were not found to favor the growth of excised corn root tips to any marked degree. Report of the growth of root tips of other plants is also given.

Robbins, William J.—Isoelectric Points for the Mycelium of Fungi. Jour. Gen. Physiology, Vol. 6: pp. 259-271. 1924. The hydrogen-ion concentration of the mycelium of *Rhizopus nigricans* washed with various buffer mixtures and grown in various media are reported. The hydrogen-ion concentration of the mycelium of *Fusarium lycopersici* stained with certain acid and basic dyes and washed with buffer mixtures of 0.1 M phosphoric acid and sodium hydroxide is reported.

Robbins, William J.—An Isoelectric Point for Plant Tissue and Its Significance. Amer. Jour. Bot. Vol. 10: pp. 412-439. 1923. The water absorption by potato tuber tissue in various buffer mixtures was measured. The effect of buffer mixtures on the absorption and retention of basic and acid dyes was determined.

Haseman, L., and Bromley, S. W.—Controlling Chinch Bugs in Missouri With Calcium Cyanide. Jour. of Econ. Ent. Vol. 17, pp. 324-329. April 1924. The results secured from the use of the new chemical cyanide for destroying chinch bugs at wheat harvest are given.

Sullivan, K. C., and McBride, O. C.—The Effect of Oil Sprays on Apple Aphides. Jour. of Econ. Ent. June, 1924. Extensive tests were made in 1923 and 1924 with lime sulphur, soap oil emulsions and Kayso oil emulsion sprays for the control of the common grain aphid (*Aphis avenae*) on apple. These materials were used at different strengths and although some of the material gave partial control, the results obtained do not warrant their use as materials which can be relied upon to give absolute protection.

Sullivan, K. C.—The Use of Calcium Cyanide for the Control of Fleas and Other Insects. Jour. of Econ. Ent., April 1924. Calcium cyanide was success-

fully used for the control of the dog flea (*Ctenocephalus canis* Curtis) and the human flea (*Pulex irritans* L) in both open and closed buildings. Calcium cyanide was successfully used for controlling blister beetles (*Epicauta vittata* Fob.) in gardens. Calcium cyanide also gave good results in the control of the white fly in greenhouses and for the control of San Jose scale on nursery stock, apple and peach.

Hogan, A. G., and Skouby, C. I.—Determination of the Surface Area of Cattle and Swine. Jour. Agr. Res. 25, p. 419. 1924. By using the weight and length of body, a more accurate formula has been developed for calculating the surface area of cattle and swine. The formula is:

$$S = W^{.75} \times L^{.75} \times K$$

S is the surface area in square centimeters, W is weight in kilograms, L is the length of the body in centimeters, and K is the constant 217 for cattle and 175 for swine. The maximum error is less than ± 5.5 per cent with either cattle or swine.

NEW EQUIPMENT

Agriculture Building.—The new Agriculture Building has now been completely equipped and has, as a result, greatly facilitated the work of the Experiment Station.

Apparatus.—The following scientific apparatus has been added during the year: 1 Kohler automatic farm light plant, 4 platinum crucibles, 2 platinum dishes, 6 ventilator fans, 1 electric hot plate, power sample grinding machinery, 2 metabolism crates, 1 Freas constant temperature water bath, 1 serological bath, 2 centrifuges, 1 hot air sterilizer, 2 steam pressure cookers, 1 incubator, 1 automatic water still, 1 Autoclave, 1 50-quart brine icecream freezer, 1 Ford roadster, 1 Clark sample press, 2 Lysimeters, chemicals and glassware.

SUBJECTS NOW UNDER INVESTIGATION

Agricultural Chemistry

Chemical Service.
Fertilizer Control.
Nutritional Requirements of Poultry.

Protein Storage in Protoplasmic Tissue.
Use of Feed Experiment.

Agricultural Engineering

A Study of the Methods of Prolonging the Service of Wood Fence Posts.

An Investigation of Sanitary Conditions on Farms and Experiments to Determine the Best Types of Sanitary Equipment.

Method of Clearing Cut-over Lands.

The Draft of Wagons.

Investigations to Determine the Draft of Various Farm Implements, the Effect of Different Soil Types on Draft and the Effect of the Different Treatments of Soils on the Draft of Various Implements. Also to Determine the Cost of Different Operations.

Animal Husbandry

Age as a Factor in Animal Breeding.

Age as a Factor in Animal Breeding—The Effect of Plane of Nutrition upon Immature Brood Sows.

Hogging Down Corn and Soybeans.

Molasses in Rations for Fattening Yearling Cattle.

Barley vs. Corn For Fattening Swine.

Relation of Feed Consumed to Protein & Energy Retained in the Carcass.

Factors Influencing the Normal Rate of Growth in Domestic Animals and the Permanency of the Effects of Arrested Development.

Growing Draft Colts.

The Relation of Diet To Bodily Activity and the Capacity to Withstand Unfavorable Circumstances.

Fecundity of Swine: The Normal Sexual Cycle, and as Influenced by Unfavorable Dietary Conditions.

Wintering Idle Brood Mares on Bluegrass Pasture Supplemented With Oat Straw and Limited Grain Ration.

The Effect of Yeast on Feeds and Their Utilization by Fattening Swine.

Limited Grain Rations for Fattening Cattle of Different Ages.

Botany

A Study of Certain Fusarial Diseases of Plants.

The Relation of Hydrogen-ion Concentration to the Growth of Plants.

Dairy Husbandry

A Study of Colostrum With Special Reference to the Effect of Heat (pasteurization) on its Physico-chemical, Bacteriological, Immunological and Nutritional Changes.

Official Testing of Dairy Cows.

Studies in Milk Secretion.

Standards of Growth for Dairy Cattle.

Minimum Protein Requirements for the Growth of Dairy Heifers.

The Inheritance and Transmission of the Characters "Capacity for Fat Production."

The Effect of Each Ingredient in the Manufacture of Ice Cream.

A Study of the Production and Marketing of Butter in Missouri.

The Deleterious Effects of Frozen Milk on Baby Chicks, and on the Marketability of Milk and Cream.

Entomology

Nursery Inspection.

A Study of the Life Cycle of the Codling Moth and the Best Time and Method of Applying Insecticides for Controlling it.

An Investigation to Determine the Life-history, Development and Habits of the Corn-ear Worm and Practical Methods of Controlling its Ravages.

An Investigation to Determine How Sap-sucking Insects Injure Plants.

An Investigation to Determine What Insects are Injurious to Nursery Stock in the State, Their

Life Histories, Distribution, Injury and Methods of Control.

Injurious Insect Pests of Melon and Related Crops.

The Annual Life Cycle of the Hessian Fly in Missouri and its Control.

An Investigation of Methods for Controlling the Chinch-bug.

An Investigation to Determine the Causes of the Periodical Recurrence of Insect Pests as Scourges.

Field Crops

Seed Testing Laboratory.

Comparison of Soybeans and Cowpeas for Hay and Seed Production.

A Comparison of the Most Important Grain Sorghums With Corn for Grain and Forage Production.

A Study of the Cultural Requirements and Adaptation of Sudan Grass.

A Study of the Important Varieties of Oats for Missouri Conditions.

Wheat Breeding Investigations, Including the Improvement of Commercial Varieties by (1) The Pure Line Method of Breeding, (2) Hybridization and Subsequent Selection.

A Study of the Adaptation of the Important Varieties and Selections of Soybeans to the Various Soil Types of the State.

A Genetic Analysis of Maize.

Cultural Experiments with Soybeans, Including (1) Time at Seeding, (2) Method of Seeding, (3) Rate of Seeding.

A Study of the Adaptations of the Important Varieties of Spring Barley for Missouri Conditions.

A Morphological Classification of the Varieties of Soybeans.

Cultural Experiments with Spring Barley.

Factors Influencing the Development of the Maize Plant—Field Studies of the Plant.

Home Economics

Color Knowledge Essential to Costume and its Practical Application.

Selection and Economic Use of Soap in the Home.

To Find the Causes of Vitamin Destruction in Cooked and Canned Foods: 1. To Test the Theory of Oxidation as a Cause of Vitamin C Destruction.

Investigation of Baking Qualities of Missouri Flour.

A Nutrition Problem With Special Reference to Negro Children.

The Psychology of Child Nutrition.

The Effects of External Temperature on the Basal Metabolism of Young Women Under Usual Conditions of Dress.

Horticulture

Spraying Fruits for Insect and Fungous Diseases.
 Investigations With Seed Potatoes.
 Nutrition and Plant Response of Vegetables.
 Identification and Study of Factors Determining Hardiness and Methods of Increasing It.
 The Nutrition of Fruits With Special Reference to Their Hardiness.
 The Home Orchard; Costs and Returns.
 Peach Breeding for Hardy Sorts.
 Walnut Grafting Investigation.

Breeding Apples for Late Blooming Habit.
 Treatment of Apple Canker Diseases.
 Cabbage Seed Selection for Disease Resistance.
 Tomato Seed Selection for Disease Resistance.
 Investigation of the Factors Limiting the Production of Sweet Cherries in Missouri.
 Investigations to Determine the Fertilizer Requirements, Varieties, Cultural Methods, and Seed "Place Effect" of the Watermelon and the Cantaloupe.

Poultry Husbandry

Rate of Growth of Chicks Under Normal Conditions.
 The Value of Sour Milk and Beef Scrap in Rations for Growing Chicks, and the Cost of Growing Chicks.
 Value of Sour Milk, Beef Scrap, Cottonseed Meal, Gluten Meal, and Oil Meal in Rations for Egg Production.
 Time of Molt as an Index to Productivity of Hens.

Influence of Time Laying Starts to Future Production.
 Time of Hatching in Relation to Egg Production.
 Correlation of Sexual Maturity to Annual Egg Production.
 Beef Cattle Production in Missouri.
 Cost of Producing Farm Products Under Farm Conditions.

Rural Life

The Standard of Living on the Farm as a Factor in Cost of Production.
 Distribution of Farm Labor.

Rural Training Laboratory. A Study of the Rural Primary Groups of Boone County, Missouri.
 Taxation Problems of Agriculture.

Soils

Experiments to Determine the Best Systems of Soil Management for the Most Important Soil Types in Missouri.
 Effects of Different Soil Treatments, Long Continued Upon Bacterial Activity in the Soil.
 Experiments to Determine the Value of Bat Guano as a Fertilizer.
 The Determination of the Relative Values of Different Forms of Phosphorus Upon the Soils at Columbia.
 Studies of the Tight Clay Layer in the Soils of the Level Prairies of Missouri.
 The Production and Distribution of Bacteria for Legumes.
 The Rate of Accumulation and Cost of Nitrogen and Carbon in Soils Under Different Systems of Green Manuring and Cropping.
 Studies of Water Absorption, Run-Off, Percolation, Evaporation, Capillary Water Movement and Soil Erosion Under Field Conditions.

An Investigation Having to do with the Development of the Various Parts of the Maize Plant as Influenced by Variation in Soil Moisture, Soil Composition and Texture, and in the Supply of Plant Food.
 Crop Rotation and Fertilizer Experiments.
 Miscellaneous or Service Project—"Testing Soils for their Lime Need"
 The Effect of Different Amounts and Different Methods of Applying Commercial Fertilizer on the Corn Crop.
 The Determination and Mapping of Missouri Soil Types.
 Nitrate Production in a Soil as Affected by the Crop and Cultivation.
 Studies on the Longevity of *B. Radicicola* in the Soil.
 An Investigation of the Character of the Colloids in Missouri Clay Soils.
 Studies Upon the Calcium Content of Soils and Its Relation to Acidity and the Response of Soils to Liming.

Veterinary Science

Experiment on the Viability of Hog Cholera Virus. ◀◀
 The Distribution of Abortion Infection in Swine by Positive Reacting Immune Carriers.
 Contagious Abortion Investigations.

An Experimental Study of Hog Cholera and the Factors Concerned in Immunity Against the Disease.
 Distribution of Anti-Hog-Cholera Serum.

SERVICE PROJECTS

Seed Testing Laboratory. (W. C. Etheridge, Clara Fuhr, Maxine Wilks, Helen Averitt, and J. C. Stephens.) A total of 3,348 lots of seed were tested and examined by the Seed Testing Laboratory during the year ending June 30, 1924. Of these samples 2,696 were tested for Missouri farmers and seedsmen and 152 for the U. S. Custom House, under the Seed Importation Act. Fifteen referee analyses were made for the Research and Methods Committee of the Association of Official Seed Analysts of America.

For farmers and seedsmen of other states, 485 tests were made as follows: Colorado 150, Kansas 113, Nebraska 86, Iowa 71, Arkansas 20, Illinois 15, South Dakota 12, Texas 5, Ohio 4, New Mexico 4, Oklahoma 2, Tennessee 1, Louisiana 1, Toronto, Canada 1.

The total number of tests made included the following: Purity only 68, Purity and Germination 1,150, Germination only 1,995, Purity, Germination and Identification 1, Identification only 99, Purity and Examination 4, Germination and Examination 20, Examination only 14. Of these, three were Custom House samples not under the Act, and these were sent to Washington.

In addition to the above lots of seed, 291 lots were tested in cooperation with the Missouri Corn Growers' Association, bringing the total to 3,639 lots. This is an increase of 1,238 lots over the number tested in the previous year.

Fertilizer Control. (F. B. Mumford, Director, and L. D. Haigh, Chemist) —The work under this project comprised: (1) the registration by manufacturers, jobbers, and selling agencies of all brands of fertilizer which were sold in the State; (2) the furnishing of registration tags which were attached to all sacks before they were shipped into the State; (3) the inspection of stocks of fertilizer which have been shipped into the State and collections of samples of fertilizer for analysis from these stocks and (4) the analysis of these fertilizer samples and the issuing of the printed report on the results found.

Six hundred and thirty-four brands of fertilizers were registered by 51 manufacturers. Tags were furnished to manufacturers for 40,000 to 45,000 tons of fertilizer. Inspection of shipment was made in 95 towns in 41 counties in the fall of 1923 and 25 towns in 13 counties in the spring of 1924; and 384 samples of fertilizer were obtained for analysis representing 151 brands.

This work for the year 1923 was reported in Bulletin 209 of the Missouri Agricultural Experiment Station. This shows the analyses of 348 regular and 13 special samples of fertilizer for the percentages of plant food as compared to their guarantee: the analyses of 230 nitrogen carrying fertilizers for the availability of the nitrogen, the analyses of 446 samples of limestone and other material for their power to correct soil acidity. The name and guaranteed analysis of all brands of fertilizers listed for each company, which will be sold in the State during the year 1924 were also given. A table showing the tonnage of different kinds of fertilizers shipped into each county of the State during the year 1923 was given.

The violations of the Missouri Fertilizer law found by the inspectors were listed. A method for calculating the value of the plant food in a fertilizer was given along with suggestions for dealers and consumers on things to be observed when purchasing fertilizer.

Testing Soils for Their Lime Need. (M. F. Miller, W. A. Albrecht, R. E. Uhland).—In order to encourage the growth of more legumes and the use of limestone on the more acid soils, tests of acidity for farmers and county agents were made on all samples submitted. About 425 tests were made during the

past year, making the total number of samples tested to date 4,525. These tests were made by the Truog method and by the modified Comber method.

In addition to furnishing the results of these tests, some recommendations were usually made regarding soil management. These tests have also been of great value to the soils extension specialists who have been putting on a definite campaign for the growing of more legumes and the use of more limestone.

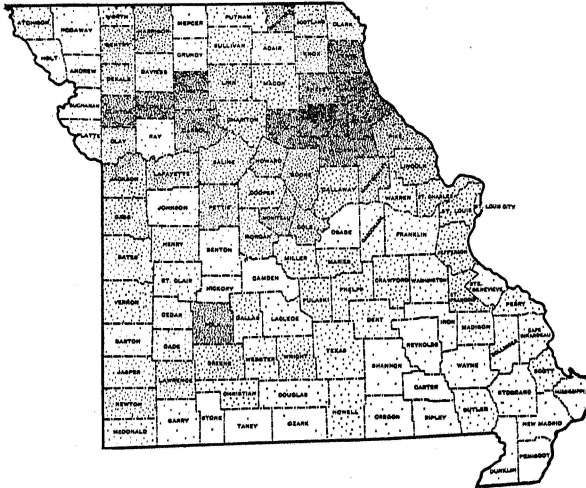


Fig. 1.—Map showing the distribution of legume inoculation cultures for the year ending June 30, 1924. Each dot represents ten cultures.

The Production and Distribution of Bacteria for Legumes. (W. A. Albrecht, R. E. Uhlend).—During the year ending June 30, 1924, 75,190 cultures were distributed to 7,173 individuals. A culture is inoculation material for $\frac{1}{2}$ bushel of seed. This was enough inoculation material to inoculate 37,595 bushels of legume seed. Cultures were distributed as follows:

Soybeans	63,782
Alfalfa	5,821
Sweet Clover	3,062
Cowpeas	1,311
Red Clover	857
Vetch	104
Miscellaneous*	253

The rapid growth of this project within the past six years is shown by the following table:

TABLE 1.—DISTRIBUTION OF LEGUME BACTERIA DURING PAST SIX YEARS.

Fiscal year ending June 30	Cultures shipped	Individuals served
1919	5,334	800
1920	5,865	900
1921	10,618	1,665
1922	22,322	2,950
1923	40,021	4,145
1924	75,190	7,173

*Velvet bean, white clover, garden bean, garden pea and alsike clover.

Reports from farmers indicated success with the use of the cultures. This great increase in demand has been made even though the Experiment Station continually encouraged the use of the soil method of inoculation.

Nursery Inspection. (L. Haseman, K. C. Sullivan, Neely Turner, G. L. Davis).—The number of nurseries inspected, distribution of nursery stock, and the issuing of official papers is reported as follows:

Nurseries Inspected.....	191
Counties.....	58
Men Making Inspection.....	4
Nurseries infested with San Jose scale.....	28
Amount of stock condemned.....	
Cases of foreign stock inspected.....	37
Plants from foreign countries.....	350,900
Counties in which foreign stock was received.....	5
Sweet potato beds inspected.....	5
Nursery inspection certificates issued.....	177
Sweet potato inspection certificates issued.....	5
Agents permits issued.....	150
Outside growers permits issued.....	171
Dealers certificates issued.....	28
Gipsy moth inspections made.....	38
Counties in which gipsy moth inspections were made.....	10

The orchard inspection work accomplished during the year consisted in a second survey of the orchards of the western half of the State. Table 2 gives the result of this survey in comparison with the 1922 survey. Fourteen counties were involved:

TABLE 2.—SURVEY OF ORCHARDS IN WESTERN HALF OF STATE, 1922-1923.

	1922	1923
Orchards examined.....	134	105
Acres visited.....	5,540	4741
Acres infested with San Jose scale.....	3,122	3407
Acres unsprayed.....	521	489*
Per cent bearing acreage unsprayed.....	9.4 %	6.7 %
Acres sprayed summer only.....	2,276	1,898
Per cent acres sprayed summer only.....	50.1 %	40.0 %

*170 newly set.

This table indicates the favorable results of the 1922 survey and the drive for scale control which followed.

In 1923, 105 acres which had no scale in 1922 showed slight scale infestation. Table 3 gives the location and number of acres of orchard on which scale was very severe in 1922, but which was completely under control in 1923.

TABLE 3.—NUMBER AND LOCATION OF ORCHARDS IN WHICH SCALE WAS CONTROLLED BY 1923.

County	Number of orchards	Acres
Cooper.....	1	10
Greene.....	2	60
Lawrence.....	5	231
McDonald.....	1	80
Newton.....	2	170
Total.....	11	551

The two preceding tables show a very substantial gain in the fight against scale in this territory. Many orchards in which scale was not completely under control were partially cleaned of the pest and in most cases the owner expected to apply a dormant spray during the winter of 1923-24.

In addition to the regular orchard survey a survey was made of the insects attacking shade trees in Carthage, at the request of the city council. The following insects were found: terrapin scale, evergreen bagworm, San Jose scale, aphids, tent caterpillars, Forbes' scale, leaf-gall insects, oyster-shell scale, scurfy scale and cottony cushion scale.

The terrapin scale was very severe on elm trees, although few trees were killed. Bagworms infested many evergreens and boxelders, and were numerous enough to require control measures during the season. The other insects were present in too small numbers to cause general damage.



Fig. 2.—Soil survey inspectors at work; drawing a sample so that they may examine it. Borings are made to a depth of three feet.

The Determination and Mapping of Missouri Soil Types.—Soil Survey. (M. F. Miller, H. H. Krusekopf, William DeYoung, Howard V. Jordan).—The mapping of three counties, Boone, Lawrence, and Phelps has been completed. Soil reports of Lafayette and St. Louis counties have been issued and are now available for distribution. A special map and report of the brown loess soil of Missouri has been completed and is ready for publication. This special map has been prepared because of the great interest being taken in this soil for the production of fruit, tobacco, and truck crops. This soil has very wide crop adaptation and offers special opportunities for the farmer with small means. About 1,500,000 acres of soil exists in Missouri.

Additional data has been collected during the year which will be used in reproducing the general soil map of the State published in 1918. All of the accumulated information on the soils of the State will be included when this report is republished.

In order to further the utilization of the county soil maps, the plan of preparing supplements has been adopted. These supplements give in condensed, tabular form, information on the general character, adaptation, and

methods of treatment of the soils of individual counties. They are attached to the county soil maps so that these can be used as wall maps.

Official Testing of Dairy Cows. (C. W. Turner).—During the year 2,266 two-day and 28 seven-day tests have been conducted.

Josephine of Cove Hollow, a Guernsey cow in the herd of L. E. Vaughan, Oronogo, Missouri, broke the state Guernsey record and took her place as the second highest butter producer ever tested in Missouri with a production of 18,119 pounds of milk containing 865.9 pounds of fat. Other Guernsey state records broken the past year included: Lena's Fawn, a senior four-year-old owned by Wm. Schneider, La Plata, with a production of 10,471 pounds of milk and 518.5 pounds of fat; Imp. Kitty 2nd of Fairmount, a junior four-year-old owned by I. Ben Miller, Cape Girardeau, with a production of 11,624 pounds of milk and 710.9 pounds of fat; and Sheila's Princess, a junior two-year-old, owned by El Jane Farm, Arcadia, with a production of 11,205 pounds of milk and 578 pounds of fat.

Two state Jersey records were broken during the year. Financial's Queen of Coleman, a yearling owned by Coleman Farm at Coleman, produced 10,664 pounds of milk and 565.9 pounds of fat, thus capturing the championship for cows under 2 years old. At the other extreme in age, Raleigh's Mabel of Granville, a twelve-year-old cow owned by Longview Farms, Lees Summit, produced 13,771 pounds of milk and 689.6 pounds of fat, thus placing first in the class of cows 12 years and over.

Distribution of Anti-Hog-Cholera Serum. (O. S. Crisler).—During the past year the University Serum Laboratory and Farm furnished the swine owners, either directly or through veterinarians and county farm bureaus, 2,527,250 cubic centimeters of anti-hog-cholera serum which was distributed in 1,772 orders to 75 counties.. Cholera was quite prevalent and there was increased demand for serum. Two thousand and seventy-three letters were written. The reports from the field showed that the serum had been satisfactory.

As funds would permit, new equipment has been installed and improvements have been made so that it is possible to produce anti-hog-cholera serum under the most sanitary and up-to-date methods.

CORRESPONDENCE

The College of Agriculture continued to exercise a very important function as a bureau of information on all agricultural subjects. The number of letters received and answered by the various departments and divisions of the College of Agriculture during the past year exceeded 100,000. The work of the Experiment Station supplies the information necessary to answer inquiries of farmers. Not all these questions can at present be answered, since the limited resources of the Experiment Station preclude the possibility of conducting some important investigations of vital significance to farmers.

Experiments in Progress During the Year Ending June 30, 1924

The following pages contain brief descriptions of experiments in progress. They are not intended to be complete, but rather progress reports of work actually accomplished during the year. The progress of the Station can be judged by comparing these reports with those of previous years.

AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

Chemical Service. (A. G. Hogan, L. D. Haigh, W. S. Ritchie, E. E. Vanatta, H. M. Harshaw, N. B. Guerrant, A. R. Hall, J. E. Hunter).—The department of agricultural chemistry makes all chemical analyses for the Agricultural Experiment Station. During the year the following analyses were made. For the department of agricultural chemistry 1,795 analyses including: 750 nitrogen determinations, 101 complete mineral analyses, 4 Ultimate analyses, 6 feeds for calcium, 3 feeds for nitrogen, 3 analyses for nitrogen as nitrates. For the department of animal husbandry 207 feed analyses and digestion trials including analyses for moisture, ash, nitrogen, fat, and crude fiber. For the department of dairy husbandry 18 analyses including 8 for nitrogen and 2 complete feed analyses. For the department of field crops 1 nitrogen determination. For the department of horticulture 108 analyses including 38 moisture, 38 crude fiber, and 8 ultimate analyses, carbon, hydrogen, moisture, and ash. For the department of soils 1,089 analyses. For the Fertilizer Control, 1,233 determinations. The department also made 14 commercial analyses and 13 qualitative analyses for miscellaneous purposes.

Protein Storage in Protoplasmic Tissue. (A. G. Hogan, W. S. Ritchie, J. E. Hunter).—General opinion indicates that there are two proteins in muscle soluble in neutral salt solution. One has many properties characteristic of albumin, the other resembles the globulin in many respects. It is also generally believed that these proteins are comparatively unstable and that their properties, solubility especially, change on standing. This is especially true of albumin, so for this and other reasons doubt has been expressed that there are two distinct proteins in the fraction soluble in neutral salts. An effort to test this point was made, using an indirect method suggested by Dakin. On account of technical difficulties the data obtained were not consistent. It was indicated, however, that the two proteins were distinct.

The isoelectric point of each of these proteins was determined. The globulin was coagulated by heat at a temperature of 50 C. The protein was then suspended in buffer mixtures with pH values ranging from approximately 3.5 to 5.0. A small portion of a suitable dye was then added. The theory was that the acid dye should be retained only on the acid side while a basic dye should be retained only on the alkaline side. The results obtained were quite consistent and indicated an isoelectric point of approximately 3.9. The albumin was coagulated with heat and the isoelectric point determined by the method just described. This isoelectric point was the same as that of the globulin, approximately at a pH value of 3.9.

Different salts have been compared in regard to their capacity to precipitate the globulin. The salts used were as follows: lithium sulphate, ammonium sulphate, sodium chloride, magnesium sulphate and zinc sulphate.

Saturated lithium sulphate and half saturated ammonium sulphate gave almost identical results. Zinc sulphate in half saturated solution precipitated completely all protein from the solutions. Saturated sodium chloride and saturated magnesium sulphate gave somewhat variable results. Precipitation by heat at 50 C. gave results similar to sodium chloride and magnesium sulphate.

In separating the albumin and globulin fractions, a larger proportion of globulin than that of albumin has been found. This does not conform to the findings of previous investigators.

Use of Feed Experiment. (A. G. Hogan, J. L. Nierman).—In the spring of 1907, there was begun an extensive investigation known as the "Use of Feed Experiment". This was outlined as "A proposed inquiry into the composition of the carcasses of cattle of different ages, different stages of development, and different conditions of fatness, or an attempt to ascertain to what uses steers of different ages, on different rations, and in different conditions put their food".

"The animals were early divided into three groups. Group I was fed all it could eat of the ration. Group II was fed for maximum growth without permitting the laying on of much fat. Group III was fed for scanty or retarded growth. The Group II steers gained about a pound a day for the first two years, while Group III cattle gained about 0.69 pounds a day."

From these animals when slaughtered various composites were made, such as blood, hide and hair, internal organs, lean and fat, and skeleton. These were analyzed for water, fat, nitrogen, ash, and phosphorus. Research Bulletin 55 should be consulted for a more complete account.

Portions of the samples just mentioned were retained for complete mineral analysis. These analyses have now been completed. The following conclusions have been drawn:

The ash of the entire bodies of calves from dams on different planes of nutrition was constant in composition. The mineral content of the entire body, on the fat-free basis, was, with the exception of phosphorus, fairly constant, and cannot be correlated with the condition of the dam.

The ash of the separate composites of lean and fat, hair and hide, internal organs, blood and skeleton, had a constant composition in all the animals.

The mineral content of lean and fat on a fat-free basis was not influenced by age or condition.

The mineral content of the hide and hair was not influenced by age or feeding conditions.

The mineral content of the internal organs decreased in the older animals, but the method of feeding probably had no effect.

The mineral constituents of blood were fairly constant for all ages and groups. Sodium and chlorine showed a slight decrease in the older animals, but it is doubtful if this decrease was due to age.

All the mineral constituents of the skeleton showed an increase in the older animals and were always higher in the well fed animals.

The mineral content of the entire animal calculated from the parts, was about constant, with the exception of calcium and phosphorus, which increased somewhat in the older animals. The mineral content was unaffected by the plane of nutrition.

AGRICULTURAL ENGINEERING

J. C. WOOLEY, *Chairman*

A Study of the Methods of Prolonging the Service of Wood Fence Posts.
(J. C. Wooley, M. M. Jones).—In 1913 a total of 170 posts, including 27

different common varieties of wood, were set. In each variety posts which had been given different preservative treatments were included. The posts have been inspected annually since the beginning of the experiment.

The following conclusions are based on the results at the end of eleven years:

1. Setting in gravel and charring did not pay.
2. Painting with hot carbolineum was perhaps better than painting with creosote.
3. The double tank treatment with creosote was the most effective treatment, the five-hour treatment being better than the two-hour treatment.
4. The following varieties made first class posts: osage orange or hedge, catalpa, black locust, and white cedar.
5. It did not pay to treat some varieties, particularly honey locust, willow, cottonwood, and white oak, unless the whole post was treated.
6. Certain varieties made good posts if given the double tank creosote treatment. Among these were black ash, sassafras, red oak, and ironwood.



Fig. 3.—Variously treated white oak posts, after ten years in the ground (1) 5-hr. double tank-treatment of creosote; (2) 2-hr. double tank-treatment of creosote; (3) no treatment.

The Draft of Wagons. (J. C. Wooley, M. M. Jones).—A farm wagon with interchangeable wheels was used. Tire widths of $1\frac{1}{2}$ inches and 3 inches were used. Thirty-six inch wheels in front and 40-inch wheels in the rear were compared with 40-inch wheels in front and 44-inch wheels in the rear. A net load of 3,000 pounds was pulled in all tests. Complete tests have been run over the following types of roadways: concrete, bluegrass sod, gravel, corn stubble,

cinder, macadam, brick in good condition, brick in poor condition, dry clay, and muddy clay.

High wheels have reduced the draft on all roadways tested, the amounts ranging from 9% on good hard-surfaced roads to 36% on roads with "chuck" holes and on roads with a firm base but with loose material on top. Wide tires have reduced the draft on all roadways tested except on roads with a firm base, but with loose material on top. The greatest reduction was 20% on corn stubble.

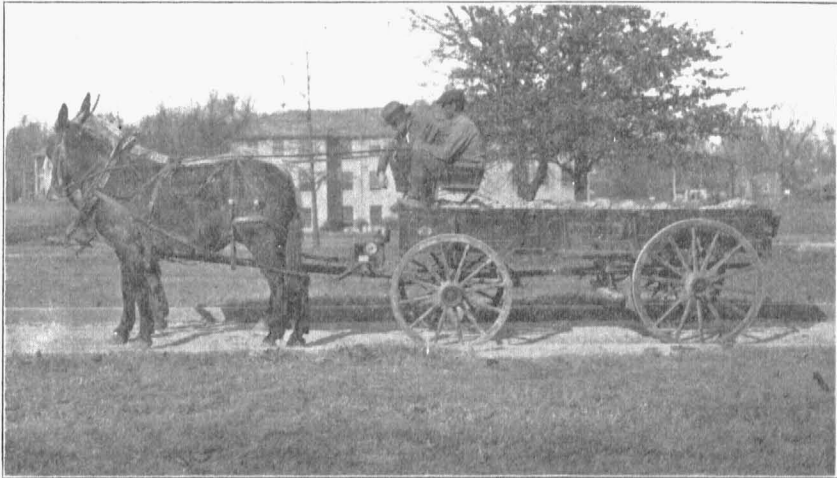


Fig. 4.—The equipment used in testing the draft of farm wagons

An Investigation of Sanitary Conditions on Farms and Experiments to Determine the Best Types of Sanitary Equipment. (J. C. Wooley, M. M. Jones).—*Cost of Electricity from 32-volt Farm Light Plants.*—Complete charge and discharge tests were made on each of three typical 32-volt farm electric plants. Fuel and oil used in charging the batteries were accurately measured. Data were also obtained on the current required to charge the batteries, and on the current which the batteries would deliver when fully charged. Thus the capacities of the batteries and their efficiencies were also determined. The following table is a summary of the results of these tests:

TABLE 4.—FUEL AND OILS, COSTS AND EFFICIENCY OF FARM LIGHT PLANTS.

Plant	Fuel and oil costs per K. W. Hr.—				Battery efficiency		Battery capacity (8-hr. rating)	
	From generator		From battery		Amp. Hr.	K. W. Hr.	Rated	Actual
	Gas	Kero.	Gas	Kero.				
	<i>cents</i>	<i>cents</i>	<i>cents</i>	<i>cents</i>	<i>per cent</i>	<i>per cent</i>	<i>amp. hrs.</i>	<i>amp. hrs.</i>
1	7.5c	4.4c	13.8c	6.7c	72.7%	56.04%	60	73.78
2	8.25c	5.17c	16.17c	10.39c	69.26%	51.5%	90	52.97
3	8.79c	-----	15.1c	-----	76.26%	59.43%	90	86.28

*Costs are based on gasoline at 20c per gallon, kerosene at 12c per gallon, and oil at 30c per gallon.

Operation of Septic Tanks.—One Dickey septic tank has been so installed at Columbia that samples of the effluent may be collected and analyzed. Also, one joint of glass pipe has been inserted in the outlet so that the overflow may be observed.

An experimental septic tank with a variable size chamber to give data on the size of tank needed for best results, has been installed on the State Farm at Dalton.

Method of Clearing Cut-over Lands. (J. C. Wooley, C. A. Helm).—*Use of Sprout-Whipping Machine.*—Six acres of sprout land was divided into six plots, and the sprouts on each plot are being cut (whipped) with a sprout mower or whipping machine at different periods of the year to determine the effectiveness of the machine and the best time to use it. The experiment was started in April, 1924, and although no conclusions regarding permanent results can be drawn at this time, the attached photograph shows the immediate effect of using this machine.



Fig. 5.—Sprout whipping machine in use. The immediate effect of the machine is seen in the foreground.

ANIMAL HUSBANDRY

E. A. TROWBRIDGE, *Chairman*

Age As a Factor in Animal Breeding. (F. B. Mumford, Fred F. McKenzie).—This project, started in 1909, has now reached the fifteenth generation. Factor 140, representing the fourteenth generation of continued early breeding, farrowed her first litter of eight pigs at 10 months, 26 days of age. This gilt came into heat first at 4 months, 26 days, and was bred at 7 months, 4 days of age. During the year two of the sows were disposed of: namely, Factor 50, representing the fifth generation, sold at the age of 9 years, 8 months, 3 days, and Factor 80, of the eighth generation, sold at 6 years, 8 months, 18 days. Both animals were in failing condition prior to and at the time of disposal. Factor 90 was bred first when seven months old and to date has farrowed 112 pigs, an average of over 12 pigs per litter, or an annual production since farrowing her first litter of 22 pigs farrowed and 15 weaned.

Age as a Factor in Animal Breeding—The Effect of Plane of Nutrition upon Immature Brood Sows. (F. B. Mumford, Fred F. McKenzie).—This

project has been in progress now four years and five months. Continued early breeding has been practiced with three lines of animals; on high, medium and low planes of nutrition respectively. The fourth-generation sows on the high plane have farrowed their first litters, one at 10 months, 2 days, the other at 1 year, 1 day of age. The representative of the fourth generation on the medium plane of nutrition came in heat first at seven months, twenty-one days, and was bred when 8 months, 13 days old. The fourth generation sow on the low plane of nutrition is now 11 months of age and has not yet come in heat.

TABLE 5.—REPRESENTATIVE PRODUCTION OF SOWS ON THE THREE PLANES OF NUTRITION.

	High Plane	Medium Plane	Low Plane
Age first bred.....	6 mos. 27 days	7 mos. 0 days	11 mos. 18 days.
Age June 30, 1924.....	4 yr. 4 mo. 24 days	4 yr. 4 mo. 24 days	4 yr. 4 mo. 24 days
Litters produced to date.....	7	7	6
Pigs farrowed.....	75	80	46
Pigs weaned.....	37	54	23
Feed consumed per sow, from birth to date:			
Corn.....	4770 lbs.	3394 lbs.	1735 lbs.
Shorts.....	1834 lbs.	1311 lbs.	663 lbs.
Bran.....	1070 lbs.	756 lbs.	556 lbs.
Tankage.....	723 lbs.	519 lbs.	257 lbs.

All hogs run in bluegrass pasture plots.

Well fed and well developed sows, when bred at six to eight months of age and twice a year thereafter, produce (1) more pigs at less cost than sows producing their first litters at eighteen to twenty months of age; and (2) pigs that develop about as rapidly and go to market about the same age as those from later bred sows.

The practice of breeding very young sows results in retarding their growth. In these investigations such early immatures bred animals required about a year and a half longer to reach mature size.

Sows fed on a ration insufficient in amount: (a) are late in becoming pregnant; and do not come in heat as often or as regularly as more generously fed animals; (b) produce fewer pigs; and (c) are so retarded in growth that they never attain the full size.

Factors Influencing the Normal Rate of Growth in Domestic Animals and the Permanency of the Effects of Arrested Development. (A. G. Hogan).—The seven steers under observation in connection with this project are now approximately seven years old. The Group I steer, No. 577, has been kept on the same nutritional plane, but all others are now being fed generously. Inspection of their measurements indicates that all of them are still growing slightly.

Hogging Down Corn and Soybeans. (L. A. Weaver).—In 1923 a fifth trial was conducted with one-acre plots outlined below:

Lot	Crop	Additional Feed
1	Corn and Soybeans	Tankage
2	Corn	Tankage
3	Corn and Soybeans	None
4	Corn	None

In addition to the four lots mentioned above, a fifth plot, planted to corn and soybeans, was hogged off; the hogs on the plot also having access to self-

feeders containing a mineral mixture made up of 45% wood ashes, 45% acid phosphate (16%) and 10% common salt. Table 6 gives the results of the 1923 trial.

TABLE 6.—HOGGING DOWN CORN AND SOYBEANS
(Sept. 7 to Oct. 3, 1923, inclusive)

Lot	1	2	3	4	5
Ration (acre plots)	Corn and soybeans	Corn	Corn and soybeans	Corn	Corn and soybeans
Supplementary feed	Tankage, in self-feeder	Tankage in self-feeder			Mineral* in self-feeder
No. hogs per lot	10	10	10	10	10
Length of feeding period (days)	25	25	26	25	21
Average initial weight (lbs.)	131.3	124.5	126.2	125.8	126.2
Average final weight (lbs.)	183.1	176.2	162.3	159.9	165.7
Total gain (lbs.)	518.0	516.5	361.0	343.0	394.5
Average daily gain per head (lbs.)	2.07	2.06	1.39	1.37	1.87
Total feed consumed (lbs.)					
Corn	1596	1332.8	1472.8	2161.6	2192.96
Soybeans	150	-----	186.0	-----	188.40
Tankage or mineral	141	134.0	-----	-----	108.50
Total	1887.00	1466.80	1658.8	2161.6	2489.86
Average daily feed (lbs.)					
Corn	6.38	5.33	5.66	8.64	10.43
Soybeans	0.60	-----	0.71	-----	0.89
Tankage or mineral	0.56	0.53	-----	-----	0.51
Total	7.54	5.86	6.37	8.64	11.83
Feed per 100 lbs. gain (lbs.)					
Corn	308.11	258.04	407.98	630.20	455.88
Soybeans	28.96	-----	51.52	-----	47.76
Tankage or mineral	27.22	25.94	-----	-----	27.50
Total	364.29	283.98	459.50	630.20	631.14

*45% wood ashes, 45% acid phosphate, and 10% salt.

It will be seen that there was little difference in either the rate or economy of gain made by the hogs in the two lots which received tankage. Also that the amount of tankage consumed by each lot was practically the same, being slightly in excess of one-half pound per head daily.

There was little difference also between Lot 3, corn and soybeans, and Lot 4, corn alone; the advantage being slightly in favor of Lot 3.

Comparing the two lots receiving tankage (Lot 1 and 2) with the two receiving no tankage (Lots 3 and 4), we find that the tankage fed hogs made materially faster gains, and since they were on the plots for the same length of time the total gain was appreciably greater where tankage was fed.

Assuming equal yields of grain, and other conditions equal, then, 141 pounds of tankage fed the hogs in Lot 1 increased their gain 157 pounds. In

other words, it would seem that tankage should be fed when hogging off corn, even though soybeans are also available in the field.

By comparing Lots 2 and 3 with Lot 4, some indication is to be had as to the relative efficiency of soybeans and tankage as a supplement to corn. Growing the beans in the corn increased the total gain produced per acre 18 pounds, while in the other case, 134 pounds of tankage increased the total gain per acre 173½ pounds.

Favorable results obtained at the Indiana Station by adding a mineral mixture to soybeans when being used as a corn supplement was responsible for Lot 5 being added to our Hogging Down Project in 1923. Comparing this lot (5) with a similar lot (3) receiving no mineral, it will be seen that the hogs made liberal use of the mineral mixture (45% wood ashes, 45% acid phosphate and 10% salt) when supplied in self-feeders, consuming approximately ½ pound per head. This mineral apparently increased the rate of gain from 1.39 pounds per head daily to 1.87 pounds, and the total gain per acre from 361 pounds to 394.5 pounds. While the mineral apparently improved the ration, still this lot did not come up with either of the lots receiving tankage.

Relation of Feed Consumed to Protein and Energy Retained in the Carcass. (A. G. Hogan).—No new material has been accumulated on this project. A general conclusion has been drawn that swine growing from 100 to 300 pounds made gains in protein at a constantly increasing cost, but that the cost of gains in energy decreased slightly.

TABLE 7.—FEED REQUIRED FOR GAINS IN PROTEIN AND ENERGY

Stage	Feed consumed	
	Per pounds protein stored	Per therm energy stored
<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
100-150	37.0	2.20
100-200	31.0	2.10
100-250	39.0	2.07
100-300	49.2	1.99

Growing Draft Colts. (D. W. Chittenden, E. A. Trowbridge).—*Suckling Period.*—The data collected on the feeding of suckling colts from idle mares on pasture included complete records on seven head, four fillies and three horse colts. These colts were all purebred Percherons foaled in the spring of 1923. The colts were all sired by the same stallion.

TABLE 8.—SUMMARY OF THE DATA ON COLTS DURING THE SUCKLING PERIOD.

Average length of period.....	145 days.
Average weight at birth.....	145 lbs.
Average weight when weaned (145 days old).....	556.37 lbs.
Average total gain per colt.....	411.37 lbs.
Average daily gain per colt.....	2.77 lbs.
Average total feed per colt	
Ground corn.....	16.00 lbs.
Ground oats.....	16.00 lbs.
Bran.....	8.00 lbs.
Pasture at will.....	145 days

Of the seven colts, three were foaled in the month of April, two in May, and two in June. The early colts were foaled before the mares were turned to

pasture, the later colts were foaled at pasture. The colts were allowed to run with the mares at all times.

From the time the mares and colts were turned on pasture May 18, 1923 until August 10, 1923, the only feed provided was bluegrass pasture.

Beginning August 10, the colts were fed grain in feed bunks placed in a creep built in the pasture. The grain ration fed was a mixture of two parts ground corn, two parts ground oats, and one part bran by weight.

The colts were started on an average of $\frac{1}{2}$ pound of grain per head daily, but after the first 30 days the grain was increased to 1 pound. The smaller colts ate very little grain. During the suckling period the colts consumed an average of 40 pounds of grain per head in addition to pasture and mother's milk.

The Weanling Period.—The colts were weaned October 5. In the daytime they were turned together in a small bluegrass pasture for exercise, and at night they were kept in large box stalls, two colts in each stall.

The colts were divided into two groups, I and II. The colts in Group I each received a full grain and alfalfa hay ration. The colts in Group II each received $\frac{1}{2}$ the amount of grain fed each colt in Group I, but received all the alfalfa hay they would eat. The hay used was choice alfalfa. The grain ration was a mixture of two parts shelled corn, two parts shelled oats, and one part bran by weight.

The weanling period began October 5, and closed May 10, a total of 218 days.

At the beginning of the period October 5, the colts in Group I averaged 533.33 pounds and the colts in Group II, 587.10 pounds. At the close of the period May 10, the colts in Group I averaged 929.83 pounds and the colts in Group II, 874.44 pounds. The colts in Group I made a total gain of 396.50 pounds per head, and the colts in Group II, 287.34 pounds per head during the weanling period.

TABLE 9.—SUMMARY OF THE DATA ON COLTS FOR THE WEANLING PERIOD.

(Colts in Group I were full fed, Group II were half fed; all were foaled in 1923 and sired by Freddie K.)

	Group I	Group II
Number of colts.....	4	3
Length of period.....	218 days	218 days
Average age beginning of period.....	141 days	152 days
Average age at close of period.....	359 days	370 days
Average wt. beginning of period.....	533.33 lbs.	587.10 lbs.
Average wt. close of period.....	929.83 lbs.	874.44 lbs.
Total gain per colt.....	396.50 lbs.	287.34 lbs.
Average daily gain per colt.....	1.81 lbs.	1.31 lbs.
Total feed per colt:		
Hay.....	1482.87	2047.33
Grain lbs.....	1952.87	1078.33
Corn.....	781.148	431.332
Oats.....	781.148	431.332
Bran.....	390.574	215.666
Average daily ration.....		
Grain lbs.....	8.95	4.94
Hay lbs.....	6.80	9.85
Feed required per 100 lbs. gain.....		
Grain.....	409.20	375.28
Hay.....	373.98	712.16
Total feed per 100 lbs. gain.....	783.18	1087.44

The Relation of Diet to Bodily Activity and the Capacity to Withstand Unfavorable Circumstances. (A. G. Hogan, H. M. Harshaw).—This project was begun in order to determine whether a ration high in protein, aside from its generally recognized physiological function, confers any protection against unfavorable circumstances. The original intention was to determine whether or not reproduction was favored by the use of a high protein diet. It early developed, however, that the synthetic ration used was quite unfavorable to reproduction without regard to the protein content. A series of investigations was then begun to determine in what respects the rations were inadequate during the reproductive cycle.

A number of different rations have been used, most of them a modification of the following: Casein 20, starch 53, milk fat 10, cod liver oil 5, dried yeast 6, salt mixture 4, and agar 2 parts. Any modification tried has not increased the effectiveness of this ration. On the other hand, some of the modifications seem less desirable.

Records for this season include too small a number of animals to yield significant data. However, the number of litters is now subnormal but the mortality is not high. Of 209 young rats that had an opportunity to live, 134 or 64 per cent survived until weaned. Many of the young were subnormal in appearance and in gains in weight during the lactation period. After weaning, the young usually grew well and were normal in appearance.

This problem has received a considerable amount of attention recently and there is yet no unanimity of opinion. Evans and Bishop, University of California, have stated that there is a vitamin in addition to the ones now generally recognized. They have called it vitamin X. According to those authors, this vitamin is dispensable except for the rearing of young. There is another group of investigators which is unwilling to admit the existence of vitamin X. Our own investigations do not positively contradict the findings of Evans and Bishop nor, on the other hand, do they support them. All the rations that we have used have permitted the birth of a considerable number of young. The difficulties encountered have been during the lactation period. Most of the young die when two or three days old, though a few may survive for two or three weeks and then die. No ration tried has permitted the rearing of any considerable number of young during the winter months. All the rations tried during the summer months have permitted at least some degree of success. The assertion has been made that the fertility of animals was considerably increased by the inclusion of roughage (agar) in the diet. Some inert material was consistently used in order to increase the bulk of our rations but no indication was given that the rations were materially improved thereby.

In order to obtain additional evidence as to the existence of vitamin X some of its alleged sources have been used in order to determine whether or not the rations may be improved by their use. In one case a commercial preparation "Vitavose" prepared by the Ward Baking Co. was used. This material has been adequate as a source of vitamin B but so far as the fertility of the animals receiving it is concerned, vitavose has not given good results. Alcohol-ether extracts of wheat germ have been prepared and added to our yeast-containing ration, without the slightest indication of resulting improvement.

According to those who are committed to the existence of vitamin X it may be stored for a short period of time and so females may be able to bear and rear a first litter. Subsequent litters, however, are few in number and are never reared. Our investigations have been under way now for 21 months and

we now have the fifth generation of one strain, all the members of which were reared on our synthetic diets. The only explanation is that the rations used are sufficiently contaminated to permit the rearing of some young. The ration used contained 10% milk fat and it has been suggested that this nutrient contained a quantity of vitamin X. Whatever the deficiency may be it seemed quite evident that the rations were in some respect inadequate.

Fecundity of Swine: The Normal Sexual Cycle, and as Influenced by Unfavorable Dietary Conditions. (A. G. Hogan, F. F. McKenzie).—"Observations began with eight-month-old virgin hogs kept in dry lot on a well-balanced ration.

"Pro-oestrus is characterized by swollen labia, open, watery vestibule, congested mucosa, and relaxed vulvovaginal Sphincter; oestrus by restlessness "mounting", increased mucous secretion, and in the late oestrus, subsiding congestion with contraction of the vestibule; metoestrus by comparatively dry and whitish mucosa (moist and pink during dioestrus) and wrinkled and contracted labia.

Smears taken from the vagina and vestibule revealed characteristic changes. Leucocytes, present during the greater part of the cycle, are few or absent immediately preceding oestrus, the smear consisting of a few nucleated and cornified epithelial cells. During oestrus large numbers of nucleated epithelial cells appear. Soon leucocytes increase until between the second and fifth days after oestrus there is a heavy leucocytic infiltration. In dioestrus leucocytes and a few nucleated and cornified epithelial cells are typical.

"Large follicles are present in the ovary during oestrus. Two days after oestrus ovulation had occurred, innumerable tiny follicles less than 1 mm. in diameter were observed. Ten days after oestrus there were per ovary 41-42 follicles of an average diameter of 3.8 mm., twelve days after oestrus 22-23 follicles 4.4 mm. in diameter, and fifteen days after oestrus 17 follicles 5.6 mm. in diameter. Thus, as the size of follicles increase, their number decreases."

In addition, observations, both macroscopic and microscopic, were made on the following organs: ovary, Fallopian tube, uterus and vagina.

Late in the year four groups of sows were started on our experimental rations. Two of these, one mature, the other just weaned, were placed on a ration believed to be adequate for growth and reproduction. Two other similar groups have been placed on rations deficient in calcium.

Molasses in Rations for Fattening Yearling Cattle. (E. A. Trowbridge).—Forty head of steers in five lots of eight head each were full-fed for 140 days as follows:

Lot 1 Shelled corn; linseed meal; corn silage; alfalfa hay.

Lot 2 Shelled corn; linseed meal; corn silage; alfalfa hay; cane molasses.

Lot 3 Shelled corn; corn silage; alfalfa hay; cane molasses.

Lot 4 Shelled corn; linseed meal; alfalfa hay; cane molasses.

Lot 5 Shelled corn; alfalfa hay; cane molasses.

The average daily gain for the steers in lots 1, 2, 4 and 5, was 2.99 pounds, with less than 0.1 pounds difference in daily gains among the four lots. The cattle in Lot 3, where no linseed meal was fed, made an average daily gain of 2.73 pounds, or practically $\frac{1}{4}$ pound less than was made in the other lots.

The amount of molasses was limited not to exceed 1 pound daily. Other feeds were fed in quantities, such as the cattle would consume, increasing the grain gradually.

The cattle in lots 1, 2, and 4, were sufficiently similar in condition at the close of the test to sell at the same price, \$10.00 per cwt. on the market. The cattle in Lot 3, which received no linseed meal, were not so fat as those in the three lots above mentioned, and brought \$9.25 per cwt. The cattle in Lot 5, which received neither linseed meal nor corn silage, were between the cattle in Lot 3 and those in lots 1, 2, and 4 in condition and brought \$9.65 per cwt.

The daily consumption of feed increased gradually during the first 90 days of the period, after which it remained stationary or decreased slightly.

The largest quantities of roughness were consumed during the early part of the feeding period.

TABLE 10.—SUMMARY OF DATA IN MOLASSES FEEDING EXPERIMENT.

Lot	1	2	3	4	5
Number of steers.....	8	8	8	8	8
Avg. initial wt. in lots.....	638.23	651.62	643.87	653.71	650.08
Avg. final wt. in lots.....	1052.5	1072.25	1027.47	1079.5	1066.37
Total gain per steer.....	414.27	420.63	383.60	425.60	416.29
Avg. daily gains per steer.....	2.96	3.00	2.73	3.04	2.97
Avg. daily ration per steer					
Shelled corn.....	16.78	16.61	17.00	16.89	17.92
Linseed oil meal.....	2.79	2.76	----	2.81	----
Corn silage.....	11.68	10.25	11.14	----	----
Alfalfa hay.....	2.55	2.59	2.82	5.22	6.40
Molasses.....	----	.98	.99	.98	.99
Gains on hogs per steer, lbs.....	33.75	28.12	24.37	43.00	21.50
Cost of feed per steer.....	50.14	52.29	44.08	52.37	46.23
Cost of gain per 100 lbs. on cattle (less gain on hogs at \$6.00 per cwt).....	11.30	12.03	11.11	11.69	10.79
Selling price in St. Louis.....	\$10.04	\$10.00	\$9.25	\$10.00	\$9.65
Percentage of dressed beef.....	59.00	59.85	59.24	59.83	58.17
Shrinkage per head in shipping (lbs.).....	15.0	19.75	19.97	15.75	15.12
Cost of marketing per steer.....	\$3.47	\$3.47	\$3.47	\$3.47	\$3.47
Money from which to pay interest, depreciation, insurance, profit, etc., per steer.....	\$5.06	\$3.08	-\$0.41	\$4.86	\$5.06

Thirty-two pounds of molasses replaced 17 pounds of shelled corn, 3 pounds of linseed oil meal, 56 pounds of corn silage, and 2 pounds of alfalfa hay in the production of 100 pounds of gain.

Where 2.79 pounds of linseed meal were eliminated and 0.99 pounds of molasses added to a full fed ration of shelled corn, corn silage, and alfalfa hay, the consumption of hay and corn increased slightly; the rate of gain was reduced by about $\frac{1}{4}$ pound per day and the selling price of the cattle at the end of the 140 day period was reduced by 75c per cwt.

Where corn silage was eliminated from, and 0.98 pounds of molasses daily added to a ration otherwise consisting of shelled corn, linseed meal and alfalfa hay, the gains produced were slightly greater, the final selling price the same, and the 32 pounds of molasses and 85 pounds of alfalfa hay were equivalent to 12 pounds of shelled corn, 2 pounds linseed meal and 394 pounds of corn silage.

Where corn silage and linseed meal were eliminated and 0.99 pounds daily of cane molasses was added to a ration of shelled corn and alfalfa hay, the amount of corn and hay consumed increased materially, the daily gain was about the same, and the final selling price was reduced 35c per cwt.

The Effect of Yeast on Feeds and Their Utilization by Fattening Swine. (L. A. Weaver).—Six lots, each consisting of eight hogs were fed for a period of

77 days, or from October 24, to January 9, in order to determine if possible the effect of yeasts on feeds and their utilization by fattening swine with particular reference to (a) the rate of gain and (b) the economy of gain. Two lots were fed a ration of nine parts ground corn, two parts wheat shorts and one part tankage. Two lots received the same ration plus 2% yeast, while the remaining two lots received the standard ration and 4% yeast. The ration for one of each of the above lots was mixed with water just before feeding, while that supplied the remaining three lots was mixed with water and allowed to soak for 24 hours before feeding. In other words, one lot was fed the standard ration unsoaked and one the same ration soaked. Likewise one of the lots receiving the standard ration and 2% yeast received their feed unsoaked while the other received feed which had been soaked for 24 hours. Likewise one of the two lots receiving the standard ration and 4% yeast received their ration unsoaked and the other soaked. The water used to soak the feed was warmed to 40 C. and the barrels in which the feed was mixed were kept covered to conserve the heat. These precautions were taken to aid any fermentation which might be caused by the addition of the yeast.

TABLE 11.—FEEDING YEAST TO FATTENING SWINE.
(Feeding Period 77 Days; Oct. 24, 1923 to Jan. 9, 1924)

Lot	1	2	3	4	5	6
Pigs per lot.....	8	8	8	8	8	8
Ration	Corn-9 Shorts-2 Tankage 1 Unsoaked	Corn-9 Shorts-2 Tankage 1 Soaked	Corn-9 Shorts-2 Tankage 1 Yeast 2% Unsoaked	Corn-9 Shorts-2 Tankage 1 Yeast 2% Soaked	Corn-9 Shorts-2 Tankage 1 Yeast 4% Unsoaked	Corn-9 Shorts-2 Tankage 1 Yeast 4% Soaked
Av. Init. Wt. per pig.....	125.54	126.06	124.7	125.1	124.56	126.83
Av. Final Wt. per pig.....	242.56	247.19	237.81	245.89	240.64	245.0
Total gain per pig.....	117.02	121.12	113.1	120.79	111.08	118.17
Av. daily gain per pig.....	1.519	1.573	1.469	1.568	1.507	1.534
Total feed per pig.....	582.0	582.0	582.0	582.0	561.0	582.0
Av. daily feed per pig.....	7.558	7.558	7.558	7.558	7.285	7.558
Feed per pound gain.....	4.973	4.804	5.145	4.818	4.833	4.925

Lot 5 went off feed Oct. 2, the pigs showing temperature varying from 103 to 104.4. The attending veterinarian diagnosed the ailment as a digestive disturbance. The amount of their ration was immediately reduced one-half and then gradually increased as the pigs regained their appetites. They were again receiving the same amount of feed as the other lots Oct. 19. This fact accounts for the smaller amount of feed per pig in this lot, and might also have some bearing on the gains.

A study of the data presented in Table 11 revealed the fact that the differences in the average gain per pig in all the lots were so small that they might well come within the range of experimental error. The addition of yeast to the ration did not prove beneficial, as the lots which received no yeast made the highest gains in their respective groups, both on soaked and unsoaked feed.

The lots receiving soaked feed made slightly greater gains than those receiving unsoaked feed, but the difference in average daily gain per pig between the highest lot of both groups was very small, being only 0.054 pounds.

There was no apparent benefit derived from the feeding of yeast, either from its fermentative effect on the feed, or from its alleged tonic effect on the animals.

In regard to feed required per pound of gain, the results were not so uniform as those recording total gain and average daily gain per pig. Lot 2, receiving the soaked standard ration, made the most economical gains, while lot 3, receiving the unsoaked standard ration plus two per cent of yeast, required the largest amount of feed per pound of gain.

Soaked feed proved to be more efficient in the production of gains than unsoaked feed, but the difference was very small. If all lots receiving soaked feed were compared with those receiving unsoaked feed, it would be seen that on the average the latter group required more feed (0.13 lb.) to make a gain of one pound live weight.

Limited Grain Rations for Fattening Cattle of Different Ages. (E. A. Trowbridge, H. D. Fox).—This test was conducted to secure further data on the rapidity and economy of gains and the degree of finish obtainable on well bred calves and yearlings when full fed in dry lot and when wintered largely on roughness and finished on grass. The first report on the study of this problem was issued one year ago.

Four lots of cattle of eight head each were used this year. One lot each of calves and yearlings was full fed for 150 days on a ration of 6 parts shelled corn, 1 part linseed meal and as much corn silage and clover hay as they would eat. One lot each of calves and yearlings was fed about what corn silage and clover they would clean up for 90 days in dry lot. Shelled corn and linseed meal, in the proportion of 6 to 1, were added to the ration and gradually increased until the cattle were on full feed, and at the end of 108 days the silage and hay were eliminated from the ration and the cattle were put on grass where they were full fed for 102 days. Hogs followed the cattle during the time the cattle were receiving corn.

TABLE 12.—SUMMARIZED RESULTS OF 1923 CATTLE FEEDING EXPERIMENT

	Lot I Yearlings	Lot II Yearlings	Lot III Calves	Lot IV Calves
Length of period in days..	150	210	150	210
Average daily gains.....	2.93	1.95	2.50	1.72
Total gain in pounds.....	441.3	410.4	376.	362.5
Feed required in lbs. to produce 100 lbs. gain.		Bluegrass at will 102 da.		Blue grass at will 102 da.
Shelled corn.....	470.	361.	442.	358.
Linseed oil cake.....	78.	59.	73.	60.
Corn silage.....	612.	737.	576.	701.
Clover hay.....	43.	77.	60.	70.

The yearlings and calves which were full fed for 150 days in dry lot made a greater total gain than the yearlings and calves roughed through the winter and finished on grass.

The calves in both cases required less grain but somewhat more roughness than the yearlings to produce 100 pounds of gain.

The gains indicate that all of these cattle were of a good grade of corn-fed cattle, when marketed.

The cattle which were finished on pasture, required some time to become adjusted to new conditions and their first month's gain on pasture was relatively light.

The calves finished on grass did relatively better than the yearlings so handled, which indicates the possibilities of this method of handling calves.

There was a longer period of time during which the calves might have been satisfactorily marketed than was true with the older cattle.

Wintering Idle Brood Mares on Bluegrass Pasture Supplemented with Oat Straw and Limited Grain Ration. (D. W. Chittenden).—A group of mares was wintered on pasture, with a small amount of grain and oat straw added when pasture was short. The amount of oat straw fed was governed by the appetites of the mares. They were allowed all the straw they would clean up. An open shed was provided for shelter and feed was fed in bunks out of doors.

The mares used were purebred Percherons, which had run on pasture during the summer while suckling foals. For thirty days prior to weaning the colts, the mares received a small allowance of grain because of short pasture.

The experiment started when the colts were weaned October 5, 1923 and closed the following spring on May 4, 1924, a period of 212 days.

From October 5 to December 21, the only feed provided the mares was bluegrass pasture. Beginning December 21, because of weather conditions, 1 pound of grain (one-third bran, one-third oats, one-third linseed oil meal by weight) and 5 pounds of oat straw were fed daily until January 7, when the grain was increased to 3 pounds per head per day. The mares were fed this amount of grain per day until January 19, when 3 pounds of shelled corn were added to the ration. On January 26 the amount of shelled corn was increased to 6 pounds making the total grain 9 pounds per head per day (6 pounds shelled corn, 3 pounds grain mixture). The mares were fed this amount of grain per day until the close of the experiment.

During the first thirty days after the colts were weaned, the total gain per mare on bluegrass pasture alone was 40 pounds. For the seven weeks following, ending December 21, there was very little variation in weight.

On December 21, the weather became cold and the mares were fed grain and straw. On this date the average weight per mare was 1,406 pounds per head. From December 21 until January 7, when the mares were getting 1 pound of grain per head per day, they lost a total of 32 pounds per mare. The weather was cold and stormy.

From January 7 to January 19, when the mares were getting 3 pounds of grain per head per day, the total loss per mare was 34 pounds. The weather during this period was extremely cold, and some snow was on the ground.

From January 19 to January 26, the mares were getting 6 pounds of grain per head per day (3 pounds shelled corn, 3 pounds grain mixture) and lost during those seven days, 45 pounds per head, averaging on January 25 only 1,295 pounds per head, making the total loss per mare from December 21 to January 25, 111 pounds.

From January 25, when the average weight per mare was only 1,295 pounds, until the close of the experiment May 4, when the average weight per mare was 1,413 pounds, the average daily rations per mare was 9 pounds of grain (6 pounds shelled corn, 3 pounds grain mixture) and 10 pounds of oat straw. During the period from January 25 until May 4, the total gain per mare was 108 pounds.

The ration provided, particularly during the early part of the winter, did not prove satisfactory. Better results might have been secured had the grain allowance been more evenly distributed throughout the experiment, but one of the objects of the trial was to determine as nearly as possible the minimum

amount of grain that would be required to winter mares under these conditions in a satisfactory manner.

During the months of January and February the mares were very thin.

Only one of the seven mares produced a foal the following spring. There was some evidence to indicate that two of the mares had aborted.

TABLE 13.—SUMMARY OF THE DATA ON WINTERING IDLE BROOD MARES.
(Experiment included 212 days, from October 5, 1923 to May 4, 1924)

Average weight per mare beginning.....	1,370 pounds
Average weight (December 21) when grain was added to ration.....	1,406 pounds
Average weight at close of experiment.....	1,413 pounds
Average total feed per mare.....	
Grain.....	984.00 pounds
Oats.....	126.66 pounds
Bran.....	126.66 pounds
Oil Meal.....	126.66 pounds
Average daily ration for 135 days fed grain and straw	
Grain.....	7.29 pounds
Straw.....	10.55 pounds

The winter of 1923-24 was more severe than usual, the lowest temperature recorded being about 19 degrees below zero and January was a month of especially severe and stormy weather.

At the close of the experiment May 4, the average weight per mare was 43 pounds more than at the beginning of the experiment.

BOTANY

(W. J. ROBBINS, *Chairman*)

A Study of Certain Fusarial Diseases of Plants. (W. J. Robbins, Irl T. Scott).—*Tomato Fusarium Wilt.* (Irl T. Scott). An effort was made to adjust the reaction of field soils to that found unfavorable for infection by *F. lycopersici*. Water-slaked lime $\text{Ca}(\text{OH})_2$ was used in treating the soils. It was applied and thoroughly worked into the upper surface 3 inches of the soil at the rates of 500, 1,000, and 2,000 pounds per acre. Untreated plots showed an initial reaction in the upper 8 inches of about pH 5.2. In about four weeks time the upper 3 inches of soil where the lime was applied, showed a marked change in reaction, the reaction averaging pH 5.9, 6.1, and 6.4 for the three treatments respectively. Bonny Best, a highly susceptible variety of tomato was set out in the plots 4 weeks after applying the lime. The root system of each seedling was thoroughly inoculated with a spore suspension of *F. lycopersici*. After one month all plots showed marked wilting, and after approximately 60 days all plots showed 100 per cent infection. Soil samples, taken below the surface 3 inches, showed pH values practically identical with those of the untreated soil. Soil removed from the roots of wilted plants showed a reaction very near that of the untreated soil.

The Relation of Hydrogen-ion Concentration to the Growth of Plants. (W. J. Robbins and Irl T. Scott).—Further experiments have been carried out to test the analogy between plant tissue and an ampholyte with a definite isoelectric point. Using a modified Hildebrand type of bubbling electrode the effect of potato tuber tissue, the root tips of soybeans and mycelial mats of *Fusarium lycopersici*, *Gibberella saubinetii*, and *Fusarium oxysporum* upon the reaction of dilute buffer mixtures, chiefly of the potassium phosphate, has been studied. All affect the reaction of the dilute buffer mixtures much as an am-

pholyte with a definite isoelectric point would be expected to, making the acid solutions more alkaline and the alkaline solutions more acid. Potato tuber tissue responds in these dilute buffer mixtures much like an ampholyte with an isoelectric point near pH 6.4. The isoelectric point for soybean tissue is not so clearly defined and lies at pH 6.2-6.4. For the mycelium of *Fusarium lycopersici* the so-called isoelectric point is near pH 5.5, for *Gibberella saubinetii* near pH 6.2 and for *Fusarium oxysporum* near pH 4.9. The difference in the points for these three nearly related fungi suggest that the determination of the isoelectric points may be of taxonomic value.

Root Metabolism. (W. J. Robbins, W. E. Maneval).—From experiments performed since the last report the indications were that the calcium content of the modified Pfeffer's solution was too high for continued growth of excised root tips and was a factor in causing the cessation of growth noted in the earlier experiments. By reducing the calcium content of the Pfeffer's solution used, root tips have been grown through six periods of transfer in the dark in a modified Pfeffer's solution plus 2% dextrose. With the normal amount of calcium found in Pfeffer's solution growth ceased in the dark in the third period. The following factors have been found to favor the growth of excised root tips under sterile conditions in a nutrient solution containing glucose: autolized yeast and peptone, light, and a reduction in the calcium content of the solution.

DAIRY HUSBANDRY

(A. C. RAGSDALE, *Chairman*)

A Study of Colostrum With Special Reference to the Effect of Heat (pasteurization) on its Physico-Chemical, Bacteriological, Immunological, and Nutritional Changes. (A. C. Ragsdale, Samuel Brody, J. B. Nelson).—*Egg-White-Milk Emulsion as a Substitute for Colostrum.*—Ten calves were fed the egg-white-and-milk emulsion. Of this number, one died. Thus 90 per cent were raised successfully. Thus far on the experiment 84.2 per cent of all calves have been raised successfully. The egg-white-and-milk emulsion here referred to was prepared by mixing the whites of eggs with whole milk free of colostrum. For the first meal whites of six eggs were used. The number of eggs was decreased by one for each feeding until the white of only one egg was given at a feeding. The white of one egg was continued with each feeding until the calf was seven days old. The theory on which the feeding of egg whites was based, was that some constituent of the egg was a carrier of immune bodies similar to those of colostrum.

Hens were immunized against red blood cells of the horse. Nine hens were injected both intravenously and subcutaneously, with suspensions of packed cells. Blood drawn from the hens and pooled gave complete hemolysis of a cell suspension in dilution 1-40. Egg white was shown to contain hemolysin. In two instances the titer was found to be 1-20. Egg white was then fed to a series of three calves. The blood serum of these calves showed hemolysin but the titer was low. In one case the serum, in dilution 1-2.5, gave complete hemolysis of a cell suspension. There is an indication that egg white may act as a carrier of immune bodies, offering evidence for the assumption on which this work was based.

The Bactericidal Properties of the Blood of the Calf Before and After Ingesting Colostrum. A study based on data derived from six cows and eight calves showed that the blood serum of the mature cow was bactericidal to

Bacillus coli; that is, a certain amount of *Bacillus coli*, inoculated into unheated cow serum, died. The blood serum of the newly born calf, on the other hand, when inoculated with the same quantity of *Bacillus coli* survived and grew luxuriantly. The serum of the calf, therefore, lacked some part of the defensive mechanism against coli.

Colostrum was found to have no complement which is one of the constituents necessary for bacteriolysis. The amount of complement in calf serum at birth was less than one-third that of the cow. The concentration of complement rapidly increased during the first few days, even when no colostrum was ingested, and with the increase of complement, there was an increase of bactericidal properties. Thus it was demonstrated that the increase of one of the constituents of the defensive mechanism was more or less independent of the ingestion of colostrum. However, the agglutinating properties of calf serum were found to be absolutely dependent on the ingestion of colostrum, thus demonstrating some constituent on which the phenomenon of agglutination is based was derived from colostrum.

Studies in Milk Secretion—(a) Time Relations in Milk Secretion (b) Mechanisms Regulating Variations in the Composition of Milk. (A. C. Ragsdale, Samuel Brody, C. W. Turner).—*The Effect of Gestation on the Rate of Decline of Milk Secretion with the Advance of the Period of Lactation.*—It was found that the effect of pregnancy during lactation becomes apparent in a reduced rate of milk secretion when the period of pregnancy exceeds about five months. The total reduction amounted to 480 to 800 pounds of milk when cows were bred during the early months of lactation. The data indicated that the decline in milk secretion due to pregnancy was related to the increase in weight in gestating cows from which it was inferred that growth of the foetus was, in part at least, responsible for the decline in the milk flow due to the demands of the foetus for nutrients to support its life processes.

The Rise and Fall of Milk Secretion with Age.—A study of the records of 46,002 cows of the Jersey, Guernsey, Holstein-Friesian, Ayrshire, and the Dairy Shorthorn breeds and of 104,583 Holstein-Friesian seven-day records, showed that from the age at which milk secretion usually began (two years) that butter fat production gradually increased up to between 7 and 8 years of age (when maximum body weight was reached). After this age there was a gradual decline with the onset of old age. The close relation found between an increase in body weight and milk secretion with age was interpreted as indicating that the upward trend of the milk secretion curve with age was due to growth while the descending segment of the curve was due to senescence. This was taken to mean that growth and senescence go on simultaneously from the beginning to the end of life.

These data were also used as a basis for a method of converting the fat production records of dairy cows made at any age to a "mature equivalent" as an aid in making studies of the transmitting ability of dairy sires.

The Rate of Milk Secretion as Affected by an Accumulation of Milk in the Mammary Gland.—A study of four dairy cows milked during an experimental period of about three months has shown that the speed of milk secretion in unit time was governed by the amount of milk accumulated in the udder, or the interval between milkings. If the amount of milk secreted during the first hour was called 100 per cent, the amount of milk secreted each succeeding hour was approximately 95 per cent of that secreted during the preceding hour. The percentage of fat and total solids gradually decreased with the lengthening

of the interval between milkings until the time interval exceeded 14 to 16 hours. Thereafter, there was a slight increase up to the 24th to 26th hours, followed again by a gradual decline until the 36th hour.

The Relation of Milk Secretion and Body Weight to Feed Consumption during the Lactation Period.—The data were taken from 47 Holstein cows on yearly test milked four times a day. The milk secretion curve reached the maximum at about 35 days but consumption of energy feeds did not reach a maximum until 4 months, and digestible protein until 5 months after calving. The cows lost weight during the first three months. After the period of maximum feed consumption there was a gradual decline in feed consumption averaging about 98% of the previous month's consumption. Because the rate of decline of milk secretion was more rapid, averaging about 94 per cent of the previous month's production, the surplus feed was used in increasing the live weight during the last four months of the lactation period.

Diurnal Milk Secretion as Affected by Time of Feeding.—Data from two trials with four cows milked at 2-hour intervals and also fed at 12 and 24-hour intervals, showed a decrease in percentage of fat for two hours after feeding. There was then an increase which reached its peak about 6 to 8 hours after feeding, and thereafter a steady decline in the percentage of fat until the next feeding. The amount of milk produced followed roughly the curve of the percentage of fat when the cows were fed twice daily.

The Effect of Each Ingredient in the Manufacture of Ice Cream. (W. H. E Reid, D. H. Nelson).—The effect of the milk-solids-not-fat and their relation to the freezing process was studied. Mixes containing 6, 10, 12, 14, and 18 per cent milk-solids-not-fat were used. Skim milk powder, whole-milk powder,

TABLE 14.—RELATION OF MILK-SOLIDS-NOT-FAT TO THE VISCOSITY AND ACIDITY OF THE ICE CREAM MIXTURE

% M. S. N. F.	Viscosity	Acidity
Water ice	1.23	.01
4% (sherbet)	1.46	.10
6%	1.66	.13
10%	1.90	.21
12%	2.45	.26
14%	2.55	.33
18%	4.24	.38

TABLE 15.—RELATION OF MILK-SOLIDS-NOT-FAT TO THE RATE OF LIBERATION OF HEAT UNITS, FREEZING POINT, AND CRYSTALLIZATION POINT.

% M. S. N. F.	Temp. at beginning	Temp. 1½ minutes later deg. C	Time required to reach crystallization point		Time required to reach freezing point		Crystallization point deg. C.	Freezing point deg. C.
			min.	sec.	min.	sec.		
Water ice	-0.21°C	-----	0	49	1	46	-1.245	-0.858
4% (sherbet)	-0.21°C	-1.455	2	28	3	21	-2.910	-0.925
6%	-0.21°C	-1.806	3	10	3	48	-2.688	-1.504
10%	-0.21°C	-1.540	5	43	6	42	-3.540	-1.890
12%	-0.21°C	-1.900	6	20	7	15	-3.810	-2.210
14%	-0.21°C	-1.620	5	46	6	22	-3.990	-2.530
18%	-0.21°C	-1.910	6	40	7	30	-4.440	-3.100

and evaporated milk furnished the milk-solids-not-fat, increased the percentage of milk-solids-not-fat in the ice cream mix, increased the viscosity and acidity, lowered the crystallization and freezing point, retarded the liberation of heat units, and did not affect the amount of supercooling. The source of the milk-solids-not-fat had a definite though inconsistent effect upon the viscosity, acidity, crystallization point, freezing point, and rate of liberation of heat units.

The Inheritance and Transmission of the Characters "Capacity for Fat Production." (C. W. Turner).—A study of the transmitting ability of 229 Holstein-Friesian sires having 10 or more daughters whose yearly production has been recorded, has been completed. The records of these daughters, made at various ages, have been converted to a "mature equivalent" basis for comparison by use of conversion factors which have been worked out at this Station. The daughters of two sires averaged over 900 pounds of fat per year. The daughters of 13 sires produced between 800 and 900 pounds; the daughters of 69 sires between 700 and 800 pounds; of 112 sires between 600 and 700 pounds; of 31, between 500 and 600 pounds, and the daughters of two were between 400 and 500 pounds.

Minimum Protein Requirements for the Growth of Dairy Heifers. (A. C. Ragsdale, W. P. Hays).—Three calves and one yearling heifer have been fed a ration in which the standard protein (milk) was the only limiting factor. Only enough milk protein was supplied at each feeding to support "normal growth". The ration consisted principally of raw sweet skimmilk. The supplementary feed given up to six months of age, and the sole ration thereafter, consisted of a mixture of skimmilk powder, starch, sugar, codliver oil, bone ash, iron oxide, and cellulose. At this time it is uncertain whether the cellulose in the ration will prove altogether satisfactory. It may become necessary to add straw.

Guinea pigs have been fed a grain mixture of ground corn 4 parts, wheat bran 1 part, oil meal 1 part, alfalfa meal 4 parts. This mixture was reduced to a 10 per cent protein plane by the addition of starch. Practically normal growth has been secured up to the time of sexual maturity. No reproduction has occurred.

Standards of Growth for Dairy Cattle. (Samuel Brody, A. C. Ragsdale).—*Change of Form with Age.*—Calves have relatively longer legs, greater height at the croup, lighter and much shorter bodies, and are more rectangular in form than cows. Mature cows were proportionately much broader and deeper throughout the hind quarters. The results of this study are now in press.

Growth in Linear Dimensions.—Twenty-one different linear measurements taken on Jersey, Holstein, and Ayrshire cattle were studied. It was found that if the unit of time taken was sufficiently large to eliminate fluctuation, the amount of growth made during a given unit of time at any age tended to be a constant percentage of the growth made during the preceding unit of time. That is, the growth in height at withers made during any year was about 34 per cent of the growth made during the previous year. Similarly the growth in weight made during any year was 56 per cent of the growth made during the preceding year.

Relation Between Growth and Senescence.—A theory of growth and senescence of the dairy cow was formulated on the basis of change of milk secretion with age. This theory was substantiated by a study of the changes in the vital processes with age in the domestic fowl, man, and *drosophila*. This work has

been reported under the heading "Contributions to Scientific Journals and Periodicals", the names of the articles being, "The Rate of Growth of the Dairy Cow" III and IV, and "The Rate of Senescence of the Domestic Fowl".

Normal Growth of Male Calves.—Table 16 gives the normal growth in weight and height at withers of males of the Holstein and Jersey breeds.

TABLE 16.—NORMAL GROWTH OF HOLSTEIN AND JERSEY MALES

Age Mos.	Normal Weight				Height at Withers (in.)			
	Number Animals		Weight in lbs.		Number Animals		Height at Withers	
	Jersey	Holstein	Jersey	Holstein	Jersey	Holstein	Jersey	Holstein
Birth	21	27	63	92	28	34	26.6	28.9
1	21	27	86	125	28	32	29.8	30.6
2	22	26	119	172	31	28	30.4	32.6
3	23	26	158	228	32	31	32.5	34.9
4	21	25	220	291	31	30	34.9	37.1
5	22	25	277	345	30	28	36.7	38.9
6	22	25	340	428	28	27	38.8	40.6
7	20	24	374	496	21	25	39.5	42.1
8	19	23	414	576	21	22	40.7	43.3
9	20	19	476	644	19	20	41.5	44.4
10	16	16	513	691	16	17	41.8	45.3
11	12	13	564	763	11	17	43.0	45.2
12	10	13	586	827	9	14	43.8	47.5
13	7	13	626	884	7	13	44.7	48.4
14	7	10	665	942	6	11	44.7	49.6
15	5	10	753	995	5	10	45.9	48.8
16	4	9	834	1038	4	9	47.0	50.1
17	4	8	883	1051	4	8	47.2	50.5
18	3	7	855	1128	3	8	46.6	51.2
19	3	6	887	1172	3	6	47.7	51.7
20	3	6	917	1203	3	5	48.4	52.1
21	2	6	973	1258	2	5	48.9	53.0
22	2	5	1029	1314	2	5	49.3	53.0
23	2	5	1028	1376	2	5	48.3	53.7
24	1	5	1085	1356	1	5	48.5	53.9
25	1	4	1095	1347	1	4	49.2	54.4
26	1	3	1095	1487	1	3	49.6	55.1
27	1	3	1145	1502	1	3	51.3	55.3
28	--	1	----	1645	--	1	----	56.2
29	--	1	----	1700	----	1	----	56.2

ENTOMOLOGY

(L. HASEMAN, *Chairman*)

Injurious Insect Pests of Melon and Related Crops. (L. Haseman, K. C. Sullivan).—Experiments on the control of the striped and spotted cucumber beetles were continued this year with the addition of three new materials: gypsum, lime and cyanide C dust. The gypsum was applied alone and with 5% calcium arsenate; the lime was mixed with 10% of the same poison. The "C" dust, a new strength of "A" cyanide containing 25% cyanide or half the strength of the dust used last year was applied with a small hand duster while

the gypsum, lime and tobacco dust were applied by hand sprinkling. The materials used, rate, and number of applications were as follows:

TABLE 17.—RESULTS IN EXPERIMENT FOR CUCUMBER BEETLE CONTROL.

Material used	No. of applications	Aver. rate of each ap. per hill	Burning	Leaves injured by beetles per hill.	
				<i>squash</i>	<i>cucum.</i>
Gypsum, plain-----	5	¾ oz.	0	1.7	5.55
Gypsum and 5% calcium arsenate-----	5	¾ oz.	0	2.4	5.44
Lime and 10% Calcium arsenate-----	5	¾ oz.	0	2.3	4.5
Nicotine dust (4% Nic.)-----	5	¾ oz.	all*	4.5	9.3
Moth balls, 2 per hill-----	1	2 balls	0	2.0	7.6
Calcium cyanide 25%-----	1	¼ oz.	severe	----	----
Check-----	0	0	0	3.28	9.51

*All plants slightly damaged.

The 25% cyanide dust burned the plants severely and only temporarily disabled the bugs. The naphthene balls had little repellent effect upon this insect. The nicotine 4% dust burned the leaves slightly and apparently did the bugs no permanent harm. The lime + 10% calcium arsenate protected the plant as long as the plants were covered with material. There was no burning. Plain gypsum gave great promise; little eating occurred where plants were treated and there was no burning. Gypsum + 5% Calcium Arsenate gave very satisfactory results. There was no burning and plants were kept free from bugs as long as the material was on the leaves.

The Annual Life Cycle of the Hessian Fly in Missouri and its Control.—(L. Haseman, K. C. Sullivan).—Wheat seeding plots have been continued at Columbia, Maryville, Webster Groves, Cuba, Charleston and Springfield, with the results shown in Table 18.

TABLE 18.—DATA OBTAINED IN HESSIAN FLY EXPERIMENT, 1923-24.

Plat No.	Maryville		Columbia		Webster G.		Cuba		Charleston		Springfield	
	Date Seeded	% Inf.	Date Seeded	% Inf.	Date Seeded	% Inf.	Date Seeded	% in	Date Seeded	% Inf.	Date Seeded	% in
I	9/15	----	9/24	4.4	10/2	6.2	10/2	0	10/2	41.1	10/2	0
II	9/22	----	10/1	3.0	10/4	0	10/9	0	10/9	6.9	10/9	0
III	9/26	62.0	10/4	0	10/12	0	10/12	0	10/12	0	10/9	0
IV	10/3	33.6	10/8	0	10/15	0	10/15	0	10/15	0	10/15	0
V	10/6	1.5	10/15	0	10/22	0	10/22	0	10/22	0	10/22	0

There was very little or no fly, in the wheat during the past year, except in Northwest Missouri. In this section there was slight infestation after the fly-free date; not enough however, to cause any serious loss.

A very large percentage of the wheat sown in Missouri is now sown after the fly-free date as recommended by the College of Agriculture, with the result that very little damage is done even in bad fly years.

A Study of the Life Cycle of the Codling Moth and the Best Time and Method of Applying Insecticides for Controlling It. (L. Haseman, K. C. Sullivan, Neely Turner).—Trees were sprayed with arsenate of lead solutions using 100, 175, and 200-pound pressures. A bordeaux nozzle, a disc nozzle and a spray gun were used at the pressures mentioned previously. Samples were taken soon after the calyx cup closed. Two classes of samples were used, the tip and cup. Table 19 gives the results of the analyses:

TABLE 19.—ANALYSIS OF CALYX CUPS AND TIPS AFTER SPRAYING AT DIFFERENT PRESSURES

Pressure	Nozzle	Samples	Variety	Grams As ₂ O ₃ per calyx cup or tip
		<i>cups</i>		<i>per cup</i>
250	Bordeaux	500	King David	.000138483
175	Bordeaux	500	King David	.000112695
100	Bordeaux	464	Payne's	.000062009
250	Gun	500	King David	.000087698
175	Gun	500	Payne's	.000041507
100	Gun	500	Payne's	.0000327
250	Disc	500	King David	.00006831
175	Disc	500	Payne's	.000044023
100	Disc	500	Payne's	.0000327
		<i>tips</i>		<i>per tip</i>
250	Bordeaux	50	King David	.00094915
175	Bordeaux	50	King David	.0003396
100	Bordeaux	50	Payne's	.00032389
250	Gun	50	King David	.00065346
175	Gun	50	Payne's	.000295583
100	Gun	50	Payne's	.0002517
250	Disc	50	King David	.005589
175	Disc.	50	Payne's	.0004559
100	Disc	50	Payne's	.0003775

Experiments previously reported have shown that the lethal dosage for third instar and older codling moth larvae is approximately 0.0005 grams of powdered arsenate of lead. In a few cases in the foregoing data low pressure treatments left an insufficient amount of arsenate of lead to kill codling moth larvae.

The data obtained checks very closely with that reported in 1923.

An Investigation to Determine the Causes of the Periodical Recurrence of Insect Pests as Scourges. (L. Haseman, K. C. Sullivan).—The severe cold weather of the winter of 1923-24 was a contributing factor in checking the increase of the cotton boll weevil. No boll weevil injury whatever has been reported from the cotton producing section in Southeast Missouri this season. The cold winter of 1923-24 also helped to a great extent in keeping certain other insect pests in check, such as the army worm, grasshopper, melon worm, codling moth and chinch bug.

The heavy rains during the months of May, June, and July practically controlled the chinch bug. The migration of the surviving chinch bugs from the wheat to the corn was also seriously interfered with. The wet weather not only held the chinch bugs in check but undoubtedly helped to prevent serious damage by grasshoppers and army worms.

An Investigation of Methods for Controlling the Chinch Bug. (L. Haseman, K. C. Sullivan).—In spite of the severe winter of 1923-24 chinch bugs in

threatening numbers passed the winter and appeared in the wheat fields in the spring. However, the rains began just as the eggs were being laid for the spring brood and while in some sections of the State the chinch bugs caused some damage, the pest did relatively little damage over the State as a whole.

Investigations with calcium cyanide as a barrier to the migrating bugs were carried on. Some of the work was at Columbia and some on the Soil experimental field at Stark City, Missouri. This year's work substantiated the results reported last year, as far as calcium cyanide as a barrier was concerned. A plowed furrow in which calcium cyanide flakes were sprinkled each afternoon at the rate of 1 pound to 60 linear feet proved an effective gas barrier. It was maintained at a cost of \$4 per day for a $\frac{1}{4}$ mile of barrier.

Further studies were made on the practicability of using calcium cyanide dust for treating corn after infestation with chinch bugs. The material was effective when used in this way, but it was more economical to fight the bugs with barriers and prevent them from reaching the corn crop.

An Investigation to Determine What Insects are Injurious to Nursery Stock in the State, Their Life Histories, Distribution, Injury and Methods of Control. (L. Haseman, K. C. Sullivan, Neely Turner, G. L. Davis).—Some rather extensive work has been in progress during the past year with reference to the control of San Jose scale and aphides. Particular emphasis has been placed on determining the efficiency of the new oil preparations which have been developed during the last three years. A great deal of work has been carried on at Boonville, in the commercial orchard of Mr. Paul Jaeger for the control of San Jose scale. The work on aphides has been carried on in orchards in the Station grounds.

TABLE 20.—REPORTS OF FIRST AND SECOND COUNTS IN JAEGER ORCHARD.

Plat	Treatment	Date applied	Percentage scale dead	
			Mar. 12	Apr. 9
1	2% Commercial soap oil emulsion	1/31/24	100.00	100.00
2	Lime-sulphur 1-7	1/31/24	99.00	99.28
3	Scalecide 1-15	1/31/24	100.00	100.00
4	Home-made oil emulsion 2%	1/31/24	93.42	88.09
5	Kayso oil emulsion 2%	1/31/24	98.53	98.97
Check	No treatment	-----	38.3	-----

These sprays were followed by a second application in April. The third count is as follows:

TABLE 21.—REPORT OF THE THIRD COUNT IN THE JAEGER ORCHARD.

Plat	Treatment	Date second spray was applied	Percentage scale dead May 3.
1	Lime-sulphur 1-7	April 10, 1924.	99.5
2	Lime-sulphur 1-7	April 10, 1924.	99.0
3	Scalecide 1-15	April 10, 1924.	97.66
4	Scalecide 1-15	April 10, 1924.	100.00
5	Commercial soap oil emulsion 2%	April 10, 1924.	100.00

All the work at Boonville was done by members of the Station staff and every spray was thoroughly applied. Good results were obtained with practically all of the materials used. On the whole, however, the commercial soap and oil emulsion gave the best results with scalecide a close second. Some very serious injury, however, to some of the trees was evidently caused by the commercial oil emulsion. It has not been determined why the oil emulsion caused such severe injury and until more is known about the newer sprays it is doubtful if they should be strongly recommended for commercial use.

The Effect of Oil Spray on Apple Aphides.—In certain sections of the Mississippi Valley the lubrication oil emulsions have been used as a dormant spray for the control of San Jose Scale with a high degree of success. The question has been raised as to the effect of these emulsions on apple aphides. The common practice is to apply a separate spray of nicotine sulphate just as soon as the aphides hatch. This spray for the control of aphides costs considerable in both time and material. Some growers, however, have added the nicotine sulphate to the first summer spray of lime-sulphur and arsenate. This has been fairly satisfactory but is just a little late for the most effective results.

The lubricating oil emulsions have been used extensively at the Missouri Agricultural Experiment Station during the past two years in order to determine their value as a dormant spray and also as a summer spray on apple trees. During the course of this work extensive observations were made as to the efficiency of these sprays in controlling apple aphides.

Control of Aphides.—The aphid which has caused the most trouble in Missouri on apples during the past two years is the common grain aphid (*Aphis avenae*). This aphid migrates to the apple in the fall from the grain and deposits eggs in the small twigs and buds. At the time the buds begin to push out in the spring the eggs hatch. From three to four generations are reared on the apple before they migrate back to the grain. They very often are present in large numbers and cause considerable damage to the young tender growth.

The following varieties of apples were sprayed and counts made to determine aphid control: Rome Beauty, Delicious, Jonathan, Winesap, Ben Davis, Grimes Golden, Black Ben, Liveland Raspberry, Stayman Winesap, Paragon, Early Harvest, McIntosh, Ben Hur, King David, Ingram, Ginnie and Buer Sweet.

TABLE 22.—EXPERIMENTS IN 1923 FOR CONTROL OF APHIDES.

Treatment	Date sprayed	Date counted	Number of buds	Aphides alive	Av. per bud
1. Lime-sulphur 1-7.....	4/9/23	4/12/23	110	319	2.8
2. Soap oil emulsion; soap 1.0, oil 2.0.....	4/9/23	4/13/23	64	271	4.23
3. Soap oil emulsion, 1% with CuSO ₄	4/10/23	4/16/23	102	319	3.12
4. Soap oil emulsion 2% with CuSO ₄	4/10/23	4/16/23	113	93	0.823
5. Kayso oil emulsion.....	4/10/23	4/13/23	38	32	0.842
6. Lime-sulphur 1-7.....	4/11/23	4/17/23	33	12	0.363
7. Soap oil emulsion; Soap 1.0, Oil 2.0.....	4/11/23	4/12/23	57	285	4.52
8. Check.....	-----	4/14/23	33	164	4.97
9. Check.....	-----	4/17/23	16	95	5.93
10. Check.....	-----	4/18/23	82	575	7.01

TABLE 23.—EXPERIMENTS IN 1924 FOR CONTROL OF APHIDES.

	Sprayed	Counted	Buds	Aphides	Av. per bud
1. 10% Kayso oil emulsion, dormant.....	2/22/24	4/25/24	150	194	1.29
2. Lime-sulphur 1-7.....	4/11/24	4/12/24	152	43	0.282
3. 10% Kayso oil emulsion, delayed dormant.....	4/12/24	4/25/24	124	43	0.346
4. 10% Kayso oil emulsion, delayed dormant.....	4/12/24	4/25/24	150	51	0.34
5. 2% Kayso oil emulsion.....	4/14/24	4/15/24	150	546	3.64
6. 2% Kayso oil emulsion.....	4/14/24	4/15/24	51	8	0.15
7. 4% Kayso oil emulsion.....	4/14/24	4/25/24	100	346	3.46
8. Lime-sulphur.....	4/24/24	4/25/24	100	901	9.01
9. 1% Kayso oil Emulsion, 2% with 3-4-50 Bord.....	4/21/24	4/25/24	450	879	1.95
10. Kayso in lime-sulphur.....	4/21/24	4/25/24	100	48	0.48
11. Check.....	4/12/24	4/25/24	292	198	0.678
12. Check.....	4/12/24	4/25/24	450	1659	3.46

Tables 22 and 23 show the kind of sprays used, date spray was applied, date counts were made, number of buds counted, number of aphides alive and the average number of life aphides on each bud.

It will be noted that in no case did any of the spray materials used give effective control as compared to the checks. With one exception, the 10% Kayso Oil Emulsion applied as a dormant spray, all sprays were applied after the eggs had hatched. The data showed that some of the emulsions as well as the lime-sulphur gave partial control but not enough to warrant recommending them. For the regular dormant spray for San Jose scale a 2% oil emulsion is usually recommended. In this work it will be noted that a 10% oil emulsion was tried and still not enough control was obtained to recommend its use. From the results obtained it is evident that none of the spray mixtures such as lime-sulphur or lubricating oil emulsions can be recommended for the control of apple aphides.

FIELD CROPS

(W. C. ETHERIDGE, *Chairman*)

A Morphological Classification of the Varieties of Soybeans. (W. C. Etheridge, C. A. Helm).—About 200 kinds of soybeans have been distinguished from more than 800 samples of so-called varieties collected from the experiment stations and the seedsmen of the country. Colors of the glume, testa, cotyledons, and pubescence of the stems and pods provide the principal basis of the classification. Less important distinctions are size and form of seed, color pattern and polish of the testa, size and color of the hilum and color of the pods. An economic quality such as the length of the growth period sometimes distinguishes an individual variety. In general, the classification when complete will subordinate genetic relationships to the convenience of identifying agronomic varieties. For this convenience the classification will utilize, so far as possible, characters easily seen at maturity.

A Study of the Cultural Requirements and Adaptation of Sudan Grass. (W. C. Etheridge, C. A. Helm).—On thin upland soil at Cuba the acre yields of several forage crops, measured in tons, were: Sudan grass 1.8, Red Amber sorghum 1.6, Whippoorwill cowpeas 0.7, Virginia soybeans 1.2.

A Comparison of the Most Important Grain Sorghums With Corn for Grain and Forage Production. (W. C. Etheridge, C. A. Helm).—In 1923 the sorghum worm (*Celama sorghiella*) greatly damaged all crops of sorghum in this experiment. At the same time the season for corn was remarkably favorable. For the first time since the comparison of the two crops on very thin upland soil at Cuba corn out-yielded sorghum in bushels of grain per acre. However, the yields of both crops were small.

TABLE 24.—COMPARATIVE YIELDS OF CORN AND THE SORGHUMS IN GRAIN AND CURED FORAGE PER ACRE.

Crop	Grain	Forage
Corn		
White Pearl	9.7	1.4
90 Day.....	11.8	1.0
Reids.....	13.2	1.3
Grain Sorghum		
Dawn Kafir.....	6.4	1.4
Sunrise.....	5.3	1.1
Feterita.....	4.5	.5
Dwarf Milo.....	2.2	1.0
Sweet Sorghum		
Orange.....	2.4	2.0
Amber.....	4.2	1.1
Honey.....	2.4	2.1

Cultural Experiments with Spring Barley. (W. C. Etheridge, C. A. Helm).—Yields of spring barley were compared with yields of oats at Maryville. When both crops were well treated spring barley outyielded oats in pounds of grain per acre on highly fertile soil in Northwest Missouri. Table 25 gives the result of this investigation.

TABLE 25.—YIELDS OF BARLEY AND OATS AT MARYVILLE

Grain	Seedbed double disked		Seedbed spring plowed and double disked	
	No fertilizer	200 lbs. 16% A. P. per acre	No fertilizer	200 lbs. 16% A. P. per A.
Oats (Nebraska 21).....	1,216	1,437	1,430	1,536
Barley (Oderbrucker).....	643	1,771	931	1,814

Comparison of Soybeans and Cowpeas for Hay and Seed Production. (W. C. Etheridge, C. A. Helm).—Two leading varieties of soybeans, Virginia and Morse, were compared in yields of seed and hay with two leading varieties of cowpeas, New Era and Whippoorwill. When the varieties were planted in rows 40 inches apart the average yield of soybean hay was nearly double that of cowpea hay, and the average yield of soybean seed was nearly four times that of cowpea seed. When the varieties were sown with an 8-inch grain drill the yield of soybean hay was again nearly double the yield of cowpea hay, and the yield of soybean seed was 13.4 bushels per acre, while cowpeas failed to make any seed at all.

Cultural Experiments with Soybeans, Including (1) Time of Seeding, (2) Method of Seeding, (3) Rate of Seeding. (W. C. Etheridge, C. A. Helm).—When Morse and Wilson varieties of soybeans were planted for hay, in rows 3.5 feet apart, at rates ranging from 15 to 30 pounds of seed per acre, there was no

significant variation in yield according to the rate of planting. When the Morse, Wilson, Midwest and Haberlandt varieties were planted for seed at dates ranging from May 15 to July 15, the earlier plantings were generally the most productive as Table 26 shows.

TABLE 26.—YIELDS OF SOYBEANS IN BUSHELS OF SEED PER ACRE, AS AFFECTED BY DATE OF SEEDING.

Variety	Date of Seeding				
	May 15	June 1	June 15	July 1	July 15
Morse.....	38.5	32.2	20.0	21.9	16.2
Wilson.....	33.6	29.8	24.9	17.3	17.4
Midwest.....	36.2	31.6	24.1	20.8	15.6
Virginia.....	38.2	35.9	24.4	24.9	17.0

When these varieties were planted August 1, they were all caught by frost and produced no seed. The same varieties were harvested for hay at stages ranging from full bloom to the falling of leaves. The yields of cured hay increased generally with the stage of maturity, though frequently there was little or no increase from one stage to the next.

TABLE 27.—TONS OF SOYBEAN HAY PER ACRE, AT DIFFERENT STAGES OF MATURITY.

Stage	Wilson	Virginia	Midwest	Morse
Full bloom.....	1.5	0.9	1.2	1.0
Pods formed.....	1.7	1.3	1.9	1.5
Seed in milk.....	1.7	1.7	2.0	1.7
Seed in dough.....	1.7	1.7	2.0	1.7
Leaves beginning to fall.....	1.7	2.3	2.1	2.3

A Study of the Important Varieties of Oats for Missouri Conditions.
(L. J. Stadler).—The yields of the leading varieties of oats at Columbia in bushels per acre in 1923 were as follows:

Fulghum.....	66.2	Sterilis selection.....	55.4
Canadian.....	56.2	Burt.....	49.2
Silvermine.....	55.6	Kherson.....	47.7

These results are of special interest in showing the value of Fulghum in a favorable season. This variety, first tested by the Experiment Station in 1919, has been one of the best yielding varieties in each of the five seasons in which it has been tested. Its average yield for the five-year period is better than that of any other variety grown at Columbia.

On the outlying fields also Fulghum has been a leading variety. Its yields in 1923 at Warrensburg and Maryville, in comparison with those of other standard varieties, are shown in Table 28.

TABLE 28.—COMPARATIVE YIELDS OF OATS VARIETIES AT MARYVILLE AND WARRENSBURG IN 1923.

Variety	Yield in bushels per acre	
	Maryville	Warrensburg
Fulghum.....	41.4	34.1
Red Rustproof.....	41.3	27.2
Burt.....	38.8	25.3
Kerson.....	26.5	25.1
Silvermine.....	27.9	22.0

Wheat Breeding Investigations, Including the Improvement of Commercial Varieties by (1) The Pure Line Method of Breeding, (2) Hybridization and Subsequent Selection. (L. J. Stadler).—The pure line selections of Michigan Wonder wheat produced at this Station again demonstrated their superiority to the parent variety, which was much the highest yielding variety in Central Missouri in the eight-year variety test reported in Bulletin 188. The yields in 1923 of the variety Michigan Wonder and of these two pure lines at Columbia and on two outlying experiment fields are shown below:

TABLE 29.—COMPARISON OF YIELDS FROM TWO PURE LINE SELECTIONS OF MICHIGAN WONDER WHEAT AND FROM THE PARENT STOCK, IN 1923.

	Columbia	Warrensburg	Cuba
Michigan Wonder.....	21.8	18.5	13.2
Michigan Wonder Sel. No. 8.....	23.9	21.1	13.8
Michigan Wonder Sel. No. 21.....	23.9	20.5	14.0

There is little doubt that these selections are the highest yielding wheat varieties now available to farmers in Central Missouri. They have one notable disadvantage in their susceptibility to loose smut. In an attempt to improve the stock in this respect hybrids have been made between these Michigan Wonder selections and several varieties resistant to loose smut. In the progeny of these hybrids selections will be made for wheat combining the high productivity of Michigan Wonder with the disease resistance of the other parent.

A Study of the Adaptations of the Important Varieties of Spring Barley for Missouri Conditions. (L. J. Stadler).—The yields of the leading varieties of barley at Columbia in bushels per acre in 1923 were as follows:

Oderbrucker.....	31.4
Frankish.....	30.6
Odessa.....	28.7
Manchuria.....	27.0

During the five-year period 1919-23 a fairly extensive trial of promising varieties of barley has been made at Columbia. The leading varieties for the period are Sandrel, Trebi, Manchuria and Oderbrucker.

A Study of the Adaptation of the Important Varieties and Selections of Soybeans to the Various Soil Types of the State. (L. J. Stadler).—Pure line selections of Midwest, Wilson, and Virginia soybeans were tested for yield at Columbia for the first time in 1923. About 100 pure line selections of each of these varieties were made in 1921. Twenty-five pure lines of each variety were included in the yield tests and the remainder were grown in observation rows. These pure lines were found to vary materially in yield and other characters of economic importance, and offer an opportunity for the improvement of soybeans by the same selection methods as have been successfully used in the improvement of wheat and oats.

A Genetic Analysis of Maize. (W. H. Eyster).—*Pericarp Studies.*—A special study of variegation in maize has shown that orange pericarp, variegated pericarp of a number of distinct patterns, self-red pericarp, and colorless pericarp have a common origin. The study included the frequency of changes from one type to another, and a genetic interpretation of these changes has been made.

Mosaic pericarp was a very coarse type of variegation, and gave rise to a number of distinct patterns, self-red, colorless and an orange-colored pericarp

similar to the orange found in the variegation described above. The study included the frequency of changes from one type to another.

Chlorophyll Studies.—A study has been made of more than 25 chlorophyll characters. Those which have been completed are:

- ar.....argentina, a silver striping.
- pk.....polkadot, leaves yellow, dotted with green.
- ab.....abraided, a fine-striped leaf.
- f₂.....fine-striped leaves.
- pt.....pale-tipped leaves, a seedling pattern that appears only on plants grown from sugary seeds.
- se.....seriated, a much striped leaf.
- au.....a golden yellow seedling and mature plant.
- gl.....a yellow seedling that exudes glucose; it has a deficiency analogous to diabetes in animals.
- yg.....yellow-green seedlings and plants.
- oy.....oil-yellow seedlings and plants.
- ol.....olive green seedlings and plants.
- as.....striped on the auricles of the leaves.

Plant Abnormalities.—A study of the inheritance of the following characters has been completed:

- zg.....a zigzag culm.
- z.....a second factor for zigzag culm.
- tw.....a factor which produces a twisted culm.
- sw.....a factor for a swollen and twisted ear shank.
- co₁.....a factor for coherent leaves.
- co₂.....a second factor for coherent leaves.
- d₂.....a factor for dwarf plant.
- an₂.....a factor for anthers on the ears.
- cr₂.....a factor for crinkly leaves.

Vivipary in Maize.—Maize soprophytes that pass through the seed stage without becoming dormant have been studied.

- pm₁.....a factor for loss of the period of dormancy, in the seed stage.
- pm₂.....a second factor for loss of dormancy.

Anther Sterility.—Sterile plants crossed with normal plants gave plants that were completely sterile.

Linkage Studies.—The following linkage relations have been established:

- The factor *ar* belongs to the C-SH-Wx group.
- The factor *pk* belongs to the C-SH-Wx group.
- The factor *au* belongs to the C-SH-Wx group.
- The factors *pm*₁, *Wx*, and *vx* are linked.
- The factors *an*, and *ad* are linked.
- The factors *as* and *ad* are linked.
- The factors *ra* and *se* are linked.
- The factor for fine striping, *f*₂ is linked with one of the factors for colored aleurone.
- The factors *an* and *ab* are linked.

These linkage relations have been established, but further study will be necessary to determine the exact location of the factors in the chromosome.

A Giant Type of Maize.—A giant type of maize occurred in an inbred strain of Mastodon maize which has remarkable growth characters. The leaves averaged 5 to 6 inches in width, and were thick and leathery. The

strain has been inbred for six generations but has not been greatly reduced in vigor. The vigorous growth and large leaves are characteristic of the F_1 plants when crossed with normal plants. Preliminary yield tests indicated that the hybrids would outyield the best commercial types. Commercial strains have been inbred and crosses made in an effort to build up a superior, high yielding commercial type of maize. Results from this breeding are not yet available.

HORTICULTURE

(T. J. TALBERT, *Chairman*)

Identification and Study of Factors Determining Hardiness and Methods of Increasing It. (H. D. Hooker, Jr.).—The studies on the chemistry of pectin have been continued. They are now being prepared for publication. Some information concerning the chemical structure of pectic acid has been gained and a satisfactory method for establishing pectin has been worked out.

Previous work on the effect of various pruning treatments in developing the more hardy basal buds in peaches has been published in *Agricultural Experiment Station Bulletin 207*.

Walnut Grafting Investigation. (T. J. Talbert).—Seedling black walnuts were very successfully top-worked and several new varieties of pecans, shagbark hickories, and filberts have been planted.

Difficulty has been experienced in top-working (cleft-grafting) the native seedling hickory to different varieties of the pecan. Several different kinds of budding have been employed this year to find a more satisfactory method of utilizing the native hickories for pecan production.

Missouri now leads all other states in the production of black walnuts. The grafting investigational work has shown that the seedling black walnuts grown in Missouri may be grafted to improved sorts like the Stabler, Thomas, Ohio, and others which have thinner shells, larger kernels, better flavor and quality and a higher market value. The seedling hickories are also being grafted but with less success. The grafting operations do not impair the value of the walnut or hickory for use as lumber.



Fig. 6.—A close view of seedling black walnuts cleft-grafted to improved varieties, after 3 years growth.

The Home Orchard: Costs and Returns. (T. J. Talbert).—This project was started to determine the cost of bringing a home orchard and fruit plantation into full bearing. The results obtained showed that the home fruit project was a profitable one. The indications were that it should be a paying proposition after the second or third year.

Orchard and Strawberry Nutrition. (H. D. Hooker, Jr., H. G. Swartwout).—The study of the relative value of spring and fall applications of nitrate of soda and sulphate of ammonia has been continued. A plot of York trees that have been treated in the fall with nitrate of soda blossomed this spring for the fourth consecutive year. The treatment has been sufficiently successful to warrant placing an entire York orchard under this treatment. Individual tree records showed that nearly all the treated trees responded to the fall treatment though one of the trees studied has continued to alternate. The spur records showed that these trees were biennial bearers before the treatment was initiated and that the check trees have remained biennial bearers.

A study of the best time to apply nitrogen fertilizers to peach trees was made and the results to date published in Missouri Agricultural Experiment Station Bulletin 207. The experiments showed the advisability of delaying nitrogen applications to peaches until after blossoming time or until danger from spring frosts had passed.

Investigation of the Factors Limiting the Production of Sweet Cherries in Missouri. (T. J. Talbert, A. P. Boles, and A. M. Burroughs).—Work on this project has been limited to the taking of yield and circumference records on sweet cherry trees in the University orchard, and to investigating reports of successful sweet cherry production in various parts of the State. The number of trees and varieties of sweet cherries in the University orchards have been increased by new planting.

Spraying Fruits for Insects and Fungous Diseases. (T. J. Talbert, H. D. Hooker, Jr., H. G. Swartwout, and A. M. Burroughs).—The scope of this project has been broadened to include: (1) studies of the preparation of spraying materials, (2) the determination of the composition and physical properties of spraying materials, with particular reference to spraying oils and emulsions, and (3) a study of the physiological effect of spray materials on the tree and fruit.

A method has been developed for the preparation of colloidal copper hydroxide, and tests are now being made to determine its efficiency as a fungicide and its effect on the trees. A method for making oil emulsions has been perfected, and sprays made by this method have given good results at Columbia and other localities in Missouri, in the Pacific Northwest and the Southern Atlantic fruit section. By this method oil was emulsified without heat by using calcium caseinate in place of potash fish-oil soap as an emulsifying agent. Emulsions made in this way were cheaper, easier to prepare, and more stable than those made according to the government formula.

In order to determine the essential qualities for a good spraying oil a number of determinations of specific gravity, viscosity, iodine number, boiling limits and emulsifying qualities of a large number of oils have been determined. These include brands which have proven successful, and brands of which the insecticidal and emulsifying qualities are still unknown, together with mineral oils separated from proprietary miscible oils of known insecticidal value.

The experiments to determine the effect of application of oil sprays on fruit trees indicated that concentrations of oil below 5 per cent may be applied

safely to dormant trees. There was a strong possibility that applications of 2 per cent oil may safely be made up to the cluster bud stage. Oil sprays applied after blossoming were believed to be detrimental to the health of the apple tree and severely injured the foliage of the stone-fruits.

One year's results from experiments on the effect of bordeaux mixture on apple trees showed that the method of making the mixture had no effect on the amount of burning of the fruit; that severe burning followed applications two weeks after the calyx spray, and that the size of leaves and partly grown fruits was reduced by bordeaux sprays.

Peach Breeding for Hardy Sorts. (A. M. Burroughs).—Blooming records taken in the spring of 1923 indicated that none of the seedlings in the plots planted in 1920 possessed late blooming qualities. The severe cold in January 1924 killed all the fruit buds, so the trees were renewed by cutting them back severely. Several of the seedlings bore fruit of good quality in the summer of 1923. These individuals have been propagated by budding on seedling peach trees in the nursery.

Treatment of Apple Canker Diseases. (H. G. Swartwout).—Tests have been made in the use of a number of materials to cover pruning wounds and exposed wood of apple trees after cleaning blister canker infections. The materials whose comparative values were tested were white lead linseed oil paint, sodium silicate (waterglass), tanglefoot, and a modified grafting wax.

The pruning wounds were 2 inches to 6 inches in diameter. The cleaned cankers varied from a length of 8 inches and a width of 4 inches to a length of 3 feet and a width of 8 inches. All the wounds were sterilized with a solution of copper sulphate, 1 pound to 1 gallon of water, before the coverings were applied.

Observations after one year showed the cambium to be dead on most of the treated cankers and on many of the pruning wounds to a distance of $\frac{1}{4}$ inch to 1 inch beyond the edge of the original wound. This death of the cambium was apparently caused by the strong solution of copper sulphate. Some of the treated cankers showed further progress of the disease below and above the treated areas with all materials. The greatest spread occurred with those treated with white lead and linseed oil paint, the next greatest spread with sodium silicate, the next with grafting wax, and the least with tanglefoot. The amount was about the same for all materials except the tanglefoot with which the percentage spread was very small.

So far the tanglefoot appears to be the best covering. All the wounds covered with the tanglefoot have been perfectly protected. The material adheres well and does not become so hard in cold weather as to crack and expose the wood beneath or to run during the hot weather of midsummer.

The grafting wax made a good covering where it could be made to adhere but with the moist surface which resulted from the bleeding of the wounds some difficulty was experienced in getting the wax to stick.

The white lead linseed oil paint had nearly all scaled off at the end of one year and the wood was badly checked. When this material was used it appeared that two paintings a year were necessary to protect the wounds effectually.

Waterglass gave no protection, the wounds to which it was applied being indistinguishable from the checks.

Tomato Seed Selection for Disease Resistance. (J. T. Quinn).—Forty-four different selections of strains and varieties of tomatoes resistant to the to-

mato wilt (*Fusarium lycopersici*) were tested. Some of the strains selected at this Station for the last five years have given increases in yields as high as eight tons per acre, over the non-resistant commercial varieties.

A partial report of this project was included in Missouri Agricultural Experiment Station Bulletin 212.

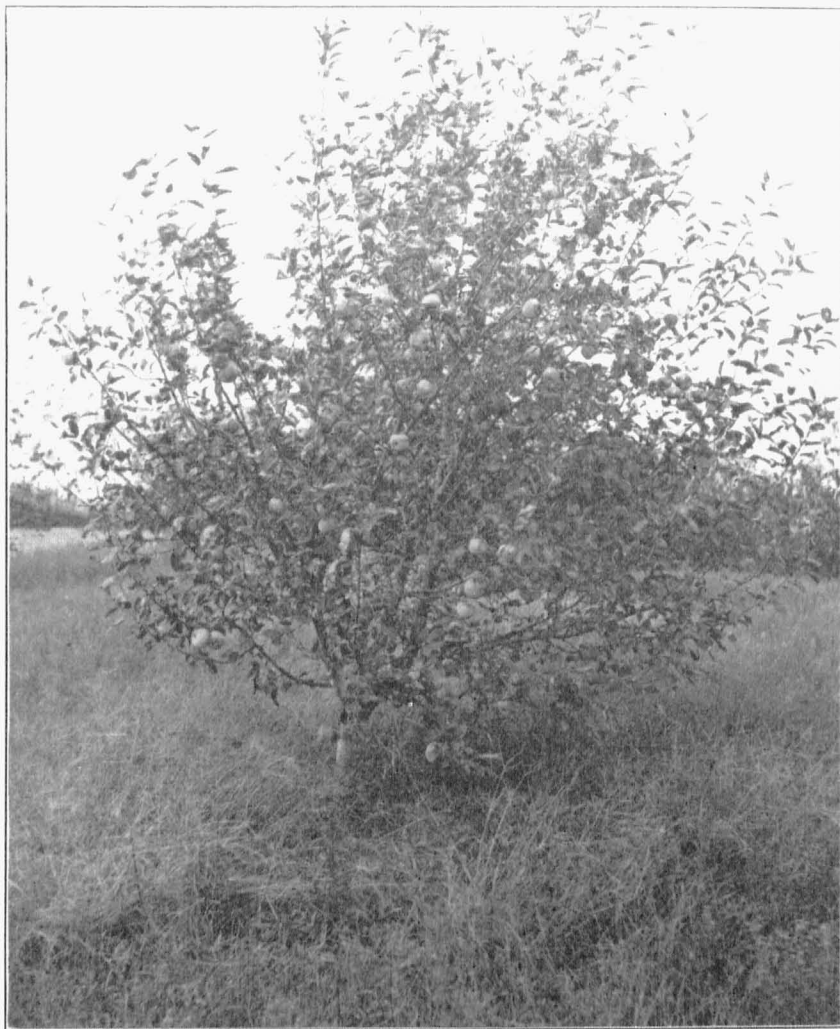


Fig. 7.—A nine-year-old seedling apple tree produced from a Rome-Geniton cross by the Missouri Agricultural Experiment Station. The crop the tree bears in the picture was produced in 1921 when the commercial apple crop in Missouri was destroyed by late frosts and freezes. It bore heavy crops in 1922 and 1923.

Breeding Apples for Late Blooming Habit. (A. M. Burroughs).—Bloom-
ing data, taken in 1923 and 1924, showed that between 40 and 50 of the 250

new varieties, grown from crosses made in 1911 and 1912, were late bloomers.

The first large crop from this planting was obtained in the fall of 1923. Of the late blooming sorts, 10 gave promise of having the qualities sought for in a commercial variety. Many of the seedlings, while not late bloomers, have good appearance and eating quality. Some of the more promising new sorts have been propagated and will be tested out later under various conditions and in various localities in the State.



Fig. 8.—Research laboratory of the Department of Horticulture at the Missouri Agricultural Experiment Station.

Investigations With Seed Potatoes. (J. T. Quinn).—The results obtained in the investigations with Irish potatoes have shown that:

1. Certified northern grown seed continued to produce more profitable crops than non-certified northern seed.

2. The hot formaldehyde seed treatment—1 pint of commercial formaldehyde to 15 gallons of water heated to 118° or 120°F. continued for four minutes—gave approximately the same control for rhizoctonia and common scab as the corrosive sublimate treatment of 4 oz. of corrosive sublimate to 30 gallons of water, treated for 1½ hours.

3. Potatoes kept in cold storage during the entire storage period, showed a higher percentage of germination and a greater uniformity of vine growth than those stored under ordinary cellar conditions.

Cabbage Seed Selection for Disease Resistance. (J. T. Quinn).—Varieties and strains of cabbage resistant to the “yellows” caused by *Fusarium*

Conglutinous have shown infections from 3 to 27 per cent. The "Wisconsin All Season" is the most resistant of the varieties tested. Non-resistant commercial varieties showed infections as high as 87 per cent.

Investigations to Determine the Fertilizer Requirements, Varieties, Cultural Methods, and Seed "Place Effect" of the Watermelon and the Cantaloupe. (J. T. Quinn).—The results of this year's work on this project showed that the Polloch 10-25 variety of cantaloupe was one of the best varieties for Southeast Missouri; that there was no great differences in yield between cantaloupe seed from Colorado, Florida, and home grown seed; that maximum yields of cantaloupes were obtained from the use of a 3-12-4 fertilizer applied in the hill, at the rate of 600 pounds per acre. A 3-12-4 fertilizer applied in the hill, at the rate of 500 pounds per acre gave approximately the same yields of cantaloupes as did well rotted manure, applied in the hill at the rate of 5 tons per acre.

Nutrition and Plant Response of Vegetables. (J. T. Quinn).—Placing fertilizer in the row in growing potatoes and tomatoes has been more profitable than broadcasting the fertilizer. Complete fertilizers containing up to 6 per cent potash have given profitable increases in yield of potatoes.

A partial report of this project has been included in Experiment Station Bulletin 212.

HOME ECONOMICS

(JESSIE A. CLINE, *Acting Chairman*)

The Psychology of Child Nutrition. (C. Rowena Schmidt).—The purpose of this study was to investigate circumstances under which children refuse to eat, and to determine what psychological principles were involved. The following general conclusions were reached:

1. Many of the problems of malnutrition have their foundation in earlier psychological problems of training in food habits.
2. The early solution of psychological feeding problems should, therefore, establish better health conditions among children.
3. Psychological feeding problems are easy of solution if the parents recognize and handle them early enough; they are possible, though more difficult of solution when recognized later.
4. The hope of the future in this matter lies in the wider education of mothers in the fundamental principles of child psychology. This may be accomplished through: (a) Interesting mothers in the literature of the subject now available. (b) Assembling and publishing in popular form those scientific principles of child psychology which bear directly upon the subject of child training. (c) Lecturing on the subject to Parent-Teacher Associations, Mothers' Clubs and similar organizations. (d) Enlisting the help of mothers in original investigations, and making the results of such investigation available to them in some printed form.

Thrice-Cooked Vegetables for Diabetics. (Hannah A. Stillman).—Thrice-cooked vegetables have been frequently prescribed for diabetics both during the starvation period at the beginning of treatment and also throughout the treatment of severe cases. This brings the quantity of food somewhere near normal without adding materially to the fuel value of the diet. Not much

data have been available on the mineral and vitamine content of the diabetic diet.

Young rats 40-55 days old were placed on a basal diet of 15% purified casein, 10% Crisco, 72% corn starch and 3% salt mixture (Gulick's formula). This basal diet was furnished in unrestricted quantities. The vegetable, which was intended as the only source of vitamine, was given daily in weighed amounts. Eight rats were given 4 g. of raw spinach, and eight were given 4 g. of thrice-cooked spinach. About 75 g. of vegetable was used to 1 liter of water, and this was cooked 10 minutes and repeated twice.

The raw spinach furnished satisfactory growth, but no growth was obtained with the thrice-cooked spinach. On the twenty-fifth day, the first of the eight died; the second died on the thirty-first day. The fortieth day another died and the internal organs were eaten by those in the cage with it. The survivors made no gain following this. On the forty-seventh and forty-eighth days two more died, one being eaten by the survivors. The experiment was then discontinued on account of lack of spinach. Some experiments with cabbage indicated that these results were not confined to one vegetable.

From this investigation it would seem that thrice-cooked vegetables, if not totally devoid of vitamine, contained an amount which was relatively insignificant. No attempt was made to determine which of the vitamins were lacking.

Color Knowledge Essential to Costume and its Practical Application. (Mrs. Lulu Williams Gillum).—The purpose of this investigation was twofold: (1) to select the knowledge of color that was essential to apply to costume; and (2) to interpret the effect of color in costume on the complexion, hair, and eyes of various types of people.

Yellow reflected its own color on the hair, eyes, and complexion, more than did its complement, purple. Red was one of the most pleasing colors in its effect on the wearer. Its reflections were health suggestive, especially in its lighter tones. Although blue is one of the most used colors it was not found to be the most becoming one. Its universal use is due to its modest, retreating qualities, its depth and richness of hue, and its practicability. Green was more difficult to wear than either yellow or blue; orange was more enhancing than yellow, less so than red; and purple was less becoming than either blue or red. Black is perhaps the most severe of all colors on the complexion. Its shadows are dark and colorless, it emphasized all lines of age and care in the face, and bleached by value of contrast the color that was already in the complexion. White brought out all the color that was in any of the three features. Its effect was just opposite that of black. Gray, being a soft and quiet color, was more or less neutral in its effect on the features. It should be avoided for the most part by those having neutral coloring. The following are the conclusions on the use of color in costume applicable to all types.

Choice of Hue.—This factor depended on the general qualities of colors and their combinations rather than their effect on the features of the individual. Avoid garnish colors, too drab colors, too great a variety of colors, too strong a contrast both in mass and tone, too simple colors, and colors that rob one of one's own individuality.

Choice of Value.—The value of the color or colors to be worn depended on the value of the individual's coloring; light for light people, medium for medium, and dark for dark, was a safe rule to follow.

Choice of Intensity.—Colors of vivid intensity should be used with great caution. Those who have both vivid coloring and personality may best wear them.

Harmony of Costume.—There are nine general methods of obtaining harmony of color: analogy of color; contrast of color; contrast of value, intensity or mass; black with bright colors; dominant color combined with smaller masses; light colors in combination; the use of one color in its different values and intensities; bright colors with neutral tones; and adjacent or closely related colors.

The following general conclusions applied to the selection of becoming colors applicable to group types.

Blondes.—Light colors in middle or high light values are best for the blonde, blues, greens, light reds, and soft browns are most enhancing to her delicate coloring.

Brunettes.—The strong coloring of the brunette calls for strong and deep colors in costume. The oranges, reds, rich browns, bright yellows, and strongly contrasted colors are most flattering to her warmth of color.

Combination Type.—Since this type is one containing some of the features of the blonde, and some of the features of the brunette, then for her color choice she must be guided by those of both of these types.

Titian.—The strong coloring of the titian's hair makes it expedient to choose calmer colors to soften the effect. Also the cool contrasting colors form a pleasant effect, relieving the warmth of her hair. Grays, blues, greens, browns, and tans almost comprise the range of colors permissible for her. Black is oftentimes striking in its effect, and very becoming to this type.

Gray.—Since the coloring of this type has lessened in intensity, bright colors and very dark colors should be avoided for the most part, for they make her look more faded and colorless by contrast. Soft grayed tones of all the colors, especially old-rose, and lavenders; black if relieved next to the face; white almost always; and to some extent those colors particularly becoming to the type to which she belongs, whether blonde or brunette.

Selection and Economic Use of Soap in the Home. (Louise Stanley and Lillian Sensintaffar).—A number of brands of soaps, soap chips, soap flakes, and soap powders were examined chemically. The constituents of soap which affect its value as a detergent were (1) percentage of moisture, (2) percentage of unsaponified matter, (3) percentage of crude fatty acids, (4) percentage of free alkali, (5) percentage of combined alkali, (6) percentage of alkali as carbonate, silicate, and borate, and (7) percentage of insoluble material.

Pure bar soaps have a high percentage of combined soda, a high percentage of crude fatty acids, a low percentage of unsaponified matter, a low percentage of free alkali, a low percentage of alkali as carbonate, silicate, and borate, and no insoluble material. Pure soaps are always more expensive than inferior soaps, even when the cost is reckoned on the basis of actual soap cost per ounce.

Soap chips vary in purity as do bar soaps. Some brands had a high percentage of alkali as carbonate, silicate, and borate. The cost of soap chips was about the same as that of bar soaps of similar quality.

The soap flakes tested were practically pure soap, and their cost was not greatly different from that of pure bar soaps. Washing compounds had a very high percentage of alkali as carbonate, silicate, and borate. Taking into con-

sideration their quality and cost, they were considerably more expensive than bar soaps.

In general, toilet soaps were purer than laundry soaps; they were also more expensive.

Washing soda is to be recommended as a water softener for use in general cleaning purposes, and for laundering cotton material. Borax is the best and cheapest of the softeners suitable for use in laundering silk or wool.

A Nutrition Problem with Special Reference to Negro Children. (Bertha K. Whipple and Mary Baynham).—Although the groups were small it is believed that they are representative of the conditions found at large. A study of conditions was made in the negro and white elementary schools in St. Louis. Three classes were studied: (1) white pre-school children, (2) negro pre-school children, (3) negro school children.

Children from homes where a high standard of living prevailed were better cared for than children from homes of lower standards of living, although there seems to be a growing tendency toward formation of good health habits in people of limited education.

Children who have lived in accordance with the rules of health are normal mentally and physically. All of the group of children of college women were above normal in weight and all who had mental tests were accelerated by one, one and one-half, or two years.

The lower the standards of living the lower the mental and physical condition of the child. The lower the educational status of the mothers, the less emphasis seemed to be put upon right living.

The negro children in the elementary schools showed a smaller percentage of malnutrition than the white children. However, the negro pre-school children were not in as good physical condition as the white pre-school children. Bad food habits were more noticeable in the negro children than in the white children.

The Effects of External Temperature on the Basal Metabolism of Young Women Under Usual Conditions of Dress. (Hannah A. Stillman and Mary Lawrence).—This investigation was undertaken to find out whether there was any change in the metabolism of young women due to external temperature, under usual living conditions. The temperatures experimented with were ordinary room temperatures of from approximately 20° to 30°C. compared with cool room temperature, lowered to approximately 5° to 15°C. The subjects in the cool room temperature were dressed as for outdoors. One observation was made with the subjects exposed as they would be outdoors. Another observation was made with the subjects covered, but still in the cool atmosphere, as they might be if prepared for sleep.

Twelve college women were tested over a period of ninety days, to determine their basal metabolism. With dress and temperature as in outdoor conditions, eight showed an increase in metabolism rate, and four showed no consistent change. Under sleeping conditions, ten showed an increase, and two showed no consistent change. These tests indicated an increase in the metabolism rate and therefore an increase in the energy requirement due (1) to the kind of clothing worn in winter and (2) breathing cold air.

POULTRY HUSBANDRY

(H. L. KEMPSTER, *Chairman*)

Time of Molt as an Index to Productivity of Hens. (H. L. Kempster).—Data on White Leghorns for 1922-23 indicated that early molters were not only inferior layers one year but also the following. On November 1, 1922, the hens were grouped as to their condition of molt. Hens having a new coat of plumage were classified as having completed the molt; others were classified as molting, and the third group as showing no signs of molt on that date.

TABLE 30.—EGG PRODUCTION AS RELATED TO TIME OF MOLTING.

Condition Nov. 1	No. of hens	Egg prod. prev. Yr.	Winter egg prod. following Yr.	Egg prod. following Yr.
No trace of molt.....	78	164	21.7	142
Full molt.....	102	156	18.0	118
Molt completed.....	20	137.6	17.2	110

That the early quitter was closely associated with poor production was shown in data compiled during 1022-23. Not only do the early quitters make inferior records for the season, but this difference was also shown the subsequent year.

TABLE 31.—YEARLY EGG PRODUCTION AS RELATING TO THE TIME THAT LAYING CEASES.

Month stopped laying	No. of hens	Days vacation	Egg prod. 1921-22	Winter egg prod. following Yr.	Egg prod. 1922-23
July.....	4	182	109.0	18.0	100
August.....	8	151	134.0	18.6	115
September.....	25	143	137.4	17.4	102
October.....	121	94	153.0	17.3	119
November.....	59	69	170.6	22.0	131
December.....	11	45	174.0	33.8	147.5

To keep hens which quit laying early with the expectation that they will lay more eggs the following winter and year appears to be an erroneous idea.

Value of Sour Milk, Beef Scrap, Cottonseed Meal, Gluten Meal and Oil Meal in Rations for Egg Production. (H. L. Kempster, E. W. Henderson).—To a basal mash consisting of equal parts by weight of bran shorts and cornmeal, various protein concentrates as indicated in Table 32 were added, except Pen 10 in which case sour milk was given as a drink. The grain ration was a mixture of 2 pounds corn and 1 pound oats. Limestone grit and oystershell were always available. White Leghorn hens which had passed through one laying season were used in these tests.

Correlation of Sexual Maturity to Annual Egg Production. (H. L. Kempster).—Observations of White Leghorn pullets for 1922-23 showed a slight correlation between length of maturity and egg production. The correlation was of such a nature that in general the shorter the length of time between hatching and the date of the first egg the better the egg record. The correlation was—.1934±.043. A correlation 4.56 times the probable error was significant. Table 33 shows the average results:

The average length of time required to mature White Leghorn pullets in 1922 was 232 days, and the average egg production was 145. It is thus seen that those which matured in less than the average length of time were superior in production. Those maturing in 200 to 224 days made the best record.

Attention should be called to the fact that practically all which matured in less than 200 days, laid during the early fall months and then went into a winter molt. This greatly handicapped their egg record for the year following. That the earlier maturers possessed superior qualities was shown by correlating the length of maturity with the best month's record. This correlation was $-.2149 \mp .044$.

TABLE 32.—VALUE OF CERTAIN PROTEINS IN RATIONS FOR EGG PRODUCTION.

Pen No. and ration	Av. egg production	Grain per hen per year	Mash per hen per year	Feed (lbs.) to produce 1 doz. eggs
1 Tankage 20 %-----	122	50	33	8.3
2. Meat scrap 20 %-----	120	44	33	7.7
3 Dried buttermilk 35 %-----	96	45	33	9.7
4 Tankage 15 %-----	123	50	40	9.0
5 Tankage 15 %; cottonseed meal 5 %-----	121	44	35	7.9
6 Tankage 10 %; Cottonseed meal 10 %-----	102	53	37	10.5
7 Tankage 10 %-----	112	50	23	7.8
8 Tankage 5 %; cottonseed meal 15 %-----	93	44	27	7.9
9 Tankage 5 %-----	85	43	34	11.0
10 Sour milk-----	120	53	35	8.8*

*Does not include milk.

TABLE 33.—RELATION OF EGG PRODUCTION TO TIME REQUIRED TO REACH MATURITY.

Days to mature	No.	Fall eggs	Winter eggs	Total Nov. 1—Oct. 31
150 to 174	8	36	27.5	131.2
175 to 199	25	19	32.5	141.7
200 to 224	68	2	42.4	159.5
225 to 249	65	0.9	35.2	148.0
250 to 274	41	----	30.1	137.0
275 to 300	14	----	21.0	116.5
300 or more	8	----	16.1	117.5

Time of Hatching in Relation to Egg Production. (H. L. Kempster).—So far as White Leghorns are concerned there appears to be little disadvantage to hatching even as early as February. Contrary to general opinion those hatched early made as satisfactory egg records as did those hatched in May. There appears to be a distinct advantage for April hatching as is shown in the following data:

TABLE 34.—EGG PRODUCTION AS RELATED TO TIME OF HATCHING.

Month hatched	No.	Fall eggs	Winter eggs	Total, Nov. 1 to Oct. 31, 1923.
February-----	53	16.49	31.6	145.4
March-----	55	1.04	35.5	140.5
April-----	91	0.34	36.9	148.2
May-----	36	----	28.3	139.6
June-----	2	----	22.5	107.0

When one considers also the extra price received for early broilers the advantage in hatching early becomes two-fold.

Rate of Growth of Chicks Under Normal Conditions. (M. A. Seaton).—Table 35 shows the rate of growth under normal conditions observed for various breeds during the year 1924.

TABLE 35.—WEIGHT OF CHICKS IN POUNDS AT AGES OF 0 TO 15 WEEKS

Age in weeks	Weight in Pounds						
	R. I. Reds	Buff Rocks	White Rocks	Barred Rocks	R. I. Whites	Anconas	White Leghorns
0	0.0781	0.092	0.0737	0.082	0.079	0.078	0.072
1	0.1023	0.143	0.11	0.116	0.123	0.11	0.095
2	0.143	0.204	0.156	0.163	0.197	0.16	0.13
3	0.176	0.341	0.222	0.26	0.258	0.196	0.16
4	0.2203	0.401	0.33	0.37	0.357	0.279	0.213
5	0.276	0.483	0.368	0.472	0.44	0.361	0.236
6	0.375	0.694	0.46	0.588	0.618	0.54	0.361
7	0.528	0.935	0.583	0.715	0.781	0.585	0.506
8	0.694	1.166	0.748	0.902	1.056	0.63	0.65
9	-----	1.41	0.946	-----	1.265	-----	-----
10	-----	1.495	1.134	-----	1.464	-----	-----
11	-----	1.69	1.316	-----	1.7	-----	-----
12	-----	1.96	1.474	-----	1.9	-----	-----
13	-----	2.25	1.65	-----	2.13	-----	-----
14	-----	2.4	-----	-----	2.36	-----	-----
15	-----	2.6	-----	-----	2.53	-----	-----
No.	155	71	305	73	149	104	546

The Value of Sour Skimmilk and Beef Scrap in Rations for Growing Chicks, and the Cost of Growing Chicks. (E. W. Henderson).—Tests were made to determine the effect of freezing and subsequent thawing of milk products of various kinds on the growth and mortality of chicks. The products were fed in liquid state and were the sole source of animal protein. From the data secured, the freezing of milk apparently had no deleterious effects. There were no apparent differences in the various lots that could be attributed to frozen or unfrozen milk.

Influence of Time Laying Starts to Future Production. (H. L. Kempster).—Pullets that start laying too early usually experience a fall and winter molt that greatly handicaps them so far as making satisfactory egg records are concerned. The practice of holding Leghorn pullets back by methods of feeding is quite common and in many cases such treatment results in injury to the flock. To retard the entire flock because of a few precocious pullets is not a wise procedure and one should judge the general average rather than the few that start laying early. That the early layer is not seriously handicapped is shown by the following data:

TABLE 36.—EGG PRODUCTION AS RELATED TO THE TIME WHEN LAYING STARTS.

Month laying started	No.	Eggs before Nov. 1	Winter eggs	Total for year
July.....	6	30.5	28.1	114.8
August.....	12	32.5	25.0	143.5
September.....	5	25.4	44.2	185.6
October.....	33	6.3	39.0	149.4
November.....	72	-----	41.3	152.6
December.....	58	-----	34.7	148.0
January.....	45	-----	22.8	129.5
February.....	6	-----	12.0	109.8

Of the July group, three failed to lay more than 7 eggs each the following summer. This may be considered accidental and should not be given undue weight while the number which started in September was too small to justify conclusions. From the standpoint of winter egg production, not considering the September group, those starting in November had a slight advantage, followed closely by those starting in October and December. This difference was also shown in the annual egg yield.

Data compiled from previous records covering these same points but including a larger number of birds showed the following:

TABLE 37.—PREVIOUS RECORDS ON NUMBER AND VALUE OF EGGS LAID BY HENS GROUPED WITH REFERENCE TO THE TIME LAYING STARTED.

Month laying started	No. of hens	Eggs before Nov. 1	Winter eggs	Total for year	Value of eggs* produced Nov. 1-Oct. 31
July.....	4	46.0	27.7	171.5	\$4.14
August.....	25	39.3	34.0	163.6	4.14
September.....	15	20.2	25.8	141.2	3.06
October.....	53	6.2	43.58	166.8	4.59
November.....	195	----	36.8	150.0	3.72
December.....	105	----	29.7	140.0	3.35
January.....	76	----	21.1	127.9	2.67
February.....	55	----	8.8	96.9	1.92

*Local prices 1921-22.

RURAL LIFE

(O. R. JOHNSON, *Chairman*)

Movements of Rural Population in Missouri. (E. L. Morgan).—The purpose of this study was to determine and interpret in general, and specifically where possible, the effect of rural population movements upon the families migrating, upon the local rural community, and upon general and public welfare in the State. A general study is being made of the counties of New Madrid, Perry, Ozark, Laclede, Cedar, Johnson, Lincoln, Knox, Grundy, Nodaway, and an intensive study is being made of Boone County.

Some of the causes of migration, listed in the order of the frequency of their occurrence, are as follows:

1. Desire for better farm.
2. Leaving agriculture by choice.
3. Dislike of neighborhood.
4. Dislike of school.
5. Leaving agriculture because of economic necessity.

Migration was found to be greatest on poor soil, near poor schools, in close proximity to an industrial city, and where there was little community cooperation of either an economic or social nature.

Eighty-eight per cent of those studied who have migrated from farms have profited financially by the change; twelve per cent have lost money.

In all localities where migration had been marked, there was the opinion that the community has suffered through the effect this migration had on the activities of the school, the church, farm organizations, and social interest.

Cost of Producing Farm Products Under Farm Conditions. (O. R. Johnson, B. H. Frame).—Data on the cost of producing the following crops were

obtained from the eleven records summarized so far: corn 175 acres; wheat 188 acres; oats 127 acres; clover 56½ acres; cowpeas 42 acres; soybeans 33 acres; miscellaneous 89 acres.

From production factors obtained since this project was started, the cost of producing the 1923 crops of wheat, corn and oats in Missouri was \$1.40, 50c and 64c per bushel respectively.

Distribution of Farm Labor. (O. R. Johnson, B. H. Frame).—A detailed analysis of the labor requirement for production of corn by operation and by months has been made. The years 1912 to 1922 inclusive are included and the acreage opposite each operation is also given.

An Analysis of the Columbia Trade Area Showing the Influence of Various Economic Factors on the Shape and Size of This Trade Area. (O. R. Johnson).—There were more newspaper and hardware accounts per mile on gravel than on dirt rural route roads. There were fewer grocery accounts on gravel than on dirt rural route roads. The territory within three miles of town showed a marked increase in the number of newspapers, hardware and grocery accounts per mile of road in comparison with that part of the rural route territory which was farther than three miles from Columbia. There was no evidence that increase and decrease in newspaper subscriptions and hardware accounts for the different soil regions bore a direct relation to the standing of the soil regions with respect to their productivity. In fact, there seemed to be a slight tendency for the number of newspapers and hardware accounts per section to decrease from the poorest to the productive soil regions. As the number of newspaper accounts increased the hardware accounts also increased. This showed beyond much doubt that newspapers had the effect of increasing the number of hardware accounts carried in Columbia.

The Standard of Living on the Farm as a Factor in Cost of Production. (O. R. Johnson, B. H. Frame).—The accompanying figure shows that standards of living as indicated by cost of family living were closely related to cost of production except for the variable factor of yield per acre. The farmer is more concerned with cost per bushel as that is the basis of sale of his products, but cost per bushel is more varied because of fluctuation in yield than because of present cost factors. These cost factors are possibly very closely allied to the cost of family living. With the exception of the year 1916 the curves here given correspond fairly well. In 1916 Missouri had a very short corn crop with an average yield of 19.4 bushels. This made the cost per bushel run very high for that year in comparison to other costs in farm operation.

A Study of the Rural Primary Groups of Boone County, Missouri. (E. L. Morgan).—Fifty-nine primary population groups (neighborhoods) and 15 secondary groups (communities) were found in the county. The origin of the various group names were: from an individual 30, natural phenomenon 11, school 5, church 5, former population center 2. For the remainder no definite assignment could be given for the particular group name.

In the intensity of group consciousness rating, 7 were found to be high, 10 medium plus, 25 medium, 10 low, and 7 low minus. It was found that the self-consciousness of primary population groups varied directly with the distance from a larger community center. The intensity was also found to be greatest where the most activities center.

TABLE 38.—PERCENTAGE DISTRIBUTION OF MAN LABOR BY OPERATIONS ON CORN, 1912-1922.

Operation	Acres covered	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Hrs. per acre
Hauling manure.....	657.12	14.3	6.1	17.1	35.5	8.8	6.1	.4	2.6	.1	2.9	2.9	3.2	1.61
Removing stalks.....	1039.	.9	7.8	14.2	51.2	25.6	0.3	0.1	---	0.6	2.0	3.4	.9	3.83
Breaking.....	4312.3	2.0	1.8	10.6	39.2	36.4	3.1	0.1	---	---	0.6	.1	---	1.64
Disking.....	4120.37	---	---	16.1	34.9	43.0	5.2	0.9	---	---	---	---	---	1.26
Harrowing.....	5283.8	---	---	1.0	24.0	63.4	10.7	13.3	---	---	---	---	---	.97
Rolling and dragging.....	1133.87	---	---	---	8.8	55.8	22.1	1.5	---	---	---	---	---	1.48
Listing.....	676.	---	---	---	20.2	69.2	9.1	0.5	---	---	---	---	---	1.44
Planting.....	4887.3	---	---	---	15.7	67.2	16.6	9.0	---	---	---	---	---	1.10
Replanting.....	1417.	---	---	---	---	34.4	56.6	53.0	---	---	---	---	---	1.89
Thinning.....	193.5	---	---	---	---	2.8	44.2	30.5	2.3	---	---	---	---	6.01
Cultivation.....	6389.12	---	---	---	0.4	10.4	56.4	---	32.1	43.3	24.3	0.3	---	4.64
Making Silage.....	486.75	---	---	---	---	---	---	---	---	---	---	---	---	---
Cutting corn*.....	141.0	---	---	---	---	---	---	0.7	14.9	57.2	26.6	0.6	---	3.21
Shocking corn.....	397.75	---	---	---	---	---	---	---	19.4	54.7	25.9	---	---	2.01
Husking from shock.....	938.	5.8	2.9	---	---	---	---	---	1.2	9.2	14.5	44.9	21.5	6.65
Husking from stalk.....	3468.6	3.8	1.5	---	---	---	---	---	0.5	4.0	12.8	47.0	30.4	5.57
Care of seed.....	84.	---	---	---	---	---	---	---	---	73.8	9.8	16.4	---	.36
Cutting weeds.....	717.	---	---	---	0.4	1.2	24.7	33.0	27.6	13.1	---	---	---	1.2
Management.....	93.	---	---	---	---	---	37.5	---	31.2	12.5	---	18.8	---	0.1

*Binder or sled.

TABLE 39.—PERCENTAGE DISTRIBUTION OF HORSE LABOR BY OPERATIONS ON CORN, 1912-1922.

Operation	Acres covered	Month												Hrs. per acre
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Hauling manure.....	657.12	14.1	6.5	16.7	37.7	9.2	4.6	0.3	2.5	.1	2.5	2.6	3.2	2.96
Removing stalks.....	1039.	1.4	9.4	14.1	55.9	18.9	.3	----	----	----	----	----	----	1.92
Breaking.....	4312.3	1.9	1.7	9.5	42.9	36.9	3.2	----	----	.6	2.0	.4	.9	10.54
Disking.....	4120.37	----	----	5.5	39.2	49.1	5.6	----	----	----	.4	.2	----	5.23
Harrowing.....	5283.8	----	----	1.0	24.1	65.1	9.2	0.6	----	----	----	----	----	3.99
Rolling and dragging.....	1133.87	----	----	----	11.6	59.3	21.5	7.6	----	----	----	----	----	2.17
Listing.....	676.	----	----	----	22.2	68.6	8.2	1.0	----	----	----	----	----	4.52
Planting.....	4887.3	----	----	----	17.4	66.6	15.5	.5	----	----	----	----	----	2.21
Replanting.....	1417.	----	----	----	----	24.9	51.9	23.2	----	----	----	----	----	.36
Thinning.....	193.5	----	----	----	----	----	----	----	----	----	----	----	----	----
Cultivation.....	6389.12	----	----	----	.8	10.7	58.7	28.4	1.4	----	----	----	----	10.06
Making silage.....	486.75	----	----	----	----	----	----	----	26.1	32.7	40.7	.5	----	8.05
Cutting corn*	141.0	----	----	----	----	----	----	1.9	22.7	48.6	25.5	----	1.3	2.05
Shocking corn.....	397.75	----	----	----	----	----	----	----	----	50.2	49.8	----	----	.26
Husking from shock.....	938.	5.8	2.4	----	----	----	----	----	.7	6.9	12.2	41.7	30.3	4.92
Husking from stalk.....	3468.6	4.1	1.3	----	----	----	----	----	.5	4.0	11.7	46.1	32.3	8.30
Care of seed.....	84.	----	----	----	----	----	----	----	----	80.0	20.0	----	----	.18
Cutting weeds.....	717.	----	----	----	----	----	----	34.2	15.8	36.8	----	----	----	.05
Management.....	93.	----	----	----	----	----	54.5	----	----	18.2	----	27.3	----	.06

*Binder or sled.

TABLE 40.—CORRELATION OF PRIMARY GROUP NAMES WITH THE INTENSITY OF GROUP CONSCIOUSNESS.

Origin of group name	Intensity of group consciousness					Total
	High	Medium+	Medium	Low	Low-	
An individual.....	4	5	10	7	4	30
Natural phenomenon.....	1	1	6	2	1	11
School district and church.....	0	0	5	0	0	5
Former population center.....	0	0	2	0	0	2
Church.....	0	3	0	0	2	5
Miscellaneous.....	2	1	2	1	0	6
Total.....	7	10	25	10	7	59

Beef Cattle Production in Missouri. (E. A. Trowbridge, O. R. Johnson, B. H. Frame).—Complete reports on beef cattle feeding operations on 450 separate bunches of cattle containing 24,476 head are now available.

This work has been carried on by the departments of rural life and animal husbandry of the Missouri Experiment Station in cooperation with the Bureau of Agricultural Economics at Washington. Preliminary reports have been issued by the Washington office following the completion of each year's records. The following tables are extracts from the Preliminary Report issued in March, 1924.

TABLE 41.—COMPARISON OF RESULTS OF DIFFERENT FEEDING METHODS.

	Method I	Method II	Method III
Number of droves.....	23	35	24
Number of cattle bought.....	970	2402	1770
Number of cattle died.....	18	10	10
Initial weight per head.....	624	865	823
Final weight per head.....	917	1216	1150
Days on farm.....	206	267	298
Average daily gain.....	1.45	1.32	1.10
Feed per hundred pounds gain			
Grain, lbs.....	468	616	670
Concentrates, lbs.....	33	53	11
Alfalfa and clover, lbs.....	168	134	175
Other hay lbs.....	82	108	67
Stover and straw lbs.....	34	271	385
Silage lbs.....	481	172	77
Pasture days.....	31	45	55
Feed cost per 100 lbs. gain.....	\$11.00	\$12.95	\$14.67
Initial cost per head.....	\$33.41	\$53.87	\$50.11
Feed cost per head.....	32.89	45.67	48.31
Other miscellaneous costs.....	8.68	10.72	10.86
Total cost per head.....	74.98	110.26	109.28
Manure and pork credits.....	5.55	7.29	5.43
Net cost per head.....	69.43	102.97	103.85
Sales price per head.....	71.17	111.02	99.77
Profit per head.....	1.74	8.05	4.08
Loss per head.....			
Sales price per cwt.....	\$ 7.70	\$ 9.12	\$ 8.67
Initial cost per cwt.....	5.35	6.23	6.09
Margin necessary to break even.....	2.16	2.23	2.93
Margin received.....	2.35	2.89	2.58
Amount returned per bushel of corn fed.....	.79	.98	.68
Farm price of corn.....	.75	.78	.79

Table 41 is a summary of the results of three different methods of feeding

that are most common in this part of Missouri. They are defined as follows:

Method I.—Cattle bought in the fall, pastured on grass and cornstalks, and then finished out in the feedlot on grain for a late winter or spring market.

Method II.—Cattle bought in the fall, roughed through the winter and finished on grass with a liberal feed of grain the following summer.

Method III.—Cattle bought in the fall, well-wintered on shock corn and finished on grass with practically no corn.

Table 42 shows the financial results of cattle feeding through the last five years. Attention is called to the fact that much rough feed was disposed of by feeding cattle which would otherwise have little or no sale value and when this fact is considered feeders should be well satisfied with the results in 1919 and in 1922-23.

TABLE 42.—FINANCIAL RESULTS OF FEEDING OPERATIONS DURING THE LAST FIVE YEARS WHEN CHARGING FEED TO CATTLE AT CASH FARM PRICE.
(On the basis of one steer; average of all cattle)

	1919	1920	1921	1922	1923
Number of droves.....	50	100	105	101	94
Number of cattle sold.....	3473	5184	5139	4914	5766
Initial weight.....	729	807	843	769	803
Gain weight per head.....	268	258	342	339	324
Final weight per head.....	997	1065	1185	1108	1127
Original cost of feeder animal.....	\$71.38	\$77.25	\$67.81	\$45.72	\$49.42
Interest					
On money in cattle.....	2.55	2.70	3.25	2.16	2.51
On money in equipment.....	.85	.86	.79	.68	.46
Operating costs					
Feed.....	56.91	65.69	48.04	34.26	43.01
Man and horse labor.....	4.89	4.66	4.64	3.20	2.64
Building and equipment.....	.66	.79	.62	.72	.51
Death loss.....	.89	.52	.46	.42	.31
Veterinary.....	.16	.08	.04	.08	.03
Insurance.....	.25	.03	.07	.06	.02
Taxes.....	.16	.28	.32	.33	.37
Incidentals.....	.22	.31	.29	.27	.21
Marketing.....	2.67	2.96	4.70	3.12	3.14
Total operating, interest and original cost.....	141.59	156.13	131.03	91.02	102.63
Manure credit.....	.24	1.98	.82	1.31	1.57
Pork credit.....	6.78	8.22	7.15	7.25	4.47
Net cost.....	134.57	145.93	123.06	82.46	96.59
Sales price.....	133.71	126.61	91.06	93.09	98.52
Profit (feed charged at cash farm prices.).....	---	---	---	10.63	1.93
Loss.....	.86	19.32	32.00	---	---
Cost of feeder cattle per cwt.....	9.79	9.57	8.04	5.95	6.16
Net cost of pound gain.....	.236	.266	.161	.108	.144
Net cost per cwt. of beef laid down at market.....	13.50	13.70	10.38	7.42	8.56
Necessary margin.....	3.71	4.13	2.34	1.47	2.40
Margin received.....	3.62	2.31	— .36	2.45	2.56
Price received per bushel for corn fed to cattle.....	1.60	.80	— .10	.71	.83
Average farm price of corn.....	1.49	1.42	.60	.48	.78

Taxation Problems of Agriculture. (S. D. Gromer).—Tax records have been collected in certain counties of the State as follows: New Madrid 60, Boone 85, Osage 18, Maries 20, Morgan 10.

It is proposed to collect additional records up to a total of 400, in Harrison, Gentry, and Saline Counties. These records are now being collected.

Cost of Producing Farm Products Under Farm Conditions (Poultry). (O. R. Johnson, B. H. Frame).—The average labor requirements of poultry per year were 1.71 man hours and 0.118 horse hours per hen per year. More man labor was required in March, April and May, while more horse labor was required in December, January, February and March.

The feed cost per hen per year was \$.6636. The heaviest feed requirement was in February; the lightest requirement in June.

In studying the kinds of feed fed to poultry it was found that corn made up 49.3 per cent of the total value of the ration; mill feed made 15.6 per cent; oats 10.4 per cent; wheat 8.8 per cent; proteins 8.7 per cent. These were the most important feeds fed.

Of the total cost of keeping poultry, man labor made up 27.7 per cent; feed 56.3 per cent; cash items 7.5 per cent; distributed costs (building, equipment, taxes and interest) 7.6 per cent, and horse labor .9 per cent.

The total income per hen was \$1.6661. Of this total, eggs and poultry sold made up \$1.3202, products used on the farm made up \$.2499 and miscellaneous items the remainder.

In comparing cost and incomes it was found that the most profitable year for these flocks was 1921 when each hen made an average profit of \$1.2927. The years 1912 to 1922 averaged \$.4877 in excess of receipts over expenses. Only one year (1916) did the poultry flock return less than its cost. This year the cost was \$.1141 more than the income.

In comparing cost and returns for different sized flocks those flocks with less than 100 hens and those with more than 300 hens were most expensive. Those flocks with from 100 to 300 hens were less expensive to keep. The labor expense per hen decreased as the size of the flock increased. The feed cost remained fairly stationary until the 300-hen flock was reached, when a definite tendency was shown for this charge to grow.

The income per hen became greater as the number of hens per flock increased from 100 to 200. The flocks of more than 300 hens were second in income; the flocks of less than 100 hens third, and the 200 to 300-hen flocks showed the smallest returns. This was attributed to the difference in methods used on farms where flocks were kept only to supply home needs as compared to methods followed on farms where poultry was a commercial proposition. The 200 to 300-hen flock was large enough to be of commercial importance and should be treated accordingly, but they evidently were treated in the same manner as the 100-hen flock. In spite of a higher cost of the 300-hen flock the owners were able to realize a greater net return than on the farm where the flock was less than 100 hens in size.

SOILS

(M. F. MILLER, *Chairman*)

Crop Rotation and Fertilizer Experiments. (M. F. Miller, F. L. Duley).—These experiments have now been carried on for 36 years. The yields of wheat last year gave further evidence of the possibility of maintaining yields through the use of chemical fertilizers. The plot which was sown to wheat annually and treated with sufficient fertilizer to supply all of the nitrogen, phosphorus, and potassium for a 40-bushel wheat crop, produced 32.37 bushels an acre. Most of the heavily manured plots caused the wheat to lodge and the yields were greatly reduced. The highest yielding plot in the field (32.78 bushels) has been in continuous wheat, receiving manure during the first twenty-five years and acid phosphate annually before wheat since that time.



Fig. 9.—The thirty-fifth consecutive crop of wheat on this land. The soil has received an annual treatment of chemical fertilizers. The yield in 1923 was 32.37 bushels per acre.

A few plots manured until 1913 have had no treatment since that time. The residual effect of the manure is still plainly evident.

TABLE 43.—PERCENTAGE OF LAND OCCUPIED IN MANURED AND UNTREATED PLOTS BY TIMOTHY AND OTHER GRASSES AND WEEDS

Species found in survey of plots	Plot 22, manured 6 tons annually	Plot 23, untreated
Timothy.....	65 %	1 %
Kentucky bluegrass.....	20	10
Canada bluegrass.....	--	25
Orchard grass.....	2	--
Redtop.....	2	15
Brome grass.....	2	--
Witch grass.....	--	4
Red sorrel.....	0.5	40
Wild lettuce.....	--	3
White top.....	--	0.5
Miscellaneous species.....	0.5	0.5
Unoccupied ground.....	8	1

The plots in continuous timothy have not been reseeded since 1918. The effect of the continuous cropping to grass without treatment has resulted in practically a complete substitution of other grasses and of weeds for the timothy. This was not true of the manured plot. A rough botanical survey of these plots showed approximately the percentage of the land occupied by different species.

Studies of the Tight Clay Layer in the Soils of the Level Prairies of Missouri.—(Richard Bradfield).—Fundamental studies of the characteristics of the colloidal fraction of heavy clay subsoils have been made. A small amount of field work has also been carried on in connection with percolation experiments.

Flocculation studies on the colloidal fraction of acid heavy clay subsoils have shown that when acid or neutral salts were used as flocculants the minimum electrolyte requirement increased only slightly when the concentration of the clay suspension was increased, but when alkaline flocculants were used this increase was almost directly proportional to the concentration of the clay suspension. For example, the ratio of the minimum requirement of CaCl_2 to that of $\text{Ca}(\text{OH})_2$ in case of a dilute suspension (0.125%) is 14.3: 100, while that for a more concentrated suspension (3%) was 3.0:100. These results indicate that neutral or acid salts are much more efficient flocculating agents than alkaline salts.

In the case of neutral clays the differences in the efficiencies of the neutral and alkaline electrolytes were not so marked as with acid clays.

Studies were made on the effect of the hydrogen ion concentration upon the absorption and exchange of bases by colloidal clay. Treatments which lowered the Sorensen value of the clay caused the liberation of more equivalents of total bases than were absorbed; treatments which were isohydric with the clay caused equivalent exchange; treatments which raised the pH value of the clay caused the absorption of more equivalents of bases than were liberated.

The divergent results frequently reported upon the liberation of native soil potassium by gypsum and lime can probably be explained in the light of these findings. Gypsum being a neutral salt tended to decrease slightly the pH value of acid soils and consequently caused an approximately equivalent exchange of bases, while CaO or CaCO_3 which are essentially alkaline in their reaction did not liberate an appreciable amount of bases until after the acidity of the soil was neutralized. This usually occurred only with excessive applications.

Experiments to Determine the Best Systems of Soil Management for the Most Important Soil Types in Missouri.—**Soil Experiment Fields.** (M. F. Miller, F. L. Duley).—The field at Windsor on the Oswego silt loam was dropped at the end of the 1923 season. It is planned to continue to harvest crops from these plots in order to determine the residual effect of the soil treatment.

A summary of all results and observations to date showed that red clover may be successfully grown in most sections of Missouri by proper soil treatment. Failure to get a stand of this crop was seldom caused by dry weather where the soil had been treated for clover. It has been further observed that there may be more than one treatment or combination of treatments on a given soil which will result in a good stand of clover. On the fields in Newton County on Crawford silt loam good clover has been produced the past year

with a combination of acid phosphate and limestone, manure and acid phosphate, or acid phosphate and a top dressing of straw on wheat. The best yields were obtained from the more complete treatments of manure, acid phosphate and limestone.

It has been demonstrated over a considerable number of years that some of the poorest Ozark land of the State can be made to produce approximately as high yields as the average yields of some of the best sections of the State.



Fig. 10.—Kafir on Eldorado Springs outlying Experiment Field. Manured land, yield 32.4 bushels of grain.



Fig. 11.—Kafir on Eldorado Springs field. No soil treatment. Yield 12.5 bushels of grain.

Pasture experiments at St. James show excellent returns from the use of phosphates and manure upon the growth of orchard grass, red top and blue grass.

TABLE 44.—COMPARATIVE YIELDS OF GRAIN CROPS ON PROPERLY TREATED OZARK SOIL AND BEST AGRICULTURAL LANDS OF STATE, UNTREATED.
(Figures from Report of State Board of Agriculture)

Crop	Poor Ozark soil (a) properly treated	Atchison County (b) Av. 1911-1920
Corn.....	30.2 bu.	32.7 bu.
Wheat.....	16.5 bu.	18.6 bu.
Clover.....	1.6 tons	1.5 tons

(a) Best treatments on experiment fields.

(b) Considered one of the best agricultural sections of the State.

Farmers' meetings were held on the fields at Windsor, Eldorado Springs, Stark City (3), St. James, Cuba, and Maryville.

The Effect of Different Amounts and Different Methods of Applying Commercial Fertilizer on The Corn Crop. (M. F. Miller, F. L. Duley).—The past year was the eighth year during which experiments in corn fertilization have been conducted. The original plan provided for a two-year rotation of corn and soybean, with an intervening crop of rye plowed under as green manure. This plan was changed in 1922 to a system of corn, followed by rye, in which sweet clover was seeded, the rye taken off and the sweet clover plowed under for corn the second year. The new plan provided for building up the nitrogen supply of the soil. In making the change in the cropping system, a crop of soybeans was plowed under for the 1923 corn crop. This, together with the season, resulted in much better returns than usual.

TABLE 45.—THE 1923 RETURNS AND AVERAGE RETURNS FROM DIFFERENT METHODS OF APPLYING FERTILIZER ON CORN.

Fertilizers Applied To Corn	Increases from treatment, Bu. per acre	
	1923	1916-1923
300 lbs. 2-10-2 drilled ahead of planter.....	16.56	8.40
150 lbs. 2-10-2 drilled ahead of planter.....	13.93	5.52
250 lbs. 2-10-2 drilled ahead of planter and 50 lbs. drilled in row.....	13.68	5.04
150 lbs. 2-10-2 drilled in row.....	9.91	2.88
75 lbs. 2-10-2 drilled in row.....	15.14	2.58
100 lbs. 14% Ac. Phos. drilled in row.....	3.14	1.16
150 lbs. 2-10-2 along row at 3rd cultivation.....	0.63	2.00
300 lbs. 2-10-2 along row at 3d cultivation.....	7.91	3.29
150 lbs. 2-10-2 along row at 2d cultivation.....	1.00	0.20
75 lbs. 2-10-2 drilled in with planter and 150 lbs. along row at 3rd cultivation.....	14.63	4.78
75 lbs. 14% Ac. Phos. drilled in row with planter and 150 lbs. at 3d cultivation.....	3.89	2.96

Dry weather during the summer months greatly reduced the beneficial effect of the fertilizer treatment. Planting later than usual had a similar effect. In general, the application of fertilizer over the whole surface of the ground has given better returns than where fertilizer was applied in the row. Fertilizer, used as a side application at the second or third cultivation of corn, has given inconsistent and, usually, unsatisfactory returns. A good season, however, greatly increased the yields where fertilizer was used. On the whole, however, droughts so interfered that fertilizer applied to corn in central Missouri,

considering the corn crop alone, has scarcely been profitable. The returns on the following crop of soybeans, however, were quite marked. This should be taken into consideration in determining net returns.

The Rate of Accumulation and Cost of Nitrogen and Carbon in Soils Under Different Systems of Green Manuring and Cropping. (M. F. Miller, F. L. Duley).—The rate of accumulation of the nitrogen and carbon was measured by quantitative chemical determinations at intervals of four years. The plots were first sampled in 1917 and again in 1921. While four year's interval was almost too short to allow accurate measurement of the effects of the various treatments, the analyses showed measurable increases in nitrogen as brought about by certain of the treatments. This was particularly true in the case of rye and cowpeas turned under and of red clover turned under. Where crops of corn, wheat, and clover in rotation have been removed, and

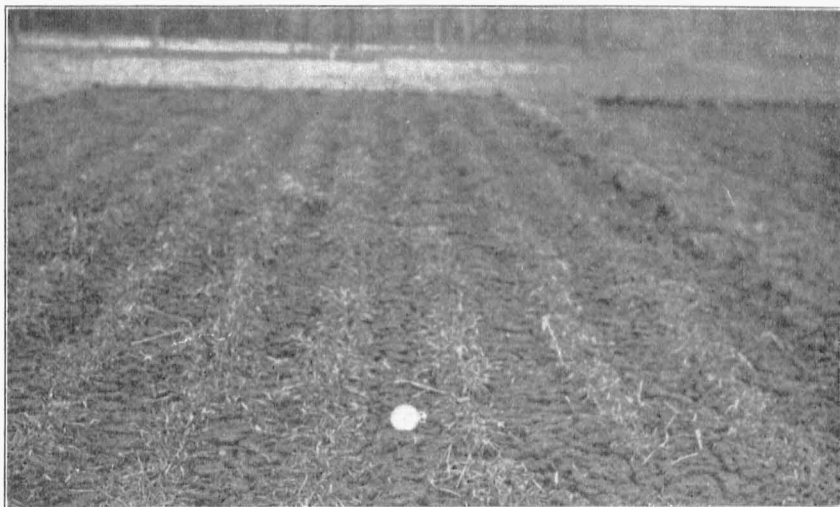


Fig. 12.—The condition of the soil in the spring where both rye and cowpeas have been plowed under.

where red clover has been grown regularly and the crops removed, no measurable increases in nitrogen were recorded. The next sampling of these plots will be in 1925.

The effect of plowing under a cowpea crop and a rye crop the same season, as compared with plowing under a rye crop alone, has thus far shown very little difference in the yield of the rye. However, it has been noticed that the additional cowpea crop has an important physical effect upon the soil. The alternate freezing and thawing in the spring produced a much more honey-combed structure where both rye and peas were plowed under, than where only the rye was plowed under.

Nitrate Production in a Soil as Affected by the Crop and Cultivation. (W. A. Albrecht).—The close relationship of nitrate production in the soil to the crop and soil treatment was emphasized. The crop was so important in

nitrate removal that the general nitrate content in the soil during the season was almost a reciprocal of the crop growth. Early spring plowing and early fall plowing increased nitrogen accumulation. Late fall plowed soil, probably as a result of weed growth, allowed little accumulation. There has been little significant difference visible in the fall growth of wheat as a result of early plowing, yet the yield of grain has been materially increased. The soil mulch under fallow has resulted in a slight average increase in nitrogen accumulation in the surface soil. The straw mulch has markedly inhibited nitrification. It was indicated that the high moisture retention due to the straw mulch, with the absence of alternate wetting and drying and freezing and thawing, brought on a bad physical condition of the soil which excluded the air to the point where nitrification was greatly depressed. Temperature studies failed to show any causal connection of this factor with the rate of nitrate accumulation.

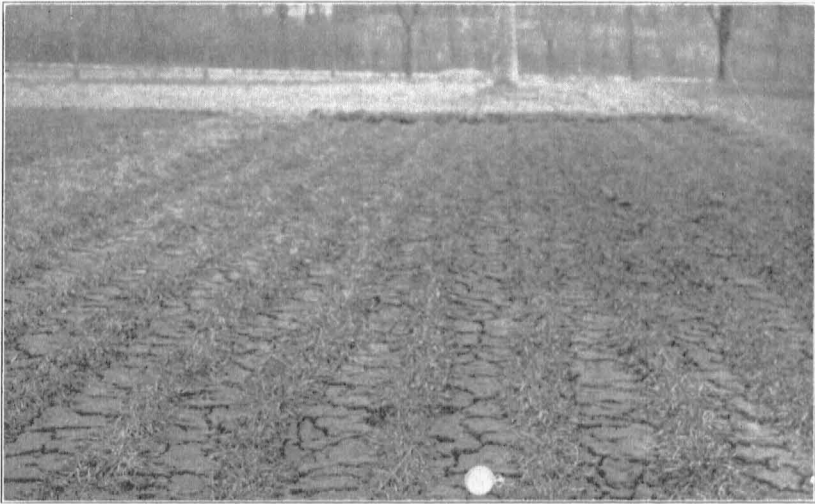


Fig. 13.—The plot where rye alone was plowed under. (Photograph was taken same time as that on opposite page.)

Effects of Different Soil Treatments, Long Continued, upon Bacterial Activity in the Soil. (W. A. Albrecht).—Four additional plots were sampled during the year, including continuous oats and continuous wheat under different treatments. The results again emphasized the low nitrate production in the plots continuously cropped without organic matter or fertilizer addition, even though limestone was added. When manure was added, nitrate accumulation was higher even when the plots were not limed. This suggested that manuring had lessened the injurious effect of acidity on nitrification. The plot fertilized with chemicals showed a nitrate accumulation practically equal to plots receiving manure and almost equivalent to that on which both manure and lime were added. This suggested that pure chemicals had helped to maintain the soil's ability to nitrify. The combination of lime and manure gave high nitrate accumulation in all soils, with no important differences related to past

soil treatments. This indicated that the soils had not lost their ability to nitrify when organic nitrogen and lime were supplied.

Studies on the Longevity of *B. Radicicola* in the Soil. (W. A. Albrecht).—In 1917 two different soils, each treated in part with lime and fertilizer and on which soybeans and red clover had grown with plenty of root nodules, were stored to prevent contamination. In storing the soil, a portion of each treatment was dried in the sunlight, another part in the dark and later both put away in dry condition in containers stored in the laboratory. A third portion was left out of doors in partly buried jars, open at the bottom to maintain the moisture in the soil. Samples of all these soils have been planted to soybeans and red clover under sterile conditions at intervals of six months or a year. The last test, (spring of 1924) indicated rather definitely that the bacteria were no longer viable in the soils stored in the dry condition. All eight of the dried and stored samples grown to red clover failed to inoculate the crop, while seven of the eight grown to soybeans failed to inoculate. Since but one sample in sixteen produced nodules, the conclusion was drawn that bacteria could not live in these dry soils longer than six years. Those soils left out of doors gave good inoculation in all cases. It made little difference in the length of persistence by the living organism whether the soil was dried in the sunlight or in the dark, whether it was fertilized or unfertilized, or whether it was a soil fairly high or low in organic matter. In the dried soil there was some suggestion of lessened numbers of bacteria after three years but it was not until six years had elapsed that inoculation failed entirely. The soil stored out of doors still produced nodules profusely six and one-half years after crop removal.

The Determination of the Relative Values of Different Forms of Phosphorus Upon the Soils at Columbia. (M. F. Miller, F. L. Duley).—Work on one series of plots devoted to this project was discontinued because of lack of the uniformity of the land. The work was done on small plots with many replications so that the results should be quite dependable.

TABLE 46.—EFFECT OF ACID PHOSPHATE VS. MIXED FERTILIZERS ON YIELD OF WHEAT.
(Bu. per acre)

Treatment	Average yield	Increase over no treatment	Increase for nitrogen	Increase for potash
Acid phosphate 150 lbs.....	27.12	9.27	----	----
2-12-0, 200 lbs.....	28.35	10.50	1.23	----
2-12-2, 200 lbs.....	30.71	12.86	----	2.36
Acid phosphate, 175 lbs.....	26.58	8.73	----	----
2-12-0, 175 lbs.....	26.46	8.61	----	----
2-12-2, 175 lbs.....	27.10	9.25	----	----
No treatment.....	17.85	----	----	----

During the last year the acid phosphate application was increased from 125 pounds to 150 pounds. The mixed fertilizer carrying an equivalent amount of phosphate was increased from 166 to 200 pounds. The uniform applications were increased from 150 to 175 pounds.

Where equivalent amounts of phosphorus were used an increase of only 1.23 bushels of wheat can be attributed to the nitrogen. This would hardly be enough to pay the difference in the cost of application. The increase of 2.36 bushels due to the potash would give a good profit on money invested in this material.

For moderate applications of fertilizer on this type of land, the acid phosphate was the best investment. The only variations from the average

results were that potash showed somewhat greater returns than in the earlier years, while the larger applications of the three fertilizers (175 pounds each) have shown more nearly uniform increases.

Studies Upon the Calcium Content of Soils and Its Relation to Acidity and the Response of Soils to Liming. (F. L. Duley).—Samples of soil for study have been obtained from Wisconsin, Ohio, Illinois, Iowa, Kentucky and Missouri experiment fields. Determinations have been made of the amount of calcium soluble in .04 N. carbonate water, the soil acidity, total nitrogen and total phosphorus. The result shows that the results obtained from the use of lime in the field can be much more readily explained upon the basis of the amount of soluble calcium than by a determination of soil acidity. Soils that showed less than 700 pounds of soluble calcium in the top 7 inches have given good returns from the use of lime in the fields, while those that showed decidedly more than this amount have not only been greatly benefited from further applications of lime but for the most part have been soils that produced good clover or alfalfa without the use of liming materials.

Many fertile soils have been found to be growing good crops of clover or alfalfa in spite of a strong degree of acidity, but all of these soils so far examined have shown a plentiful supply of soluble calcium. On the other hand, some soils with slight acidity respond well to applications of lime and in such cases the supply of easily soluble calcium has been found to be low.

Studies of Water Absorption, Run-Off, Percolation, Evaporation, Capillary Water Movement, and Soil Erosion Under Field Conditions. (M. F. Miller, F. L. Duley).—Three new plots have been started for the purpose of studying methods of rejuvenating eroded soils. These have been separated by 18-inch strips of galvanized iron. The plan of treatment is as follows: *First* plot, surface 7 inches of soil removed. Lime and chemical fertilizer added. *Second* plot, surface 7 inches of soil removed. No soil treatment. *Third* plot, original soil farmed without treatment.

TABLE 47.—POUNDS NITROGEN AND PHOSPHORUS REMOVED PER ACRE ANNUALLY IN ERODED MATERIAL.
(Average of two years)

Plot	Treatment	Nitrogen lost	Phosphorus lost.
		<i>lbs.</i>	<i>lbs.</i>
1	Uncultivated.....	98.8	47.4
2	Plowed 4 in. in spring. Fallowed.....	95.4	45.4
3	Plowed 8 in. in spring. Fallowed.....	73.8	33.2
4	Bluegrass sod.....	0.5	0.09
5	Wheat—annually.....	29.5	10.8
6	Rotation—corn, wheat, clover.....	5.9	2.2
7	Corn, annually.....	40.3	8.1

Two new lysimeters have been constructed for further study of the amount and composition of drainage water.

A report of the work accomplished since 1917 has been published in Missouri Research Bulletin 63. Experiment Station Bulletin 211 has also been published, which calls attention to the practical application of the results of these experiments.

On soil with a slope of 3.68 feet per hundred, deep plowing (8 inches) was only slightly more effective than shallow plowing (4 inches) in preventing runoff and erosion. Grass or clover land absorbed much more water than cultivated land.

The amount of rainfall absorbed by uncropped land, or land in a cultivated crop, like corn, was practically constant from year to year even with considerable variation in the annual precipitation. A heavy dashing rain has often been observed to remove more surface soil within a few hours than was lost during a whole year when the rainfall was well distributed. The loss of important nutrient elements from the soil through erosion may often be more serious than the loss through the removal of crops.

The use of a cropping system that included sod crops a considerable portion of the time was the most practical means of reducing erosion.

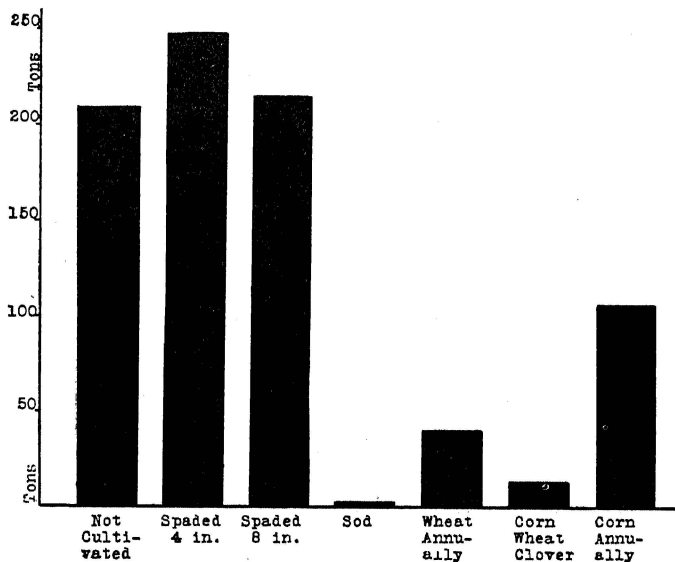


Fig. 14.—Graphic comparison of the total losses of soil through erosion in six years from plots having different treatments. Columns represent number of tons per acre as shown on scale at the left.

Last year the rainfall was below normal and consequently the runoff and erosion were low. At the beginning of this year soil in an equal amount to that removed during the previous six years was taken from the surface of adjoining lands, and replaced on these plots. This was almost equivalent to starting the experiment over again. The plot, which had been uncultivated was plowed 8 inches deep and planted to soybeans. The loss from soybean land was approximately the same as from wheat land, slightly greater than from corn land in a three year rotation, but only about half as much as from land in corn annually.

VETERINARY SCIENCE

J. W. Connaway, *Chairman*

Contagious Abortion Investigations (J. W. Connaway, A. J. Durant, H. G. Newman).—*Infectious Abortion and Immunity in Swine*. Infectious abortion disease in swine conforms closely to the Bang abortion disease in cattle in the matters of cause, transmission of infection, and in the transmission of the specific abortion antibodies to the newborn pigs through the ingested

olostrum. Moreover, the specific abortion antibodies occasionally pass from the lood of the mother to the young *in utero*. Properly checked cases were observed in which abortion antibodies were found in the blood serum prior to nursing. The interpretation, in these cases, is that a lesion of some extent was present in the placental tissues which permitted a leakage of the indiffusible antibodies, or more likely their transfer from the mother to the offspring from the inflamed placental area by migrating leucocytes, which had produced or imbibed the *B. abortus* antibodies.

It is evident that any attempt to confer a practical immunity upon the young through uterine processes by artificial inoculation of the dam, either by hypodermic or intravenous injection, or by feeding the dam with infectious materials is doomed to failure; since the immunizing substances, either of a passive nature like the antibodies, or of an active nature in the form of specific microbes—even in a mitigated form—do not pass from mother to young in utero except in an injured state of the placental tissues.

Experiments on Transmission of Hemolysin from Sows to New-born Pigs. Transmission of hemolysin from sows to nursing pigs through the colostrum was demonstrated. The blood cells from the same horse gave identical results on cows and nursing calves in an experiment carried out concurrently by dairy department. It was also demonstrated that *B. abortus* antibodies and hemolysins were transmitted simultaneously by colostrum to nursing pigs. In no case was there any evidence that hemolysin had been acquired by any pig *in utero*. It does not appear that protein thereby will prove of value in destroying the *B. abortus* microbe, although such treatment may activate the normal defenses against infections in general. The intravenous method of injecting protein was attended with some danger.

The results obtained in these investigations agree with those of other investigators who have studied different species. Certain phenomena related to the production and distribution of immune bodies are not, however, in seeming accord; since in the case of hemolysin a greater amount was stored in the blood than in the colostrum; while in the case of the *B. abortus* antibodies a greater quantity was stored in the colostrum than in the blood. This is probably due to the fact that the udder is a favorite and, as a rule, constant habitat for the Bang abortion microbe in the infected female.

With respect to the production of hemolysin, the spleen is doubtless the important organ. This organ has the special function of digesting worn out blood cells and other protein debris. And in carrying out this function, the greater mass of the blood cells injected into the blood stream would be caught and held in this organ; and herein, through the activity of the phagocytic splenic cells the greater amount of the specific hemolysin is probably produced and liberated into the blood stream. There exists an affinity between the splenic tissues and foreign blood cells, and other protein debris, comparable to that existing between the udder tissues and the Bang abortion organism, insofar as it relates to a tendency toward accumulation of the respective antigens in the different organs. The phenomena which appeared to be discordant from an immunological point of view are shown to be the logical results of definite biological processes operating in the one case in combat upon a **live antigen** located largely in one organ, the udder, and in the other case upon a **dead antigen** located largely in another organ, the spleen. The fundamental immunologic processes in both cases are the same.

Duration of Reaction to B. Abortus Antigen from Ingestion of Colostrum.— The serological reaction of 99 litters of pigs farrowed by sows which were carriers of abortion infection shows that the duration of the passive reaction induced by ingestion of the colostrum was of much longer duration in the litters that were farrowed during the early years of the herd infection. The duration of this phenomenon appears to be dependent upon the **quantity** of the antibodies ingested with the colostrum. The greater the amount of the antibodies ingested the longer the reaction persists. As the serological reaction of the infected sows becomes weaker or variable, the duration of the passive reaction in the offspring became less. These studies on swine abortion supply an explanation of why in cattle herds, in which great losses occur for a time, the disease apparently dies out for a considerable time, or until new infection is brought into the herd.

FINANCIAL STATEMENT

University of Missouri Agricultural Experiment Station
In account with
The United States Appropriations, 1923-24

	Hatch Fund	Adams Fund
Dr.		
To balance from appropriations for 1922-1923.		
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1924, under acts of Congress approved March 2, 1887 (Hatch Fund) and March 16, 1906 (Adams Fund).....	\$15,000.00	\$15,000.00
Cr. Abstract		
By Salaries..... 1	\$ 7,218.93	\$ 5,118.83
Labor..... 2	3,674.83	2,614.21
Stationery & Office supplies..... 3	143.34	37.42
Scientific supplies, consumable.... 4	272.70	1,319.34
Feeding stuffs..... 5	2,130.72	2,160.06
Sundry supplies..... 6	588.49	350.91
Fertilizers..... 7	20.50	4.70
Communication service..... 8	37.67	13.80
Travel expenses..... 9	69.34	148.87
Transportation of things..... 10	164.23	296.06
Publications..... 11	7.35	-----
Heat, light, water, and power 12	63.84	398.28
Furniture, furnishings, & fixtures 13	52.11	136.61
Library..... 14	24.00	6.00
Scientific equipment..... 15	258.60	1,969.05
Livestock..... 16	47.60	106.65
Tools, machinery, & appliances.... 17	225.75	204.86
Building & land, repairs..... 18	-----	110.45
Contingent expenses..... 19	-----	3.90
Balance.....	\$15,000.00	\$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the University of Missouri Agricultural Experiment Station for the fiscal year ended June 30, 1924; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was \$ none on the Hatch Fund and \$ none on the Adams Fund: that the receipts for the year from the Treasurer of the United States were \$15,000.00 under the act of Congress of March 2, 1887, and \$15,000.00 under the act of Congress of March 16, 1906, and the corresponding disbursements \$15,000.00 and \$15,000.00 for all of which proper vouchers are on file and have been by us examined and found correct, leaving balance of \$ none and \$ none.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, and March 16, 1906, and in accordance with the terms of said acts, respectively.

Attest:

LESLIE COWAN.
Custodian.

Signed:

EDWARDE E. BROWN
Acting as Auditor for the
Curators, University of Missouri.