

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

BULLETIN 244

Solving Farm Problems By Research

One Year's Work, Agricultural Experiment Station

(Report of the Director; July 1, 1925 to June 30, 1926)

If there is a farmer in America who has not received, as the result of scientific research, more actual profit than the entire cost to him of all forms of public education, it is because he has refused or neglected to make practical use of the information that has resulted from such research.

—Stratton D. Brooks

COLUMBIA, MISSOURI

NOVEMBER, 1926

Agricultural Experiment Station

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*In service of U. S. Department of Agriculture.

†On leave of absence.

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Solving Farm Problems By Research

F. B. MUMFORD, *Director*

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

The true purpose and function of an agricultural experiment station is the discovery of truth. In this respect it is like all other institutions for scientific research. The experiment station differs, however, from the ordinary research foundations or institutions in that it is specifically required to investigate the phenomena which control or influence the industry of agriculture.

It is not the primary function of agricultural experiment stations to advance the several sciences by making important contributions thereto. It is the function of the agricultural experiment stations to utilize to the fullest extent the methods of science for the solution of farm problems. It is true that the problems of the farm embrace almost the entire range of the natural sciences, and in its larger aspects the economic and social sciences as well. The field of research of the experiment stations is therefore almost unlimited so long as its investigations keep clearly in mind the ultimate solution of problems which will advance the cause of agriculture.

The broad field of investigation open to the investigators in agricultural experiment stations is indicated by the most recent Federal law providing for scientific research for the benefit of agriculture. In the Purnell Bill, passed by the Federal Congress and approved February 24, 1925, the field of experimentation is indicated in the following language:

"The funds appropriated pursuant to this act shall be applied only to paying the necessary expenses of conducting investigations or making experiments bearing directly on the production, manufacture, preparation, use, distribution, and marketing of agricultural products and including such scientific researches as have for their purpose the establishment and maintenance of a permanent and efficient agricultural industry, and such economic and sociological investigations as have for their purpose the development and improvement of the rural home and rural life and for printing and disseminating the results of said researches."

In these words, after specifically naming the various major enterprises essential to successful agriculture, there is clearly set forth the broad purpose of all scientific research in agriculture, which is to establish and maintain a permanent and efficient agricultural industry and to develop and improve the rural home and rural life. It is clear, therefore, that any investigation which has for its purpose the establishment of a more successful agricultural industry or a more efficient rural civilization falls within the field of research which may be undertaken by the experiment stations.

The publication of scientific results has come to be a major function of the agricultural experiment stations. It is more important at the present

time than formerly when experiment station investigators more frequently came in direct contact with farmers. The development of the extension organization has also made it still more important that results be promptly published and in such form that they shall be available for use.

The value of an important investigation is exceedingly limited until the results are published. It matters little how efficient the investigator may be; his usefulness and his influence are very greatly limited if he fails to place in permanent form the results of his investigations. If the results of his investigations are valuable, then they should be promptly published. If the results of his investigation are not valuable, then the investigator may be wasting time and money which could be used to better purpose.

The Missouri Experiment Station has given particular attention to its publication project. It has at present an exceptionally valuable series of available publications which represents the accumulated results of many years of investigation. Many of these publications are frequently reprinted in order to supply the demand. The chief limitations to the influence of the publications of this Experiment Station at the present time are the very limited funds available. If more funds were available for publication purposes, these bulletins could be much more widely distributed and the improved methods and practices could then more quickly come to the knowledge of the farmers of the State. At the present time unfortunately we must limit the distribution of publications to some extent.

CHANGES IN STATION STAFF

Appointments

A. H. Eddins, Assistant Instructor in Field Crops.
 Warren Gifford, Assistant in Dairy Husbandry.
 Eva Mae Davis, Instructor in Home Economics.
 Wm. Kyle Moseley, Assistant in Dairy Husbandry.
 F. L. Thomsen, Assistant Professor of Marketing.

Resignations

F. R. Lesh, Assistant in Soil Survey.
 L. S. Backus, Associate Professor of Veterinary Science.
 Sarah Helen Bridge, Professor of Home Economics.
 Laurel E. Davis, Research Instructor in Home Economics.
 F. L. Duley, Associate Professor of Soils.
 W. P. Hays, Instructor in Dairy Husbandry.

PUBLICATIONS

A. A. JEFFREY, *Agricultural Editor*

The publications of the agricultural Experiment Station are issued in three series: bulletins, circulars, and research bulletins. The bulletin is a report of some specific investigation, presenting the results in such terms that they may be readily understood by the farmer and applied to everyday practice. The circulars are intended for popular use and include in brief form not only the results of experiments but also an interpretation of existing knowledge related to the practices involved in such experiments. The

research bulletins are detailed reports presenting technical information for the agricultural scientist and investigator.

Following are the titles, number of pages and size of editions of the publications issued during the year ending June 30, 1926.

Bulletins

No.	Title	Pages	Edition	Total pages
208	Grape Growing in Missouri (Reprint)	32	7,500	240,000
216	Spraying Missouri Fruits (Reprint)	31	12,500	387,500
182	Thirty Years of Field Experiments With Crop Rotation, Manure and Fertilizer (Rpt.)...31	31	5,000	155,000
236	Some New Developments in Agricultural Science (Annual Report of Director)	92	6,500	598,000
237	The Draft of Farm Wagons as Affected by Height of Wheel and Width of Tire	14	10,000	140,000
238	The Soils Experiment Fields of Missouri	60	8,000	480,000
239	Testing Fertilizers for Missouri Farmers; 1925..64	64	5,000	320,000
240	Potato Growing in Missouri	32	10,000	320,000
241	How to Make Good Bread from Missouri Soft Wheat Flour	8	8,000	64,000
242	Missouri Strawberries	28	10,000	280,000

Circulars

108	The Durability of Fence Posts (Reprint)	4	4,000	16,000
111	Feeding for Egg Production (Reprint)	12	15,000	180,000
115	Feeding Dairy Cows (Reprint)	12	10,000	120,000
120	Pruning Apple and Pear Trees (Reprint)	16	7,000	112,000
137	Fire Blight of Apples and Pears	8	10,000	80,000
138	Fattening Farm Poultry	8	5,000	40,000
139	Nitrogen Fertilizers for Fruit Trees	8	5,000	40,000
140	Bermuda Onion Culture in Missouri	8	5,000	40,000
141	Report on Missouri Cotton Experiment Fields; 1925	7	5,000	35,000
142	Artificial Incubation	8	10,000	80,000
143	Direct-to-Consumer Marketing Farm Prod- ucts	4	10,000	40,000
144	Northeast Missouri Crops Experiment Fields	4	5,000	20,000
145	Package Fertilizer and the Missouri Ferti- lizer Law	4	2,000	8,000
146	Variations in Cream Tests	4	10,000	40,000
147	Picking, Packing, and Shipping Apples	44	10,000	440,000

Research Bulletins

78	The Correlation Between Sexual Maturity and Egg Production	16	2,500	40,000
79	A Comparison of Guernsey Sires	62	2,500	155,000
80	The Course of Skeletal Growth in the Dairy Cow	35	2,500	87,500
81	The Adequacy of Synthetic Rations for the Growth of Chicks	51	2,350	119,850

(RESEARCH BULLETINS—CONTINUED)

No.	Title	Pages	Edition	Total pages
82	The Effect on Viscosity, Bacterial Flora and Quality of the Resulting Ice Cream When the Ice Cream Mixture is Re-emulsified, Reviscolized, or Re-homogenized	23	2,500	57,500
83	The Physical Composition of a Lean, a Half Fat, and a Fat Beef Carcass and the Relative Cost of the Nutrients Contained in Each	63	3,500	220,500
84	Missouri Farm Prices and Purchasing Power	34	2,000	68,000
85	The Utilization of Pentoses by Yeasts and the Composition of Plant Gums	29	2,000	58,600
86	The Normal Oestrous Cycle in the Sow	41	2,000	82,000
Total.....		897	217,350	5,163,850

Distribution.—Each of these publications, with the exception of reprints, was mailed to all public libraries and to all agricultural teachers and investigators in the State. A great many publications were mailed to the agriculture classes in the 99 Missouri high schools where vocational agriculture is taught. Very general distribution was made also to pupils in other schools throughout the State, and thousands of the bulletins and circulars were given out by county agents to farmers asking for them. Farmers and homemakers in every Missouri county have drawn at will on the supply of publications in the Station mailing room throughout the year.

The publications of the Experiment Station were distributed to every county in Missouri, to every state in the United States and to forty-two foreign countries. Most of these were sent out in response to requests. The total number of publications definitely accounted for was 142,070 of which 94,924 were used by residents of Missouri.

The 69 Missouri counties where county or district extension agents were at work used an average of 1056 Station publications each. The 45 non-agent counties used an average of 489 each. The counties drawing most freely on this service used publications as follows: St. Louis 4728, Jackson 3519, Jasper 3343, Lafayette 2996, Buchanan 2118, Carroll 1913, Butler 1894, Pike 1803, Greene 1799, Monroe 1609, and Lawrence 1469.

The states making most frequent requests for Missouri publications used the following numbers: Illinois 3722, Texas 2460, New York 2330, Iowa 1890, California 1742, Kansas 1741, Tennessee 1553, Minnesota 1517, Ohio 1487, Oklahoma 1360, Pennsylvania 1302, Indiana 1104, and Nebraska 1028. Hawaii used 501, Porto Rico 446, the Philippine Islands 361, and Alaska 133.

Among the forty-two foreign countries using the publications of this Station Canada received the largest number, 995. England used 724, Russia 557, South Africa 456, Argentina 301, France 258, China 248, Japan 237, Ireland 152, Australia 142, India 138, Chile 130, and New Zealand 111.

Additional Information Service.—With the cooperation of the Extension Service a five-column clip-sheet containing about 4,000 words was issued weekly to all newspapers and farm journals in the State. Through this medium and the splendid cooperation of the editors of the State the people have been currently informed of the discoveries of the Station and have been

supplied a succession of timely articles giving the best information on the farm and home problems incident to each week of the year.

An important service was rendered throughout the year by members of the Experiment Station staff who filled speaking assignments on the radio broadcasting schedule conducted jointly by the Station and the Extension Service. Three lectures a week were broadcast during the year over equipment supplied by the State Bureau of Markets, Christian College, and Stephens College.

Synopses of New Publications

Some New Developments in Agricultural Science.—F. B. Mumford (Missouri Agr. Exp. Sta. Bul. 236 (1926), pp. 3-90, figs. 14). This is the annual report of the Director of the Experiment Station. It includes brief mention of the results obtained during the year in each of ninety-two investigations and a report of the work done in each of the eight public service projects of the Station. The bulletin contains also a review of the Station's publications and a statement of its receipts and expenditures.

The Draft of Farm Wagons as Affected by Height of Wheel and Width of Tire.—J. C. Wooley and Mack M. Jones (Missouri Agr. Exp. Sta. Bul. 237 (1926), figs. 11). A study of the draft of wagons on wheels of varying types showed that increasing the width of tire from 1½ to 4 inches was more effective in decreasing draft than was the increase of the height of the wheel from 38 to 42 inches. On different types of roadway it was found that increasing the height of wheel or width of tire becomes less effective in reducing draft as the density of the road surface is increased. The bulletin also contains an analysis of the forces involved in the draft of a wagon.

The Soils Experiment Fields of Missouri.—F. L. Duley and M. F. Miller (Missouri Agr. Exp. Sta. Bul. 238 (1926), pp. 3-60, figs. 40). This report covers field experiments on most of the extensive soil types of Missouri over a period of 21 years. Most of the soils have given good returns from phosphates and manure. Phosphates have given their most profitable results on wheat, clover and alfalfa. Lime has been of great value on certain soil types in growing the clovers and alfalfa. Where lime has been combined with manure and acid phosphate it has made clover growing highly successful on practically all soils of the State. Potash has given slight increases on most fields, but in only a few cases has it been of sufficient importance to justify much attention to its application in the form of fertilizer. Rock phosphate has given slight returns but on the average it has not been used at a profit. Legumes planted in the corn for the purpose of supplying green manure have not justified the practice. The bulletin also gives the results of individual fields and shows by means of maps where the results of these experiments may be most directly applied.

Testing Fertilizers for Missouri Farmers: 1925.—F. B. Mumford and L. D. Haigh (Missouri Agr. Exp. Sta. Bul. 239 (1926), pp. 3-72, figs. 1). This is a report of the analyses of 558 official samples representing 140 registered brands of commercial fertilizers taken from stocks offered for sale in Missouri. The testing of native limestone for agricultural use is also reported, the analyses of 727 samples being tabulated.

Potato Growing in Missouri.—J. T. Quinn (Missouri Agr. Exp. Sta. Bul. 240 (1926), pp. 3-32, figs. 23). This bulletin covers most of the practices involved in potato growing, using the results of a long series of investigations

and reporting in detail the data from the most recent experiments at this Station. Data are given which show the value of different fertilizers, alone and in combination with barnyard manure and green manures. Acid phosphate in combination with barnyard manure gave economical returns. The largest yield, 327.9 bushels per acre, followed the use of 400 pounds of 3-12-4 fertilizer plus 8 tons of barnyard manure, plus soybeans as a green manure. Data on the rate of application of a complete fertilizer showed greatest net returns from applications of 400 to 500 pounds an acre. Over a period of three years, certified northern-grown seed potatoes showed an increase over spring home-grown seed of 22.7 bushels for the Irish Cobblers, and 25.6 bushels for the Early Ohios. Date-of-planting tests indicated that on the average for Central Missouri, the highest yields were received from potatoes planted between March 20 and March 30.

How to Make Good Bread from Missouri Soft Wheat Flour.—Eva Mae Davis and Jessie Alice Cline (Missouri Agr. Exp. Sta. Bul. 241 (1926), pp. 2-8, figs. 7). This bulletin deals with the results of using dried yeasts with Missouri soft winter wheat flour for breadmaking. The results of these investigations showed that good bread could be made from Missouri flour, using dried yeast, comparable in quality to that made with compressed yeast, or to that made from our best hard wheat flours. It requires only two and one-half to three hours after the preliminary fermentation period. Recipes, with methods of procedure, are given.

Missouri Strawberries.—T. J. Talbert (Missouri Agr. Exp. Sta. Bul. 242 (1926), pp. 3-28, figs. 17). The statement is made in this bulletin that the strawberry is the most valuable small fruit grown in Missouri. It will succeed under a great variety of soil and climatic conditions. Crop rotation systems using legumes and non-legumes, with and without manure, are valuable in preparing old land for strawberry production. The response of strawberries to fertilizers is usually unsatisfactory. Acid phosphate has shown the most beneficial results in yields. Nitrogenous fertilizers are generally harmful rather than helpful to yields with the Aroma variety. Pedigreed strawberry plants are rarely better than the original variety. Ever-bearing strawberries, under irrigation and normal rainfall, have not been found as profitable as the standard spring bearing varieties.

Fire Blight of Apples and Pears.—T. J. Talbert (Missouri Agr. Exp. Sta. Circ. 137 (1925), pp. 8, figs. 6). This is a careful, though brief, discussion of the disease variously known as pear blight, blossom blight, fruit blight, blight canker, sun scald, and canker. The plan suggested for the control of this disease includes cutting and burning the hold-over cankers, the control of insects that spread the blight, and the regulation of the growth of the fruit trees.

Fattening Farm Poultry.—E. W. Henderson (Missouri Agr. Exp. Sta. Circ. 138 (1925), pp. 4, figs. 2). This circular emphasizes the fact that as much as 30 per cent gain can be made in the live weight of a fowl in ten to fourteen days of crate feeding and that an average of 3.26 pounds of feed is required for 1 pound of gain. The most successful feeding methods are clearly described, including the construction of fattening crate and stand, and the mixing of fattening rations.

Nitrogen Fertilizers for Fruit Trees.—H. D. Hooker (Missouri Agr. Exp. Sta. Circ. 139 (1926), pp. 8). The effects of three kinds of fertilizer—manure,

nitrate of soda, and sulphate of ammonia—are considered in this circular. Though manure is the best of the three, its relative scarcity and high cost of transportation prevents its use in many cases. The circular describes the effects of these fertilizers on growth, disease resistance, hardiness, set of fruit, regularity of bearing and date of ripening. It tells how to apply the fertilizers, the amounts to use, and emphasizes the danger of injury from too heavy applications.

Bermuda Onion Culture in Missouri.—J. T. Quinn (Missouri Agr. Exp. Sta. Circ. 140 (1926), pp. 8, figs. 4). This circular was issued to meet the emergency growing out of the widespread interest in Bermuda onion culture on the part of persons entirely unfamiliar with the difficulties and practices involved. Careful attention is given to soils and fertilizers, varieties, seed, plants, time and method of planting, cultivation, harvesting, grading, and packing. The problems of selling the crop and the statistics on demand as related to the onion production and shipping seasons of other states are discussed.

Report on Missouri Cotton Experiment Fields; 1925.—B. M. King (Missouri Agr. Exp. Sta. Circ. 141 (1926), pp. 7, figs. 3). The growth of the cotton growing industry in Missouri is noted in this circular; namely, an increase from 103,000 acres producing 70,000 bales in 1921 to 487,000 acres producing 260,000 bales in 1925. In the experiments in Southeast Missouri here reported Trice and Delfos were the varieties yielding best on heavy soils, while Express and Acala did best on the lighter soils. Two to four plants in hills spaced 10 to 12 inches apart give higher acre-yields, as a rule, than single plants in hills spaced 12 to 18 inches apart. The only fertilizer treatments that produced consistent increases in yield were a combination of 300 pounds of acid phosphate, 50 pounds of sodium nitrate, and 30 pounds of potassium chloride an acre; and a combination of 300 pounds of acid phosphate and 30 pounds of potassium chloride an acre.

Artificial Incubation.—E. W. Henderson (Missouri Agr. Exp. Sta. Circ. 142 (1926), pp. 8, figs. 3). This circular briefly covers the successful hatching of chicks as influenced by the following factors: Vigor in breeding stock, care and management of the breeders, selection of the hatching eggs, storage of the hatching eggs, time when eggs are set, incubator management, and operating the machine. Naturally, to be consistent with the title, more than half of the circular is taken up with the consideration of the last two factors in the foregoing list.

Direct-to-Consumer Marketing of Farm Products.—F. L. Thomsen (Missouri Agr. Exp. Sta. Circ. 143 (1926), pp. 4). This circular points out the potential outlet for directly marketed products in this State by citing statistics from the 1920 census which revealed that there were then in Missouri 1,586,633 consumers living in 63 cities and towns of more than 2500 population, in addition to the rural and village population. The types of direct marketing described are roadside markets, the pick-it-yourself method, sales to retail stores, parcel post shipments, and express sales.

Northeast Missouri Crops Experiment Field; Second Annual Report, 1925.—C. A. Helm (Missouri Agr. Exp. Sta. Circ. 144 (1926), pp. 4). This is a report of the wheat yields for the crop seasons of 1924 and 1925, and the yields of corn, grain sorghum, soybeans, oats, and barley for 1925 as obtained on the farm of Fred Burckhardt in Shelby County. This experiment field is

maintained by the Station with the cooperation of Mr. Burckhardt to find out the most productive cropping systems for the flat prairie lands of Northeast Missouri.

Package Fertilizer and the Missouri Fertilizer Law.—F. B. Mumford and L. D. Haigh (Missouri Agr. Exp. Sta. Circ. 145 (1926), pp. 4). This circular was issued especially to call the attention of dealers to the fact that the Missouri Fertilizer Law applies to the sale of fertilizer in small packages of 1 ounce to 50 pounds (for home use on flowers, potted plants, lawns, and gardens) just as truly as it applies to the sale of farm fertilizer in sacks of 100 pounds or more. The circular includes a list of the companies registering fertilizer to be sold in packages in the State during the current year, and also the brands and guaranteed analyses of these fertilizers.

Variations in Cream Tests.—A. C. Ragsdale (Missouri Agr. Exp. Sta. Circ. 146 (1926), pp. 4). Herein are listed nine of the principal causes of variations in tests of cream and skimmilk. Each cause is then discussed with a view of helping the farmer to control these conditions so that cream of high quality may be delivered without waste of cream and without loss of skimmilk from the farm. It is stated that the producer should ordinarily skim the milk so that he has cream testing about 35 to 40 per cent fat.

Picking, Packing, and Shipping Apples.—T. J. Talbert (Missouri Agr. Exp. Sta. Circ. 147 (1926), pp. 44, figs. 35). This is a comprehensive summary of the best information of the Station on the practices indicated by the title. The points covered are grouped under the following main divisions: picking, bulk shipments, harvesting and packing methods, grades and standards, barrel packing, basket packing, box packing, loading and hauling records, shipper's hints, loading cars, shipping point inspection, apple packages, and bracing loaded cars.

The Correlation Between Sexual Maturity and Egg Production.—H. L. Kempster (Missouri Agr. Exp. Sta. Res. Bul. 78 (1925), pp 3-16, figs. 2). This report covers work extending over a period of six years. The studies include the correlation between sexual maturity and annual egg yield for the first laying season from November 1 to October 31, winter egg production, that is, November 1 to March 1; spring egg production, March 1 to July 1; summer egg production July 1 to October 31; best monthly production; and best two months' production. Also time of hatching is correlated with rate of maturing. The measure of sexual maturity as used in these data is the length of time between hatching date and date of the first egg.

A Comparison of Guernsey Sires.—C. W. Turner (Missouri Agr. Exp. Sta. Res. Bul. 79 (1925), pp. 3-62, figs. 8). This bulletin reports a study of the progeny performance of 263 Guernsey sires having ten or more daughters in the Advanced Register. Conversion factors based on the relation between age and fat production were used to convert all records to their "mature equivalent." The relation between the fat production of the dams and daughters of groups of sires was then determined. The potential transmitting ability of each sire was obtained from the relationship shown. By means of genealogy charts, it was found that the average production of a sire's daughter was a better index of his transmitting ability to his sons and through them to his granddaughters than is the dam's own record of production an index of her transmitting ability to her sons and through them to

her granddaughters. In other words, a proved sire of high producing daughters, or a son of a proved sire, is on the average, greatly superior to a son of a high-record cow in transmitting high production to his daughters.

The Course of Skeletal Growth in the Dairy Cow.—Samuel Brody and A. C. Ragsdale (Missouri Agr. Exp. Sta. Res. Bul. 80 (1926), pp. 35, figs. 23). The course of skeletal growth of Jersey and Holstein heifers is presented in the form of 23 charts. The charts give the absolute value of 21 skeletal measurements from birth to 60 months of age, monthly gains in the measurements for each of the 60 months, and rational equations for each of the 21 curves relating to the course of growth with age, and the monthly gains with age. The physiological significance of the growth equations is discussed. The numerical data on the course of skeletal growth as represented by 21 measurements are also presented.

The Adequacy of Synthetic Rations for the Growth of Chicks.—A. G. Hogan, N. B. Guerrant, and H. L. Kempster (Missouri Agr. Exp. Sta. Res. Bul. 81 (1925), pp. 3-51, figs. 38). In the experiments here reported the Station successfully reared a considerable number of chicks on synthetic diets. In some cases synthetic rations were used entirely, while in others some natural food-stuffs were incorporated in the synthetic rations. The synthetic rations were composed of relatively pure constituents, as protein, carbohydrates, fat, and mineral mixtures. Vitamin B was supplied in the form of dried yeast or a commercial concentrate. The results chiefly emphasize the importance of an adequate supply of vitamin B in the diet, and lead the authors to believe that the nutritional requirements of chicks differ markedly from the known requirements of mammals.

The Effect on Viscosity, Bacterial Flora, and Quality of the Resulting Ice Cream When the Ice Cream Mixture Is Re-emulsified, Reviscolized, or Re-homogenized.—Wm. H. E. Reid and S. F. Scism (Missouri Agr. Exp. Sta. Res. Bul. 82 (1925), pp. 3-23, figs. 6). Reprocessing an ice cream mixture a second or third time using an emulsifier gives an increase in the viscosity. An ice cream mixture viscolized or homogenized a second or third time undergoes a decrease in viscosity. Reprocessing the mixture increases the number of bacteria, improves the body and texture of the ice cream, assures greater dispersion of butterfat in the mixture, decreases mechanical loss of the mixture, and gives greater increase in viscosity during the period of aging.

The Physical Composition of a Lean, a Half Fat, and a Fat Beef Carcass and the Relative Cost of the Nutrients Contained in Each.—A. T. Edinger (Missouri Agr. Exp. Sta. Res. Bul. 83 (1925), pp. 3-63, figs. 21). Three steers varying in age and in degree of finish and weighing 945, 1070 and 1000 pounds, respectively, were slaughtered and a physical analysis of carcasses was made. The thin and fat steers varied considerably in composition. The thin steer contained 24 per cent more lean, 20 per cent less fat and 5 per cent more bone than did the fat steer. The plates and the flanks in the three steers carried the largest percentage of fat, and the ribs, loins, rounds, and chucks follow in the order named. The protein in a pound of lean was found to be the greatest in amount when the flesh was taken from the half-fat animal. In the fatter animal the percentage of moisture and protein in the fatty tissue decreased with an increase in fat. The cuts from the fat steer produced about twice as many calories per pound as the same cuts from the thin steer. The food values of the meat did not correspond to the market prices of the

different cuts. The most economical source of protein was the chuck, followed in order by the round, rib and loin. The cuts with the lower market value produced protein and calories at a lower cost than the more expensive cuts.

Missouri Farm Prices and Purchasing Power.—Donald R. G. Cowan (Missouri Agr. Exp. Sta. Res. Bul. 84 (1926), pp. 3-34, figs. 9). In this bulletin, both by graphs and tabulated statistics, the author shows the actual monthly prices paid to Missouri farmers for most of the farm products sold by them, the relative monthly price of each commodity, the trend of more important farm prices from month to month and year to year, and the relative purchasing power of thirteen Missouri farm products. The report also shows the relationship between hog and corn prices in Missouri since 1910.

The Utilization of Pentoses by Yeasts and the Composition of Plant Gums.—Ouida Davis Abbott (Missouri Agr. Exp. Sta. Res. Bul. 85 (1926), pp. 3-29, figs. 1). About one-half of the yeasts and related organisms tested were able to destroy the five-carbon sugar, arabinose, in a mineral nutrient solution under pure culture conditions. Xylose and arabinose disappeared in solutions to which Fleischmann's yeast cake was added. Reactions more acid than pH 5.0 interfered with the destruction of the pentoses by the yeasts used. Traces of CO₂ and alcohol, and some non-volatile acid were formed by the yeast in the utilization of pentoses. A substance of high reducing power, which may be glyceric or glycollic aldehyde, was also produced in some cases. The fermentation method as commonly used for the determination of pentoses may be inaccurate because of the presence of foreign organisms, because the common varieties of yeast such as are found in Fleischmann's yeast cake can utilize pentoses and because galactose is as resistant to utilization by the yeasts in Fleischmann's yeast cake as are the pentoses. Orange gum could be completely hydrolyzed by taka-diaxase. A combustion on orange gum gave the empirical formula C₃₂H₄₁O₃₅.

The Normal Oestrous Cycle in the Sow.—Fred F. McKenzie (Missouri Agr. Exp. Sta. Res. Bul. 86 (1926), pp. 3-41, figs. 24). This bulletin gives the results of an experiment conducted cooperatively by this Station and the Bureau of Animal Industry of the United States Department of Agriculture. Twelve sows of good breeding and individuality were kept under observation and killed at various stages of the oestrous cycle. Vaginal smears were made from the live animals. Leucocytes and epithelial cells were found in the smear in greatest numbers the week following heat and were fewest just before heat; a few cornified cells occurred at every stage however, the epithelial cells of late oestrous showed definite signs of cornification. Other external signs are described. The histology of the vestibule, the vagina, and uterus with reference to oestrus is discussed in some detail. The epithelia of vestibule and vagina were thick, consisting of many cell layers, throughout oestrous proper as compared with low epithelia of few cell layers during the dioestrum. The columnar epithelium of the uterus is highest in metoestrum, and there is a marked edema of the uterine stroma in prooestrum. The follicles and corpora lutea of the ovaries were measured and some descriptive notes made. Many follicles of small size in dioestrum were succeeded by a few follicles of medium to large size in prooestrum and early oestrus. The corpora lutea were largest between the eighth and tenth days after heat when they turned from red to pink and later became white and persisted till the middle of the second dioestrous interval.

A Study of the Use of Missouri Soft Wheat Flour in Making Light Bread.—Eva Mae Davis and Jessie Alice Cline (Missouri Agr. Exp. Sta. Res. Bul. 87 (1926), pp. 3-42, figs. 37). This bulletin deals with the result of an investigation of some of the problems involved in the use of Missouri soft winter wheat flour for bread making and is expected to result in a more general and extensive use of Missouri flour within the State by showing that good yeast bread, as well as good pastries, cakes, and quick breads, can be made from home-grown wheat flour. An experimental study was made of the effect of variations of methods of procedure, and of amounts and kinds of ingredients on the texture, loaf volume, and length of time required for making bread from Missouri flour. From the results of these experiments recipes have been formulated which prove that with slight modifications in proportion of ingredients and procedure, bread comparable in quality to that made from the flour of other states can be made from Missouri flour.

The Relation of the Date of Sexual Maturity to Egg Production.—H. L. Kempster (Missouri Agr. Exp. Sta. Res. Bul. 88 (1926), pp. 3-12, figs. 3.) The studies forming the basis of this report have extended over seven years and include the trapnest records of 1110 White Leghorns. Correlation studies were made between date of sexual maturity and winter egg production, and date that laying ceased. The author concludes that the optimum date of sexual maturity is about November 1. Early layers make the best winter and annual records. There is a slight tendency for early layers to postpone the date on which they cease laying.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS AND PERIODICALS

In addition to publishing results of important experiments in the regular Experiment Station Bulletins, our investigators have published articles extensively in the leading scientific journals as indicated in the following list of titles.

DULEY, F. L., and JONES, M. M.—*Effect of Soil Treatment Upon the Draft of Plows.* Soil Science, Vol. XXI, No. 4, April, 1926.

HELM, C. A.—*The Kentucky of Missouri.* Better Crops, Vol. VI, No. 4, June, 1926.

REID, W. H. E.—*The Effect of Freezing on the Marketability of Milk and Cream.* Certified Milk Producer's Association of America, Vol. 9, No. 6, December, 1925.

BRODY, SAMUEL.—*Time Relations of Growth I. Genetic Growth Constants of Animals.* The Journal of General Physiology, Vol. 8, No. 3, January, 1926.

BRODY, SAMUEL; SPARROW, CHESTER D.; and KIBLER, HUDSON H.—*Time Relations of Growth II. The Equivalence of Age in Mammals, Estimated on the Basis of Their Growth Constants.* The Journal of General Physiology, Vol. 9, No. 3, January, 1926.

TURNER, C. W.—*A Quantitative Form of Expressing Persistency of Milk or Fat Secretion.* Journal of Dairy Science. Vol. 9, No. 2, March, 1926.

HAYS, W. P.—*The Effect of Environmental Temperature on the Percentage of Fat in Cow's Milk.* Journal of Dairy Science, Vol. 9, No. 2, March, 1926.

DULEY, F. L.—*The Loss of Soluble Salts in Run Off Water.* Soil Science, Vol. XXI, No. 5, May, 1926.

ALBRECHT, W. A., and UHLAND, R. E.—*Nitrate Accumulation Under the Straw Mulch*. Soil Science, Vol. 20 (1925) 253-257.

MILLER, M. F.—*Waste Through Soil Erosion*. Journal American Soc. Agron. 18 (2) 153-160, 1926.

HOOKE, H. D.—*Plant Growth*. Proc. Nat. Acad. Sci. 11; 710-713 (1925).

HOOKE, H. D.—*A Survey of Investigations by American Horticulturists on Carbohydrate-Nitrogen Relations*. Journal Pom. and Hort. Science 5; 34-42 (1925).

HOOKE, H. D.—*Fruit Bud Formation and Growth*. Proc. Amer. Soc. Hort. Sci. 22; 123-126 (1925).

AHMANN, C. F., and HOOKE, H. D.—*The Determination of Pectin*. Journal Ind. & Eng. Chem. 18; 412-414 (1926).

MURNEEK, A. E.—*Effects of Correlation Between Vegetative and Reproductive Functions in the Tomato*. Plant Physiology 1; 3-56 (1926).

MURNEEK, A. E.—*Is Fruiting of the Apple an Exhaustive Process?* Proc. Amer. Soc. Hort. Sci. 22; 196-200 (1925).

QUINN, J. T.—*Some Effects of Fertilizers on Sweet Potatoes*. Proc. Amer. Soc. Hort. Sci. 22; 360-363 (1925).

TALBERT, T. J.—*Sprays and Spraying Materials*. Proc. Amer. Soc. Hort. Sci. (1925).

TALBERT, T. J.—*Oil Emulsion Sprays—Their Place, Use and Manufacture*. Trans. Iowa State Hort. Soc. Vol. 60 (1925).

TALBERT, T. J.—*Hardening Off of Plants*. Trans. Iowa State Hort. Soc. Vol. 60 (1925).

TALBERT, T. J.—*Missouri's Qualifications for Entering the Lists*. Amer. Nut Journal. Vol. XXIII, 84-85, November, 1925.

TALBERT, T. J.—*The Business of Horticulture*. Biennial Report of the Kansas State Hort. Soc. Vol. XXXVII. 1926.

SWARTWOUT, H. G.—*Fruiting Habits of the Grape*. Proc. Amer. Soc. Hort. Sci. (1925).

NEW EQUIPMENT

The following new equipment has been purchased during the year:

1 Uviarc quartz mercury arc lamp, 4 electric brooders, 40 tubs for growing trees under controlled conditions, 1 Killifer deep subsoiling machine with fertilizing attachment, 1 bacteria incubator, 1 combination microscope (special equipment), 1 thermostat bath DeKhotinsky, 1 Beckmann thermometer, 3 surface integrators, 1 Marchant automatic calculating machine, 1 MacMichael viscosimeter, 1 hydraulic press, 1 Spencer rotary microtome, 1 Spencer freezing microtome, 1 Dare hemoglobinometer, 1 haemocytometer, miscellaneous glassware, chemicals, and other supplies.

SERVICE PROJECTS

Seed Testing Laboratory (W. C. Etheridge, Clara Fuhr). A total of 6139 lots of seeds and plants were analyzed and examined by the Seed Testing Laboratory. This represents an increase of 30 per cent over the similar work done in 1925. Of the tests made, 5537 were for Missouri farmers and seedsmen and 60 Custom House samples were analyzed under the Seed Importation Act. Forty referee analyses were made for the Research and

Methods Committee of the Association of Official Seed Analysts of America. Five hundred two tests were made for farmers and seedsmen of other States, as follows:

Nebraska	172	Oklahoma	4
Kansas	116	Illinois	1
Iowa	106	Texas	1
Colorado	50	Michigan	1
Arkansas	26	Ohio	1
South Dakota	24		

The necessity for careful seed testing by farmers or by public service such as that given at the Seed Testing Laboratory, is clearly shown by the following summary: (a) About 900 lots of corn were tested but only slightly more than half showed a germination percentage of 90 or above. About one-fourth of the lots germinated below 75 per cent of the seed. (b) Of 554 lots of soybeans tested approximately 64 per cent had planting value while the remaining 36 per cent was worthless. (c) Of 1885 lots of cotton seed tested only about 30 per cent had planting value. (d) Eleven lots of seed rice were tested for Missouri planting. This is the first season in which the seed of this crop has been officially tested in Missouri.

Fertilizer Control (F. B. Mumford, director; L. D. Haigh, chemist).—Four hundred and sixty-seven brands of fertilizers were registered by 48 manufacturers, importers and others. Four hundred sixty-three samples were collected in the fall of 1925, and 120 samples in the spring of 1926. One hundred eighty-six towns were visited in the work of inspection in addition to numerous visits to farms.

Bulletin 239 reports the results of the work for the calendar year 1925 and includes valuable information on judging the value of fertilizer. The analyses of 510 samples of fertilizer, in comparison with their guarantees, are given. The ratings of the availability of the nitrogen in the fertilizer samples are given through the proportion of water soluble and permanganate soluble nitrogen which they contain.

The registered list of fertilizer brands for 1926 is also given. The tonnage of fertilizer used in the various counties of the State and the purity of limestones tested for agricultural purposes are listed in tables. Violations of the State fertilizer law found by the inspectors are listed.

Testing Soils for Their Lime Need (M. F. Miller, W. A. Albrecht, R. E. Uhland).—During the year 1096 samples of soils were tested for farmers from different sections of the State. This is the largest number ever tested during any one year. Farmers have realized that in order to grow any of the sod legumes successfully their soil must be fairly well supplied with lime.

These tests have also proved of value to the soils and crops extension specialists, who have been conducting a definite campaign for the growing of more legumes and the use of more limestone. Sod legumes are found in counties which show a fairly low percentage of acid soils, or where a large tonnage of limestone has been applied. The annual legumes, such as cowpeas and soybeans, are found on the more acid soils.

The Production and Distribution of Bacteria for Legumes (W. A. Albrecht, R. E. Uhland).—For a number of years an intensive campaign to increase the acreage of legumes in Missouri has been carried on. To assist

in this work the Agricultural Experiment Station has been supplying legume inoculation for Missouri farmers, the purpose being to interest farmers in the important matter of inoculation, to disseminate the inoculating bacteria widely through the soils of the State, and to assist in standardizing commercial inoculants.

This project has developed into a distinct service, and has reached 34,224 farmers, and represents enough bacteria to treat 174,262 bushels of seed, or plant approximately 774,175 acres.

During the past year, 116,882 cultures were sent out to 9621 individuals. This represents inoculation for 58,424 bushels of seed or 237,276 acres of legumes. The number of cultures for the various legumes were as follows:

Soybeans	79,680
Sweet clover	19,520
Alfalfa	11,112
Red and alsike clovers	3,752
Cowpeas	2,306
Miscellaneous	512

The increase in the use of sweet clover inoculation was very marked. The number of cultures sent out during this year was 136.5 per cent greater than in the previous year. The number of cultures for alfalfa increased 74.2 per cent, and the number for soybeans 50.9 per cent.

In order to produce cultures more efficiently and to overcome some of the difficulties of obtaining inoculation on certain soil types, investigations have been undertaken to study these problems. Soluble calcium, independent of hydrogen-ion concentration, was more important in determining the number of nodules on soybeans than was commonly supposed.

Reports from a large number of farmers from all sections of the State who have used legume inoculation material showed that over 95 per cent secured satisfactory inoculation.

Official Testing of Dairy Cows (Warren Gifford).—One thousand eight hundred eleven two-day tests were conducted on a total of 330 cows on yearly test. Of this total number, 208 were placed on test during the year, while 122 were in progress at the beginning of the year.

There were 16 Holstein-Friesian seven-day tests conducted, which is a 23 per cent increase over last year.

Green Hills Mary 2908 and Green Hills Leda 3224, Dutch Belted cows owned by John L. Green, Centaur, have recently qualified for Advanced Registry, as junior four-year-olds, with 9900.2 pounds of milk and 388.8 pounds butterfat, and 6787.5 pounds milk and 316.3 fat, respectively. These are the first cows of the breed to qualify for Advanced Registry in Missouri and both became class leaders in their particular classes.

Distribution of Anti-Hog-Cholera Serum (O. S. Crisler).—During the year the serum laboratory furnished swine owners, either directly or through veterinarians, county agents, and farm bureaus, 1,335,635 c.c. of anti-hog-cholera serum. This was distributed in 1,246 orders to 64 counties.

Hog cholera was not so prevalent during the year and the demand for serum was not so great. Reports show that excellent results were obtained from the serum furnished.

The buildings and equipment of the serum plant have been improved and repaired during the year.

Experiments in Progress During the Year Ending June 30, 1926

AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

Nutritional Requirements of Poultry (A. G. Hogan, C. L. Shrewsbury).

—Synthetic diets for chickens have been only partially successful. Normal adult size may be attained, but the rate of growth always has been subnormal.

Artificial housing conditions apparently were not responsible for the delayed growth rate, since chicks reared under identical conditions, but given a diet of natural foodstuffs, grew very well. Rations chiefly synthetic, but containing 10 per cent of either dried egg yolk or wheat germ, have supported normal growth. Palatability was not responsible for this lack of growth because force-feeding has also proved unsuccessful. In one case the growth was slightly accelerated in this manner, but the advantage was slight.

The type of ration customarily used seemed inadequate in some respect. There was some reason to believe the inadequacy due to a lack of vitamin B, since in a number of instances leg weakness has been observed, apparently of the neuritic type. Dried yeast has been used as a source of vitamin B, usually at a level of about 9 per cent, and this has been supplemented with a commercial vitamin B concentrate. The activity of the concentrate has been too low to encourage its use, and it was not certain that a sufficient quantity of this vitamin has been fed. Dried yeast has been supplied at higher levels, 15 per cent, but only recently with encouraging results.

Susceptibility of baby chicks to disease greatly handicapped their use for experimental feeding tests. Dried egg yolk and wheat germ, have been extracted with ether, followed by an alcohol extraction, and the latter extract has been included in our so-called synthetic diets. This ration has been surprisingly satisfactory and permitted the chicks to attain a practically normal rate of growth.

Changes in the Composition of Protoplasmic Tissue by Partial Starvation (A. G. Hogan, W. S. Ritchie, J. E. Hunter).—The methods for separating and preparing muscle proteins were unsatisfactory and considerable attention has been given to a study of procedures.

There is at the present time no quantitative method of extraction that has received unqualified approval. The problem of separating the different soluble proteins of muscle is also in a confusing state. Studies of salt separations have been made, and while this procedure has some value, altogether concordant results when different salts were used were not obtained. Investigations of the method of electro dialysis, in the hope that the globulins would be precipitated as the salts were removed, have been continued. This method seemed promising in earlier trials, but later attempts were unsuccessful, due to the high acidity that developed in the solution and consequent precipitation of the albumin. In order to reduce this acidity, a chromgelatin membrane was used to separate the anode from the center compartment, but in this case the solution became too alkaline.

Two sets of samples were taken from the lean of the loin of a yearling steer and an eight-year-old steer; one set was removed from the left loin immediately after killing the animal, the other was obtained from the right loin

after twelve days in the cooler. Methods developed in earlier work were used for the protein extraction and subsequent precipitation of protein fractions. The results are shown in Table 1.

TABLE 1.—ANALYSES OF LOIN SAMPLES FROM YEARLING STEER AND EIGHT-YEAR-OLD STEER

	From samples taken 1 hr. after slaughtering		From samples taken after cooling for 12 days	
	Yearling steer	8-year-old steer	Yearling steer	8-year-old steer
Total nitrogen in sample.....	3.126	2.685	3.158	2.718
Total nitrogen extracted by 10 per cent NaCl.....	2.256	1.631	1.062	1.290
Total nitrogen extracted in per cent of total nitrogen..	72.08	60.74	33.62	47.40
*Globulin precipitated by NaCl.....	54.74	59.93	45.85	48.99
Albumin by heating filtrate and adding CCl_3COOH ...	26.19	26.88	26.37	26.66
Non protein nitrogen.....	19.78	14.82	35.12	26.74
Globulin by Li_2SO_4	77.90	71.44	56.40	59.63
Albumin by heat + CCl_3COOH	8.52	10.55	12.92	17.75
Non protein nitrogen.....	16.70	18.53	32.00	24.19

*All figures below this line represent nitrogen in terms of the extracted nitrogen.

Chemical Service (A. G. Hogan, L. D. Haigh, W. S. Ritchie, E. E. Vanatta, A. R. Hall, H. M. Harshaw, J. E. Hunter, C. L. Shrewsbury).—The following laboratory analyses have been made during the year:

Department Investigations: 6 feeds for complete analysis (moisture, fat, nitrogen, ash, fiber); 12 pig embryos for complete analysis (moisture, fat, nitrogen, ash, fiber); 4 pig embryos for iron; 106 determinations on two steers slaughtered and separated into parts for moisture, ash, nitrogen, and fat determinations, and one steer for phosphorus determinations; 10 special samples for iron haemoglobin, water extract, and study of different forms of nitrogen involving 1500 determinations; investigations on forms of nitrogen in flesh involving 400 single determinations; total 2006 determinations.

Fertilizer Control: 505 regular inspection samples involving 300 nitrogen determinations, 990 total and available phosphorus determinations, 214 potash determinations, 300 water soluble nitrogen determinations, 240 permanganate soluble nitrogen determinations; total 2044 determinations. Also 58 special fertilizer samples involving 38 nitrogen determinations, 45 total phosphorus determinations, 45 insoluble phosphorus determinations, 19 potash determinations, and 5 chlorine determinations; total, 162 determinations.

Commercial and Other Materials: 1 commercial feed complete analysis (protein, fat, fiber, ash, moisture, carbohydrates); 12 commercial feeds (protein, fat, fiber); 21 commercial feeds (protein); 2 commercial feeds (fiber); 1 commercial feed (salt); 2 white flour (moisture, nitrogen, ash); 5 sodium Fluoride samples for purity; 1 spent bone black (calcium, phosphorus); 1 irrigation water for acid neutralizing power; 1 lime sludge, qualitative test of constituents; 2 condimental feeds, qualitative examination; 1 commercial grade common salt for purity; 1 stomach for poison; 12 samples of drinking water for qualitative examination; total, 97 determinations.

Animal Husbandry: 3 blood albumen and 1 dried liver sample for calcium; 22 mixed feeds for complete analysis (moisture, fat, ash, fiber, nitrogen); 11 mixed feeds (calcium, phosphorus); 31 bone samples (calcium, phosphorus); 2 special feeds (phosphorus); 3 digestion trial feeds (moisture, fat, fiber, ash); 4 digestion trial feeds (nitrogen, calcium, phosphorus); total 224 determinations.

Horticulture: 153 samples of fruit twigs (total and water soluble nitrogen); 28 samples tomato plants (total nitrogen, water soluble nitrogen, ash, potassium, phosphorus); 22 samples tomato plants (crude fiber); 66 samples fruit bark (total nitrogen); total, 534 determinations.

Soils: 6 crop samples (moisture, nitrogen); 20 samples artificial manure (total nitrogen, water-soluble nitrogen, active nitrogen); 16 samples water, leachings from lysimeters (organic nitrogen, nitrogen as ammonia, nitrites, nitrates); 1139 samples limestones and related materials (calcium carbonate equivalent); total, 1275 determinations.

Total Chemical Analyses: 6342 determinations.

AGRICULTURAL ENGINEERING

J. C. WOOLEY, *Chairman*

An Investigation of Sanitary Conditions on Farms and Experiments to Determine the Best Types of Sanitary Equipment (J. C. Wooley, M. M. Jones).—*Costs of Operating Battery Types of Farm Light Plants and Non-Battery Automatic Plants*. The non-battery automatic plant has the advantage of no expensive battery, but has the disadvantage of a high fuel cost when operated at low loads. The fuel cost of the battery type was found to be more or less in proportion to the amount of electric energy used from the plant, while the fuel cost of the automatic non-battery plant when operated at low loads, (one-fourth to one-third full load) was more nearly proportional to the length of time the plant was run, rather than the amount of energy supplied.

A complete report on this project has been published in Mo. Agr. Exp. Sta. Bul. 243.

A Study of the Methods of Prolonging the Service of Wood Fence Posts (J. C. Wooley, M. M. Jones).—Four varieties are outstanding for use as fence posts: catalpa, black locust, Osage orange, and white cedar. Since very few of these posts have failed to date, thirteen years, it is impossible to determine the effect of the different treatments on these varieties.

In general, the most effective treatments were the double-tank treatments of creosote. Willow was more favorably affected by treatment than was cottonwood.

Table 2 shows the increase in useful life of treated posts over untreated posts.

TABLE 2.—COMPARISON OF TREATMENTS FOR PROLONGING SERVICEABILITY

Treatment	No. of varieties used	Avg. Life of untreated posts	Avg. Life of treated posts	Per cent increase in life
Set in screened gravel.....	16	3.85	4.71	22.3
Butts charred.....	17	3.66	3.90	6.5
Brush-coat hot carbolineum.....	13	3.59	5.74	59.8
2 Brush-coats hot creosote.....	16	4.17	4.41	5.7
2-Hour double-tank creosote.....	11	3.00	8.20	173.0
5-Hour double-tank creosote.....	7	3.00	8.30	177.0

Experiments to Determine the Proper Size, Depth, and Spacing of Tile Drains for Missouri Soils (J. C. Wooley, R. R. Parks).—A series of wells have been set in a line at right angles to the line of the drain tile. The purpose of the wells was to determine the water table in the soil at different distances back of the tile line, and thus determine how much land a line of tile will effectively drain.

Figure 1 shows the level of the water in the test wells four days after a rain which saturated the soil and caused the wells to stand full.

The rate at which the tile will lower the water table in the soil or the rate at which water will seep into the tile governs its effectiveness. Daily readings on the test wells gave information on the former, and a water meter installed at the outlet gave data on the latter.

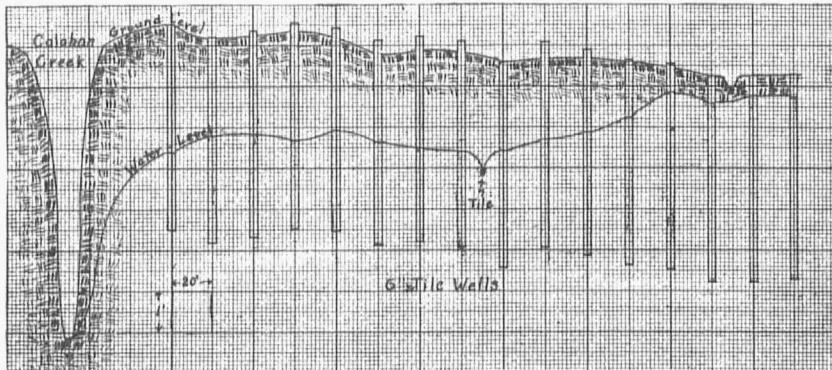


Fig. 1.—Effect of tile on water level. Wells are 20 feet apart and 5 feet deep.

Great care must be exercised in laying tile to prevent a change of current and the collection of silt. If tile is laid through a pond or low place where water stands, bell-mouth sewer tile should be used and a surface inlet provided. On the bottomland soils of Boone County 120-foot spacing and a 3-foot depth gave efficient drainage.

Relation of Electricity to Agriculture (J. C. Wooley, M. M. Jones). *Cost of Power for Operating Electric-driven Milking Machines.*—The energy used by an electrically driven milking machine has been metered and the results are given in the following table. The machine operated four milking units and was driven by a 3 H. P. motor. From 35 to 40 cows were milked; about two-thirds of them twice a day, and the remainder three times a day.

Total milk extracted	315,953.8
Total cow milkings	34,740
Total energy used	4,229.5 Kw hr.
Energy per 100 lbs of milk extracted	1.33 Kw hr.
Energy to milk a cow once .....	.1217 Kw hr.

These figures compare very closely to those obtained for the period a year earlier.

The Design of Farm Buildings and Equipment to Meet the Needs and Conditions of the State (J. C. Wooley, M. M. Jones, R. R. Parks).—*The Mis-*

souri Lime Spreader.—A home-made lime spreader has been designed and developed. It consists essentially of a hopper which attaches on the rear end of an ordinary farm wagon. The bottom of the hopper is oscillated back and forth by a star wheel attached to the back of the hopper and trailing on the ground. The rate of spreading is adjusted by raising or lowering the oscillator board at the bottom of the hopper. The spreader covers a strip a half rod wide so that the rate of spreading can be closely estimated in the field. The spreader can be made at a cost of from \$10 to \$20.

Small General Purpose Barn.—Plans and a bill of materials have been made for a small general purpose barn, 28 ft. x 40 ft., which will accommodate 5 horses, 8 cows, 400 bushels of oats, 250 bushels of ear corn, and 20 tons of hay. The barn will range in cost from \$1800 to \$2200, depending on material and labor costs.

Small Farm House.—Plans have been made for a 5-room one-story house 27 ft. x 38 ft. The living room and dining room are combined, and there are two bedrooms with bathroom between. A washroom is in the back hall. The house can be completed with full basement, hot air heat, plumbing and lighting fixtures for \$4000 to \$5000.

The Missouri Poultry House.—Plans have been completed, in cooperation with the Poultry Department, for two additional sizes of the square, straw-loft Missouri type of poultry house. The two are 26 x 26 and 40 x 40. This makes the sizes now available, 20 x 20, 26 x 26, 30 x 30, and 40 x 40.

Complete blueprint plans are available for all of these buildings. A nominal charge is made to cover cost of blueprinting and mailing.

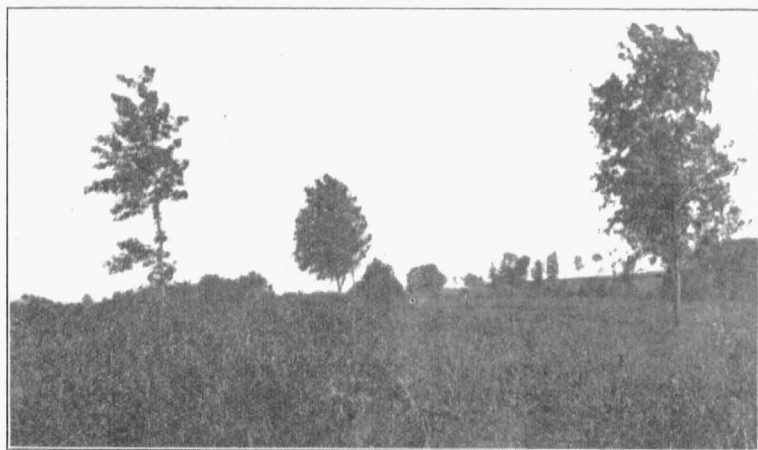


Fig. 2.—The work of the sprout mower. (At left) Sprouts before stripping; (at right) after stripping.

Method of Clearing Cut-over Lands (J. C. Wooley, A. J. McAdams, C. A. Helm).—Investigations have been made with the Shubert sprout mower as to its ability to strip the leaves and buds from growing sprouts. The beater shaft of this mower is equipped with chains which strip the leaves and buds from the brush as the machine is pulled forward. Figure 2 shows a

plot on which the machine was used on May 14, 1924. The machine removed about 90 per cent of the leaves from the sprouts less than two feet in height. In the loose ground, common in cut-over land, the machine does not have sufficient traction if the brush is heavy.

A piece of cut-over land having as near as possible a uniform growth of sprouts was secured and divided into six plots of about one-fourth acre each. Plot No. 1 was stripped with the machine on May 25, July 10, and August 25, Plot No. 2 May 25 and August 25, Plot No. 3 June 25 and August 25, Plot No. 4 July 10, Plot No. 5 August 10, Plot No. 6 August 25.

Pasturing the brush land, after the sprout mower had been used, greatly increased its effectiveness. The sprout mower greatly increased the effectiveness of goats or sheep maintained for brushing by destroying a large percentage of the leaves. Two strippings each season seemed necessary to get satisfactory results from the machine. One treatment during the latter part of April or the first of May and a second treatment in August has given the best results.

ANIMAL HUSBANDRY

E. A. TROWBRIDGE, *Chairman*

Fecundity of Swine: The Normal Sexual Cycle, and the Cycle as Influenced by Age, and by Unfavorable Dietary Conditions (A. G. Hogan, F. F. McKenzie).—The breeding of immature gilts and in turn, gilts from the first litters of these early bred animals, has been continued. The project has now advanced to the sixteenth generation. The sixth generation gilts on each of the high, medium, and low planes of nutrition, have not farrowed their first litters.

To study the effect of a low calcium ration on fecundity in swine, three lots of purebred Duroc gilts were fed in outside pens on board floors, shelters adjoining.

TABLE 3.—RATIONS USED IN EXPERIMENT ON FECUNDITY OF SWINE

	Ration Ad (parts)	Ration CaH (parts)	Ration CaL (parts)
Corn chop.....	80	85	85
Alfalfa meal.....	5	--	--
Tankage.....	10	--	--
Linseed oil meal (O. P.).....	5	--	--
Blood albumen.....	--	10	10
Cellulose.....	--	3	3
Cod liver oil.....	--	2	2
Mineral.....	2	4	4

The mineral for ration Ad, consisted of equal parts by weight of ground limestone, bone ash, and common salt. The mineral for Ration CaH, consisted of a mixture of several salts including calcium lactate and calcium phosphate. The mineral for Ration CaL, consisted of a mixture of several salts but was free of any calcium.

The average calcium content of each of the three rations for the first half of the year (similar rations used the whole year, but analyses not yet made) is:

Ration Ad	1.0002% elemental calcium
Ration CaH	0.5057% elemental calcium
Ration CaL	0.1865% elemental calcium

During the period September 3 to October 7, 1925, an exceptionally high calcium ration was used for the calcium low group (0.559% Ca) during the rest of the period the percentage Ca ranged from 0.062% to 0.068%.

The reduced calcium intake affected the skeleton as evidenced in the frequency of fracture among animals fed the low calcium ration. When the animals were slaughtered the metacarpal bones of the left leg were removed, weighed, boiled in an alkali solution (0.5% KOH), dried, photographed, and analyzed for calcium and phosphorus. Figure 3 shows the effect of a low calcium ration on the skeleton.

Ration Ad gave fairly satisfactory results in number of pigs farrowed, the number weaned, and in birth and weaning weights. The sows on the other two rations failed to produce pigs strong enough to live more than a day for the most part. The birth weights were clearly low. It was also evident that some other factor, or combination of factors, in addition to calcium seemed to be entering in, as indicated by the record of the sows on the Ration CaH, which was identical with the low calcium ration except for addition of calcium salts. The two rations were not high in the antiscorbutic Vitamin C, nor were any of the sows in the experiment free to exercise a great deal.

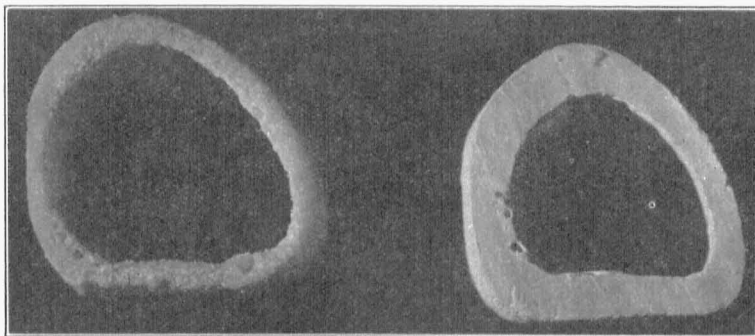


Fig. 3.—(At left) Cross-section of metacarpal bone from gilt on a low calcium ration, and (at right) cross section from bone of gilt on an adequate calcium ration. Note the thin-walled, spongy porous condition in the bone at the left as compared with the thick-walled, hard, almost solid specimen on the right.

TABLE 4.—ANALYSES OF BONES OF GILTS ON LOW CALCIUM RATION AS COMPARED TO AN ADEQUATE CALCIUM RATION.

Ration	Dry weight of bone	%Ca	Wt. Ca	%P	Wt. P.
CaL.....	13.35 grams	15.022	2.0054 g.	9.905	1.3223 g.
Ad.....	23.15 grams	17.094	3.9573 g.	10.807	2.5018 g.

The CaL gilt was killed at 7 months, 25 days of age, and weighed 115 lbs.; the Ad gilt at 8 months, 9 days, weighing 134 lbs.

Factors Which Influence the Quality and Palatability of Meat (E. A. Trowbridge, A. G. Hogan, M. T. Foster, F. F. McKenzie, C. S. Maddox, Miss Jessie Cline, M. G. Clark).—Seven lots of cattle were placed on experiment December 21 to determine the relative merit and possibilities of heifer and steer calves for the production of fat yearlings.

Steer calves on a full feed of shelled corn, six parts linseed oil meal, one part alfalfa hay and corn silage, made somewhat greater and more economical daily gains than heifer calves of similar breeding on practically the same daily ration. Heifers showed a satisfactory market condition in 30 days less time than the steers. Steers weighing 754 pounds sold at \$9.75 in St. Louis and after paying for their feed, the cost of shipping, and receiving credit for pork produced behind them, left a balance of \$3.82 for interest, risk, labor, and profit. The heifers weighing 708 pounds sold for \$10, leaving \$6.21 a head for interest, risk, labor, and profit.

Steers full fed on grain gained 2.25 pounds daily for 140 days in dry lot, while steers fed a half grain ration and the silage and alfalfa hay that they would eat averaged 1.73 pounds daily gain. Steers wintered on the corn silage and hay that they would eat, gained 1.06 pounds daily. Heifers full fed gained 2.01 pounds daily; heifers half fed gained 1.67 pounds daily.

Steer calves full-fed for 140 days were valued on May 10 at \$9.25 per cwt., which was 50c above the valuation on the steers which received half a grain ration and 80c per cwt. above those which received only silage and hay.

The cattle wintered on roughness were valued on a feeder basis. The cattle that received one-half grain ration were valued for the purpose of slaughter.

The more grain the calves were given, the less roughage they consumed.

On May 10 the full-fed cattle, both heifers and steers, showed slightly better financial results than the other cattle.

A study of the problem, "Feeding Beef Calves Previous to Weaning Time and Ultimately Finishing Them for Market" has been cooperatively conducted by the Bureau of Animal Industry, U. S. Department of Agriculture, Sni-A-Bar Farm, Grain Valley, Missouri, and the Missouri Agricultural Experiment Station.

Four lots of steer calves were included. One lot ran with their dams and received no grain during the grazing season. Lot 2 ran with their dams and had access to a grain mixture in a self-feeder. The third lot grazed a separate pasture from their mothers, and were allowed access to grain the same as the second lot and were allowed to nurse twice daily. Lot 4 consisted of calves separated from Lot 1 a month before weaning and given a grain mixture that last month.

High-grade native spring calves, sold at weaning time, yielded greater profit when they had been creep-fed grain while suckling their mothers.

Creep feeding in pasture proved more satisfactory than separating calves from their mothers and feeding grain and permitting them to nurse twice daily. Calves which had grain for about a month before weaning weighed 50 pounds more and were valued at 50c per 100 pounds more at weaning time than calves which had been fed no grain.

The calves which had been grain fed while nursing were fat enough to sell for slaughter at weaning time.

Calves fed grain while nursing their mothers made less economical but equally rapid gains after weaning as calves which had no grain during the suckling period.

The gains on both grain fed calves and calves which had no grain during the nursing period were economical.

Calves fed grain while nursing and full-fed grain for 84 days after weaning, carried flesh and weight sufficient to command a relatively high price,

while calves which had no grain while nursing required a longer time to reach an equally marketable condition. Early spring calves fed grain while suckling may be made to weigh better than 600 pounds before winter.

Quality and good breeding are essential when calves are to be fattened and marketed at an early age.

Two steers were studied with respect to relation of age to quality and quantity of carcass.

One 12-months-old fat calf, weighing about 800 pounds and a 9-year-old steer in medium fat condition were slaughtered.

Physical and chemical analyses, histological studies and cooking tests of the carcasses are being made.

Forage Crops for Swine (L. A. Weaver).—Experiments during the past year concerned the different kinds of concentrates fed on forage.

The following different combinations were fed to hogs on alfalfa pasture.

Lot I, shelled corn; Lot II, shelled corn 16 parts, tankage 1 part; Lot III, corn 8 parts, linseed oil meal 1 part; Lot IV, corn 8 parts, whole soybeans 1 part; Lot V, corn 8 parts, soybean oil meal 1 part; Lot VI, corn 24 parts, tankage 1 part, linseed oil meal 1 part; Lot VII, corn 24 parts, tankage 1 part, whole soybeans 1 part; Lot VIII, corn 24 parts, tankage 1 part, soybean oil meal 1 part; Lot IX, corn 8 parts, whole soybeans 1 part, plus mineral (composed of equal parts ground limestone, acid phosphate and salt) self fed.

The hogs in all lots made satisfactory gains, both from the standpoint of rate and economy. There was little difference between any of the lots. There was apparently no advantage to be had by combining protein feeds, or as a matter of fact, feeding any nitrogenous concentrate whatsoever, on alfalfa pasture. This one year's result, however, should not be regarded as conclusive, since an average number of experiments indicate that corn alone will not give as good results when full fed to hogs on alfalfa as will a ration of corn and a small amount of supplementary nitrogenous feed.

Hogging Down Corn and Soybeans (L. A. Weaver).—Missouri Agricultural Experiment Station Bulletin 224 reports the results of five years' investigation on this project. During the past year additional work has been done comparing corn, soybeans, and minerals to a ration of corn and tankage.

Six one-acre plots were used in this experiment. Three of the plots were planted to corn alone and three to corn and soybeans. When ready for hogging down ten shoats were placed on each 1-acre plot. Those on the corn plot received tankage in addition, while those turned on the corn and soybean plots had access to a mineral mixture composed of ground limestone, acid phosphate, and salt. Both the mineral and tankage were supplied in home-made self-feeders.

The hogs receiving corn and tankage made faster gains and produced a larger amount of pork per acre than did the hogs on the adjacent plot receiving corn, soybeans and mineral.

Growing Draft Colts (D. W. Chittenden).—Table 5 gives a summary of the data on this project for the first part of the two-year-old period, May 2, 1925 to December 5, 1925. Table 6 gives a summary of the data for the second part of the two-year-old period up to the time the colts were put to work. From that date on the grain ration changed to equal parts of shelled corn and oats by weight. From February 7 to April 14 sheaf oats were used for roughage. Both groups were fed alike from February 7 on.

TABLE 5.—GROWING DRAFT COLTS; FIRST PERIOD
(First Part of Two-Year-Old Period, from May 2, 1925 to December 5, 1925)

	Group I Full-Fed	Group II Limited Grain
Number of colts.....	3	3
Length of period.....	217	217
Avg. age beginning.....	730 days	728 days
Avg. age close.....	947 days	945 days
Avg. weight beginning.....	1321.44 lbs.	1170.44 lbs.
Avg. weight close.....	1465.00 lbs.	1390.33 lbs.
Total gain per colt.....	143.56 lbs.	220.00 lbs.
Avg. daily gain.....	0.66 lbs.	1.01 lbs.
Total feed per colt		
Hay (lbs.).....	1693.00	846.50
Grain (lbs.).....	52.67	18.00
Pasture.....	217.00 days	217.00 days
Avg. daily ration		
Hay.....	0.25	.08
Grain.....	7.80	3.90

TABLE 6.—GROWING DRAFT COLTS; SECOND PERIOD
(Second Part of Two-Year-Old Period, from December 5 to February 7, 1926)

	Group I	Group II
Number of colts.....	3	3
Length of period.....	64	64
Avg. age beginning period.....	947 days	945 days
Avg. age close of period.....	1011 days	1009 days
Avg. weight beginning period.....	1465 lbs.	1390.33 lbs.
Avg. weight close period.....	1520 lbs.	1378.33 lbs.
Total gain or loss.....	+55 lbs.	-12.00 lbs.
Avg. daily gain or loss per colt.....	0.85 lbs.	-0.18 lbs.
Avg. total feed per colt		
Hay (lbs.).....	1009.	1162.16
Grain (lbs.).....	728.00	364.00
Avg. daily ration		
Hay (lbs.).....	15.76	18.15
Grain (lbs.).....	11.37	5.68
Measurements on February 7		
Ht. at withers (in.).....	64.50	64.16
Ht. at rump (in.).....	65.50	65.16
Dept. of chest (in.).....	30.30	29.50

Methods of Wintering Pregnant Ewes and Fattening Their Lambs for Early Market (M. T. Foster). *Creep Feeding Lambs.*—Fifteen purebred and and cross-bred lambs were started on a creep feeding experiment March 9, 1926. These lambs ranged from 17 to 54 days old, the average age being 35 days. They received a grain ration composed of 3 parts corn, 3 parts oats, 1 part bran and $\frac{1}{2}$ part linseed-oil meal. On April 30 the grain ration was changed to 6 parts oats, 2 parts bran, 1 part linseed-oil meal. These lambs were in dry lot from March 9 to April 14. After April 14 they were pastured on rye and bluegrass pasture for a few hours each day. The average final weight on June 15, 1926 was 62.3 pounds; the average daily gain was 0.373 pounds; and the feed consumed per pound gain was 1.64 pounds.

The lambs were in good market condition when sold and were ready for market sufficiently early to take advantage of relatively high prices.

The Relation of Diet to Bodily Activity and to Capacity to Withstand Unfavorable Circumstances (A. G. Hogan, H. M. Harshaw).—Data reported last year confirmed the existence of a recently announced nutritional factor, vitamin E. Additional evidence has been obtained during the year and is summarized in Table 7. Investigations were made on rats.

TABLE 7.—SUMMARY OF OBSERVATIONS MADE ON REPRODUCTIVE CYCLE OF FEMALE RATS AS AFFECTED BY VITAMIN E

	No. of animals	Litters	Resorp-tions	Young born	Young retained	Young reared
Rations free of vitamin E	36	28	59	167	134	11
Rations containing vitamin E	13	36	2	223	190	107

The suggestion has been made that vitamin E was identical with the pyrrole nucleus of hemoglobin, and was essential for the formation of red blood cells. Numerous blood counts were taken on experimental animals but no indication was obtained that reproductive failures were due to anemia.

Observations were also made on the fertility of male rats, and it was evident that these also become sterile on diets lacking vitamin E.

Although there seems to be no doubt of the existence of vitamin E, there is no reason as yet to believe it is a factor of much immediate importance. This vitamin has a wide distribution and some care is necessary in preparing rations free from it.

Fattening Lambs in the Corn Field (M. T. Foster).—Wyoming lambs showing considerable fine wool blood, averaging 56 pounds in weight and of very good quality were placed on test September 30, 1925.

Three one-acre forage plots were planted in corn. Plot I was planted to corn and cowpeas; Plot II, corn alone; Plot III, corn and soybeans. It was estimated that the plots would yield between 25 and 30 bushels of corn. Plots I and III had a very good stand of cowpeas and soybeans respectively. During the first week the lambs ate grass and weeds; during the second week the lambs in Lots I and III started to eat leaves from the cowpea and soybean plants. The lambs in Lot II continued to eat grass, weeds and some of the blades of the corn. During the third week the lambs in Lots I and III stripped all the leaves from the cowpea and soybean plants and some of the lower blades from the corn. The lambs in Lot II had started to eat some corn. During the fourth week the lambs in Lots I and III cleaned up the cowpea and soybean pods and started to eat corn. By the end of the fourth week the lambs had the forage consumed in their lots and were eating corn. From October 27 until November 10 the lambs in each lot received 6 pounds of mixed hay each evening. Table 8 shows the results of this investigation.

TABLE 8.—FATTENING LAMBS IN CORNFIELD ON CORN ALONE, CORN AND COWPEAS, AND CORN AND SOYBEANS

	Lot I (Corn and cowpeas)	Lot II (Corn)	Lot III (Corn and soybeans)
Initial lot-weight (Sept. 30, 1925)-----	447.75 lbs.	448.75 lbs.	448 lbs.
Final lot-weight (Nov. 10, 1925)-----	472.5	448.5	471.5
Gain or loss in weight for the six-weeks period-----	+24.75	-.25	+23.5

The gains made by the lambs were not large and the lambs were finished in dry lot after the test closed.

BOTANY

W. J. ROBBINS, *Chairman*

Relation of Hydrogen-ion Concentration to the Growth of Plants (W. J. Robbins).—Further studies of the effect of hydrogen-ion concentration of potato-tuber tissue, on elodea and on three fungi, *Gibberella Saubinetii*, *Fusarium oxysporum* and *Rhizopus nigricans*, have been made. The ash content of discs of potato tuber which had been immersed in dilute sodium phosphate buffer mixtures of different reactions showed, in general, little loss of ash in solutions of from pH 7.0 to 8.0, some loss in solutions of from pH 6.0 to 7.0, more loss in solutions of from pH 4.5 to 6.0 and rapid loss in solutions more acid than pH 4.5. Potato tuber tissue dies rapidly in solutions of dilute sodium phosphate more acid than pH 4.5. The death of potato tuber tissue in dilute sodium phosphate solutions more acid than pH 4.5 is delayed by the addition of small quantities of calcium salts. The loss of ash elements from the potato tissue also occurs less rapidly in the acid solutions which contain traces of calcium.

Elodéa (*Anacharis canadensis gigantea*) responded in many ways as though it had an isoelectric point of pH 6.0 to 6.2. Detached leaves of elodea remain alive in diffuse light for more than a week in sodium phosphate buffer mixtures containing 0.03 N sodium and varying in reactions from pH 4.8 to 7.2. The elodea leaves in such solutions gradually become yellow, the chloroplasts shrinking in size and developing a golden yellow color. This change occurs more rapidly in solutions acid to pH 6.0 or 6.2. The protoplasmic streaming is more rapid in the acid solutions than in those near neutrality. In buffer mixtures, the acid dyes, eosin and martius yellow, are more toxic to elodea in solutions more acid than pH 6.0 or 6.2 than in the more alkaline solutions; the basic dyes, safranin, methylene blue and dahlia are more toxic in solutions more alkaline than pH 6.0 or 6.2 than in more acid solutions.

Cultures on liquid and solid media containing uniform concentrations of toxic acid or basic dyes but differing in hydrogen-ion concentration show that the toxicity of the acid dyes is markedly increased for *Rhizopus nigricans* in solutions acid to about pH 5.0; for *Gibberella saubinetii* in solutions acid to about pH 6.4. The basic dyes are decidedly more toxic in solutions alkaline to these points. *Fusarium oxysporum* responds much like *Gibberella saubinetii*. These results are correlated with the isoelectric points previously reported for the first two organisms but not with that found for the third.

A Study of Certain Fusarial Diseases of Plants (Irk T. Scott).—*Some Protein Analogies of the Mycelium of Fusarium Lycopersici, the Causal Organism of Tomato Wilt.*—An extensive study has been made of the effect of the mycelium of *Fusarium Lycopersici* upon the reaction of both buffered and unbuffered single-salt solutions at different hydrogen-ion concentrations. Both colorimetric and electrometric methods of determining the hydrogen-ion concentration were used. When mats of the living fungous mycelium grown in full nutrient solutions were washed and then added to dilute buffered single-salt solutions such as potassium phosphate, sodium phosphate, sodium acetate and potassium phthalate, and to dilute unbuffered single-salt solutions such as potassium chloride, calcium chloride, magnesium chloride, copper sulphate, and mercuric chloride at different hydrogen-ion concentrations and the change in reaction was such that the initial reactions of the solutions more acid than pH

5.4 were made less acid reaching equilibrium at or near pH 5.4, while in solutions more alkaline than pH 5.4 the reaction was made less alkaline reaching equilibrium at or near the same point. It is suggested that such behavior is analogous to that of a colloidal ampholyte like gelatin. As further evidence of a protein analogy it was found that when the percentage of spore germination of this fungus was determined in solutions of different hydrogen-ion concentration containing a toxic cation (mercuric, cupric, or methylene blue—a basic dye) or a toxic anion (cyanide or eosin—an acid dye), spore germination was greatly inhibited in solutions more acid than pH 5.4 in the presence of the toxic anion, and in solutions more alkaline than pH 5.4 in the presence of a toxic cation. On the basis of a protein analogy it would appear that the living tissue of *F. lycopersici* has an isoelectric point near pH 5.4. When the fungous mats were killed by means of hot water or ethyl alcohol it was found that the equilibrium point reached by the solutions in which the mats were placed was not the same as that obtained with living tissue, nor was the same equilibrium point obtained in every case. The inconsistent results with the dead tissue are attributed to some effect produced on the protoplasm by the different methods of killing or to a difference between living and dead protoplasm.

Wheat Scab Varietal Resistance.—A study of the relative resistance of twenty-nine strains and varieties of wheat to the wheat scab organism, *Gibberella saubinetii*, was continued. Artificial inoculation with spore suspensions of three different strains of the causal organism failed to give a higher infection than 10 per cent on the most susceptible strains. Weather conditions during the spring of 1925 were not altogether favorable for the development of wheat scab, but it is believed that the relative resistance and susceptibility observed is comparable to that of previous seasons. The Red May strains still persist in showing marked resistance, the following Station selections being outstanding: W203, W210, and W214, with infection amounting to only 0.28, 0.37, and 0.18 per cent, respectively. Poole C. I. 5653 (W174) showed only 0.18 per cent infection. This latter strain in three years' trials has given an average infection of only 0.47 per cent. The Turkey-Kanred strains and most of the Mediterranean group continued to show relatively high infection.

Alfalfa Fusarium Blight.—Further isolations of species of *Fusarium* were made during the past year. Considerable damage has resulted from this disease in scattered localities throughout the State. All isolations so far made gave every evidence of being identical to those previously reported.

Miscellaneous Investigations (Irl T. Scott). *Bacterial Blight of Alfalfa.*—This spring a number of specimens of blighted alfalfa plants were received. The loss in some cases amounted to 70 per cent of the entire crop. The disease is characterized by a dry rot confined to a zone about one inch in length at the crown of the plant. Plants become yellow and soon collapse, many breaking off at the crown. No fungous parasite could be detected in the diseased tissue but careful examination revealed small brownish areas in the interior of the rotted zone. These areas contained large numbers of bacteria in all cases. This bacterium has been isolated from numerous diseased plants. While the total extent of the injury from this disease throughout Missouri is not yet completely known, the losses so far observed indicate that it is likely to become a serious menace to alfalfa growers.

Cytospora (Valsa) Canker of Apple.—The canker or “die back” of apple caused by a species of *Cytospora* (probably *Valsa leucostoma*) is becoming serious in some orchards in this State. Specimens of cankered limbs have been obtained from a number of widely distributed localities. The “die-back” appears to attack only weakened trees, particularly those suffering from winter-injury, root-rots, or constitutional diseases. An effort is being made to determine the primary cause of the weakening in several cases. These give every appearance of being injured by parasitic fungous root-rots.

DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

Studies in Milk Secretion: (a) Time Relations in Milk Secretion; (b) Mechanisms Regulating Variations in the Composition of Milk (A. C. Ragsdale, C. W. Turner, Samuel Brody, E. C. Elting, and Warren Gifford). *Factors Affecting the Development of the Mammary Gland and Milk Secretion.*—Relation between the oestrus cycle and the development of the mammary gland and secretion has been studied. An unbred heifer yielded a small amount of a very watery secretion after the first and second period of heat occurred. A sprayed heifer of similar age has yielded no secretion up to the present time. The development of the mammary gland of a three-year-old non-pregnant heifer has been studied. The glandular development above the milk cistern was rather limited, the ducts and secretory tissue extending into the fatty tissue. First-calf heifers and dry pregnant cows have been milked at regular intervals during pregnancy. An increasing volume of secretion has been obtained during the latter part of the period of pregnancy.

The Relation Between Age and the Persistency of Milk Secretion.—Two-year-old cows were found to be the most persistent during lactation. The degree of persistency declined with age up to five or six years. This was believed to be caused by the fact that young animals were growing and developing during the first several lactations and therefore yielded a larger relative quantity of secretion during the latter period of the lactation period than the mature cows.

The Percentage of Milk Secreted During the Interval Between Milkings.—The milk yield from each quarter of a cow's udder was carefully measured and tested for three days at 12-hour intervals. The cow was then killed at the usual time of milking, and the blood entirely removed and the cow milked. It was found that 69 per cent of the previous yield of milk could be obtained from the udder after the cow had been killed. In a second trial that had averaged 10 pounds of milk for nine days the cow was killed, the udder removed and milked immediately, and each one-half hour thereafter until a total of six milkings had been completed. The yield was 11.3 pounds of milk.

The Relation Between Increase in Milk Secretion and Growth in Weight With Age in Dairy Cattle.—Up to about 8 years of age, milk secretion and growth in body weight in dairy cattle on official test increased at the same rate. The increase of milk secretion with age in dairy cattle not on official test lagged behind the increase in cattle that were on test by about 2 years.

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, C. W. Weber, Samuel Brody).—

The Transmission of Immune Bodies from the Cow to the Calf in Colostrum. There was a rapid rise in the bactericidal titer for *Bacillus coli* in the blood serum of all calves during the first few days of life and independent of the food ingested. This was further substantiated by analysis of the blood of two calves fed colostrum and three calves fed *Lactobacillus acidophilus*. A study was made of the opsonic index for *Bacillus coli* of the blood serum of calves before and after ingesting colostrum and before and after ingesting milk. The milk was fermented with *Lactobacillus acidophilus* before being fed. The opsonic indices of the blood of eight calves at birth were low in all cases. Of the three calves fed colostrum, all showed a marked increase in the opsonic content of their blood serum for an avirulent strain of *Bacillus coli*. Using the same strain of *Bacillus coli* the blood serum of five calves, after ingesting the fermented milk, showed a slight increase in the opsonic index.

Colostrum as a Pabulum for Bacillus Coli (or the Growth of Bacillus Coli in Colostrum).—Preceding the infection of young calves with *Bacillus coli* there was a large increase in the numbers of this organism at the point of infection, which was usually through the small intestine. The growth of a stock strain of *Bacillus coli* in ten samples of milk and as many samples of raw and inactivated colostrum was studied. In six of these same samples of colostrum the growth of a strain of *Bacillus coli*, isolated from a calf dead of this infection, was studied. All of the samples of milk showed marked bactericidal action for the stock strain of *Bacillus coli*. Samples inoculated with as many as 4000 organisms per c.c. often showed a count of less than 100 organisms per c.c. after five hours incubation. The virulent strain of *Bacillus coli* always showed growth in the samples of raw milk, but the growth was less rapid than in the inactivated milk samples. The first four samples of colostrum studied showed a very marked bactericidal action for the stock strain of *Bacillus coli* and in one case destroyed more than 10,000 organisms per c.c. in the first hours after inoculation. Later samples showed a marked variation in the bactericidal action for *Bacillus coli*, some samples being an ideal medium for the growth of both the avirulent and virulent strains. Most of the samples of colostrum showed a higher bactericidal action for *Bacillus coli* than control samples of milk.

Lactobacillus Bulgaricus and Lactobacillus Acidophilus Fermented Milk as Substitutes for Colostrum to the New-born Calf.—Two calves removed from their dams at birth, were fed milk fermented with *Lactobacillus bulgaricus* as a substitute for colostrum. Both calves died at the age of two days. The diagnosis was gastritis. Three calves were removed from their dams at birth and fed milk fermented with *Lactobacillus acidophilus*. Two of the calves remained healthy for forty days, when they were sold. The third calf died at the age of eight days, having been fed three days previous on milk which was very sour. Post-mortem examination revealed a marked case of gastritis. Bacteriological analysis of the visceral organs of the three calves dead of gastritis were all negative. None of the calves died of *Bacillus coli* infection, as is usually the case when colostrum is withheld.

Nutrition of Heifers: Protein Requirements for Growth (A. C. Ragsdale, E. C. Elting).—Complete feed records have been obtained on 13 Holstein females, 11 Jersey females, 13 Holstein males, and 6 Jersey males from birth ranging up to 14 months of age. Weights were taken daily from birth to four

weeks of age, then weekly until the age of two months and at monthly intervals thereafter, and 5 skeletal measurements taken monthly from birth have been obtained on all animals.

Growth Investigations (A. C. Ragsdale, Samuel Brody, E. C. Elting).—The collection of data on growth of the males and females of the Jersey, Holstein, and Ayrshire breeds in the Station herd has been continued.

Similar data have been taken on two hundred and twenty-five animals in representative Jersey and Holstein herds in the State of Missouri.

By means of a method of determining equivalence of age it was indicated that the Jersey matures at an earlier age than the Ayrshire, and the Ayrshire matures at an earlier age than the Holstein.

Various measurements have been made on 1500 head of cattle of different ages of the Lombardy, Brittany, Brown-Swiss, Ayrshire, and Shorthorn breeds of cattle. These measurements were all taken in Europe in the native homes of the breeds. The Brittany cattle matured early and at a relatively small size.

The Inheritance and Transmission of the Characters "Capacity for Fat Production" (C. W. Turner, Warren Gifford).—A study of the progeny performance of 404 Jersey sires, having 10 or more Register of Merit daughters, and of 175 Ayrshire sires having five or more Advanced Registry daughters, has been completed.

It was found that for each 100 pounds fat increase in the dam's yearly production, there was a complete average increase in the daughter's production amounting to, in round figures, approximately 10 pounds of butterfat yearly in the case of Jerseys, and almost 20 pounds in the case of Ayrshires.

By means of genealogy charts the ability of the sires and dams to transmit the favorable factors concerned in fat production through their sons to their granddaughters was studied. In the Jersey breed, the sire's daughter's average fat production was found to bear the following relation to the son's daughter's average production:

$$\begin{array}{l} \text{Son's daughter's yearly} \\ \text{fat production} \end{array} = 302 + 0.481 \times \begin{array}{l} \text{Sire's daughter's fat} \\ \text{production} \end{array}$$

The relation between the dam's record and her son's daughter's average fat production is expressed by the following equation:

$$\begin{array}{l} \text{Son's daughter's yearly} \\ \text{fat production} \end{array} = 463 + 0.176 \times \begin{array}{l} \text{Dam's yearly fat} \\ \text{production} \end{array}$$

This indicated that the record of the production of the dam was a poor index of her transmitting ability to her granddaughters. A more satisfactory indication of the dam's transmitting ability was found to be her sire's average progeny performance. Similar conclusions were drawn for the Ayrshire breed.

A study was made of the twinning in the Missouri Station dairy herd. Of a total of 981 calves born in the herd there were 12 pairs of twins. This is a twinning percentage of 1.24. The Holstein breed showed the greatest percentage of twins.

Of the 12 sets of twins, 3 were both males; 5 male and female; and 4 both female. Only one cow produced two pairs of twins. No sire was found which produced an exceptionally large proportion of twins, although in the Holstein herd six of the seven dams were by a single sire.

The Effect of Each Ingredient in the Manufacture of Ice Cream (W. H. E. Reid, W. K. Moseley).—Studies have been made on the effect of emulsification, homogenization, and viscolization on the microscopic change of the fat, the surface tension, the viscosity, the freezing qualities of ice cream mixtures, and also on the hardness, the stability at summer temperatures, and the quality of the ice cream frozen from the different mixtures. Five 55-pound batches of ice cream mixtures were emulsified. One batch was emulsified one time, the other batches two, three, four, and five times respectively. Batches weighing 55 pounds were processed with the viscolizer at pressures varying at intervals of 500 pounds, and ranging from 500 to 5000 pounds pressure. The pressures used on the two-stage homogenizer ranged as follows: 1000-0, 1500-500, 2000-1000, 2500-1500, 3000-2000, 3500-2500, 4000-3000, 4500-3500, and 5000-4000 pounds on the first and second valves respectively.

Processing increased the viscosity and surface tension, brought about a clumping and a decrease in the size of the fat globules, and aided in the control of the freezing process of ice cream mixtures. It resulted in an increased smoothness in the texture of the ice cream, in no change in the hardness, and in a decrease in the stability of the ice cream frozen from the mixtures when exposed at summer temperatures.

The results with the emulsifier were not as pronounced as those produced by the homogenizer and the viscolizer. At pressures below 4000 pounds the viscosity of the homogenized mixtures was less than the viscosity of the viscolized mixtures. Above 4000 pounds the homogenized mixtures had the highest viscosity. The best quality of ice cream was processed at 3500-2500 pounds pressure on the two valves of the homogenizer and at 3000 pounds on the viscolizer.

The Deleterious Effects of Frozen Milk on Baby Chicks and on the Marketability of Milk and Cream (W. H. E. Reid).—Milk was frozen in graduated cylinders for a period of three hours at 0° F. and then allowed to thaw at 60° F. for one hour. The decrease in the length of the cream line, in comparison with the original, was 39 per cent; after thawing for three hours the decrease was 42.44 per cent; and after standing for 24 hours the length of the cream line had decreased 45.9 per cent. When frozen at 0° F. for five hours and thawed at 60° F. for one hour, the decrease in the cream line was 40.75 per cent. After three hours of thawing the decrease was 42.65 per cent, and after 24 hours, 45.9 per cent.

As the freezing temperatures were raised from 0° F., to 6° F., 10° F., 15° F., 20° F., and 30° F., the length of the cream line increased. The same was true in the samples frozen for five hours at the same temperatures.

Freezing greatly intensified off flavors in milk. Microscopic examinations showed freezing milk testing 3.70 per cent fat caused a decided clumping of the butterfat globules. The clumps increased in size as the time of freezing was prolonged. The globules in the milk frozen appeared distorted and irregular in shape.

Creams testing 10, 20, 30, and 40 per cent butterfat were frozen, thawed, and photographed with the aid of the microscope. The globules appeared as individuals and as clumps. In some cases the clumping was so great as to appear as a mass. The same distorted appearance and irregularity in shape of the globules was observed as was found in the milk and this increased as the butterfat content was increased.

ENTOMOLOGY

L. HASEMAN, *Chairman*

An Investigation of Insecticides (L. Haseman, K. C. Sullivan).—Experiments with calcium cyanide for greenhouse fumigation have been carried on. Most plants in a greenhouse will stand a dose of 0.02243 grams calcium cyanide per cubic foot. White flies and greenhouse plant lice can be killed with a dosage of 0.00945 grams for each cubic foot. Greenhouse scale requires 0.01475 grams for each cubic foot. Thrips require 0.02835 grams for each cubic foot and red spiders require 0.08505 grams for each cubic foot. Three dust formulæ have been used in the orchard dusting experiments for codling moth. They are as follows: (1) Sulphur, 90 pounds and arsenate of lead, 10 pounds; (2) Sulphur, 85 pounds and arsenate of lead, 15 pounds; (3) hydrated lime, 80 pounds, powdered copper, 12 pounds, and calcium arsenate, 8 pounds. The sulphur and arsenate of lead have proved most effective. Sodium fluorsilicate showed promise as being valuable for control of more resistant chewing insects, such as the striped cucumber beetle.

The Annual Life Cycle of the Hessian Fly in Missouri and Its Control (L. Haseman, K. C. Sullivan).—Plots were maintained at Carthage, Springfield, Charleston, Cuba, St. Louis, Columbia, Warrensburg, and Maryville. Five plots were planted in wheat in each experiment field, two before the safe seeding date, one on that date, and two after that date. These tests have now been repeated for ten successive years and this year's result completes the project. The results are now being prepared for publication. The Hessian fly can be effectively stamped out and kept under control by applying three farm practices in connection with wheat growing. First, plow under all wheat stubble not seeded to clover or timothy some time after wheat harvest; second, cultivate this ground and keep down volunteer wheat during the summer and fall; third, seed the wheat on and soon after the safe seeding date as determined for the particular locality by these experiments. During the year there was very little fly anywhere in the State.

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).—Investigations with both spraying and dusting have been carried on. The spraying experiments were conducted in the orchards at Columbia. Three nozzles, disc, bordeaux, and gun, each with three pressures 100, 150, and 250 pounds were used. Counts on the fruit picked this fall are shown in Table 9. In the control of the codling moth and curculio the dust has given as good results as sprays.

TABLE 9.—EFFECT OF DIFFERENT NOZZLES AND DIFFERENT PRESSURES USED IN SPRAYS ON THE CODLING MOTH

Nozzle	Pressure	% Calyx worms	% Side worms
Disc.....	100	.64	19.0
Bordeaux.....	100	.24	15.2
Gun.....	100	.29	14.2
Disc.....	150	.32	8.3
Bordeaux.....	150	1.14	10.6
Gun.....	150	1.53	30.69
Disc.....	250	.29	5.8
Bordeaux.....	250	.38	4.21
Gun.....	250	0.0	5.04

FIELD CROPS

W. C. ETHERIDGE, *Chairman*

Cereal Breeding (W. C. Etheridge, L. J. Stadler, R. T. Kirkpatrick).—*Wheat Breeding Investigations, Including the Improvement of Commercial Varieties* by (1) *The Pure Line Method of Breeding*, (2) *Hybridization and Subsequent Selection*. Forty-two pure line selections of the leading varieties of wheat were compared in yield in a nursery test. These were the most productive of 1000 plant selections made in 1920. The yields in 1925 varied from 9.7 to 22.7 bushels an acre. The selections were closely studied in regard to various characters of economic importance, particularly resistance to loose smut. Susceptibility to this disease is the principal disadvantage of our best varieties, especially Michigan Wonder. A number of the pure lines have consistently shown extremely low percentages of infection with loose smut during the last four seasons. Some of the resistant strains which have given high yields were multiplied for more extensive trials. First generation hybrids of Michigan Wonder crossed with several varieties resistant to loose smut were grown in 1925. In breeding for resistance to loose smut an important source of difficulty is the measurement of resistance, since effective means of inoculating plants for this disease have not yet been devised. For this reason extensive trials were made in an attempt to develop methods of inoculation.

A Study of the Adaptations of the Important Varieties of Wheat for Missouri Conditions.—Twenty-four varieties and strains of wheat previously found most valuable for Missouri conditions, were in 1925 compared under nursery conditions. The yields varied from 15.3 to 21.7 bushels an acre. During the past four seasons accurate yield comparisons of a number of commercial stocks of Fulcaster secured from experiment stations and seedsmen in different parts of the country have been made. All of the stocks tested were practically pure and true to the standard description of the variety. Forty-six stocks were tested in 1922, 50 in 1923, 15 in 1924, and 16 in 1925. The extent of variation in yield among these stocks of the same variety was indicated by the yields of seven representative stocks given in Table 10.

TABLE 10.—COMPARATIVE YIELDS OF DIFFERENT COMMERCIAL STOCKS OF FULCASTER WHEAT

Accession number	Yield an acre				4-yr. average
	1922	1923	1924	1925	
W161	29.9	26.4	17.4	19.7	23.4
18	31.7	23.2	14.3	23.3	23.1
298	30.7	18.8	11.8	19.6	20.2
1415	23.1	15.5	16.8	19.1	18.6
191	21.5	14.9	15.9	19.7	18.0
194	23.1	13.7	13.5	19.4	17.4
1426	17.8	9.0	16.0	18.2	15.3

These data indicated that the results of a variety test were largely dependent upon the stocks which happen to be chosen as representative of the varieties tested. The results of a variety test may properly be applied only to the strains actually tested.

A Study of the Important Varieties of Oats for Missouri Conditions.—The thirty-two varieties and strains of oats previously found to be adapted to Missouri

conditions were tested. The yields of these varied from 35.7 to 51.5 bushels an acre. Yields of the leading strains were as follows:

0432 Selection from Red Rust Proof.....	51.5
0149 Fulghum	51.1
0151 Fulghum	50.6
065 Fulghum	50.3
0145 Fulghum	50.0
0953 Selection from Kherson	49.9
01375 Selection from Fulghum	49.5
0152 Fulghum	48.9
015 Burt	47.2

Fulghum oats have clearly demonstrated their superiority to the other varieties of oats formerly recommended in Missouri. The selection 01375, although derived from a commercial strain of Fulghum, differs distinctly from Fulghum in general characteristics. This selection has given very promising results considering its average yield for the last three seasons, and appears to be the most promising of the selections which have thus far been made.

A Genetic Analysis of Maize (L. J. Stadler). *Variation in the Intensity of Linkage in Maize*.—Studies of the variability of crossing over in the *C-sh* and *Sh-Wx* regions in maize were continued, with special reference to family differences, constancy of crossing over within the individual, and the effects of X-rays. The effect of X-rays on crossing over in this material is of special interest because crossing over in these two regions in maize has been found remarkably constant within the individual, regardless of differences in age and temperature, etc. In the fruit-fly X-rays influence crossing over decidedly in regions not susceptible to the effects of age and temperature. Young tassels of heterozygous plants were irradiated at various dosages, the treatments being given during the period of maturation of the male germ cells, as determined by cytological examination. Irradiation at the greater dosages resulted in the death of a considerable proportion of the pollen and in some cases in distortion of the tassel. There was no significant difference in crossover percentage in treated and untreated tassels of the same plants at any dosage used.

The Frequency of Mutation in Maize.—Preliminary studies of the frequency of mutation in the genes for several endosperm characters have been made. The method followed eliminated contamination as a source of error and permitted the production and examination of populations practically unlimited in size, thus making it possible to determine the rate of mutation in genes not selected because of their high mutability. Plants dominant for the gene under investigation were pollinated by recessive plants. All F_1 grains showing the recessive character were tested by backcrossing to the recessive parental stock. The production of a wholly recessive ear in this backcross was taken as evidence that the female gamete from which the recessive seed was produced lacked the dominant gene, as a result of mutation in the germ cell lineage previous to the first division of the megaspore. In 1924, among about 2000 grains so pollinated as to show mutation of *R* (a gene for aleurone color) two colorless grains were found. Both were tested in 1925 and found to be homozygous recessives, indicating a rate of mutation for *R* of the order of 1 per 1000. Among about 3000 grains which could have shown mutation of *C* (another gene

for aleurone color) one colorless grain was found, but this did not germinate and could not be tested. In 1925 a more extensive trial was made, using as pollen parents stocks recessive for the genes *c*, *sh*, *wx*, *su*, and *pr*, in various combinations. Among 55,618 kernels which could have shown mutation of *C* 5 colorless kernels were found, and among 93,106 kernels which could have shown mutation of *Sh*, 2 shrunken kernels were found. Only about 10,000 grains could have shown mutation of *Su*, *Pr*, and *Wx*, and no mutations of these genes were found. These data are provisional, pending the results of the back-cross tests. Although linked genes were under observation in some 60,000 cases, in no case did the simultaneous loss of linked genes occur, indicating that the loss of chromosome was not an important factor in this material.

From these trials it appeared that mutation in some genes occurred frequently enough to be susceptible to quantitative experimental investigation by the method outlined. Multiple recessive stocks for determining the rate of mutation in 13 genes for endosperm characters have been prepared in quantity.

Inbreeding Corn for Economic Improvement.—The work of inbreeding strains of Missouri varieties and crossing inbred strains, in an attempt to produce seed stocks of practical value, has been continued and extended. About fifty hybrids of inbred strains produced at this station were tested for yield in comparison with Commercial White, Boone County White, and Reid's Yellow Dent. Some of the inbred strains gave hybrids of much promise, but many years of further investigation will probably be necessary before stocks of proved practical value can be produced in this way.

A Study of the Adaptation of the Important Varieties and Selections of Soybeans to the Various Soil Types of the State (W. C. Etheridge, L. J. Stadler, R. T. Kirkpatrick).—Sixty-four pure line selections of Midwest soybeans, each descended from a single plant selected in 1921, were tested for yield of

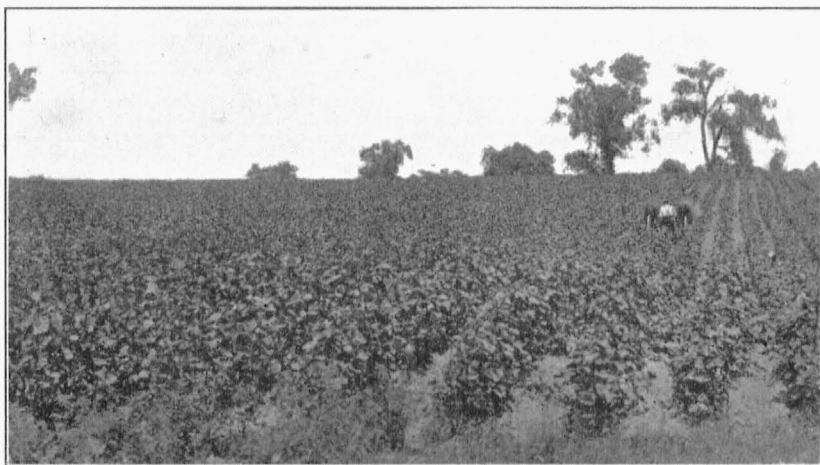


Fig. 4.—On this thin hill land in Central Missouri where the yield of wheat was too small for profit, the Virginia variety of soybeans shown in the picture produced nearly three tons of excellent hay to the acre.

seed under nursery conditions. The seed yields of the pure lines ranged from 21.86 to 30.13 bushels an acre. In a similar test the seed yields of thirty-two pure line selections of Haberlandt and Morse soybeans were determined. These varied from 18.76 to 27.00 bushels an acre.

Cultural Experiments with Cotton, Including: (a) Fertilizer Tests, (b) Spacing Tests, and (c) Variety Tests (W. C. Etheridge, B. M. King) *Fertilizer Tests.*—Fertilizer tests were conducted on Southeast Missouri lowlands at Wyatt, Sikeston, New Madrid, and Caruthersville, and on Ozark upland at Doniphan. Applications of 50 or 100 pounds of sodium nitrate alone, of 300 pounds of acid phosphate alone, and of the combination of 50 pounds of sodium nitrate with 300 pounds of acid phosphate, failed to give a significant increase in yield on any of the fields.

Combination of 300 pounds of acid phosphate, 50 pounds of sodium nitrate, and 30 pounds of potassium chloride, gave increases ranging from 55 to 138 pounds of seed cotton an acre, with an average increase of 96 pounds. Acid phosphate at the rate of 300 pounds, combined with 30 pounds of potassium chloride, gave an average increase of 70 pounds of seed cotton an acre. On the basis of prices received for cotton in 1925 the value of these increases from the two last named treatments was approximately equal to the cost of the treatments in each case.

On the Doniphan field the combination of acid phosphate, sodium nitrate and potassium chloride gave an increase of 176 pounds of seed cotton an acre, which because of the comparatively low yields on this field, represents an increase of 41 per cent. Acid phosphate and potassium chloride combined, and acid phosphate alone, gave percentage increases of 33 and 20 respectively.

Spacing Tests.—Tests were conducted on three of the important soil types of the Southeast Missouri lowland and on the Missouri Experiment Station field at Columbia to determine the proper distance that cotton should be spaced in the row. The results are shown in Table 11.

TABLE 11.—LOCATION OF COTTON SPACING TESTS AND YIELD OF SEED COTTON IN POUNDS AN ACRE

Spacing of plants in rows	Caruthersville	Sikeston	Wyatt	Columbia
2 to 4 plants a hill, hills 10-12 inches apart.....	2156	1654	2090	936
1 plant every 12 inches.....	1930	1484	1798	----
1 plant every 18 inches.....	1760	1407	1713	648

The plants in hills spaced 10 to 12 inches apart gave an average yield in seed cotton of 229 pounds more than single plants spaced 12 inches apart, and 327 pounds more than single plants spaced 18 inches apart.

Variety Tests.—Ten varieties or strains of cotton considered as having special merits under Missouri conditions were included in tests conducted on Southeast Missouri lowlands, on Ozark uplands, and at Columbia. Trice, Delfos, Express, and Acala were the highest yielding varieties in the tests. On the lowland fields Trice and Delfos gave the best returns, as a rule, on the heavy or very fertile soils, while Express and Acala gave the best returns on the lighter soils. Express and Trice gave the highest yields of seed cotton on Ozark upland soils and on the Experiment Station field at Columbia.

Cultural Experiments with Soybeans, Including: (a) Time of Seeding; (b) Method of Seeding; (c) Rate of Seeding (W. C. Etheridge, C. A. Helm).—When Virginia, the leading variety of soybeans for hay, was drilled at rates ranging from 40 to 120 pounds of seed an acre, the lower rates were found the more economical, since there was no consistent variation in yield. The results are expressed in the following table:

Pounds of seed sown per acre	Tons of Hay yielded per acre
45.....	2.2
60.....	2.1
75.....	2.3
90.....	2.0
105.....	1.9
120.....	2.2

Although the yield was not materially affected by the changes in the rate of seeding, as the data show, the proportion of weeds, especially crab grass, decreased in the crop, and therefore the quality of the hay increased, with the heavier rates of seeding.

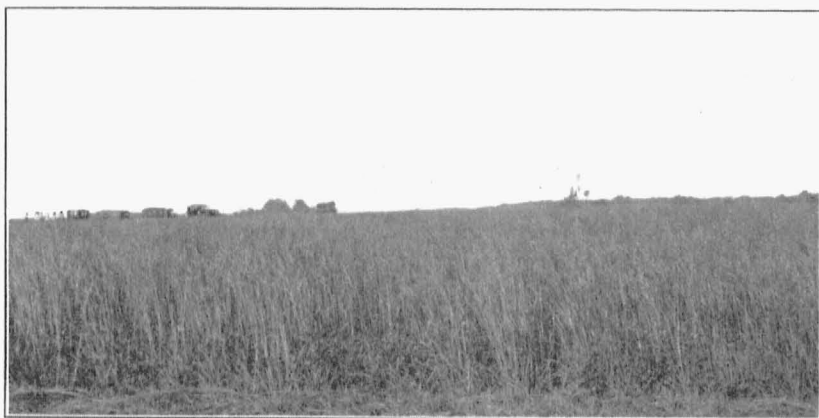


Fig. 5.—Orchard grass is excellent for meadows and pastures in South Central and Southwest Missouri. Stark City Experiment Field, 1926.

When the Virginia, Morse, Wilson, and Midwest varieties were sown by different methods (drilling solid 60 pounds an acre, and planting in 3'-6" rows, at 20 pounds an acre) the acre yields were the following:

TABLE 12.—YIELDS OF SOYBEANS FROM DRILLING AND PLANTING

Variety	From drilling solid		From 3'-6" rows	
	Bu. seed	Tons hay	Bu. seed	Tons hay
Virginia.....	20.9	2.4	25.8	1.9
Morse.....	13.2	2.0	30.5	2.0
Wilson.....	17.1	2.0	24.0	2.0
Midwest.....	15.7	2.0	25.0	2.0

A Study of the Cultural Requirements and Adaptation of Grain Sorghum (W. C. Etheridge, C. A. Helm).—At Stark City, on Hagerstown silt loam soil, Sunrise kafir in a rotation with soybeans, wheat, and clover, yielded 31.9 bushels of grain an acre. Wheat in this rotation received 200 pounds of acid phosphate an acre, but no other crops were fertilized or manured. In an adjacent series of plots the acre-yield of corn in a rotation with oats, wheat, and clover, was 41.2 bushels of grain. In this rotation also the wheat received 200 pounds of acid phosphate an acre, and the clover 6 tons of manure.

At Cuba, on Lebanon silt and gravelly loam soil, Sunrise kafir in a rotation with wheat and clover, yielded 24.4 bushels of grain an acre where 6 tons of manure an acre had been applied to the clover crop preceding the kafir, but only 8.8 bushels an acre where the clover crop had been untreated.

At Shelbyville, on Putnam silt loam, Sunrise kafir in rotation with oats, grass and alsike clover, was compared in yield with corn in rotation with soybeans, wheat and one year of red clover. No fertilizer or lime was used in the kafir rotation, but both fertilizer and lime were applied in the rotation including corn. One-half of each rotation was manured, the other half receiving no manure.

Under these conditions the yields of corn and Sunrise kafir were the following:

TABLE 13.—COMPARISON OF YIELDS FROM KAFIR AND CORN

Crops	Bushels of grain per acre	
	Manure	No manure
Sunrise kafir	36.8	27.2
Reid Yellow Dent	32.5	21.5
Ninety-Day Yellow	31.6	24.7



Fig. 6.—Winter barley is a promising grain crop in Southwest Missouri. It is especially useful for early feed before new corn is available. Stark City Experiment Field, 1926.

A Morphological Classification of the Varieties of Soybeans (W. C. Etheridge, C. A. Helm).—About 200 morphological types 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 bloom, testa, cotyledons, and pubescence of the stems and pods provide the principal basis of the classification. Less important distinctions are size and forms 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 growth period sometimes distinguishes an individual variety. For convenience in identification the classification will utilize, so far as possible, characters easily seen at maturity. The clear distinction of agronomic varieties, rather than the arrangement of genetic relationships, has been the aim of this study.

HOME ECONOMICS

JESSIE ALICE CLINE, *Acting Chairman*

Investigation of Baking Qualities of Missouri Flour (Eva Mae Davis, Jessie Alice Cline).—Three million five hundred thousand barrels of flour are used annually in the State of Missouri, but only 15 per cent of this amount is produced within the State. This is due to the fact that soft wheat is produced in Missouri and to the claim that soft wheat flour can not be used for bread-making purposes. Compressed yeast has also been objected to because it is not practical to keep it perfectly fresh in rural districts, and it is also the most expensive kind of yeast.

Dried yeast and liquid yeast have been substituted for compressed yeast, and the results have proved conclusively that excellent bread can be made from soft winter wheat flour using either dried or liquid yeast. The bread made from dried or liquid yeast required more sugar, less yeast, an overnight (12 hours) fermentation period, and yeast food in the form of minerals and acids, furnished by potato water; milk and buttermilk as the liquids; and potato, cornstarch, or scalded flour as forms of gelatinized starch. Excellent bread was also made with liquid yeast using apples and apple water.

Missouri soft wheat flour gave the best results by the straight dough process with the following procedure: (1) a preliminary fermentation period in which the larger part of the sugar, the yeast, the gelatinized starch, and the liquid were allowed to stand at 95° F for from twelve to eighteen hours; (2) sugar, lard, salt, and flour added, and a mixing period of 8 to 10 minutes; (3) a fermentation period of sufficient length to allow the dough to double its volume (about 40 to 60 minutes); (4) a gentle kneading and moulding period of about 2 minutes per pound loaf; (5) a proofing period of sufficient length to allow the dough to treble its bulk in the pan; and (6) a baking period of 35 minutes, during the first 10 minutes of which the temperature is maintained at 350° F. to allow the dough to finish proofing in the oven; and during the last 25 minutes of which the temperature is increased to 410° or 420° F.

Several recipes have been worked out varying the kinds of liquid and gelatinized starch used. All gave excellent results. The bread was com-

parable in every respect, regardless of the different liquids and starches used.

The proportions used were as follows:

Flour	325	grams	.....	3½	cups (sifted)
Potato water	137.5	grams	.....	¾	cup
Sugar	17.2	grams plus	.....	4	tsp. plus
	3	grams		1½	tsp.
Yeast (dried)	3.5	grams	.....	¼	cake
Lard	6.5	grams	.....	1	tsp.
Salt	5.0	grams	.....	1	tsp.
Potato	75.0	grams	.....	1	(medium size)
or					
Scalded flour	16.2	grams	.....	4	tbsp.

Milk or buttermilk (220 grams or ¾ cup) may be used instead of potato water. Best results were obtained by using one-half (110) grams milk, plus one-half (110 grams) potato water.

For potato bread with liquid yeast exactly the same proportions were used except in place of the dried yeast 50.0 grams of liquid yeast were used with 115.0 grams of potato water being necessary to make the dough of the desired consistency.

For apple bread with liquid yeast the following proportions were used:

Flour	325	grams	.....	3½	cups (sifted)
Liquid yeast	50	grams	.....	¼	cup
Apple water	100	grams	.....	½	cup
Apples	75	grams	.....	2	(medium size)
Sugar	17.2	grams	.....	4	tsp. plus
	plus 3	grams		1½	tsp.
Lard	6.5	grams	.....	1	tsp.
Salt	5.0	grams	.....	1	tsp.

The results of these experiments have conclusively shown that light bread can be made from soft wheat flour, using either dried yeast or a starter.

HORTICULTURE

T. J. TALBERT, *Chairman*

Breeding Apples for Late Blooming Habit (A. E. Murneek).—Some 70 of the most promising seedlings have been retained for further observation. The other seedlings have been removed to give room for new material. The most desirable sorts are being propagated on nursery stock. Numerous crosses of some of the late blooming Ingram-Delicious crosses and Daru-Delicious crosses with Jonathan, Delicious and King David have been made.

Peach Breeding for Hardy Varieties (A. E. Murneek).—None of the seedling peaches on the experimental grounds have shown the desired hardiness. The planting has therefore been removed with the exception of one row, which is being used for propagation purposes. Bud wood of new hardy varieties has been secured from a number of northern states and from Canada.

Seasonal differences, however, have interfered with the propagation of this material.

Apple and Cherry Pollination Investigations (A. E. Murneek).—Extensive pollination investigations have been conducted with most of the leading varieties of apples. Either partial or complete sterility seems to be a common condition among apples in some years. Practically all of the main commercial varieties of apples in Missouri have been benefitted by cross-pollination.

The Duke cherries, due to their hybrid condition, are self-sterile. Montmorency, Early Richmond, and English Morello, the three leading sour cherries, are partially self-sterile. The degree of sterility in the sour cherries is evidently caused by environmental factors. All three of these varieties have been found to be inter-fertile.

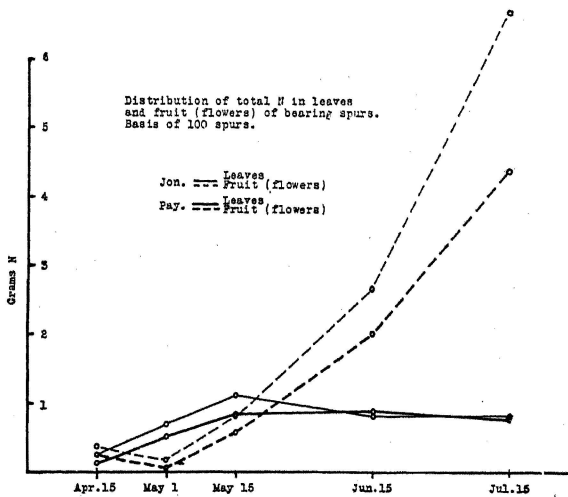


Fig. 7.—Distribution of total nitrogen in leaves and fruit (flowers) of bearing spurs. Basis of 100 spurs.

Physiology of Reproduction in Horticultural Plants (A. E. Murneek).—A study of the nitrogen distribution in organs of the apple spur system has shown that both the percentage and total amounts of nitrogen was exceedingly high in the leaves early in the season. Soon after flowering most of the nitrogen was diverted to the developing fruit. Comparatively small amounts of nitrogen were used by the vegetative extension of the spur. This indicated a keen competition early in the spring between leaves and fruit for the stored or newly elaborated nitrogenous substances.

The seasonal distribution of nitrogen in the shoot complex of apples showed a similar situation, excepting that nitrogen storage was of greater significance than in the spur.

The removal of flowers and very young fruits in the "on" year of biennially bearing trees led to annual fruit bud formation. Fruit thinning after "June drop" has no effect on flower bud formation in the year of treatment.

It has been found of great economic value, however, in increasing the size of fruit.

Metabolic efficiency of the tomato plant was influenced by sexual reproduction, leading to increase in assimilation of soil nutrients and synthesis of organic substances. Excessive reproduction, however, caused a reduction in the development of all vegetative organs of the plant. It interfered, also, with subsequent flower bud development.

Cyclic sterility was conditioned by preceding reproductive activities. This form of sterility has been completely overcome in *Cleome* by the early removal of the developing seed pods. Hence, studies of this and other related forms of sterility should be removed from the field of genetics and put on a physiological basis.

Identification and Study of Factors Determining Hardiness and Methods of Increasing It (H. D. Hooker).—To identify the hydrophilous colloids associated with hardiness, brambles were subjected to treatments that varied the degree of hardiness and the bark was analyzed for pentosans, pectin, protein, and total nitrogen. The procedures for the estimation of pectin and total pentosans previously developed by this Station were used. The percentage of colloiddally bound water was found to be a reliable measure of hardiness in brambles.

A fall cover crop combined with an application of nitrogen fertilizer gave the maximum degree of hardiness. Removal of the first two crops of shoots induced the development of greater hardiness in red raspberry canes.

The Home Orchard: Costs and Returns (T. J. Talbert).—Three-fourths of an acre devoted to such fruits as apples, peaches, cherries, nuts, grapes, blackberries, strawberries, raspberries, currants, and gooseberries was profitable over a six-year period. An accurate and careful record of the production and actual cost, including plants, labor, and materials used, was maintained.

Walnut Grafting Investigations (T. J. Talbert, A. E. Murneek).—Material has been gathered in an effort to adapt the filbert to the climatic conditions of Missouri. The following varieties have been set out: Native Hazel (*C. Americana*), Du Chilly, Merveille de Dolwyller, Red Aveline, Daviana, Nottingham, Turkish Hazel (*C. colurna*), Borcelona, Merribrooke, and Indiana Hazel.

The Nutrition of Fruit Plants (H. D. Hooker, H. G. Swartwout).—A study of the seasonal changes in the chemical composition of shoots and spurs of the sour cherry has been made. Samples were collected from trees in sod, with and without nitrate applications, and from cultivated trees. Analyses showed that in the spring nitrogen moves in considerable amounts into the spurs and the tips of shoots. During the winter sugars decreased and starch increased. In early spring the sugar content decreased and the starch increased. After growth started, the carbohydrates decreased rapidly.

Treatment of Apple Canker Diseases (H. G. Swartwout).—A bulletin on black rot and blister cankers of the apple is in preparation and will soon be available for distribution.

Blister canker at one time was a vital factor in the apple industry of the State. However, it does not now assume the importance that it once had, since the two varieties chiefly affected by the disease—Ben Davis and Gano—are not being planted extensively at the present time; and the light method

of pruning now being used has reduced the damage from this disease materially. Blister canker is a wound parasite, and the light pruning now recommended has greatly reduced the number of new infections.

Investigations with Seed Potatoes (T. J. Talbert and J. T. Quinn).—Certified northern grown potatoes continued to produce more profitable returns than the uncertified northern grown seed. The Irish Cobbler variety withstood the unfavorable weather conditions of 1925 much better than did the Early Ohio variety. Nebraska grown certified Bliss Triumph potatoes produced good yields with a very small percentage of mosaic present in the growing plant. Due to unfavorable weather conditions, potatoes planted April 10 yielded approximately the same as the March 20 planting.

Cabbage Seed Selection for Disease Resistance (J. T. Quinn).—Non-resistant commercial varieties of both late and early cabbage showed infection as high as 92 per cent on the infected plots. A selection from a strain of Copenhagen showed the greatest resistance of the early cabbages. The Wisconsin All-Season and Wisconsin Hollander varieties were the most resistant of the later varieties.

Tomato Seed Selection for Disease Resistance (J. T. Quinn).—Thirty-six different selections of strains and varieties of tomatoes resistant to the tomato wilt (*Fusarium lycopersici*) were tested. New selections were added and some of the less resistant strains were dropped. Norton, Marvel, and Norduke varieties, together with Missouri selections, were the most resistant. The Bonny Best variety from commercial seed, failed to mature a single fruit on wilt-infected soil.

Investigations to Determine the Fertilizer Requirements, Varieties, Cultural Methods, and Seed "Place Effect" of the Watermelon and the Cantaloupe (J. T. Quinn).—It was originally planned to conduct this experiment on a typical melon soil in Dunklin County, Southeast Missouri. In 1925, however, it was carried on to a very limited extent on a Putnam silt loam near Columbia. The Pollock 10-25 cantaloupe was one of the best varieties tested. The starting of cantaloupes in paper and wooden "bands" under glass was proved practicable for the commercial melon-growing districts of Southeast Missouri.

POULTRY HUSBANDRY

H. L. KEMPSTER, *Chairman*

Relation of Time Laying Starts to Future Production (H. L. Kempster).—These studies were made on 1,110 birds, and included the relation of the date of maturity to winter egg production, November 1 to February 28; summer egg production, July 1 to October 31; and annual egg yield, November 1 to October 31. Early laying pullets laid more eggs during the year, especially during the winter and summer. They laid at a slightly faster rate over a period of two months, and continued laying later the following summer. Little, if any, correlation existed between the date of maturity and speed of production as measured by the best month's performance.

Correlation of Sexual Maturity to Annual Egg Production (H. L. Kempster).—A total of 731 birds was used. From this study it was indicated that the rate of maturity was not inherited by the daughter from the dam.

Value of Sour Milk, Beef Scrap, Cotton Seed Meal, Gluten Meal, and Oil Meal in Rations for Egg Production (H. L. Kempster, E. W. Henderson).—White Leghorn hens were fed the following protein concentrates: cottonseed meal, with and without mineral supplement; soybean meal, with and without mineral supplement; tankage, meat scrap, fish meal, and dried buttermilk. In the mineral-supplement pens, 1 per cent salt and 4 per cent bone meal were added to the mash. The basal mash consisted of equal parts bran, shorts, and cornmeal. Various amounts of protein concentrates were added as shown in Table 14. The remainder of the ration was a scratch food consisting of 2 pounds corn and 1 pound of oats.

TABLE 14.—EFFECT OF VARIOUS PROTEIN CONCENTRATES ON EGG PRODUCTION
(For the Year Ending October 31, 1925.)

Pen No. and Ration	Grain per hen per year (lbs.)	Mash per hen per year (lbs.)	Avg. egg production	Feed (lbs.) to produce 1 lb. of eggs
1. Cottonseed meal 30%-----	46.2	19.2	67.6	7.78
2. Cottonseed meal 30% Mineral mixture 4%-----	45	18	125.1	4.04
3. Soybean meal 30%-----	46	19	71.3	7.2
4. Soybean meal 30% Mineral mixture 4%-----	55	15	126	4.47
5. Tankage 20%-----	56	19	122	4.81
6. Meat Scrap 20%-----	58	21	124	5.13
7. Fish meal 20%-----	49.6	18.7	103	5.25
8. Dried buttermilk 30%-----	48	21.	131	4.23

The hatchability of the eggs laid by hens in the various pens is shown in Table 15.

TABLE 15.—HATCHABILITY OF EGGS FROM HENS FED VARIOUS PROTEIN CONCENTRATES

Pen No.	Eggs Incubated	No. Hatched	Percentage hatchability
1	120	37	30.8
2	178	95	53.3
3	116	19	15.4
4	182	105	57.7
5	128	78	60.9
6	132	52	39.4
7	116	66	53.4
8	171	116	67.8

The value of Sour Skim Milk and Beef Scrap in Rations for Growing Chicks, and the Cost of Growing Chicks (H. L. Kempster, E. W. Henderson).—Chick-feeding experiments in which yellow and white corn with and without eggs as a supplement were compared, were conducted. Yellow corn proved superior to white. However, the deficiency of the white corn was corrected by using eggs as a supplement. The mortality in the pen receiving white corn alone was extremely high. The chicks receiving the eggs were more thrifty in appearance than those not receiving eggs.

Nutritional Requirements of Poultry (H. L. Kempster).—In experiments with White Rock pullets, yellow corn to the extent of 56 per cent of the

ration proved superior to similar rations containing white corn. The balance of the ration was bran, shorts, and tankage with grit, oyster shell, and milk *ad libitum*. The birds fed white corn developed nutritional roup two months after being put on the ration, the production being reduced to zero. The trouble was checked by changing to yellow corn. The addition of 4 per cent bone meal and 1 per cent salt to the mash failed to show any beneficial effects. The egg production was not satisfactory due to the absence of the vitamin D factor. When this factor was introduced in the form of ultra-violet exposure with a Quartz Mercury vapor lamp, exposure to direct sunlight, or cod liver oil, the production was more satisfactory. Exposure of adult birds to ultra-violet treatment, however, had apparently little effect on egg production until after the length of exposure was increased from 15 to 25 minutes daily.

On May 5 ultra-violet treatment was started in a pen which had received no light treatment but had received yellow corn from November 29 to May 5. Production increased from 12 per cent to 43 per cent in three weeks' time on this pen. A similar increase (13 per cent to 54 per cent) resulted in another pen when direct sunlight was admitted by removing the windows. This pen had received white corn only. Production was increased in another pen receiving white corn to 44.7 per cent from March 1 to May 30 by the addition of 1 per cent cod liver oil. Additional vitamin A in the form of sweet butter failed to increase production. The pens fed cod liver oil were no better in hatchability than the pens not receiving light.

RURAL LIFE

O. R. JOHNSON, *Chairman*

Farm Management Survey (O. R. Johnson).—Records of the 1924 farm business year were secured as follows: Linn County, 50; Jackson County, 43; St. Charles County, 28; Buchanan County, 165. For the 1925 farm business year, records were secured as follows: Linn County, 50; Jackson County, 35; St. Charles County, 50; Buchanan County, 50; Mississippi County, 30; Scott County, 30; New Madrid County, 30.

Cost of Family Living on the Farm (O. R. Johnson, B. H. Frame).—The influence of net worth, or equity in the farm property, on the standard of living of farm families has been studied. The standard of living rose with an increase in net worth, in two years out of the three. Cash expenses were of relatively greater importance in the low equity group than in the high equity group. This was probably due to the fact that renters were included in the low group.

Marketing Butter (F. L. Thomsen, W. H. E. Reid).—A number of creameries have been visited and arrangements made for obtaining the necessary data. This involved a large amount of work on the part of the creameries, and to date only a few have reported.

Distribution of Farm Labor (O. R. Johnson, B. H. Frame).—Tabulations of man and horse labor on the farm-accounting cooperating farms for the years 1920-1924 have been made. Labor was classified into three groups: labor on livestock, labor on crops, and all other (miscellaneous) labor. The

distribution of man labor on livestock was fairly steady throughout the year. The peak of man labor on crops came in July when corn, wheat, oats, and hay all require attention. The miscellaneous labor was more flexible in time than that on either crops or livestock. The distribution of horse labor was not as regular as that of man labor. This was because a much larger percentage of the total labor was on crops. The peak of both the crop labor and all labor came in May. During corn cultivation and harvest not so many horses are used for each man as when the soil is being prepared and planted.

Farm Cost Accounting (O. R. Johnson, B. H. Frame).—A study of the value of pasture for farm work horses has been made. There was a fairly definite relation between labor and pasture, but the increase in labor with the decrease in pasture was not as great as expected. This indicated that many farmers did not utilize pasture for their work animals as much as they should. There was a decided drop in the feed (other than pasture) fed where pasturage was utilized while horses were not working. Pasture seems to have a very high value for work horses if used in limited amounts, but its value decreases fairly rapidly as the amounts are increased.

Tractor and Other Farm Equipment Costs on the Farm (B. H. Frame, O. R. Johnson).—The tractors on which records were obtained were owned and operated by the farmers cooperating in the regular farm cost accounting work. The net cost, on the basis of horse hours used, was 4.18 cents in 1923, 3.57 cents in 1924, and 4.24 cents in 1925.

Cost of Producing Farm Products Under Farm Conditions (O. R. Johnson, B. H. Frame).—The cost of producing oats in Missouri in 1925 was 52 cents a bushel at the farm; for corn, 67 cents; and for wheat, \$1.47. The average yield of oats was 26.5 bushels; of corn, 29.5 bushels; and of wheat, 13.2 bushels.

The Agricultural and Market Value of Missouri Farm Lands (O. R. Johnson).—The sale value of farm lands has been brought up to date for Texas and Webster Counties. The data from Boone, Adair, and Pike counties had been previously secured. This project is being carried on in cooperation with the Section of Land Economics, Bureau of Agricultural Economics, U. S. Department of Agriculture.

Movements of Rural Population in Missouri (E. L. Morgan).—Movements from farms in the counties of New Madrid, Perry, Ozark, Laclede, Cedar, Johnson, Lincoln, Knox, Grundy, and Nodaway have been studied. All but two of these counties have lost in both total population and rural population during the last two decades. Of 1000 persons who left farms and moved to town, 81 per cent were owners and 19 per cent tenants. They moved an average of eight miles. Of those moving, 12 per cent believed they had lost financially by the move, while 88 per cent believed they had gained. Fifty-nine per cent were regarded as leaders in the communities which they left, 64 per cent held membership in some farm organization, and 70 per cent held membership in the church. Eighty-four per cent left farms which were on improved roads.

Factors Influencing the Effective Location of Rural Groups (E. L. Morgan, B. A. McClenahan).—This study included eight churches, eight schools,

eight libraries, six hospitals, eight farm clubs, eight community centers, six small-town chambers of commerce. Of the unsatisfactory organizations 80 per cent were in towns which lost in total population in the last decade, and which also lost in rural population and experienced a decline in crop yields during the same period. There was strong competition in the work in which the organization was engaged in the case of 91 per cent. Frequent changes in leadership were reported for 54 per cent. Among the successful it was found that without exception the program of work had radically changed during the past three years. It was further observed that these organizations had a rather decided community service point of view in relation to their work.

SOILS DEPARTMENT

M. F. MILLER, *Chairman*

Studies of Water Absorption, Runoff, Percolation, Evaporation, Capillary Water Movement and Soil Erosion Under Field Conditions. (M. F. Miller, H. H. Krusekopf).—The first year's work on the new erosion plots has been completed. This year's work indicated that the steeper slope has a much greater runoff, altho a long slope does not have a correspondingly larger runoff than a short slope. The loss of soil from the corn plots was far greater than from the clover plots.

The effect of cropping and loss of surface soil is becoming more apparent on the old erosion plots. Young plantings are slow to start in the spring on the plot which has been in continuous corn.

The soybean plot, in its third year only, showed little tendency to erode while the crop was on the land. The runoff water was relatively clear and comparable to that from the sod plot. After the crop was removed, however, erosion was more destructive, and resembled that on the other cultivated plots.

Table 16 shows the work on the rejuvenating of eroded soils.

TABLE 16.—REJUVENATION OF ERODED SOILS

Plot	Treatment	Hay yield (2 cuttings)
1 Surface soil removed	Ac. Phos., lime and sodium nitrate	2671 lbs.
2 Surface soil removed.....	No treatment	406 lbs.
3 Surface soil in place.....	No treatment	3809 lbs.

A mixture of clovers and grasses were sown on these plots. The hay on Plot 1 consisted mostly of sweet clover, that on Plot 2 was weedy, while that on Plot 3 consisted largely of grass and alsike clover.

Relatively small amounts of commercial fertilizer greatly increased the productive capacity of eroded land.

Experiments to Determine the Best Systems of Soil Management for the Most Important Soil Types in Missouri (M. F. Miller, H. H. Krusekopf).—Five outlying soils experiment fields have been operated during the past year. As an average of all the fields, the phosphate, potash and lime treatment has increased the 1925 yield of corn and wheat by 16.62 and 12.13 bushels an acre

respectively. For wheat, the phosphate and lime treatment averaged $2\frac{1}{2}$ bushels higher an acre than for manure treatment. Acid phosphate alone gave economic crop returns on most soils. On pasture lands in the Ozark Region, acid phosphate was superior to any other treatment, including manure. Surface reseeding of old pastures with sweet clover was only partially successful, and only when the soil was limed. Sweet clover was more subject to winter-killing by heaving on soils that have tight, heavy subsoils than on soils that have more open and porous subsoils. A rice experiment field near St. Peters in St. Charles County has been established.



Fig. 8.—Clover plots on Eldorado Springs soil experiment field. (Left) No treatment. (Right) Manure, acid phosphate and lime treatment.

An Investigation of the Character of the Colloids in Missouri Clay Soils (R. Bradfield).—A rather definite amount of bases present in the soil can be removed by electro dialysis in a three-compartment cell, equipped with parchment membranes. In most of the soils studied, from 70 to 97 per cent of the total electro dialysable bases were calcium and magnesium. Muck soils were almost totally lacking in dialysable potassium. The amount of anions removed by prolonged dialysis of soils was, in general, less than 5 per cent of the amount of cations removed, indicating over 95 per cent of the cations had been combined with anions too large to pass through the parchment membrane.

Colloidal clay from the Putnam silt loam subsoil from which all acids of crystalloidal dimensions and all dialysable bases had been removed, formed a stable sol with a pH value of 3.4 and a titrable acidity of 74 milliequivalents per 100 g. of oven dry colloid. An acid clay, formed by leaching for several weeks with $n/100$ HCl, then with H_2O until free from chlorides, gave a similar value for the titrable acidity.

This similarity indicated a correlation between the exchangeable base content of soils as determined by the normal neutral salt extraction methods and the content of bases removable by electro dialysis at low current densities. A study of a series of soils, some pure minerals and a permutit of high exchange capacity, indicated that the two methods gave almost identical results.

Crop Rotation and Fertilizer Experiments (M. F. Miller, H. H. Krusekopf).—The wheat crop of 1925 was one of the best ever harvested from Sanborn Field. Seventeen of the thirty-nine plots in the field were in wheat. Plot No. 9, which has been in wheat continually for thirty-seven years without manure or

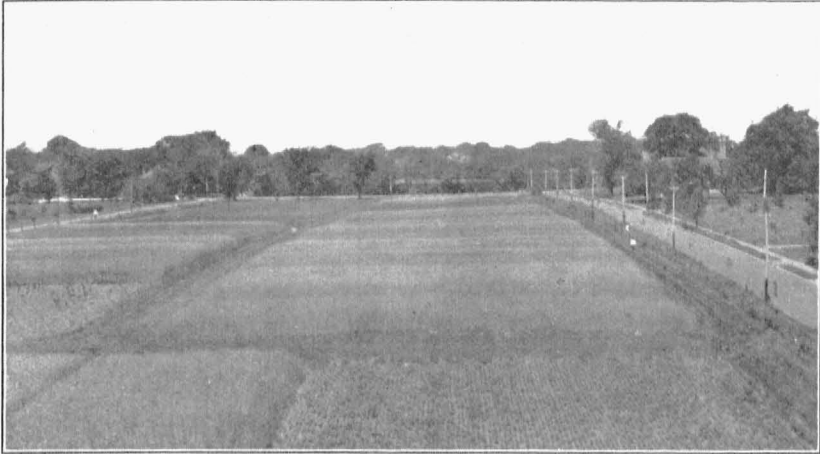


Fig. 9.—View of Sanborn Field, Missouri Agricultural Experiment Station (viewed from the east). The last cropping season represented the 37th year of the experiments.



Fig. 10.—The 37th consecutive wheat crop on Plot 2, Sanborn Field, which yielded 39.1 bushels. This plot in continuous wheat receives heavy annual applications of commercial fertilizer. The average for the thirty-seven crops is 19.09 bushels.

fertilizer treatment, yielded at the rate of $32\frac{1}{2}$ bushels an acre, a most remarkable yield considering the plot's history. These results clearly indicated the very marked influence of favorable weather conditions on wheat yields. The plots receiving manure yielded between 30 and 40 bushels, while the continuous

wheat plot, which has received a heavy application of commercial fertilizer each year, yielded 39.1 bushels. This is also a most remarkable yield, considering the fact that it was the thirty-seventh consecutive wheat crop on this land. The average yield of this plot for the thirty-seven years has been approximately 19 bushels. The continuous wheat plot receiving barnyard manure at the rate of 6 tons an acre annually yielded 31.2 bushels, a lower average than the untreated plot because of lodging. The average of this plot for the thirty-seven years has practically equalled that receiving heavy applications of commercial fertilizer. The straw yields of the manured wheat plots were about 500 pounds higher than the one receiving commercial fertilizer. The manured plots have generally shown more lodging than the fertilized plots, thus somewhat curtailing the weight of grain.



Fig. 11.—View of the plots on which the investigation of the carbon and nitrogen accumulation is being conducted.

The Rate of Accumulation and Cost of Nitrogen and Carbon in Soils Under Different Systems of Green Manuring and Cropping (M. F. Miller, H. H. Krusekopf).—The plots of this experiment were carefully sampled in 1925, the eighth year since the beginning of the investigation. The sampling of the surface soil was taken to a depth of seven inches and the subsurface from seven to twelve inches, the two together making up the surface foot. In the surface seven inch samples in continuous clover, left on ground; continuous blue grass, clipped and left on ground; and continuous alfalfa, cut and removed; the nitrogen was slightly increased. All other plots had lost nitrogen to a measurable degree, particularly the continuous rye and the corn, wheat, clover rotation, even when manured. When the subsurface samples were considered, all plots have lost nitrogen under every system. The largest loss was in the case of continuous rye plowed under, and the least under continuous sod.

The Effect of Different Amounts and Different Methods of Applying Commercial Fertilizer on the Corn Crop (M. F. Miller, H. H. Krusekopf).—The rotation for the experiment in fertilizing corn has been one of corn and soybeans. Owing to the fact that the land was quite low in organic matter and

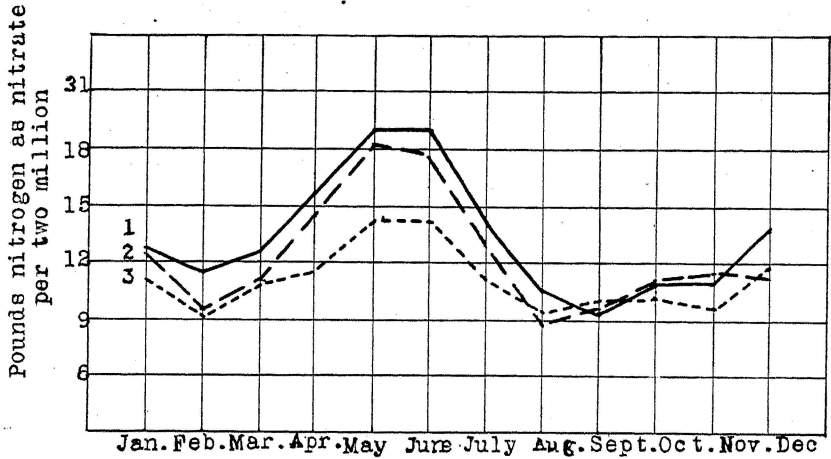


Fig. 12.—Nitrates in soil under corn, as influenced by spring plowing and cultivation. (1) Spring plowed, cultivated 3 times. (2) Spring plowed, surface scraped. (3) Surface scraped, not spring plowed. Curves represent 6-year monthly averages.

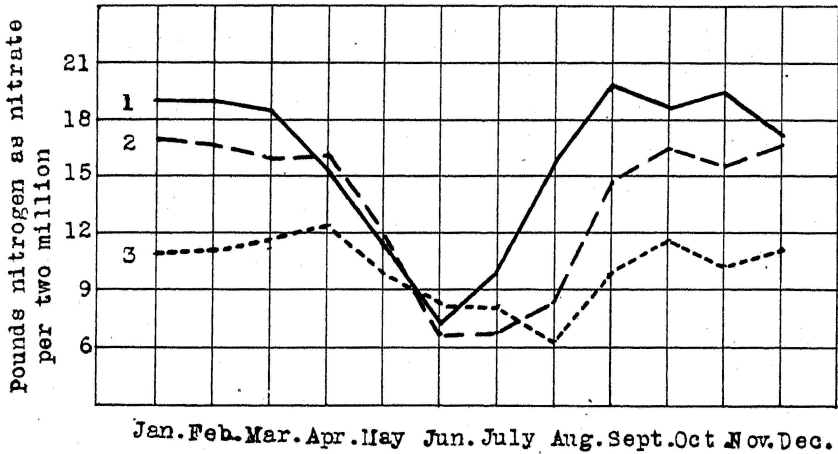


Fig. 13.—Nitrates in soil under wheat as influenced by date of fall plowing. The date of plowing starts the nitrates upward. (1) Plowed July 15. (2) Plowed Aug. 15. (3) Plowed Sept. 15. Curves represent 6-year monthly averages.

nitrogen, it was changed to a two-year system of corn and a small grain, followed by sweet clover turned under in the spring for corn. The year 1925 was the first one when the results of turning under the sweet clover were obtainable. Results were quite remarkable, giving an average yield for all plots, both fer-

tilized and unfertilized, of 58.2 bushels an acre, while the average of all plots for the eight years preceding was but 28.37 bushels. The fertilizer treatments averaged 12.8 bushels more than the unfertilized plots. This average was higher than that of the best fertilizer treatment for the eight preceding years. The small amount of nitrogen applied in 300 pounds of a 2-10-2 fertilizer, which was the largest nitrogen addition in any case, was not large enough to be of much significance on land of such a low nitrogen content, even when soybeans were grown and removed on alternate years. When a sweet clover crop, carrying over 100 pounds of nitrogen, was turned under, nitrogen was no longer the most important limiting element and the phosphorus of the fertilizer gave a large increase in yield.

An Experiment for the Purpose of Determining the Proper Fineness of Grinding the Limestone (M. F. Miller, H. H. Krusekopf).—Lime requirement determinations have been made on a series of small plots to which 10-mesh ground limestone was applied ten years before. Some of these plots were limed to neutrality or heavier in the surface eight inches, others to neutrality in the subsoil 8 to 18 inches, others had both layers neutralized, while still others were unlimed.

All layers were again acid except the surface layer (0 to 8 inches) where the limestone was applied heavily. There has been little tendency for the lime applied to the subsoil to move downward into the underlying layers, although there has been a tendency for this to move upward where the surface layer was unlimed.

On another series of plots where limestone was applied to the surface soil 5 years preceding (1921) at rates varying from 2 to 24 tons an acre, the surface soil of the plot receiving a 2-ton application showed marked acidity, that receiving the 4-ton application slight acidity, while all the others were neutral. The subsoil (8 to 18 inches) in all limed plots, however, showed approximately the same degree of acidity as the untreated plot.

Studies on the Longevity of *B. Radicicola* in the Soil. (W. A. Albrecht).—Final duplications were carried out on the last remnants of dry soils to verify the results indicating that the legume bacteria were no longer living in the dry soils after five or more years. Soils left out-of-doors were also tried again and produced nodules. The data of nodule productions as given by the various tests are assembled in Table 17 and indicate that the longevity differs little whether or not the soil is fertilized and gives some suggestion of the possession of greater longevity by the red clover organism than by the soybean organism.

Effects of Different Soil Treatments, Long Continued, Upon Bacterial Activity in the Soil (W. A. Albrecht).—Ammonia and nitrate production studies were started on soils from the plots in a six-year rotation, using the check, or no treatment plot, and the plot which received about 6 tons of manure an acre annually from 1889 to 1913 inclusive and from then, the equivalent of 3 tons annually along with two applications of acid phosphate a rotation. The rotation consisted of corn, oats, wheat, clover, timothy and timothy. Manure was applied at the rate of 8 tons an acre before the corn and 5 tons before both the wheat and the second crop of timothy. The acid phosphate was used at the

TABLE 17.—LONGEVITY OF LEGUME BACTERIA OF SOYBEANS AND RED CLOVER

		Time of Test in Years After Drying Soil							
		1	2	3	4	5	6	7	
Soil	No Treatment	Dried-Sun	### ***	### ***	### ***	### o	o o	o o	o o
		Dried-Dark	## ***	## ***	o ***	## o	o **	o o	o -(b)
		Undried	### ***	### ***	### ***	-(a) ***	-(a) o	### ***	### ***
No. 1	Fertilized	Dried-Sun	### ***	### ***	### ***	## **	# *	o o	o *
		Dried-Dark	### ***	### ***	### ***	### **	o *	o o	o
		Undried	### ***	### ***	### ***	## **	### ***	### ***	### ***
Soil	No Treatment	Dried-Sun	### ***	### ***	# ***	# (a) ***	o *	o o	o -
		Dried-dark	### ***	### ***	# ***	# ***	o *	o o	o o
		Undried	### ***	### ***	### ***	# # (a) **	o **	### ***	### ***
No. 2	Fertilized	Dried-Sun	### ***	### ***	### ***	o ***	o **	o o	o -
		Dried-Dark	### ***	### ***	# ***	o ***	o **	### o	o -
		Undried	### ***	### ***	### ***	## **	- ***	### ***	### ***

Legend: # indicates Soybeans
 * indicates Red Clover
 ### or *** indicate Nodules on all plants in test
 ## or ** indicate Nodules on more than half of plants
 # or * indicate Nodules on less than half of plants.
 o indicates No nodules present.
 (a) indicates Plants injured by damping off disease
 (b) indicates None of soil left for test

Time of test represents years after drying soil or 1/2 year longer in each case since the crop was grown on soil.

rate of 300 pounds an acre with the corn and wheat. Liming helped nitrate accumulation markedly in the case of the plot with no treatment, but not so markedly in the plot receiving manure and phosphate. The use of either green manure only, or limestone only, was less helpful in nitrate accumulation on

the untreated plot than on the manured plot, suggesting that soil treatments on the better land may sometimes be more helpful than on poorer land. General nitrogen accumulation activities were at a higher level where the manure and phosphates were used than where no treatment was applied.

Nitrate Production in a Soil as Affected by the Crop and Cultivation (W. A. Albrecht).—Six years' study showed the following effects of the crops and cultivation on nitrate accumulation in the soil. Under a sod crop the nitrate accumulation followed closely the moisture supply or rainfall curve with a very low supply of nitrates at all times. Under wheat, the nitrates present in the soil showed an inverse relation to the rate of crop growth. The decrease in nitrates occurred from March to June while the wheat was growing rapidly and then an increase followed until October. The degree of exhaustion of the nitrates by wheat went very low. Under corn the relation was again inverse to the crop growth corresponding to a different part of the season than for wheat. Under corn, the nitrates increased from March to May or June, decreased from June to August and then increased later. The degree of exhaustion did not go as low under corn as under sod or wheat. Plowing with the mold board plow favored nitrate accumulation significantly whether in the spring or fall season. In fall plowing for wheat the earlier date of plowing gave greater nitrate content. Ordinary surface cultivation with the standard 8-shovel cultivator increased the nitrate accumulation.

VETERINARY SCIENCE

J. W. CONNAWAY, *Chairman*

Infectious Abortion Investigations (J. W. Connaway, H. G. Newman, Andrew Uren).—*Studies on Percentage of Abortion Reactors in Cattle Herds.* Serological tests for *B. abortus* (Bang) antibodies were made on 142 cattle herds. One hundred six herds showed positive reactors. The 36 herds which were negative were known to be free from the Bang abortion disease, but were re-tested for check purposes. The total number of animals included in the investigation was 2,268 head. The number of positive reactors was 710, or 31.3 per cent. During the past ten years more than fifteen thousand serological tests for abortion disease have been made, and the averages for the ten-year period were 30.22 per cent positive.

These data can not be taken as a basis for estimating the extent of abortion disease in the herds of the State, since only those herds were tested in which abortion was suspected.

Persistent Positive Reaction an Evidence of Persistent Infection. Five cows infected with the Bang abortion organism in 1918 continue to produce specific *B. abortus* antibodies. The living organisms are still harbored in the udder. It has been concluded that a positive reaction for *B. abortus* (Bang) antibodies is evidence of the presence of the living organisms of this infection in the reacting animal.

Infectiousness of Full-term Afterbirths from Abortion Reactors. Two non-reacting pregnant cows were fed a half-portion each of a full term afterbirth from an abortion reacting cow. The afterbirth showed no areas indicating disease. One of the cows aborted, but did not develop a reaction to the abortion test.

The other cow calved normally. Another cow, in the same experimental herd, and which had not been fed any placental tissue, also aborted without showing any reaction to the abortion test. These cows had been kept on an alfalfa ration during the winter, no grain being fed. The unbalanced ration is regarded as the cause of the premature calving in the two cases reported. Previous attempts to produce abortion by feeding apparently healthy afterbirths from abortion reactors did not cause abortion. In two instances, however, the serological reactions were produced. The indications are that the afterbirths from abortion reactors may vary greatly in their pathogenic properties, the more healthy in appearance the less dangerous.

Abortions and Sterility Associated with Grainless Rations. The experimental herd has been allowed to run on a large pasture during the entire year. During the spring, summer, and autumn they have an abundance of bluegrass pasture, while in the winter they are fed alfalfa hay of second grade quality. No grain has been supplied.

From thirteen breeding cows six living calves were produced; four abortions; two doubtful conceptions; and one failure to conceive from chronic disease. It is not certain that the conditions reported were due to nutritional deficiencies from lack of a grain ration. However, it can be stated with considerable assurance that the Bang abortion organism was not responsible for the abortions that occurred in this experimental herd.

Infectious Abortion in Swine. The experimental herd in this investigation contained 26 sows and 1 boar. Five of these sows were acquired in the winter of 1919-1920 and all have shown a positive reaction to the serological tests for abortion disease. All of these sows farrowed during the year. The pigs showed a positive reaction after nursing the colostrum milk. During the greater part of the year the blood reactions from these sows were negative at the monthly test. There has evidently been a great mitigation in the virulency of the infection with the increase of the age of these sows. The other 21 sows of the herd and the boar are progeny of the original herd; no new animals have been added from outside sources. In this group of younger sows only one became a persistent reactor after reaching sexual maturity. This sow did not farrow during the year, although bred a number of times. Of the remaining twenty non-reactors, ten were bred and farrowed litters of living pigs. The blood and colostrum milk of six sows were negative for *B. abortus* antibodies, and the blood of all their pigs was likewise negative to the test after nursing. The other four sows, and some of their offspring showed positive reactions in some form. Apparently the udder is a favorite and very persistent habitat of this infection, whether virulent or greatly mitigated.

No premature farrowings occurred during the year. Six sows, however, produced very small litters, from one to four pigs. These might be classed as "partial aborters."

Experiments to Determine the Efficacy of Intravenous Injections of Drugs to Destroy the Bacillus abortus (Bang) in the Infected Animal. In recent years certain drugs, for instance, mercurochrome and acriflavines, have given good results in human practice in combating blood infections.

An attempt is being made to test the value of mercurochrome for combating Bang abortion infection. Three cows and one bull, all infected with the abortion

disease, have had repeated injections of mercurochrome. At the present time a total of three doses has been given. No results are available yet on this project.

Poultry Disease Investigations (A. J. Durant).—*Entero-Hepatitis in Turkeys*. The protozoan parasite *ameba meleagridis* is generally regarded by poultry pathologists as being the cause of "blackhead" or entero-hepatitis in turkeys. The lesions characteristic of the disease are found in the cecal pouches and in the liver. Apparently the primary invasion of the ameba occurs in the cecal pouches. Therefore if the cecal pouches could be removed by surgical operation, with safety to the bird, the principal access of the blackhead ameba would be removed. An attempt was therefore made to extirpate the two ceca after ligating the neck at junction with the main gut. The attempts at surgical removal were not very encouraging. A simpler operation, which effectually cut off the connection of the two ceca with the main gut was found to be successful; namely, the ligation of the neck of each cecum, without disturbance of the mesenteric attachments. It was found that this "abligation" of the ceca, and their retention in the body caused only a slight and temporary disturbance to the health of the bird. Moreover, the ligation ultimately resulted in completely severing the ceca from the main gut without leakage from the stump ends. The operation has been made at the site of caponizing on the left side of the bird and requires but little more time than the caponizing operation. In developing the technic a number of birds have been sacrificed to determine the purely surgical results. Out of 63 turkeys operated upon 43 died, but in no case was there any evidence of blackhead present in the liver or in the ceca of any turkey in which the surgical technic had completely cut off the passage from the main gut into the cecal pouches. Two poults which had been operated on died of blackhead, but an autopsy showed that the ligature had evidently loosened on one of the ceca of each bird, and the connection with the main gut had been re-established.

A group of twelve abligated poults and five controls were exposed to badly infected grounds for four months. None of the abligated birds have shown any evidence of blackhead. An autopsy has been made on five of the abligated birds, three of which had died from tape-worm infestation, one from roup, and one from accident. Three of the five control birds have died, showing well marked lesions of blackhead.

Treatment of blackhead in turkeys with fluid extract of ipecac has been recommended for a number of years. Seventy turkeys, all apparently in the advanced stages of blackhead, were treated with the fluid extract of ipecac. Twenty-eight of the sick birds recovered. The efficiency of this drug is probably better than shown by these data, since many of the turkeys were almost dead when received for treatment.

Fluid extract of ipecac, if given continuously, will prove fatal, since it is very toxic. However, if given in broken periods of treatment good results will be obtained.

Inherited Inco-ordination of Muscles in Newly Hatched Chicks (A. J. Durant).—This disease was first reported in the eastern part of Missouri in 1922. The condition may be described as a muscular inco-ordination of the head and neck of newly hatched chicks. It is characterized by a "palsy" or

short jerky motion of the head. In some cases the head may be drawn backward until it rests on the top of the back. Or again the head may be drawn to one side as in a case of wry neck. In the most extreme cases of this nature the chicks will topple over backward and are able to sustain their equilibrium only by bracing the body against some object. Excitement or sudden noises or movements increase the severity of the symptoms.

Chicks showing signs of this disease appear normal otherwise and will make efforts to eat, but without success. All chicks that exhibit symptoms die from starvation.

The disease is transmitted almost exclusively by the male birds and from fourteen to fifteen per cent of chicks hatched from matings with males carrying this disease character will be visibly affected. The removal of the male birds carrying this disease character practically eliminates the disease.

The disease has been carried through three generations, and birds, both males and females, are available for further studies.

FINANCIAL STATEMENT

University of Missouri Agricultural Experiment Station

In account with

The United States Appropriations, 1925-1926

Dr.		Hatch Fund	Adams Fund	Purnell Fund
To balance from appropriations for 1924-1925		\$-----	\$-----	\$-----
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1926, under acts of Congress approved March 2, 1887 (Hatch Fund), March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund)		15000.00	15000.00	20000.00
Cr.				
	Abstract			
By salaries	1	\$8840.14	\$4074.31	\$11225.47
Labor	2	2291.62	3341.76	3263.86
Stationery and office supplies	3	187.22	116.61	205.62
Scientific supplies, consumable	4	131.36	1797.04	304.91
Feeding stuffs	5	1795.60	3224.51	1434.02
Sundry supplies	6	719.27	520.77	623.59
Fertilizers	7	-----	25.75	-----
Communication service	8	25.89	.90	195.00
Travel expenses	9	3.00	41.63	911.04
Transportation of things	10	36.22	291.73	193.98
Publications	11	-----	(Omit)	44.98
Heat, light, water, and power	12	67.44	153.85	-----
Furniture, furnishings, fixtures	13	255.76	171.88	391.57
Library	14	-----	34.50	10.07
Scientific equipment	15	-----	521.88	83.64
Livestock	16	493.00	138.50	-----
Tools, machinery, and appliances	17	127.57	297.49	451.86
Buildings and land	18	25.91	246.89	658.34
Contingent expenses	19	-----	-----	2.05
Balance				
Total		15000.00	15000.00	20000.00

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, 1926; 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 \$15000.00 under the act of Congress of March 2, 1887, \$15000.00 under the act of Congress of March 16, 1906, and \$20000.00 under the act of Congress of February 24, 1925 and the corresponding disbursements, \$15000, \$15000, and \$20000; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of None, None, and None, respectively.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts.

(Signed) EDWARD E. BROWN,

Attest: LESLIE COWAN
Custodian of the Seal.

Business Manager Acting as Auditor
for Curators University of Missouri.