

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

BULLETIN 210

# CONTRIBUTIONS TO KNOWLEDGE IN AGRICULTURE

One Year's Work, Agricultural Experiment Station

(Report of the Director; July 1, 1922 to June 30, 1923.)

“Take interest, I implore you, in those sacred dwellings which one designates by the expressive term: LABORATORIES. Demand that they be multiplied, that they be adorned: these are the temples of the future—temples of well-being and of happiness. There it is that humanity grows greater, stronger, better.”

—Louis Pasteur

COLUMBIA, MISSOURI

FEBRUARY, 1924

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COLLEGE OF AGRICULTURE  
Agricultural Experiment Station

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June, 1923

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E. E. BROWN, Business Manager.

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

To His Excellency,  
HONORABLE ARTHUR M. HYDE,  
*Governor of Missouri.*

Sir:

In accordance with the Federal law requiring that the Director of the Experiment Station report annually to the Chief Executive of the State, I have the honor to transmit herewith a report of the work of the Agricultural Experiment Station of the College of Agriculture for the year ending June 30, 1923.

Respectfully submitted,

F. B. MUMFORD,

*Director.*

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# Contributions to Knowledge in Agriculture

(By The Missouri Agricultural Experiment Station)

F. B. MUMFORD, *Director*

The following pages of this report give evidence of industry and successful achievement in every department of the Experiment Station. The demand upon the resources of the institution for exact information on many and complicated problems of agriculture has greatly increased. Peculiar conditions which have caused widespread agricultural distress have imposed upon the farmer the immediate need of developing more economic methods of production, of replanning his systems of farming, and of proceeding with confidence and assurance with those plans through the help of the exact knowledge accumulated by long years of research in the Agricultural Experiment Station.

There is a widespread opinion among teachers and investigators that the very rapid development of agricultural extension work has in itself imposed upon the experiment station a greatly increased burden. The more rapidly the results of our investigations are carried directly to the farmers, the more insistent they become in requiring that all their problems be solved and that the Experiment Station answer the important questions which are of such vital significance to the farmer in his business.

Unfortunately the development of extension activities has been very much greater than has been the development of the resources of the experiment stations. The result of this condition is that the Experiment Station finds itself embarrassed because of its inability to promptly direct the work of its scientific investigators to new problems as they arise.

It is also true that as the agriculture of a region becomes older the difficulties increase. All injurious plant and animal diseases increase in extent and in virulence. The soil becomes more and more depleted and the problem of soil conservation becomes more expensive and requires greater skill. The soil may become infected with substances poisonous to particular plants. It may also become infected with the germs of dangerous diseases. As the systems of livestock farming become more intensive, and a larger number of animals are kept in a confined space, the more difficult it becomes to guard against dangerous and devastating animal diseases. The need of continuous scientific research in order to determine the best means and the most successful methods of eliminating these handicaps to a prosperous agriculture increases, therefore, as the agriculture of a country becomes older. The time will never come when a successful agriculture can be long maintained without continuous and extensive scientific research.

But the problems of the farmer are not alone problems of production. It becomes increasingly apparent that marketing of farm products, orderly distribution,

transportation, and world markets are vitally connected with the farmers' success. The agricultural experiment stations have devoted the major portion of their time and energy to the solution of problems of production. They have been markedly successful in this field. Careful investigation by trained economists can render as great, or perhaps a greater, service to the farmer in the solution of his broad-economic problems in which he is now properly demanding guidance.

It is also apparent that a successful agriculture is intimately associated with such questions as land utilization and land taxation. Little attention has been given to the field of land economics in all of its bearings, and in this field lies a great opportunity for service to agriculture. The agricultural experiment stations have been unable to enter this field because the appropriations of the Hatch and Adams Acts have apparently restricted their operations to problems of production. Recognizing this fact, there has recently been introduced in Congress by Hon. F. S. Purnell of Indiana, a bill providing funds which may be used for investigations in agricultural economics. The bill provides:

"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 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."

Under the provisions of this bill it will also become possible for the experiment stations to extend their researches into the field of home economics and rural community development, both of which are fundamental to a permanently prosperous and efficient rural civilization.

It is of the utmost importance to the agricultural industry that the whole subject of agricultural economics receive the same thorough investigation by as carefully trained investigators as has been given to such subjects as soils, field crops, animal husbandry, dairy husbandry, and other subjects. In order to make these investigations the resources of the Station must be greatly increased.

The achievements of the agricultural experiment stations of the United States have been noteworthy and have won for them the confidence and support of the Federal and State Governments. They have also won the confidence and approval of the farmers themselves.

The need for the kind of service which the Agricultural Experiment Station is able to render is very urgent at the present time. Agriculture is entering upon a new era. Recent experience has demonstrated that it cannot survive permanently under present conditions. New methods, new systems, new plans must be evolved. The farmer himself cannot afford to experiment. It is the duty and opportunity of the Agricultural Experiment Station with adequate resources available, to undertake the solution of these great problems and to guide the farmer in his earnest endeavor to new and better conditions, which shall result in better standards of living, more satisfactory conditions in the rural community, and a great development of cooperation among farmers for the improvement of his economic, intellectual, and social condition.

#### COOPERATION WITH OTHER AGENCIES

**Seed Testing Laboratory.**—The Agricultural Experiment Station conducts a regional seed testing laboratory in cooperation with the United States Department of Agriculture. During the past year it has also cooperated with the Missouri State

Board of Agriculture in making the analyses necessary under the Missouri Seed Testing Law.

**Cereal Investigations.**—The Department of Field Crops is cooperating with the Bureau of Plant Industry in important investigations having for their purpose the improvement of varieties of field crops.

**Beef Cattle Survey.**—An interesting and valuable survey of the cattle feeding enterprise has been conducted by the Departments of Farm Management and Animal Husbandry in cooperation with the Bureau of Animal Industry of the United States Department of Agriculture. These surveys have resulted in giving very exact information as to the success of the methods of cattle feeding in Missouri.

**Soil Survey.**—Through the long-time and satisfactory cooperation of the Agricultural Experiment Station with the Bureau of Soils of the United States Department of Agriculture, more than half of all the counties in Missouri have been surveyed and the soil areas mapped. The Bureau of Soils has in all but two cases printed the results of these surveys in bulletin form for distribution.

### COOPERATION WITH THE STATE BOARD OF AGRICULTURE

The College of Agriculture has cooperated with the Missouri State Board of Agriculture in the holding of Farmers' Week. The particularly valuable cooperation of the State Board of Agriculture consists in furnishing eminent speakers for the evening program of Farmers' Week and in giving wide publicity to the event.

The State Board of Agriculture has also cooperated with the Station in the conduct of the Seed Testing Laboratory.

### CHANGES IN STATION STAFF

#### APPOINTMENTS

- RICHARD BRADFIELD, *Assistant Professor of Soils.*  
WAVERLY P. HAYS, *Assistant in Dairy Husbandry.*  
E. S. LLOYD, *Deputy Nursery Inspector.*  
J. T. QUINN, *Instructor in Horticulture.*  
W. C. BONEY, *Assistant in Agricultural Engineering.*  
A. M. BURROUGHS, *Instructor in Horticulture.*  
H. M. HARSHAW, *Instructor in Agricultural Chemistry.*  
J. L. NIERMAN, *Assistant in Agricultural Chemistry.*  
I. T. SCOTT, *Assistant in Plant Pathology.*  
T. J. TALBERT, *Professor of Horticulture.*  
NEELY TURNER, *Assistant in Entomology and Deputy Nursery Inspector.*  
R. E. UHLAND, *Assistant in Soils.*

#### RESIGNATIONS

- F. C. BRADFORD, *Assistant Professor of Horticulture.*  
V. R. GARDNER, *Professor of Horticulture.*  
A. C. HILL, *Assistant in Field Crops.*  
E. F. HOPKINS, *Assistant Professor of Botany and Plant Pathology.*  
J. T. ROSA, JR., *Assistant Professor of Horticulture.*  
W. W. SWETT, *Associate Professor of Dairying.*  
E. S. LLOYD, *Deputy Nursery Inspector.*  
C. R. MOULTON, *Professor of Agricultural Chemistry.*

## PUBLICATIONS

Results of investigations conducted by the Agricultural Experiment Station are reported in three series of publications—bulletins, research bulletins, and circulars.

**Bulletins.**—Each bulletin is a definite report on some specific investigation. The results are so presented as to be readily understood by the farmer, and the methods by which the results were accomplished are recounted. Ten of these were printed or reprinted during the year ending June 30, 1923, as follows:

No.	Title	No. Pages	Edition Printed	Total No. Pages
187	Infectious Abortion in Swine (Reprint).....	28	5,000	140,000
196	Roup in Fowls.....	12	3,000	36,000
197	New Knowledge.—One Year's Work, Agricultural Experiment Station.....	96	7,500	720,000
198	Spraying Irish Potatoes.....	8	7,000	56,000
199	Cooperative Live Stock Shipping Associations in Missouri.....	12	2,000	24,000
200	Testing Fertilizers for Missouri Farmers: 1922.....	52	6,000	312,000
201	The Practical Control of Infectious Abortion in Cattle.....	12	10,000	120,000
202	Soil Experiments on the Gravelly Ozark Upland....	24	10,000	240,000
203	Soil Experiments on the Brown Silt Loam of the Border Ozark Region.....	24	10,000	240,000
204	Controlling Soil Moisture for Vegetable Crops in Missouri.....	12	5,000	60,000

**Research Bulletins.**—These are detailed scientific reports of investigations presenting technical information for the investigator or the man well advanced in agricultural knowledge. Nine numbers in this series were issued as follows:

No.	Title	No. Pages	Edition Printed	Total No. Pages
52	Scarred Endosperm and Size Inheritance in Kernels of Maize.....	12	2,000	24,000
53	The Relation of Temperature to Blossoming in the Apple and Peach.....	52	2,000	104,000
54	Studies in Animal Nutrition—II. Changes in Proportions of Carcass and Offal on Different Planes of Nutrition.....	76	2,500	190,000
55	Studies in Animal Nutrition—III. Changes in Chemical Composition on Different Planes of Nutrition.....	88	2,500	220,000
56	Observations on Winter Injury.....	28	2,000	56,000
57	Studies in the Nutrition of the Strawberry.....	32	2,000	64,000
58	Scale Insects of Missouri.....	80	2,000	160,000
59	Animal Nutrition—IV. The Nitrogen Distribution in Beef Flesh As Affected by Age and Condition.....	72	2,500	180,000
60	The Chemical Nature of a Colloidal Clay.....	60	2,000	120,000

**Circulars.**—The circulars are popular reports of experimental results, or a summarization of the best information extant. They apply to the everyday problems of the Missouri farmer. Seven numbers in this series were printed or reprinted during the year.

No.	Title	No. Pages	Edition Printed	Total No. Pages
65	Advantages from Use of Purebred Ram (Reprint)	12	4,000	48,000
107	Winter Injury of Fruit in Missouri.....	8	6,000	48,000
108	Durability of Fence Posts.....	4	4,000	16,000
109	Controlling San Jose Scale.....	4	10,000	40,000
110	The Missouri Colony Brooder House.....	2	10,000	20,000
111	Feeding for Egg Production.....	12	15,000	180,000
112	Controlling Peach Tree Borers With Paradichloro- benzene.....	4	8,000	32,000
Total (Bulletins, Research Bulletins and Circulars).....		826	142,000	3,450,000

**Distribution.**—Letters received daily by the Agricultural Experiment Station asking for bulletins and circulars have continued to increase in number until the number of bulletins and circulars mailed out in response to these direct requests frequently reached 1,000 a day. In addition to this, all publications as soon as issued were mailed to all public libraries and to all agricultural teachers and investigators in the State. Many bulletins and circulars were supplied to students in the 80 vocational agriculture high schools of Missouri, and thousands more were distributed by county agents to farmers asking for them.

#### ADDITIONAL INFORMATION SERVICE

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

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

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

#### SYNOPSIS OF NEW PUBLICATIONS

**Roup in Fowls**, A. J. Durant (Missouri Agr. Exp. Sta. Bul. 196 (1922) pp. 2-12, figs. 2).—Roup is defined as a contagious or infectious disease in all classes of poultry, its symptoms are described, and methods of prevention and treatment are given. The practice of vaccination for the prevention of roup is discouraged, the experimental vaccination of approximately 4,000 fowls is reported and a review of literature is appended.

**New Knowledge; One Year's Work of the Agricultural Experiment Station,** F. B. Mumford, Director, (Missouri Agr. Exp. Sta. Bul. 197 (1922), pp. 3-95, figs. 17.)—In this publication the Director of the Experiment Station reports in detail the progress made in agricultural investigations during the year ending June 30, 1922. An account is given also of the several service projects administered by the Station, as well as a review of its publications, and a statement of its receipts and expenditures.

**Spraying Irish Potatoes.** J. T. Rosa, Jr., (Missouri Agr. Exp. Sta. Bul. 198 (1923), pp. 2-8, figs. 3).—This publication reports two years' experiments in the use of bordeaux mixture and arsenate of lead to control common and black scab and to kill insects. Results in 1921 and 1922 are reported as indicating that spraying is beneficial to the Irish Cobbler variety, but not to Early Ohio. Vines of latter variety when kept green by spraying produce, through second growth, many misshapen tubers that are unmarketable.

**Cooperative Live Stock Shipping Associations in Missouri,** Ralph Loomis (Missouri Agr. Exp. Sta. Bul. 199 (1923), pp. 3-10). This report traces the development of cooperative livestock shipping in Missouri from the first shipment from Boone County in 1911 to the successful operation of 275 organizations in the State in 1921. Costs of operation are reported and the amount of savings estimated.

**Testing Fertilizers for Missouri Farmers; 1922,** F. B. Mumford and L. D. Haigh (Missouri Agr. Exp. Sta. Bul. 200 (1923), pp. 3-51, fig 1.) This publication is a report of the analyses of 344 official samples representing 148 brands of commercial fertilizers offered for sale in Missouri. The brands and guaranteed analyses of fertilizers registered for sale in Missouri in 1922 are listed. Violations of the Missouri Fertilizer Law are definitely reported. Reports are given also of the testing of 683 samples of native limestone submitted by Missouri farmers.

**Practical Control of Infectious Abortion in Cattle,** J. W. Connaway (Missouri Agr. Exp. Sta. Bul. 201 (1923), pp. 2-11). This report, based on the results of investigations of this Station and a careful review of literature, is a businesslike presentation of "facts of practical utility that can be used in the prevention and eradication of this disease". In twenty-two numbered paragraphs are stated the essential facts about infectious abortion in cattle; and under sixteen similar divisions are enumerated the practical measures for prevention and control.

**Soil Experiments on the Gravelly Ozark Upland,** M. F. Miller and F. L. Duley (Missouri Agr. Exp. Sta. Bul. 202 (1923), pp. 2-22, figs. 13). In this bulletin are reported the Station's investigations on the Willow Springs experiment field in Howell County, the soil type being Clarksville gravelly loam. The experiments reported extended through a period of seven years, from 1916 to 1922, inclusive. Experimental evidence is presented indicating that dairy and poultry farming along with small fruits offer better opportunities than grain or general farming on this soil type. Results of a variety of soil treatments with four separate crops—corn, soybean, wheat, and clover—are reported in detail.

**Soil Experiments on the Brown Silt Loam of the Ozark Border Region,** M. F. Miller and F. L. Duley (Missouri Agr. Exp. Sta. Bul. 203 (1923), pp. 2-24, figs. 7) In this bulletin are reported the results of ten years of experiments on the Union silt loam of the Border Ozark Region as typified near Union, Franklin County. The results show the effect of various treatments of this soil on the yield of five different crops—corn, wheat, soybeans, cowpeas, and clover. The report covers results from 1913 to 1922, inclusive.

**Controlling Soil Moisture for Vegetable Crops in Missouri,** J. T. Rosa, Jr., (Missouri Agr. Exp. Sta. Bul. 204 (1923), pp. 2-8, figs. 3). The effects of irrigation

and of mulching on yields of tomatoes, peppers, eggplants, and cucumbers are shown. Increased yields from irrigation are thought to justify the use in Missouri of overhead irrigation for intensive cultivation of valuable crops. The proportion of early maturing fruit was not affected, but susceptibility to disease was increased. Mulching gave smaller increases which appeared the latter part of the season. During the first two weeks of harvest, tomato yields were greater on the unmulched plants. Hence the straw mulch is not recommended for crops grown for early market. The effects of the mulch are attributed to reduction of soil temperature and decrease in fluctuations of the soil moisture content.

**Scarred Endosperm and Size Inheritance in Kernels of Maize**, William H. Eyster (Missouri Agr. Exp. Sta. Res. Bul. 52 (1922), pp. 5-12, figs. 6). This report, after several years of inheritance experiments with corn, embodies the conclusions of the investigator on the significance of rough indentation. Rough indentation usually results from the collapse of the pericarp over a crater-like cavity in the endosperm near the crown of the kernel. The author points out that scarred endosperm is a simple Mendelian recessive; and that this is a quantitative character determined by a single factor difference.

**The Relation of Temperature to Blossoming in the Apple and Peach**, F. C. Bradford (Missouri Agr. Exp. Sta. Res. Bul. 53 (1922), pp. 5-51, figs. 8). This report includes data on the blooming dates of fruit trees at various points in North America, particularly at Wauseon, Ohio; Pomona, Calif.; Madison, Wis.; Auburn, Ala.; and Columbia, Mo. Temperature accumulations measured in day-degrees are found to be out of agreement with blossoming dates from year to year and this is explained on the ground that ordinary temperatures are not always effective. It is also shown that different varieties of apples and peaches have different responses to high temperatures and also that early blossoming is due in some varieties to advancement during the previous fall and in others to the development of the buds during the winter. Still other varieties exhibit a mixture of genetic factors in this respect.

**Studies in Animal Nutrition II.—Changes in Proportions of Carcass and Offal on Different Planes of Nutrition**, C. Robert Moulton, P. F. Trowbridge, and L. D. Haigh (Missouri Agr. Exp. Sta. Res. Bul. 54 (1922), pp. 5-76, figs. 28). This is the second in a series of reports which when completed will constitute a comprehensive analysis and interpretation of all the data gathered in the "Use of Feed Experiments" which was started by the Station in the spring of 1907. The present report, adhering strictly to that phase of the experiment indicated in the sub-title, presents the data obtained by slaughtering representative animals from each of the groups at intervals from birth to four years of age.

**Studies in Animal Nutrition III.—Changes in Chemical Composition on Different Planes of Nutrition**, C. Robert Moulton, P. F. Trowbridge, and L. D. Haigh (Missouri Agr. Exp. Sta. Res. Bul. 55 (1922), pp. 5-88, figs. 20). This is the third report in the series described in the foregoing paragraph. Data on the chemical composition of 31 representative animals from three groups are presented in this report.

**Observations on Winter Injury**, F. C. Bradford and H. A. Cardinell (Missouri Agr. Exp. Sta. Res. Bul. 56 (1922), pp. 5-26, figs. 27). Two authors in this report present two separate papers approaching from different angles the common subject of winter injury. I.—Early and Late Winter Injury, by Bradford, discusses the killing of many apple buds at Columbia early in the winter of 1921-1922. Injury in various fruits is found closely related to two distinct growing seasons separated by a dry, hot midsummer. Kieffer pear and Jonathan apple are compared and shown to have diverse characteristics in the tenderness of their wood and fruit buds in spring and fall. II.—An aftermath of Winter Injury, by Cardinell, contains a number of observations

made on a young orchard planted from nursery stock in which the wood had been killed by low temperature, while the more resistant cambium was not injured. The tree when pruned did not heal properly and several fungi gained entrance. Recommendations for dealing with such cases are given.

**Studies in the Nutrition of the Strawberry, V. R. Gardner** (Missouri Agr. Exp. Sta. Res. Bul. 57 (1923), pp. 5-32, fig. 1).—In this report data are presented showing that production of flower clusters, flowers and berries, as well as setting of the pistils and of the flowers was affected by nutritive conditions in the plant during the fall and winter preceding fruiting, but was practically uninfluenced by fertilizer treatment in the spring up to the time of fruiting. Good conditions of nutrition the preceding fall increased the size of the berries, but fertilization in the spring had little effect. Associated with these more practical phases of the experiment are also data on the relation of nutrition to the sex of the strawberry blossom.

**Scale Insects of Missouri, A. H. Hollinger** (Missouri Agr. Exp. Sta. Res. Bul. 58 (1923), pp. 80, figs. 38). This report is a condensation of the author's thesis giving the results of two years of extensive collection and careful laboratory work. Besides a consideration of the economic importance, distribution and control of scale insects, the report includes description of 67 species that were known prior to this work and 13 new species described here for the first time.

**Studies in Animal Nutrition IV.—The Nitrogen Distribution in Beef Flesh as Affected by Age and Condition, Walter S. Ritchie, C. Robert Moulton, P. F. Trowbridge, and L. D. Haigh** (Missouri Agr. Exp. Sta. Res. Bul. 59 (1923), pp. 72). This report is the fourth in the general series of studies in Animal Nutrition issued from this Station. Besides those animals comprising what was known as the "Use of Feed" group there are included also "Special Maintenance" and "General Maintenance" groups and a few other animals. The present bulletin deals with the forms of protein in beef flesh as separated by a cold water extract and subsequent coagulations and precipitations.

**The Chemical Nature of a Colloidal Clay, Richard Bradfield** (Missouri Agr. Exp. Sta. Res. Bul. 60 (1923), pp. 2-60, figs. 7).—This report covers two years of laboratory study of the colloidal clay subsoil underlying the Putnam silt loam of the prairies of Northeast Missouri. In order to understand the chemical nature of the soil one part fresh subsoil was suspended in five parts of water by churning, the coarser material settled by gravity and the finest colloidal material separated by means of a centrifugal force about 30,000 times gravity. This fraction appeared to be made up largely of the completely broken down end products of weathering; colloidal  $Al_2O_3$ ,  $Fe_2O_3$  and  $SiO_2$ . A synthetic mixture of these colloids having a chemical composition similar to the natural colloid was prepared and their physico-chemical properties compared. Minute study of these indicate that the natural colloid was a complex alumino-silicate, rather than a mixture of the separate colloidal oxides.

**Seed Potatoes for Better Yields, J. T. Rosa, Jr.,** (Missouri Agr. Exp. Sta. Circ. 106 (1922), pp. 8, figs. 3). This is a condensed statement of the recommendations based on four years of investigation with a large number of varieties of Irish potatoes, including a number of strains of each of the more important ones. Definite recommendations are made of two varieties most productive as early croppers in Missouri, and of five other varieties best for late planting. Results are reported showing the best practices in storage, care, cutting and planting of seed potatoes.

**Winter Injury of Fruit in Missouri, F. C. Bradford** (Missouri Agr. Exp. Sta. Circ. 107 (1922), pp. 7). This is a practical discussion of investigations relating to hardiness. Many factors are shown to be contributory to the injury resulting from low

winter temperatures, namely; immaturity, crown rot, blossom injury, injury in the nursery, and sun scald. Preventive and remedial methods are suggested.

**The Durability of Fence Posts**, J. C. Wooley (Missouri Agr. Exp. Sta. Circ. 108 (1922), pp. 4, figs. 3). Nine years of experiments with 27 common varieties of wood for fence posts are reported in this circular. A table shows the serviceable life of each variety of post failing within eight years and also indicated the number of posts of each variety still serviceable in the ninth year. The results, methods and costs of treating wooden posts with carbolinum and with creosote are reported.

**Controlling San Jose Scale with Lubricating Oil Emulsion**, L. Haseman and K. C. Sullivan (Missouri Agr. Exp. Sta. Circ. 109 (1923) pp. 4, figs. 2). This report is made after the careful inspection of more than 10,000 acres of Missouri orchards in 30 counties showing an infestation of more than 50 per cent. Dormant spray methods formerly used are reviewed and a cheaper method described. Directions are given for mixing a cheap paraffin lubricating oil with an emulsifying medium composed of potash, fishoil soap and soft water.

**The Missouri Colony Brooder House**, H. L. Kempster (Missouri Agr. Exp. Sta. Circ. 110 (1923), pp. 2, figs. 3). This circular gives specific directions for building a colony brooder house 10 by 12 feet inside and includes also the lumber bill, drawing of front and side elevations, and a photograph of the finished structure.

**Feeding for Egg Production**, H. L. Kempster (Missouri Agr. Exp. Sta. Circ. 111 (1923), pp. 12, figs. 4). In this circular the subject of feeding is covered in the briefest space consistent with completeness and clarity. The author explains the essentials of profitable feeding and takes up in order the classes of feeds and the varieties of each, the balancing of rations, methods of feeding, and the stimulation of appetite by exercise and by artificial lighting.

**Controlling Peach Tree Borers with Paradichlorobenzene**, O. C. McBride (Missouri Agr. Exp. Sta. Circ. 112 (1923), pp. 4, figs. 2). Based on careful and long continued experimentations the statement is made in this circular that paradichlorobenzene is the only chemical that will kill as many as 92 to 100 per cent of the peach tree borers. Directions are fully given for applying the chemical together with specific warnings that peach trees less than five years of age and apple trees of any age may be killed by its application.

## CONTRIBUTIONS TO SCIENTIFIC JOURNALS AND PERIODICALS

**Etheridge, W. C., and Fisher, M. L.—Report of the Committee on Lectures for a Standard Introductory Course in Field Crops.** Jour. Amer. Soc. Agron. Vol. 14: pp. 128-136. "With instruction in crop production as the principal aim of the field crops curriculum, an introductory course may be organized in either of two forms: (1) individual treatment, by which crops are studied separately, according to their historical and economic significance, their ecological and botanical relationships, their physiological processes, and the cultural methods by which they are produced; or, (2) general or topical treatment, by which the history, importance, relationships, processes, and cultural methods of all crops are grouped in a topic outline and developed in a broad fundamental way. The committee strongly recommends the development of the introductory course on the latter basis. Such a course can be very widely adopted. It emphasizes pointedly, rather than incidentally the fundamentals of crop production. It can systematically give the student a general grasp of these fundamentals. It can impress him with the breadth and dignity of the subject. It is efficient, in its systematic special treatment of facts fundamental to the production of all crops; and it will stimulate the interests of teachers, since it offers a

broader opportunity for constructive study and individuality in presentation. And finally, it will awaken the student to a better appreciation of the value of the basic sciences, since it so frequently affords the opportunity for applications of scientific facts to practice."

**Etheridge, W. C., and Fisher, M. L.—A Further Report of the Committee on Lectures for a Standard Introductory Course in Field Crops.** Jour. Amer. Soc. Agron. Vol. 15: pp. 41, 42. "Early criticism of the standard introductory course in field crops on the ground that it might encroach upon the subjects of other departments, has become less frequent when the spirit and purpose of the course becomes apparent. There has been a fairly general commendation of the course, although by no means all who commend it expressed an intention to adopt it. On the other hand, opponents of the course generally criticised, not its general merits, but the details of its organization or its lack of adaptability to local curricula. The standard course is therefore being adopted, but the full extent of its adoption cannot now be measured. It has found favor among the larger institutions and this will doubtless insure its future use."

**Eyster, W. H.—The Intensity of Linkage Between the Factors for Sugary Endosperm and for Tunicate Ears and the Relative Frequency of Their Crossing Over in Microspore and Megaspore Development.** Genetics Vol. 7: pp. 597-601. 1922. "A total of 4,624 back-cross plants, representing both coupling and repulsion series of the factor pairs  $S_u s_u$  and  $T_u t_u$ , were observed. The average percentage of crossing over between these factor pairs was found to be  $28.63 \pm 0.45$ .

The same  $F_1$  plants were used both as seed and as pollen parents in back-crosses with double-recessive plants to determine the relative frequency of crossing over in megaspore and microspore development. It has been found that crossing over between  $S_u s_u$  and  $T_u t_u$  is variable in both megaspore and microspore development and occurs in each process with approximately the same frequency."

**Eyster, W. H.—Inheritance of Zigzag Culms in Maize.** Genetics Vol. 7: pp. 559-567. 1922. Zigzag culms of maize are more or less crooked instead of straight as in normal plants. "The affected internodes arch away from the point of leaf attachment, and in many instances the internodes are entirely removed from the leaf sheaths which normally clasp them.

"Crosses between normal plants and zigzag plants give  $F_1$  plants with normal culms. Some  $F_2$  progenies consist of normal plants and zigzag plants in the ratio 15:1; others have these phenotypes in the ratio 3:1. The data are explained by assuming two independent factors. These factors have been designated  $Z_{gZ_g}$  and  $Z_z$ . Zigzag culms appear only when both factor pairs are recessive.

"The factor pair  $Z_{gZ_g}$  is very closely or completely linked with the factor pair  $G_s g_s$ ."

**Ragsdale, A. C., Turner, C. W.—The Effect of Underfeeding on Milk Secretion.** Journal of Dairy Science, Vol. 6, No. 4, July, 1923.—Data were presented showing that when the ration fed to dairy cows was reduced 50 per cent there was a decided increase in the percentage of fat in the milk. The peak of the increase of the percentage of fat was reached about the third day. The percentage of fat remained abnormally high as long as the reduced ration was continued (ten days). When the reduced ration was brought back to normal the percentage of fat decreased and remained below normal for the succeeding ten day check period. The quantity of milk was reduced, the amount of the reduction depending upon the length of the feed reduction period and the stage of the lactation period. The total yield of fat was not significantly changed. Under-feeding did not appear to cause a feverish condition o

the udder. It is pointed out that the effect of under feeding should be taken into consideration in interpreting data on feeding trials of short duration, in studying the effect of drugs on the percentage of fat, pasture experiments and other work of this type where significance is placed on a variation in the percentage of fat.

**Brody, Samuel, Ragsdale, A. C., Turner, C. W.—The Effect of Gestation on the Rate of Decline of Milk Secretion with Advance of the Period of Lactation.** *Journal of General Physiology*, Vol. 5, No. 6, July, 1923.—Data were presented showing that the course of decline of milk secretion with the advance of the period of lactation in farrow cows follows the course of decline of a monomolecular chemical reaction; that is, each month's milk production is a constant percentage of the production of the preceding month, 94.77 per cent in the case of the cows under consideration, from which it is inferred that milk secretion is limited by a chemical reaction initiated at parturition, and declining with the decrease of the concentration of the limiting substance as it is transformed into milk. Data were presented showing that the decline in milk secretion due to pregnancy is related to the increase in weight of gestating animals; from which it is inferred that growth of the fetus is in part, at least, responsible for the decline in the milk flow due to the demand of the fetus for nutrients to support its life processes.

**Ragsdale, A. C., Brody, Samuel—A Weight-Height-Age Curve as a Measure of the State of Nutrition and Growth of the Dairy Cow.** *Journal of Dairy Science*, Vol. 5, No. 5, September, 1922.—The weight of an individual cow at a given age is not by itself an index of her condition or state of nutrition. It has been demonstrated that only severe conditions affect the growth and height at withers. If the relation between height and weight under normal conditions is established, it is easy to determine from the height what should be the corresponding weight. A weight-height curve has been published.

There is a definite weight for a given height under normal conditions regardless of the hereditary growth capacity. The height and weight of the relatively small Jersey fall on the same line as the weight and height of the much larger Holstein.

**Ragsdale, A. C., Turner, C. W.—Seasonal Variations of the Per Cent of Fat in Cow's Milk.** *Journal of Dairy Science*, Vol. 5, No. 6, November, 1922.—Data were presented showing seasonal variations of the percentage of fat in cow's milk derived from the study of 3,763 Guernsey, 299 Jersey, and 95 Holstein-Friesian yearly records.

The percentage of fat was less during the summer months, gradually rising and reaching a peak during the winter months and again declining.

When the different seasons of the year are accompanied by varying temperatures such as ordinarily prevail throughout the greater portion of the United States, the influence of the percentage of fat in cow's milk is greater than that of the advance of lactation.

**Brody, Samuel, Ragsdale, A. C.—The Equivalence of Age in Animals.** *Journal of General Physiology*, Vol. 5, No. 2, November, 1922.—The warm blooded animals studied go through three periods or cycles of growth which may be termed infantile, juvenile, and adolescent cycles; or first, second and third cycles.

The curve of each cycle is symmetrical around its center, the maximum of the cycle. According to theories of growth developed by Loeb, Robertson and Ostwald, growth under normal conditions is limited by a series of consecutive chemical reactions and the middle of maximum of each cycle represents the middle of the respective limiting chemical reaction. Assuming these three characteristics, then the maximum of the corresponding cycles in different animals represent equivalent stages of growth; that is, equivalent physiological ages as far as growth is concerned. The

maximum of the cycles may therefore be taken as points of reference in the course of life of animals, and the conceptional ages of these maxima may be employed for estimating the equivalence of age in different animals.

This principle of equivalence of age was used in analyses of data on growth of the dairy cow, sheep, rabbit, guinea pig, rat, mouse, fowl, and man, and a table of equivalence of age prepared.

Brody, Samuel, Ragsdale, A. C., Turner, C. W.—I. The Rate of Growth of the Dairy Cow. II. Growth in Weight After the Age of Two Years.—*Journal of General Physiology*, Vol. 5, No. 4. March, 1923.—An extensive amount of data was presented representing 14,653 cows on the growth in the weight of the dairy cow from 2 to 17 years of age. It is shown that after the age of 2 years the rate of growth declines in a non-cyclic manner. The course of decline of growth follows the course of decline of a monomolecular chemical reaction; that is, the percentage of decline of growth with age is constant. The maximum body weight is reached between 8 and 9 years of age.

Brody, Samuel, Ragsdale, A. C., Turner, C. W.—The Rate of Decline of Milk Secretion with Advance of the Period of Lactation. *Journal of General Physiology*, Vol. 5, No. 4. March, 1923.—Milk secretion is a chemical or physico-chemical process. Certain substances typical of milk are converted into three substances. The speed of milk secretion is within certain limits dependent on the supply of substances entering the reaction, for example food; on the removal of products of the reaction, for example the removal of milk; and probably on certain catalyzers produced by the pregnant uterus. If milk secretion is a process of limited duration under a plentiful food supply there must be some factor other than food which limits the speed of the process. If the limiting reaction is chemical in nature then the decline of the speed of milk secretion with the advance of the period of lactation should be expressed by the formula of some chemical reaction.

This possibility was tested by fitting formulae expressing the course of chemical reactions to data on the decline of milk secretion with the advance of the period of lactation. It was found that the equation of a monomolecular chemical reaction expresses the course of decline of milk secretion with the advance of the period of lactation; that is, the percentage decline of milk secretion with the advance of the stage of lactation is constant. This substantiates the idea that milk secretion is limited by a chemical reaction, and, in general, brings lactation into the class of processes the speed of which is determined by the concentration of a limiting substance.

Ragsdale, A. C., Brody, Samuel.—The Colostrum Problem and Its Solution. *Journal of Dairy Science*, Vol. 6, No. 2, March, 1923.—The colostrum problem as it concerns the dairyman arises when it is desired to raise progeny from cows infected with tuberculosis or other serious diseases. It has been proved that colostrum is more or less essential for newly born calves. If colostrum is infected by pathogenic organisms, these organisms may be inactivated by pasteurization. Pasteurization does not change the properties of colostrum to any appreciable extent provided *pasteurization is done in a water bath thereby avoiding local hot zones*. The lower pasteurization temperatures offer a wider margin of safety than the higher pasteurization temperatures. Perhaps the safest temperature is 140° F. for 20 to 30 minutes. Calves fed on such pasteurized colostrum were as healthy in every respect as calves that were fed naturally.

Reid, Wm. H. E.—Certified Milk, Its Production, Consumption, and Regulation of Control. *Monthly Journal of the Certified Milk Producers' Association of America*, Vol. 1, No. 9, April, 1923; Vol. 1, No. 10, May, 1923; Vol 1, No. 11, June,

1923.—This paper treats of the history of certified milk and its development through the organization of medical milk commissions. Special reference is made to the American Association of Medical Milk Commissions. Attention is called to the special place which certified milk holds in the market milk industry in general. Special requirements regulating the production, handling, and distribution of certified milk as set down by the medical milk commissions are discussed. Data collected as a result of sending out a questionnaire to all cities in the United States with a population of 20,000 or over showed that 34 cities were using certified milk furnished by 108 certified dairies. The range in population of these cities was from 33,000 to 5,000,000. The average daily consumption in the 34 cities was 4.4 quarts per 1,000 inhabitants. The cost of production varied from 10 to 20 cents per quart. There was a lack of uniformity regarding the cost of certification. The value and quality of certified milk is also discussed.

Turner, C. W.—**Seasonal Variations in Milk and Fat Production**—Journal of Dairy Science, Vol. 6, No. 3, May, 1923.—Data were presented showing that the average monthly decrease in milk production for all breeds is very uniform, the production during the twelfth month being approximately 50 per cent of the production during the best month. The principal variations in milk productions, aside from that due to the advance of lactation, were found to be largely due to the changes in pasture during the spring and summer months. The fundamental reason for the variation in milk is probably one of nutrition, this in turn being affected to some extent by atmospheric temperature. Cows on test being well fed are probably less affected, either favorably or unfavorably, by pasture than those not being pushed for maximum production. From the standpoint of total milk production, cows calving in the fall and winter months equal or exceed the average production while those calving during the summer months are generally below the average.

Branstetter, B. B.—**Fungi Internal to Missouri Seed Corn of 1921**. Jour. Amer. Soc. Agron., Vol. 14: pp. 354-356. Preliminary tests of Missouri seed corn, indicated that the fungus organisms causing corn root rot, can usually be found in the seed. A state-wide disease survey was made in 1921 by testing four ears of seed corn from 49 counties that represented the leading corn producing sections of the state. Of the 192 ears tested, 69 per cent were infected with *Fusarium moniliforme*, 53 per cent with *Cephalosporium saccharii*, and 27 per cent with *Diplodia zeae*. Only ten ears were free from infection. Apparently then, corn root rot organisms are widely distributed in Missouri. Only heavy, sound, healthy ears with no discolorations or signs of mold on the butt end of the ear or on the extreme tip of the cob are usually free from fungus infection. Comparatively disease-free seed corn may be safely selected in this way without the use of the modified rag doll germinator.

Haigh, L. D.—**A New Fertilizer Sampling Tube**. Jour. of Asso. of Official Agric. Chemists, Vol. 6: p. 410. This is a description of the sampling device used in obtaining samples of fertilizer from sacks, in the work of inspection of commercial fertilizer by the Missouri Agricultural Experiment Station. It consists of a brass tube with a solid brass point at one end and a handle at the other. The tube is slotted on one side to allow the material being sampled to enter. A solid brass core rod fits into this brass tube preventing the entrance of material while the sampler is inserted in the sack. To fill the tube the core rod is withdrawn when the tube is in position.

The Indiana double tube sampler and the sampling tube of Kellogg used in Pennsylvania, are mentioned and the advantages of the Missouri sampling tube are pointed out.

Hooker, Henry D., Jr.—**The Use of Nitrogen in the Apple Orchard**. Trans. Ill. Hort. Soc., Vol. 56: pp. 176-193. The symptoms of nitrogen deficiency and

methods of correcting it are outlined. The relation of nitrogen applications to starch accumulation and fruit bud differentiation is indicated and the dependence of the latter on leaf area, amount and character of new growth, size of crop, and number of spurs is discussed.

**Marsh, Ray S.**—The Seasonal Variation of the Sulphur Content in Certain Tissues of the Apple Tree. *Botanical Gazette*, Vol. 75: No. 4, June, 1923. The sulphur content determined by the sodium peroxide method is of the same order as the phosphorus content in various apple tree tissues. The highest percentages of sulphur were found in the leaves and then in descending order in the spurs, young bark and old bark. The sulphur content varies inversely with the phosphorus content throughout the year. Sulphur was thought not to be translocated and its seasonal variation was parallel with the hydrogen-ion concentration. The percentage of sulphur was at a minimum during the time of fruit bud differentiation. Maximum sulphur content occurred in the leaves in November just prior to their falling; it occurred in spurs during September; in young bark during January and May, and in old bark during November.

**Marsh, Ray S.**—Preliminary Studies of the Sulphur Contents of the Tomato. *Proc. Am. Soc. Hort. Sci.* 1922: pp. 83-84. Determinations of sulphur, phosphorus and hydrogen-ion concentration were made on tomato tissue collected from various zones of the plant and from plants of different ages. The sulphur content was  $2\frac{1}{2}$  to 4 times the phosphorus content. In tissues where the phosphorus content was low the sulphur content was high and *vice versa*. The sulphur content varied with the hydrogen-ion concentration. In the tips of the plants were found the greatest amounts of phosphorus and the smallest amounts of sulphur, while in the base of the plant the reverse relation of these two elements was noted.

**Hooker, Henry D., Jr.**—Some Effects of Fall Application of Nitrogen to Apple Trees. *Proc. Am. Soc. Hort. Sci.*, Vol. 19, 1922: pp. 241-243. Data are given which indicate that fall applications of nitrate of soda favor starch storage in June following the treatment and increase the chances for fruit bud differentiation at that time. The conditions under which fall fertilizer treatment might be justified are indicated.

**Rosa, J. T., Jr.**—Note on an Indirect Effect of Spraying Potatoes with Bordeaux. *American Journal of Botany*, Vol. 10: pp. 113-116. Bordeaux mixture has long been used for its beneficial results on potatoes. However, under certain conditions the application of bordeaux mixture or other spray having a similar physiological effect may produce indirect results which are undesirable. The sprayed plants of the Early Ohio variety remained green about three weeks longer and yielded an average of 34.2 per cent more than the checks, but the actual quantity of marketable potatoes was much less due to the large amount of knobby second growths.

**Boswell, Victor R.**—Dehydration of Certain Plant Tissues. *Bot. Gazette*, Vol. 75, 1923: pp. 86-94. 7 figs. Hardy cabbage and tomato leaves lost water on drying in an oven less rapidly than tender leaves, the rate of loss being inversely proportional to the degree of water-retaining capacity developed by hardening treatments. The water that passes off early in the drying process is considered "free" water, and the more tenaciously held water removed later is thought to be in colloidal combination.

**Connaway, J. W.**—Facts Relating to Infectious Abortion in Cattle and Swine; and Their Practical Application. *Journal American Veterinary Medical Association*, Vol. 53 (March 1923). This paper, which was read at the fifty-ninth annual meeting of the American Veterinary Medical Association, St. Louis, Mo., September 1, 1923, summarized and discussed the researches on abortion in cattle and swine that had

been carried out at this Station and elsewhere, and emphasized the essential facts that were of practical value to the veterinary practitioners, in their service to the cattle and swine breeders.

**Connaway, J. W.**—**The Practical Control of Infectious Abortion in Cattle Herds.** Proceedings of the Twenty-sixth Annual Meeting of the U. S. Live Stock Sanitary Association, Chicago, December 6th, 7th, and 8th, 1922, pp. 78 to 86. This paper presented the results of scientific investigation of the Bang abortion disease in cattle and pointed out some of the ways in which the official live stock sanitarians of the country could utilize the scientific facts that had been developed, in the practical control of abortion disease, and especially in lessening the spread of the disease through interstate traffic.

### NEW EQUIPMENT

**Agriculture Building**—The new Agriculture Building was occupied during the year and has made it possible to provide additional space and improved facilities for seven different departments of the College of Agriculture. In the new building the Departments of Soils, Animal Husbandry and Rural Life will have greatly enlarged and improved facilities for instruction. In the new building will also be located the Agricultural Library, the offices of the Dean and Director, the Agricultural Editor, and numerous laboratories and classrooms. The new Agriculture Building is joined with the old by a subway and arch which gives the impression of a single building. This impression is further emphasized by numbering the building consecutively, beginning with the first floor of the old Agriculture Building and continuing consecutively through the rooms of the new Agriculture Building.

**Other Improvements.**—Considerable additions have been made to a number of departments in new apparatus, improved arrangements, and laboratory facilities.

The Department of Dairy Husbandry has erected a new and modern refrigerating machine. The Department of Agricultural Engineering has rearranged its old quarters and occupies the building formerly used by the Poultry Department.

**Gift of Hatch Experiment Farm.**—This farm was formerly the property of Wm. H. Hatch, the author of the Federal Hatch Act, establishing agricultural experiment stations in the United States. It was bequeathed by his daughter, Miss Sallie Rhodes Hatch in November, 1923, to the State of Missouri for the purpose of establishing an experimental farm.

The farm consists of 110 acres, more or less rugged in contour, principally of the soil type known as loess. It is equipped with a fine residence, and other buildings. It will be developed as a branch experiment station. Plans have been made for the establishment of rotation and fertilizer experiments, the planting of an experimental orchard, and for investigations in poultry husbandry.

The farm has been assigned to the College of Agriculture by the Governor. However, this action must be approved by the Legislature before the farm actually becomes the permanent property of the College of Agriculture.

It is particularly appropriate that the great public service of Colonel Wm. H. Hatch should be memorialized by an experimental farm, and that this farm should bear his name.

### SUBJECTS NOW UNDER INVESTIGATION

#### Agricultural Chemistry

Chemical Service.  
Protein Storage in Protoplasmic Tissue.  
Fertilizer Control.  
Use of Feed Experiment.

### Agricultural Engineering

The Draft of Wagons.

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

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

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

### Animal Husbandry

Age as a Factor in Animal Breeding.

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

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

Rations for Pigs at Weaning Time.

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

Corn Silage as a Part Ration for Horses of Various Ages.

Growing Draft Colts.

Limited Grain Rations for Fattening Cattle of Different Ages.

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

### Botany

A Study of Certain Fusarial Diseases of Plants.

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

### Dairy Husbandry

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

Official Testing of Dairy Cows.

Studies in Milk Secretion.—(a) Time Relations in Milk Secretion; (b) Mechanisms Regulating Variations in the Composition of Milk.

Standards of Growth for Dairy Cattle.

Raising Calves on Milk Substitutes.

Minimum Protein Requirements for the Growth of Dairy Heifers.

Relative Vitamin Content and Growth-Promoting Properties of Heated, Dried and Filled Milk Preparations.

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

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

Silage Investigations.

### Entomology

Nursery Inspection.

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

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

An Investigation of the "Hessian-fly-resistant" Qualities of Different Varieties of Wheat.

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

An Investigation to Determine What Insects are Injurious to Nursery Stock in the State, Their Life Histories, Distribution, Injury and Methods of Control.

Injurious Insect Pests of Melon and Related Crops.

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

An Investigation of the Malarial Mosquito Plague in Missouri.

An Investigation of Methods for Controlling the Chinch bug.

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

**Field Crops**

Seed Testing Laboratory.

Comparison of Soybeans and Cowpeas for Hay and Seed Production.

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

A Study of the Adaptations of the Important Varieties of Cotton for the Southeast Missouri Lowlands.

Cultural Experiments with Cotton, Including Fertilizer Tests.

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

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

Cultural Experiments with Corn.

Wheat Breeding Investigations, including the Improvement of Commercial Varieties by: (a) the Pure Line Method of Breeding; (2) Hybridization and Subsequent Selection.

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

A Genetic Analysis of Maize.

Cultural Experiments with Soybeans, including: (1) Time of Seeding; (2) Method of Seeding; (3) Rate of Seeding.

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

A Morphological Classification of the Varieties of Soybeans.

Cultural Experiments with Wheat, including: (a) Methods of Preparing the Seed Bed, and (b) Rate of Seeding.

**Home Economics**

A Study of the Factors Affecting the Texture of Cakes.

The Wear of Hosiery.

The Effect of Salt Upon the Loss of Iron in Cooking Vegetables.

**Horticulture**

Spraying Fruit for Insect and Fungus Diseases.

Investigations with Seed Potatoes.

Nutrition and Plant Response of Vegetables.

Identification and Study of Factors Determining Hardiness and Methods of Increasing It.

Orchard and Strawberry Nutrition.

Peach Breeding for Hardy Sorts.

Walnut Grafting Investigation.

Breeding Apples for Late Blooming Habit.

Treatment of Apple Canker Diseases.

Cabbage Seed Selection for Disease Resistance.

Tomato Seed Selection for Disease Resistance.

Investigation of the Factors Limiting the Production of Sweet Cherries in Missouri.

Requirements, Varieties, Cultural Methods, and Seed "Place Effect" of the Watermelon and the Cantaloupe.

Investigations of the Method of Culture and Varieties of Basket Willows for Missouri.

**Poultry Husbandry**

Studies in Regard to Xanthopyll, the Natural Yellow Pigment of the Egg Yolk Body-fat and Blood-serum of the Hen.

Age as a Factor in Poultry Breeding.

Value of Sour Milk, Beef Scrap, Cottonseed Meal, Gluten Meal and Oil Meal in Rations for Egg Production.

Time of Moults as an Index to Productivity of Hens.

**Rural Life**

Beef Cattle Production in Missouri.

Tractor and Other Farm Equipment Costs on the Farm.

Utilization of Labor on the Farm.

Land Tenure in Missouri.

General Plans of Farm Organization and Operation in Different Sections of the State.

Cost of Producing Farm Products Under Farm Conditions.

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

Cost of Family Living on the Farm.

Farm Cost Accounting.

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

### Soils

Experiments to Determine the Best Systems of Soil Management for the Most Important Soil Types in Missouri (Soil Experiment Fields).

Effects of Different Soil Treatments, Long Continued, Upon Bacterial Activity in the Soil.

The Determination of the Relative Values of Different Forms of Phosphorus Upon the Soils at Columbia.

Studies of the Tight Clay Layer in the Soils of the Level Prairies of Missouri.

The Production and Distribution of Bacteria for Legumes.

The Rate of Accumulation and Cost of Nitrogen and Carbon in Soils Under Different Systems of Green Manuring and Cropping.

Studies of Water Absorption, Run-off, Percolation, Soil Erosion Under Field Conditions.

Crop Rotation and Fertilizer Experiments.

Testing Soils for Their Lime Need.

The Effect of Different Amounts and Different Methods of Applying Commercial Fertilizer on the Corn Crop.

The Determination and Mapping of Missouri Soil Types (Soil Survey).

Nitrate Production in a Soil As Affected by the Crop and Cultivation.

Studies on the Longevity of *B. Radicicola* in the Soil.

### Veterinary Science

Experiment on the Virability of Hog Cholera Virus.

The Distribution of Abortion Infection in Swine by Positive Reacting Immune Carriers.

Contagious Abortion Investigations.

An Experimental Study of Hog Cholera and the Factors Concerned in Immunity Against the Disease.

### SERVICE PROJECTS

**Seed Testing Laboratory.** (W. C. Etheridge, Miss Regina Schulte).—The Seed Testing Laboratory tested a total of 2,401 lots of seed during the year ending June 30, 1923. Of these lots 1,917 were tested for Missouri farmers and seedsmen, and 107 lots for the Missouri State Board of Agriculture in seed inspection for the administration of the State Seed Law. During the year 29 tests were made of Customs House samples. The 377 lots of seed tested for farmers and seedsmen of other States were distributed as follows: Colorado 122, Kansas 105, Nebraska 48, Iowa 37, South Dakota 30, Illinois 17, New York 17, Ohio 11, Wyoming 6, Texas 3, Wisconsin 3, California 2, Oklahoma 2, Arkansas 2, Louisiana 1, Tennessee 1.

The total of 2,401 tests, included 54 tests for purity only, 1,263 tests for purity and germination, 949 samples tested for germination only, 118 identifications, and 17 examinations.

**Fertilizer Control.** (F. B. Mumford, Director; L. D. Haigh, Chemist).—The work of the Fertilizer Control consisted in the main of the inspection of stocks of fertilizers in the hands of dealers and buyers throughout the State, and the obtaining

of samples of the various brands for analysis. After analysis of these samples at the chemical laboratory of the Experiment Station the results are compiled and printed in bulletin form. The last report issued is Bulletin 200.

The work this year included an inspection in the fall of 1922 and another in the spring of 1923. In this inspection 269 samples were collected and analyzed in the fall, and 56 samples in the spring. To collect these samples 113 towns were visited in 34 counties.

The results obtained on the analysis of the samples collected in the spring and fall of 1922 are published in Bulletin 200. Besides these analyses the report contains the analyses of 683 samples of limestone for their purity for agricultural purposes, the name and guaranteed composition of all brands of fertilizer registered for sale for the year 1923, and the approximate distribution by counties of the different brands of fertilizer sold in the state of Missouri during the calendar year 1922.

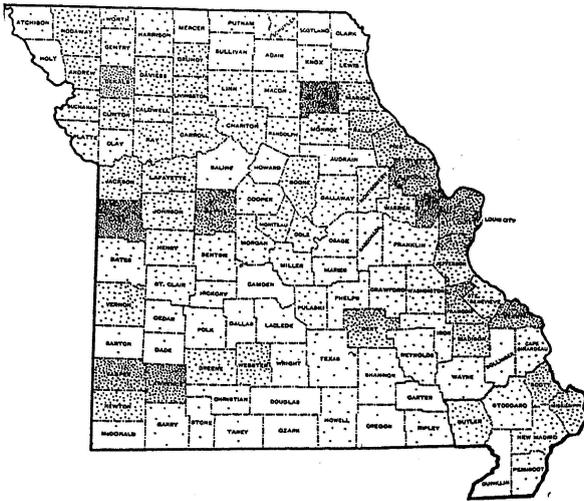


Fig. 1.—Localities from which 4,100 soil samples have been tested for their lime requirement up to June 30, 1923. Each dot represents one test.

**Testing Soils for Their Lime Need.** (M. F. Miller, W. A. Albrecht).—These tests have been made by the Truog method and by the Modified Comber method. Records are now available on more than 4,100 such tests. About 600 tests were made during the past year.

County agents and teachers of vocational agriculture are now testing great numbers of soil samples with the Modified Comber method which was developed and standardized for general use about a year ago by the Missouri Experiment Station. The simplicity, speed and general accuracy make this a method for use in the laboratory or in the field, and it may be handled by those not specially trained in chemical technic.

The accompanying map shows the location from which soil samples have been tested for their lime requirement up to June 30, 1923. Each dot represents one test.

**The Production and Distribution of Bacteria for Legumes.** (W. A. Albrecht).—

The production of cultures of legume bacteria is one of the many projects of the Experiment Station for helping Missouri farmers. The importance of inoculation for new legumes or new soils is coming to be more common knowledge, if the number of inquiries received and numbers of cultures distributed annually is any indication. During the last year 40,021 cultures were produced and distributed to approximately 4,145 individuals, representing roughly 100,000 acres of legumes. The varieties of legumes and their numbers of cultures produced were as follows: soybeans 30,415, alfalfa 5,331, sweet clover 1,893, cowpeas 1,208, red clover 1,085, alsike clover 40, vetch 39, velvet beans 4, white clover 2, garden beans 1, garden peas 1, bur clover 1, crimson clover 1, total 40,021.

This is a significant increase over the figures of the previous years, mainly because of the increased demand for bacteria for soybeans. Unusual seasonal conditions, coupled with the growing popularity of this crop seem to be responsible for this demand. A change in the organization of the work and the study of better methods of

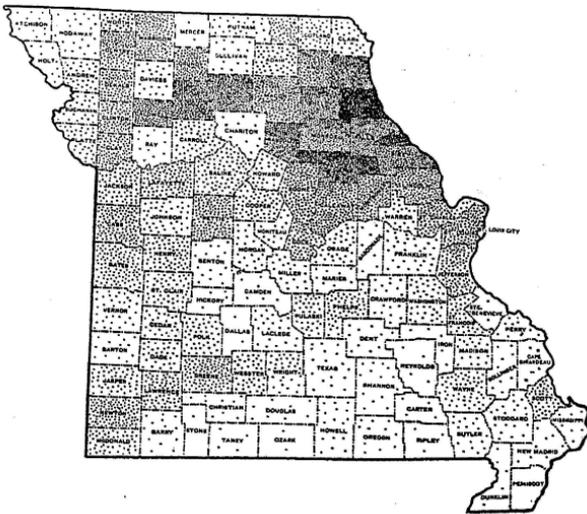


Fig. 2.—The Experiment Station has sent 40,021 pure cultures of bacteria for clover, alfalfa, soybean and other legume crops to Missouri farmers in the localities shown on this map. One dot represents five cultures.

distribution has made it possible to serve a larger number. The distribution has reached a rather large proportion and as a Station project perhaps has reached its limit educationally. The soil method of inoculation has always been recommended and encouraged, but apparently is not commonly used, if the number of cultures distributed is any indication. During the coming year, efforts will be made to spread the information regarding the soil method, and to encourage its use as a means of self help for the farmers. This is possible through the help of the county agents, who render excellent service in spreading information regarding the soil method.

Reports from farmers using the cultures, indicate success with newer legumes and the increased demand for the cultures suggested that the significance of the bacterial activity of legumes for soil improvement is being more fully appreciated.

**The Determination and Mapping of Missouri Soil Types.—Soil Survey.** (M. F. Miller, H. H. Krusekopf, Wm. DeYoung, H. V. Jordan).—In cooperation with the Federal Bureau of Soils, a soil map and report of Ray County were completed and about 85 per cent of the field work on the Boone County map has been finished. In addition, a considerable portion of Lawrence and Phelps Counties has been surveyed. The counties surveyed to date number 56 and include more than one-half the area of the State.

More than 200 soil samples were collected and complete chemical analyses made.

The special soil map and report of the brown loess soils found along the upland bordering the Missouri and Mississippi rivers has been completed. Publication of the report has been delayed, partly on account of lack of funds, and because not all of the chemical analyses have been completed. This report should be of great value because of the rapidly developing fruit and tobacco raising industries, and because of the general adoption of more intensive agricultural practices on the brown loess soils.

Considerable data has been collected to be used in republishing a state soil map. A strong demand exists for such a map, and the supply of the soil map published in 1918 has been exhausted. A general report on the Missouri soils is of great value in educational and commercial fields, as the rapid exhaustion of the previous map and continued requests for it from these sources indicate.

**Nursery Inspection.** (L. Haseman, K. C. Sullivan, O. C. McBride).—Regular nursery inspection work has been carried on the same as in previous years. The number of nurseries inspected, the inspection of foreign stock, distribution of nursery stock, and the issuing of official papers is covered in the following tabular reports.

Nurseries inspected.....	173
Counties in which nurseries were located.....	58
Men making inspection.....	4
Nurseries infested with San Jose scale.....	14
Amount of nursery stock condemned (estimated).....	\$38,000
Cases of imported nursery stock inspected.....	79
Plants from foreign countries inspected.....	1,178,344
Counties in which foreign stock was received.....	5
Sweet potato beds inspected.....	13
Nursery Inspection Certificates issued.....	171
Sweet potato Inspection Certificates issued.....	13
Dealers Certificates issued.....	39
Agents permits issued.....	157
Outside Growers Permits issued.....	158
Gypsy moth inspections made.....	28
Counties in which gypsy moth inspections were made.....	8

The orchard inspection work which has been accomplished during the past year has been of great value to the fruit growers of the State. Very thorough inspections were made in all of the fruit growing sections of the State, and out of 10,487 acres inspected 5,398 were found more or less infested with San Jose scale. As a result of this work many fruit growers applied dormant spray for San Jose scale for the first time.

**Official Testing of Dairy Cows.** (A. C. Ragsdale, C. W. Turner).—A total of 2,625 two-day and 92 seven-day tests were conducted during the year.

The largest record made during the past year was in the Holstein herd of S. C. Lindsey, Carthage, Mo. Fobes Homestead Rauward, a senior four-year-old produced 21,684 pounds of milk and 817 pounds of fat, thereby becoming state champion for the breed. She was awarded the silver cup offered by the Missouri Dairyman's Association for the largest production of fat during the year.

U. S. Beauty Aggie Grace, a senior three-year-old owned by Pickering Farm, Belton, produced 23,855 pounds of milk and 700.4 pounds of fat. This placed her first in her age class.

Campus Lady Ormsby Alma, a junior two-year-old Holstein bred and owned by the University of Missouri and the first daughter of the University Holstein herd sire, King Fayne Ormsby, broke the State record for her age-class by producing 15,665 pounds of milk and 560.9 pounds of fat. Campus Lady Ormsby Delia, another University cow, made a very worthy record when as a senior two-year-old she produced 18,887 pounds of milk containing 631 pounds of fat.

The largest Guernsey record made during the year was that made by Josephine of Cove Hollow owned by L. E. Vaughan, Oronogo. As a junior four-year-old she produced 13,799.6 pounds of milk and 675.5 pounds of fat. This production gives her the breed championship in Missouri.

Glencoe's Arline also in the herd of L. E. Vaughan as a senior three-year-old placed first in her class with a production of 10,409 pounds of milk and 521.8 pounds of fat.

Two state class Jersey records were broken during the year. Both cows were owned by S. R. Head, Hannibal, Mo. Exile's Wonder's Pet a senior yearling produced 9,067 pounds of milk and 533.11 pounds of fat while Le Gros Czarine, a junior two-year-old, produced 9,186 pounds of milk and 615 pounds of fat.

**Veterinary Diagnosis and Consultation Service.** (J. W. Connaway, A. J. Durant, H. G. Newman).—During the year many specimens of diseased tissues, blood samples, milk samples, etc., were received at the laboratory from various parts of the State to be tested or examined for diagnostic purposes. This service also involves an extensive correspondence which has been the means of carrying instruction in veterinary sanitation and prophylaxis to a large number of livestock and poultry raisers. This correspondence is in effect an extension teaching course, supplemented by the distribution of appropriate bulletins and circulars of information. This service, moreover, has been especially helpful in supplying materials and data for carrying on research project.

The work under this project has been devoted mainly to the following lines: (a) Diagnosis of abortion disease in cattle and swine herds; (b) diagnosis of poultry diseases; (c) diagnosis of rabies in farm animals; (d) examination of miscellaneous specimens of diseased tissues and parasites.

*Abortion Disease in Cattle Herds.*—During the year serological tests were made on blood samples from 2285 breeding cattle, in 143 herds. The number of suspected herds showing one or more infected animals was 112; while 32 herds were negative to the test. In most of the latter, however, there was no strong suspicion that the abortion infection was present; but, as some animals in the herds were sterile, a blood test was made to determine whether the Bang abortion microbe was responsible. Some of the negative herds consisted in part of recently purchased animals, and the tests were made as a precautionary measure. Of the total number of animals tested, 661 were reactors to the abortion test; that is, about 29 per cent. This figure, however, does not furnish a correct basis for an estimate of the percentage of reactors among the cattle herds of the state as a whole, since but few owners of clean herds call for the test. Moreover, since the calls for service come, as a rule, from cattle breeders who have had more or less trouble for two or more years, the percentage given is probably considerably greater than actually exists in the entire group of infected herds.

*Abortion in Swine Herds.*—The total number of breeding swine tested for abortion disease during the year was 838, in 37 herds. Of these, 404 showed a positive reaction, and 434 were negative. The percentage of animals showing the reaction in the infected swine herds is much greater than in infected cattle herds. The feeding habit of the two species may account for the difference.

*Poultry Diseases.*—The laboratory work in diagnosis of poultry diseases showed an increase over the preceding year. The total number of poultry raisers who received service from the laboratory during the year exceeded 900. The total number of sick birds and pathological specimens examined during the year was 1317.

**Production and Distribution of Anti-Hog Cholera Serum.** (O. S. Crisler, F. D. Goslin).—During the current year the serum laboratory supplied the swine raisers of the state, directly or through veterinarians and county farm bureaus, 2,212,775 cubic centimeters of anti-hog-cholera serum, which was distributed in 1553 orders, to 78 counties.

This service has been of particular benefit to the swine raisers in counties where veterinary service is not available, and in which the office of county agricultural agent has not been established.

New equipment necessary to maintain the serum laboratory in a high state of efficiency is added from time to time.

### CORRESPONDENCE

It is difficult to estimate the educational value of the correspondence conducted by the College of Agriculture in the course of one year. A fairly accurate estimate of the number of letters received and answered by the various departments of the College during the past year places the number at 106,500. When a farmer desires information on any subject pertaining to his operations, he knows that he can get accurate, unprejudiced information from the College of Agriculture.

As far as possible, inquiries are answered by appropriate publications, but each farmer's problem is individual and nearly always requires a personal answer. Such answers require time and often careful preparation.

This service to farmers by correspondence is made possible only through the continuous investigational work of the Agricultural Experiment Station. Often the questions asked by farmers can be answered with confidence because the Agricultural Experiment Station has carried on a series of investigations. It is true that new investigations are often initiated as the result of the information which comes to the scientific investigators in the Experiment Station.

It is unfortunately also true that questions are asked by farmers which cannot be answered because the Station has not yet been able to make the necessary investigations. It has also been true, in the last two years, that the limited resources of the Experiment Station have made it impossible to undertake new lines of work, and the Station is not, therefore, rendering the service that it is organized to render because sufficient funds have not been available for this purpose. The future of Missouri agriculture is in a large and important sense dependent upon the results of scientific research. The Agricultural Experiment Station at Columbia is the only Federal and State institution in Missouri specifically empowered to conduct these researches. The amount of service which can be rendered is now directly proportional to the funds which may be made available by the Federal and State governments.

## SUMMARY OF EXTENSION WORK. 1923

The following summary covers the last month of 1922 and the first eleven months of 1923.

Special effort has been given during the past year to the development of community organizations and local leadership. At the present time 816 communities are more or less completely organized for purposes of carrying on permanent extension activities. In 296 of these communities definite educational programs have been adopted. During the year 3,693 local leaders have actively assisted in forwarding community programs. Of this number 630 have been especially concerned with the promotion of junior work through the medium of boys' and girls' clubs.

During the year 16,884 farms were visited. Visits were made to 1,234 homes. County agents received 112,250 office calls on business relating to the conduct of extension activities. More than 100,000 letters giving information on subjects relating to agriculture and home economics were written during the year by members of the extension staff, state and county. In addition to this number of personal letters, nearly a half million circular letters were distributed.

It is impossible to estimate the number of people who have been reached through the press of the state. Records are available indicating that 6,485 articles were written by agents alone and published in local papers. To this number must be added hundreds of articles contributed by state extension specialists and distributed mainly through the regular press service of the College of Agriculture.

Training schools for local leaders were held in 311 communities. At these schools 2,765 men and women were trained for local leadership in Agriculture and Home Economics. Demonstration meetings on farms and in farm homes to the number of 4,230 were held during the year with an attendance of 98,640 people. Fifty-one junior club encampments and rallies were held during the year. They were attended by 829 club members and 4,626 other persons. A total of 2,197 general meetings other than those already mentioned, were held during the year with a total attendance of 107,158.

During the year 514 boys' and girls' clubs were organized with a total enrollment of 2,582 boys and 2,579 girls. Thirty-three boys' demonstration teams and 43 girls' demonstration teams were trained as an incident to the club activities. These boys' and girls' club teams gave demonstrations at local meetings, county meetings, and a few of them entered into state-wide and inter-state demonstration team contests.

Following is a summary of the more important activities and results recorded for the period covered by this report arranged by projects:

**Soils.**—Number of farms following instructions in use of commercial fertilizer, 4,081. Acres involved, 73,661.

Number of farms using limestone according to instructions, 1,648. Tons of limestone used, 32,588.

Limestone pulverizers introduced during year, 12. Tons of limestone pulverized on farms, 14,500.

Liming demonstrations started, 358.

Fertilizer demonstrations started, 466.

Community soil management demonstrations started, 31.

Farms building Mangum terraces as demonstrations, 66. Number of acres terraced, 966.

Farms on which soil saving dams were built as demonstrations, 107. Acres affected, 5,681.

**Field Crops.**—Number of demonstrations started or under way, 604.

Number of farmers planting selected or improved seed; corn 330, wheat 3,108.

Number of farms growing selected or improved seed for sale, 1,665.

Number of farms testing seed for germination, 1,329.

Total number of farms influenced to adopt better practices, 5,632. Total acres involved, 63,582.

Bushels of corn approved for use as seed in 1923, total 2,230 bushels; wheat 15,450, oats 250, soybeans 7,520.

**Rural Engineering.**—(Project confined this year to furnishing plans and blue prints with small amount of personal service).—Number of water systems installed 54.

Number of lighting systems installed, 28.

Number of farms on which buildings were constructed according to plans furnished, 735.

**Horticulture.**—Number of demonstrations started or under way, 375.

Increased yield per acre on demonstration farms due to better practices; tree fruits 1,295 bu., bush and small fruits 1,036 qts., grapes 3,190 lbs., canning crops 1 ton.

Number of farms planting selected stock or seed, 1,490.

Number of farms adopting pruning practice, 3,356.

Number of farms spraying or otherwise treating for diseases and insect pests, 5,134.

Number of farms following recommended cultural practices other than those mentioned above, 2,531.

Fertilizer demonstrations on potatoes, melons, and tomatoes completed, 92. Increased yield per acre, 1 ton.

Farmers using fertilizers on truck crops as demonstrations, 873. Acres fertilized, 3,241.

Bushels northern-grown certified seed potatoes planted, 21,482. Number of farmers planting such seed, 874.

**Animal Husbandry.**—Number of demonstrations started or under way; adult 277, junior 168.

Profit or saving resulting from following practices recommended by College; beef cattle \$4.57 per head, swine \$1.00 per head.

Number of boys' and girls' clubs; beef cattle 36; swine 132.

Number of club members enrolled; beef cattle 303, swine 91.

Value of animals raised by club members, \$67,331.

Total number of farms influenced by adult or junior extension work to adopt better practices relative to livestock production, 2,509.

Number of farms assisted in securing purebred sires, 514.

Number of farms adopting balanced rations for livestock, 2,379.

Number of cattle tested for tuberculosis, 53,829.

Number of animals vaccinated for blackleg, 8,869.

Number of hogs vaccinated for cholera, 52,915.

Number of sheep treated for internal parasites, 15,080.

Number creep-fed lambs, 3,192.

**Entomology.**—Number of demonstrations started or under way, 341.

Number of farms adopting insect and rodent control measures as demonstrations, 3,341. Acres involved, 102,050.

Pounds of poison bait used, 106,610.

Acres burned in fall and winter as demonstrations, 171,915.

Acres sowed to wheat on or after fly-free date as demonstrations, 226,285.

**Dairy Husbandry.**—Number of demonstrations started or under way, adult 242, junior 24.

Number of boys' and girls' dairy calf clubs, 24. Members enrolled, 240.

Total value of animals raised by boys' and girls' club members, \$7,560.

Total number of farms influenced by adult or junior extension work to adopt better practices, 1,059.

Number of purebred sires secured, 243.

Cow Testing Associations organized or reorganized during year, 22.

Number of cows under test as Associations and individual farms, 7,992.

Number of farmers testing animals for tuberculosis, 7,863. Animals tested 53,829.

Number unprofitable cows replaced by testing associations, 156.

**Poultry Husbandry.**—Number of demonstrations started or under way, adult 675, junior 50.

Number of birds involved in demonstrations, 65,427.

Value of birds raised by club members \$425,000.

Total number of farms influenced by adult or junior extension work to adopt better practices, 3,960.

Number of farms assisted in securing purebred sires, 2,337. Number secured, 4,868.

Number of farms culling flocks, 4,475.

Number of flocks fed better balanced rations, 4,029.

Number of farmers controlling insect pests of poultry flocks, 3,670.

Number of hens examined for egg production, 318,686. Number discarded as culls, 88,029.

Number modern poultry houses built or remodeled, 839.

Certified breeding flocks established, 109.

**Agricultural Economics.**—Farmers given benefit of cooperative credit associations, 360.

Farmers given benefit of cooperative marketing associations, 4,665. Estimated saving or profit per farmer \$14.60.

Number of farmers and housewives assisted in buying or selling through other channels than cooperative associations, 2,927. Estimated saving and profit per person, \$15.85.

Number of farms grading or standardizing products, 813.

Farmers' Mutual Fire Insurance Companies organized during year, 2. Number of members, 4,049. Insurance written, \$535,000. Assessments per \$100.

Number livestock shipping associations incorporated during year, 9.

**Home Economics.** (*Food and Nutrition*).—Number of demonstrations started or under way, 381.

Number of homes influenced, 3,279

Persons weighed and measured in connection with food selection project; adults 16,767, children 675.

Number of boys' and girls' clubs, 29. Members enrolled, 432

Number of homes assisted in correcting diet of under-nourished children, 374.

Number of homes using better methods of canning, drying, and otherwise preserving fruit, 5,055.

(*Clothing*).—Number of boys' and girls' clubs, 530. Value of articles made, \$6,087.80.

Homes influenced by adult or junior work to improve practices, 6,995.

Number of garments and hats made as result of instruction; garments 4,556, hats 4,749.

Number of dress forms made according to instructions, 2,249.

Number of patterns made and used according to instructions, 1,932.

Local leaders trained, 382.

**Home Health and Sanitation.**—Number of demonstrations started or under way, 111.

Number of homes given instruction in home nursing and first aid, 525.

Total number of homes influenced to adopt sanitation practices, 742.

**Household Management and Home Furnishings.**—Number of demonstrations started or under way, 1,140.

Total number of homes influenced by adult and Junior work to change practices, 1,212.

Number of homes keeping accounts, 642.

Number of homes making changes as a result of accounts, 329.

Number of kitchens rearranged, 293.

## EXPERIMENTS IN PROGRESS

(During the year ending June 30, 1923.)

The following brief descriptions of experiments in progress during the year are Progress Reports. They are not intended to be complete, but rather reports of work actually accomplished during the year. Many minor projects—some of considerable importance—are not included in this list.

By comparing these reports with similar reports on the same projects in former years a complete history of the work may be secured. The reports of former years will be found in the Annual Report of the Director which may be secured on application

### AGRICULTURAL CHEMISTRY

(A. G. HOGAN, *Chairman*)

**Protein Storage in Protoplasmic Tissue.** (A. G. Hogan, W. S. Ritchie).—A major portion of the work has been examining methods that seem suitable for the problem. According to current beliefs there are present in striated vertebrate muscle two proteins that are soluble in neutral salt solutions. One is classified as an albumin, the other as a globulin. The work has been directed to a selection of the most suitable extraction solvent for these two proteins. Rabbits have been used as experimental animals. By the methods used it was possible to extract 75 per cent of the total nitrogen of rabbit's muscle with neutral salt solutions. Some work has been done on the separation of the proteins in the extract.

**Use of Feed Experiment.** (A. G. Hogan, J. M. Nierman).—Two research bulletins, Nos. 54 and 55, were published in the fall of 1922. Two more are now in press. These are, "The Nitrogen, Ash and Phosphorus Distributions in Beef Flesh as Affected by Age and Condition", and "Changes in the Composition of the Dairy Cow During Fattening".

It is believed that with the publication of these bulletins, the project is closed so far as the metabolism of energy and organic nutrients is concerned. There are still on hand a large number of samples that have been reserved for mineral analyses.

**Chemical Service.** (A. G. Hogan, L. D. Haigh, W. S. Ritchie, E. E. Vanatta, H. M. Harshaw, A. R. Hall, E. G. Sieveking, J. M. Nierman).—The department of

agricultural chemistry does the chemical analytical work for all departments of the Experiment Station. Following is a list of the chemical analyses made for the various departments. For the department of animal husbandry; 41 complete feed analyses for moisture, ash, nitrogen, fat and crude fiber, a total of 205. For the department of dairying; 20 complete feed analyses, making a total of 100. For the department of entomology; 18 samples for arsenic only. For the department of horticulture; 29 samples for ash and phosphorus only and 17 samples for ash, calcium, nitrogen and phosphorus, making a total of 126. For the department of soils; 13 samples of crops for moisture, carbon, and nitrogen, 472 samples of soils for nitrogen, phosphorus, potassium, lime requirement, volatile matter and moisture, 604 samples for calcium carbonate equivalent, making a total of 3,475. For fertilizer control; 345 samples for nitrogen, total phosphorus, insoluble phosphorus and potassium, making a total of 1,380; commercial analyses of 24 samples of feeds for fat, nitrogen and crude fiber, making a total of 82. For agricultural chemistry: 7 Van Slyke determinations of nitrogen partition, 12 mineral analyses of swine for calcium, magnesium, potassium, sodium, sulphur, phosphorus, iron, chlorine, silicon and carbon dioxide, 400 nitrogen determinations, 13 feed analyses for moisture, ash, nitrogen, fat, crude fiber, calcium and phosphorus: 2 feeds for water, ash, calcium and phosphorus. In addition to the above, 25 samples were examined qualitatively, making a grand total of 6,128 analyses.

**AGRICULTURAL ENGINEERING**

(J. C. WOOLEY, *Chairman*)

**The Draft of Wagons.** (J. C. Wooley, M. M. Jones).—This project was designed to determine the draft of a farm wagon under various road and field conditions, and with different sizes of wheels and widths of tires; and to determine the coefficient of rolling friction for different types of roads and fields. Table 1 shows the effect of heights of wheels on draft.

TABLE 1.—DRAFT OF WAGON WITH WHEELS OF DIFFERENT HEIGHT, AND ON DIFFERENT KINDS OF ROADWAY.

Kind of roadway	Height of wheels		
	Low	Medium	High
Worn brick pavement.....	115.8	98.0	97.0
New brick pavement.....	89.5	73.5	70.7
Concrete pavement.....	93.7	87.5	82.0
Macadam.....	112.4		105.0
Dirt road (dry).....	388.5	347.9	333.8
Dirt road (muddy).....	441.1	367.8	342.3
Cinder Roadway (dry).....	164.4		128.9

The low wheels were 36-inch front and 40-inch rear; medium wheels, 36-inch front, 44-inch rear; high wheels, 40-inch front and 44-inch rear. A 3,000 pound load was used in all tests. The foregoing results are averages from 164 tests. Correction was made for grade in all tests. These results checked more closely with the rule that the draft varies directly with the load and inversely with the radius of the wheel, than with those rules using the square root or the cube root of the radius. Table 2 shows the effect of width of tire on draft.

TABLE 2.—DRAFT OF WAGON WITH TIRES OF DIFFERENT WIDTH, AND ON DIFFERENT KINDS OF ROADWAY.

Kind of roadway	Width of tires	
	Narrow	Wide
Worn brick pavement.....	99.9	81.6
New brick pavement.....	82.4	75.4
Concrete pavement.....	93.0	83.8
Dirt road (dry).....	357.4	310.0
Dirt road (muddy).....	360.6	363.0

The wide tires have decreased the draft on each of the different types of roadway to date. These results are averages resulting from 121 tests. Corrections for grade were made for all tests.

Coefficients of rolling friction derived from these tests are shown in Table 3.

TABLE 3.—COEFFICIENTS OF ROLLING FRICTION.

No. tests used	Type of roadway	Coefficient
34	Worn brick pavement	0.508
30	New brick pavement	0.366
26	Concrete pavement	0.417
26	Dry dirt road	1.814
18	Muddy dirt road	1.930
8	Gravel road	0.565
12	Cinder road	0.755

**A Study of the Methods Prolonging the Service of Wood Fence Posts.** (J. C. Wooley).—A new series (H) has been added to the experiment. It was found that in some of the varieties which had received the butt treatment, the top had rotted and the treated portion was in good condition. In series H the posts received the hot and cold butt treatments and while in the hot creosote the creosote was dipped up and poured over them giving the top the equivalent of a good paint coat.

The following varieties were included in series H: Soft Maple, Black Walnut, Hickory, Willow, Cottonwood, White Oak, Slippery Elm, and Sycamore.

Concrete posts using different mixtures and different kinds of reinforcements have been added to the experiment.

Square posts and modified triangular posts are used. Three different mixtures of concrete are also used:

- (1) One part cement to three parts sand.
- (2) One part cement to three parts bank run gravel.
- (3) One part cement to two of sand to two of crushed rock passing a  $\frac{1}{2}$ -inch mesh screen.

One-fourth-inch deformed reinforcing rods were used in one group, No. 9 wire in another, and a cable made up of three No. 11 wires in another.

**Investigations to Determine the Draft of Various Farm Implements, the Effect of Different Soil Types on Draft and the Effect of the Different Treatments of Soils on the Draft of Various Implements.** (M. M. Jones).—One hundred fifty tests of

the draft of plows were made in cooperation with the Soils Department. These tests were conducted in April and May, 1923, and the average draft per square inch for furrow slice in corn stubble was 5.04 pounds.

**An Investigation of Sanitary Conditions on Farms and Experiments to Determine the Best Types of Sanitary Equipment.** (J. C. Wooley).—Cost of electricity from the 32-volt farm plant. Two three-year-old plants were used. The batteries were charged and discharged once before the test was started. These batteries had been used about the same as they would have been used on the average farm. Fuel and oil required for each charge was measured. The battery was discharged until the voltage dropped to 28 volts. The number of k. w. hrs. derived from the battery was measured and the cost per k. w. hr. figured.

The following prices for fuel and oil were used in computing the cost:

Gasoline.....	19c per gallon.
Lubricating oil.....	95c per gallon.
Kerosene.....	11c per gallon.

The cost of fuel and oil per k. w. hr., using gasoline for fuel, was 16.3c; the cost of fuel and oil per k. w. hr. using kerosene for fuel was 9.4c.

### ANIMAL HUSBANDRY

(E. A. TROWBRIDGE, *Chairman*)

**Age as a Factor in Animal Breeding.** (F. B. Mumford, P. M. Bernard).—This project has been in progress since 1909. Its object is to study the effects of early breeding upon mother and offspring.

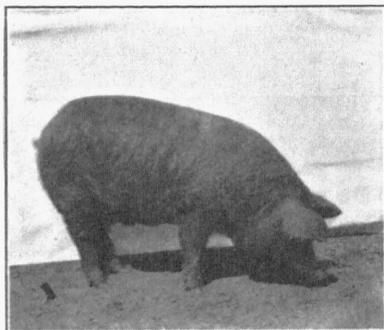


Fig. 3.—Factor V, aged 5 mos., 23 days at date of first breeding. One of the original sows in early breeding experiment. Compare with figure 4.



Fig. 4.—Factor 130, aged 5 mos., 23 days at date of first breeding. This sow represents the 13th generation in the experiment.

Factor 130, the thirteenth generation in the line of continued early bred sows has farrowed her first litter at the age of 10 months and 12 days. She weighed 280 pounds at farrowing time. The accompanying photographs show her at the age of first breeding, 5 months and 23 days, taken March 29, 1923, and also Factor V, one of the original sows with which the experiment was started, at the same age and at her first breeding, taken March 2, 1908.

During the year Factor 90, the ninth generation, reached the weight of 687 pounds, at the age of 4 years, 9 months and 12 days, the heaviest weight of any sow yet produced in the experiment. In her seventh litter she farrowed 17 pigs.

There is no evidence in the photographs or in the records of any injury to the race or breed resulting from the earliest possible mating of young sows continued now through 13 generations.

**Age as a Factor in Animal Breeding; the Effect of Plane of Nutrition upon Immature Brood Sows.** (F. B. Mumford, P. M. Bernard).—The project on "The Effect of the Plane of Nutrition Upon Immature Brood Sows," has been in progress three years and five months. Sub-factor 94, one of the sows with which the low-plane group was started, died at the time of farrowing her third litter at the age of 2 years, 8 months and 13 days. She was in extremely poor flesh.

The third generation sows in the high-plane group have raised their first litters. The third generation sows in the medium and low-plane groups are carrying their first litters as this report is written (September, 1923).

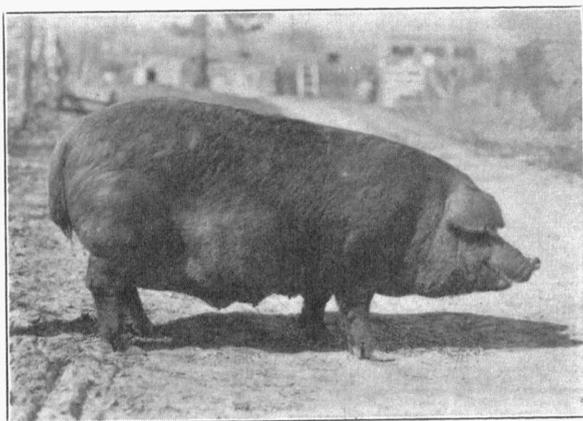


Fig. 5.—Sub-factor 91, aged 3 yrs., 1 mo., 23 days. One of the sows fed from weaning time on a high plane of nutrition. Weight 585 pounds.

The following table shows a partial record of the original sows, all litter mates, in each group up to the age of 3 years and 6 months.

TABLE 4.—RECORD OF SOWS ON THREE PLANES OF NUTRITION

Group	Lbs. grain consumed	Weight at 3 yrs., 6 mos.	No. litters raised	No. pigs raised	Av. Birth wt. of pig
<b>High-Plane Group</b>					
Sub-factor 91.....	6,036.00	585	5	29	2.25
Sub-factor 93.....	6,036.00	430	5	25	2.08
<b>Med.-Plane Group</b>					
Sub-factor 90*.....	5,116.25	341	5	39	1.77
Sub-factor 95.....	4,258.75	413	4	35	2.33
<b>Low-Plane Group</b>					
Sub-factor 94.....	1,090.0	†272	2	10	1.87
Sub-factor 96.....	2,083.4	284	4	19	2.22

\* Died at age 2yr., 8 mo., 13 da. †Weight at death.

The accompanying photographs show Sub-factor 91, a well fed sow, Sub-factor 95, a medium-fed sow, and Sub-factor 96, a poorly fed sow, at the age of 3 years, 1 month and 23 days. They are litter mates.

**Limited Grain Rations for Fattening Cattle of Different Ages.** (E. A. Trowbridge and H. D. Fox).—This experiment was planned to secure information concerning the rapidity and economy of gains and degree of finish obtainable on calves, yearlings, and two-year-olds when full-fed and when wintered on corn silage, legume hay and oil cake, and finished on grass.

Six lots of cattle of eight head each were used. One lot each of calves, yearlings, and two-year-old steers was fed for 143 days on a ration of six parts shelled corn, one part linseed oil cake (pea size), and as much corn silage and alfalfa hay as they



Fig. 6.—Sub-factor 96, aged 3 yrs., 1 mo., 23 days. One of the sows fed from weaning time on a low plane of nutrition. Weight 284 pounds.

would eat. One lot each of calves, yearlings, and two-year-old steers was fed as much alfalfa hay and corn silage as they would consume, and as much linseed oil cake as was eaten by the full-fed cattle for a 120-day period, and were finished by being fed corn and linseed oil cake for 72 days on bluegrass pasture.

A market value was placed on each lot of cattle at the end of 120 days, at which time corn silage was eliminated from the rations of the full-fed cattle and dry lot feeding continued, while the remaining lots were placed on bluegrass pasture and full-fed a ration of six parts corn and one part linseed oil cake.

With the full-fed cattle, the daily gains were greatest on the two-year-olds and slightly less on the calves and the yearlings. The younger the cattle the less grain was required to produce 100 pounds of gain, while there was very little difference in roughage consumed for 100 pounds gain. They were all of uniform good quality and sold within 40c to 70c of the top of the Chicago market for the day.

In the lots of cattle wintered without shelled corn and finished on grass, the two-year-olds made the largest average daily gain, while the calves exceeded the yearlings by 0.13 pounds per day. The feed, exclusive of grass, required per 100 pounds gain, both grain and roughage, increased with the age of the cattle, except for the one instance where yearlings ate slightly more corn than the two-year-olds. The condition of these groups is indicated by the fact that each lot sold on the market for nearly the same price as the full-fed cattle.

The elimination of the silage from the rations of the full-fed cattle was accomplished without perceptible disadvantage. The cattle which were turned on grass required some time to become accustomed to the new conditions. The groups of yearlings and two-year-olds that were full-fed made greatest gains in 143 days than the other yearlings and two-year-olds made in 192 days. However, the calves finished on grass made nearly 40 pounds greater gain than those full-fed. Less shelled corn but more corn silage was required to make the cattle marketable where they were roughed through the winter and fed out on grass.

**Rations for Pigs at Weaning Time.** (L. A. Weaver).—Seventy pigs which averaged approximately 60 pounds were divided into seven uniform lots of 10 pigs each and fed for 112 days (June 16 to October 6, 1922). All lots were pastured on Dwarf Essex rape during the entire period. The following concentrates were fed: Group 1 was fed corn; Group 2, corn four parts, shorts four parts, bran one part, and tankage one part; Group 3, corn six parts, shorts three parts, tankage one part; Group 4, corn 9 parts, tankage one part; Group 5, corn five parts, shorts five parts; Group 6, corn nine parts, garbage tankage one part; group 7, corn nine parts, dried buttermilk one part. This was the third trial conducted with the first five rations and the results secured compared very closely with those obtained the first two years, and point to the following conclusions when corn is fed to hogs on rape pasture:

- (a) Corn alone is not a sufficiently well balanced concentrate to produce maximum gains.
- (b) There was little difference in the results obtained from lot 2, lot 3, and lot 4.
- (c) A ration of corn and shorts in equal amounts proved superior to corn alone, but did not produce as rapid a gain as any of the other rations.

The results of one years work with garbage tankage fed with corn in proportion of 1 to 9 indicate that such a ration fed on rape pasture is no more valuable than is corn alone.

When dried buttermilk was substituted for tankage (packing house) the gain was slightly less and a little more feed was required to produce one pound of gain.

**Hogging Down Corn and Soybeans** (L. A. Weaver).—Four one-acre plots were hogged down. Plot 1, corn and soybeans supplemented with tankage and self-feeder; Plot 2, corn supplemented with tankage and self-feeder; Plot 3, corn and soybeans; Plot 4, corn.

An average of four years' data, 1919-1922 inclusive, indicated:

- (1) That an acre of corn pastured by hogs, supplied tankage in addition, will produce more pork than will any of the other combinations used in these experiments.
- (2) That hogs on corn and tankage gained more rapidly than those fed any of the other combinations.
- (3) That the feeding of tankage in a self-feeder to hogs on corn alone or on corn plus soybeans materially increases the rate of gain and also the economy of gain.
- (4) That soybeans planted in corn to be hogged down will not completely take the place of tankage.
- (5) That hogs on corn plus soybeans alone will make more rapid gain and slightly more pork per acre than on corn alone.

However, since the amount of feed produced per acre in the corn-plus-soybean plot was usually less than when corn was grown alone, the total amount of pork produced per acre was very little more with the combination than with corn alone.

**Factors Influencing the Normal Rate of Growth in Domestic Animals and the Permanency of the Effects of Arrested Development.** (A. G. Hogan).—This project was begun in 1914 with the idea of determining how long cattle may be stunted

by underfeeding, and still attain normal development upon refeeding. The steers were divided into three groups. One, fed to grow at normal rate; another fed to gain about  $\frac{1}{2}$  pound per day; and the third fed to gain about  $\frac{1}{3}$  pound per day. In 1917 additional calves were placed on this experiment. Some of the steers had been placed on full feed in order to determine whether they had reached the point where they were permanently stunted. Several have died and five have been slaughtered for analysis. One steer died May 25, 1923. Death was ascribed to fat necrosis. There are eight steers remaining in the investigation. Table 5 indicates the treatment of these steers and their present condition.

TABLE 5.—TREATMENT OF STEERS AND THEIR CONDITION

Group & No.	Date of birth	When put on full feed		Weight June 30, 1923
		Weight Lbs.	Date	
Group I				
577	March 1917	---	-----	1,650
Group II				
573	April 1917	604	11-17-21	1,440
578	April 1917	599	11-17-20	1,521
571	March 1917	---	-----	1,225
Group III				
585	April 1914	---	-----	1,125
575	April 1917	---	-----	905
574	April 1917	626	11-17-20	1,245
572	April 1917	491	11-17-20	1,625

From the surface area of these steers a formula for the more exact calculation of the surface area of cattle has been developed. Two factors are used in this formula—length of body, and weight. The formula itself is  $S=L.6 \times W.4 \times K$ . S is the area in square centimeters, L the length of body in centimeters, W is the weight in kilograms, K is the constant 217. The length of body is taken as the distance from the point of the withers to the end of the ischium, or pin bone. Sufficient data was available to apply the formula to 37 individuals and the maximum error was  $\pm 5.5\%$ .

**Growing Draft Colts.** (E. A. Trowbridge, D. W. Chittenden).—The data in this project is taken on four head of fillies. Two periods are covered by this project; (1) the third summer period, and (2) the fourth winter period.

## THIRD SUMMER PERIOD

(April 29, 1922 to January 19, 1923.—265 days.)

Average weight beginning of period.....	1,242.5 lbs.
Average weight close of period.....	1,413.75 lbs.
Average total gain per period.....	171.25 lbs.
Average daily gain.....	0.64 lbs.
Average daily ration bluegrass at will.....	
Average daily ration soybean and hay.....	1.28 lbs.
Average daily ration mixed hay.....	0.32 lbs.

The colts received no grain during this period and all the hay was fed during the last thirty-eight days of the period.

All fillies were bred in spring of 1922. Two proved to be in foal.

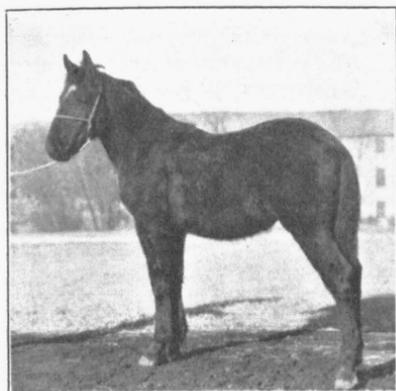


Fig. 7.—The smallest filly at the beginning of the experiment.



Fig. 8.—The largest filly at the beginning of the experiment.

FOURTH WINTER PERIOD  
(January 19 to March 2, 1923.—42 days.)

Colts run on pasture and provided shelter only on extremely cold nights.

Average weight beginning of period.....	1,413.75 lbs.
Average weight end of period.....	1,389.00 lbs.
Average loss.....	24.75 lbs.
Average daily loss.....	0.58 lbs.
Average daily ration soybean alone.....	5.59 lbs.
Average daily ration mixed hay.....	5.15 lbs.
Average daily ration bluegrass at will.....	
Average daily ration silage.....	1.91 ins.
Average daily ration grain*.....	1.59 lbs.

\*All grain was fed to one filly toward end of period as she was not in foal and was broken and put to work.



Fig. 9.—(Above) The smallest filly at maturity—same animal as in figure 7.

Fig. 10.—(At right) The largest filly at maturity—same animal as in figure 8.



A synthetic ration was made composed of casein (purified) corn starch, butter, (sometimes cod liver oil), agar, dried yeast, and salts. In the present feeding trials, ten females were used. Six bore normal litters. The young grew at less than normal rate. Three lost their litters shortly after birth. One died while pregnant, with four well developed embryos in the uterus.

The observations made have not been continued sufficiently long to determine what success the females will have in bearing subsequent litters.

**Corn Silage as a Part Ration for Horses of Various Ages.** (E. A. Trowbridge and D. W. Chittenden).—A ration of corn silage and mixed hay, and a small amount of bluegrass pasture which was available in the exercise lot was fed to pregnant mares. The bluegrass consumed was slight and was not included in the rations.

The average initial weight of the mares was 1,593 pounds. The average weight at the end of the 133-day period was 1,596 pounds, an average gain of 3 pounds.

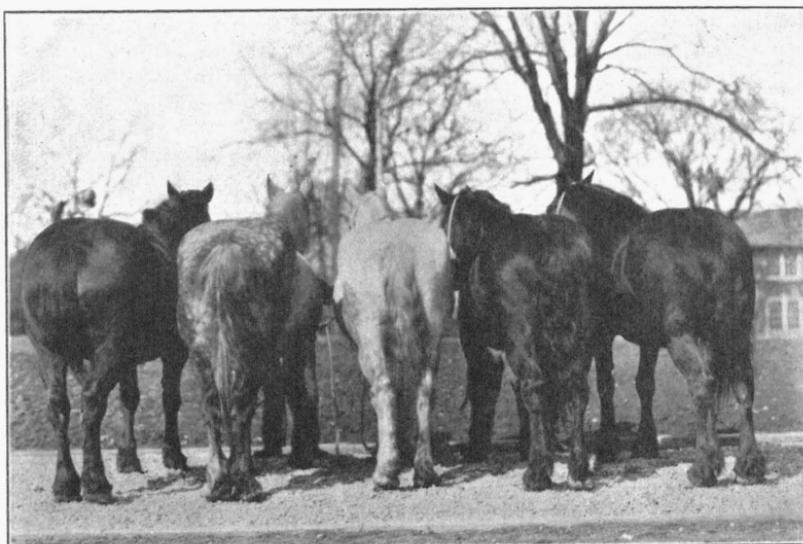


Fig. 11.—Mares which approximately maintained their weight and continued in thrifty condition on corn silage and mixed hay.

The average length of gestation period was 349.6 days. The average weight of the foals produced, 152 pounds.

The mares were fed an average daily ration of 16.82 pounds of silage and 7.97 pounds of hay. This indicated that this amount proved in this test a satisfactory ration for wintering brood mares that were safe in foal. The mares approximately maintained their weight and kept in a thrifty healthy condition. The colts produced were all strong, well developed, and normal in every way.

If corn silage is valued at \$5 per ton, and mixed hay at \$12 per ton, the daily cost of such a ration would be 9 cents per mare.

**The Relation of Diet to Bodily Activity and the Capacity to Withstand Unfavorable Circumstances.** (A. G. Hogan, H. M. Harshaw).—Young rats have been divided into two groups; one receiving a high, and one a low protein intake. Each of these groups have been sub-divided into two other groups; one receiving a slightly deficient quantity of vitamine B, and one an ample quantity. The experimental ani-

imals are really those on a low vitamine diet. Half of them received a high protein diet and half a ration low in protein. The rats receiving an ample supply of vitamine B are the control animals.

If a high protein diet is of any value besides its well known function of metabolism, the rats receiving the high protein diet as compared to the low protein diet should give some evidence of the protective action of an abundant supply of protein. Growth of the young animals has been used as an indication of the possible protective action of the high protein ration. To date, the evidence has not been conclusive but, in general, the high protein ration does not confer any special protection against a deficiency of vitamine B.

Another proposed method of attacking the problem is the behavior of females during the reproductive cycle. Before such a method can be used, a "synthetic" diet that is adequate for normal reproduction must be made. Considerable progress has been made along this line.

## BOTANY

(W. J. ROBBINS, *Chairman*)

**The Relation of Hydrogen-ion Concentration to the Growth of Plants.** (W. J. Robbins).—Experiments have been carried out on the water absorption by potato tuber tissue in buffer mixtures of phosphoric acid and sodium hydroxide, citric acid and sodium hydroxide, and potassium acid phthalate and sodium hydroxide. The curve of water absorption plotted against the hydrogen-ion concentration of the buffer mixtures shows a curve with two maxima. The minimum between the two maxima was located in the phosphate series at  $P_H$  5.8, in the citrate series at  $P_H$  5.5 to 5.7, in the phthalate series at  $P_H$  6.2. Potato tuber tissue was also stained with acid or basic dyes and washed with the buffer mixtures. The acid dyes were retained by potato tuber tissue treated with buffer mixtures of approximately  $P_H$  6 or less and lost in buffer mixtures of  $P_H$  greater than 6. The basic dyes were retained to a considerable extent at all reactions used but more strongly on the alkaline side of  $P_H$  6. Changes in the reaction of dilute buffer mixtures in contact with potato tuber tissue indicated that below  $P_H$  6 the solutions became more alkaline, and above  $P_H$  6 they remained unchanged or became more acid. The conclusion has been drawn that potato tuber tissue responds in water absorption, in the absorption of dyes and in the changes in reaction it produces in dilute buffer mixtures much like a protein with isoelectric point of  $P_H$  6.

By means of a study of the absorption of basic and acid dyes the mycelium of *Rhizopus nigricans* has been found to respond like a protein with isoelectric point at about  $P_H$  5.0 to 5.2. On potato dextrose agar and in potato dextrose broth of different hydrogen-ion concentrations the growth of this fungus was found to show a double maximum curve with the minimum between, at  $P_H$  5.2.

The demonstration that plant tissue responds like a protein with an isoelectric point would have a very important bearing upon the fundamental physiological processes and upon the use of stains in histological and cytological work.

**A Study of Certain Fusarial Diseases of Plants.** (W. J. Robbins, Irl T. Scott, B. B. Branstetter).—*Varietal Resistance of Wheat to Scab.* Seventy-three new varieties and strains other than those previously reported were given preliminary tests. In general, the season was apparently unfavorable for severe infection by the scab organism inasmuch as the maximum infection occurring in any single rod-row was only 5.4 per cent while the maximum infection for the year previous was 15 per cent. The maximum average percentage infection for four rod-rows was only 2.16 per cent. Three varieties showed no infection, while 28 varieties showed 0.5 per cent or

less, average infection in four rod-rows. The data obtained in addition to that obtained previously for 51 additional varieties give a basis for the selection of a number of promising resistant varieties for future study.

*Tomato Wilt.*—In greenhouse experiments in which tomato plants were grown in pots of soil adjusted to varying hydrogen-ion concentration by means of 1N H<sub>2</sub>SO<sub>4</sub> and 1N NaOH and inoculated with a single-spore strain of *Fusarium lycopersici* it was found that there were maxima points at which wilt occurred in ranges of average P<sub>H</sub> 3.7 to about 6.4, and average P<sub>H</sub> 7.2 to 8.45, with a minimum of wilt occurring between average P<sub>H</sub> of 6.4 to 7.0.

*Corn Root Rot.*—Field tests with diseased seed corn versus disease-free seed, as determined by the modified rag doll germinator, have shown no appreciable difference in yield in the two lots of seed.

From numerous tests of seed corn made under sterile conditions, it has been found that one can select disease-free ears without the use of the modified rag doll germinator. Ears that are sound and solid, with bright white butts and bright clean tips and that show no molds, or discolorations are, for all practical purposes, disease-free.

Preliminary greenhouse experiments indicate that corn root and stalk rot symptoms may be produced on plants from disease-free seed planted in virgin soil which has been inoculated with corn root rot fungi.

## DAIRY HUSBANDRY

(A. C. RAGSDALE, *Chairman*)

**A Study of Colostrum with Special Reference to the Effect of Heat (Pasteurization) on its Physico-Chemical, Bacteriological, Immunological and Nutritional Changes** (A. C. Ragsdale, Samuel Brody).—The most satisfactory methods of raising a calf from a cow infected with tuberculosis or other infectious disease is to separate the calf from its mother at birth, and feed the calf its mother's colostrum after it has been pasteurized in a water bath at 145° F. for 20 minutes. Eighteen calves out of 20 were successfully raised by this method. Nine calves were fed white of eggs as a substitute for colostrum; seven were successfully raised. Guinea pigs which were removed from their mothers at birth and fed on cow's milk suffered a high mortality. Six litters of guinea pigs removed from their mothers at birth and not fed milk allowing them to eat grain, hay, and carrots from birth maintained a 100 per cent survival. Of four calves removed from their dams at birth and fed on mixed whole milk from the herd, two were raised. The total number treated in this way to date, has been 22 and with 9 deaths. It was found necessary to determine the normal mortality of dairy calves in order to judge the relative mortality of experimental calves. Of 773 calves, 44 or 5.69 per cent died from all causes in the first six months after birth. Of this number 12 deaths were the result of accident, blackleg, and tuberculosis, leaving 32 deaths or 4.14 per cent due to scours, and other digestive disturbances, such as might be the results of feeding and care.

The Veterinary Department made a careful post-mortem examination and bacterial study of the organs of the non-colostrum calves and guinea pigs that died. A general congestion of the blood vessels of the visceral organs was noticeable in nearly all cases. The pathological picture was such as would ordinarily be designated as an "acute enteritis".

Several kinds of bacteria were isolated from the heart, lungs, liver, spleen and kidneys, as well as from the inflamed areas of the intestines. *B. coli* predominated. Other micro-organisms found were: *Staphylococcus—albus* and *aureus*, *B. bovis septicus*, *B. lactis aerogenes*, *streptococcus pyogenes*, *B. aerogenes capsulatus*, and *B.*

*lactis acidi*, and an unidentified bacillus. These cultures were made from the apparently fresh organs removed from the calves immediately after death.

The chemical composition of colostrum changes rapidly with each milking until it becomes normal milk about the third or fourth day. The most conspicuous change occurs with the globulin and sugar. The globulin decreases rapidly while the sugar increases. Colostrum has a considerably higher hydrogen-ion concentration than normal milk.

**Studies in Milk Secretion.**—(a) Time Relations in Milk Secretion (b) Mechanisms Regulating Variations in the Composition of Milk (A. C. Ragsdale, Samuel Brody, C. W. Turner).—*The effect of an accumulation of milk in the udder on the rate of milk secretion.*—Four cows were milked at intervals of 1 hour, 2 hours, 3 hours, on up to 36 hours after the last milking. The milk secreted per hour dropped from approximately 1 pound to less than 0.2 pound.

*The initial rise of milk secretion after calving and the relation between this initial rise and the subsequent decline.*—Fifty-five cows were milked four times a day, 32 cows three times a day, and 40 cows twice a day. The maximum production in the case of the cows milked four times a day was on the 35th day following calving; with the cows that were milked three times a day, on the 20th day; and with the cows that were milked twice a day, on the 15th day. Following the time of maximum production there was a gradual decrease.

*The rate of decline of milk secretion with the advance of the period of lactation.*—Table 6 shows the decline of milk secretion in the dairy cow with the advance of the period of lactation.

TABLE 6.—MILK YIELD PER DAY DURING SUCCESSIVE MONTHS OF LACTATION PERIOD\*

Month of Lactation	Holstein cows	Jersey cows	Guernsey cows	Scrub cows
1	39.6	30.0	33.3	20.4
2	40.3	29.4	34.3	19.0
3	38.9	27.9	32.3	16.0
4	36.5	25.9	29.9	14.0
5	33.9	24.2	28.1	12.0
6	32.5	22.7	26.4	9.7
7	30.8	21.4	24.9	8.0
8	29.3	20.6	23.7	7.0
9	27.9	19.5	22.4	5.4
10	25.4	18.6	21.0	3.7
11	23.2	17.3	19.5	
13	20.0	17.3	17.9	

\*The figures give the averages of 95 lactation periods with Holsteins, 305 periods with Jerseys, 3,215 periods with Guernsey, and 32 with scrub cows.

*The effect of gestation.*—It was found that gestation increased the rate of decline of milk secretion with the advance of the period of lactation, especially after the fourth month following breeding. In cows not bred, each month's milk production was a constant percentage of the production of the preceding month (94.77 per cent).

*The relation between body weight and milk production, and age and milk production.*—It was found that in Jersey cattle an increase of body weight of 100 pounds with age was accompanied by an increase of butterfat production of a little over 100 pounds per year. The relation between body weight at constant age and milk production showed that an increase of 100 pounds of body weight at constant age was accompanied by an increased fat production of 20 pounds. It was therefore concluded that 20 per cent of the increase of fat production with age is due to body weight and 80

per cent due to age or factors other than body weight. Milk secretion increases with the body weight of the dairy cow to the age when a maximum body weight is reached (8 years), at which time, the milk secretion takes a downward course and steadily declines with age. Thus milk secretion may be used as a measure of the effect of age on the body after age ceases to have an appreciable effect on body weight. After the age of 10 years, the butterfat produced in any year is approximately 97 per cent of that produced the preceding year.

**The Inheritance and Transmission of the Characters "Capacity for Fat Production"** (C. W. Turner).—In order to study the inheritance and transmission of butterfat production it was necessary to convert fat production records made at all ages to a "mature equivalent". This conversion factor is based on the relation between age and fat production as shown by the records of 150,585 cows of the Jersey, Guernsey, Holstein, Ayrshire, and Shorthorn breeds. A total of 273 Jersey sires having 10 or more daughters have been compared on the basis of the average butterfat production of their daughters. Dam and daughter comparisons were made of the 18 gold medal sires.

**Silage Investigations** (A. C. Ragsdale, C. W. Turner).—The loss of nutrients in the silo and during the field curing of corn on three additional experimental silos and two shocks of corn has been studied. A total of 54 experimental silos and 16 lots of field-cured corn have now been studied. These included several crops other than corn. The data covered 20 silos filled with corn cut at the proper time for good silage, 13 silos filled with shock corn after standing in the field, 8 silos of cereal crops, 4 silos of oats and peas, and 9 silos filled with leguminous crops.

In every case there was an unavoidable loss of dry matter during the ensiling process averaging for all silos 7.59 per cent, the minimum loss being 4.01 per cent in the case of silage made from fresh green corn. The greatest loss, 15.29 per cent occurred with cereal crops, which may have been due, in part at least, to the fact that cereal crops are very high in nitrogen-free extract at the time of siloing. The protein loss on all crops averaged 5.44 per cent although results with individual crops varied considerably. It appears that unless putrefaction takes place there should be but a very slight loss of nitrogen except possibly that due to the downward wash of soluble protein to the lower part of the silo. The 18 per cent gain in fat for all silos seems to indicate that during silage fermentation organic acids such as acetic and lactic and other ether-soluble substances were formed which appear with ether extract thus increasing the apparent fat content. It seems reasonable to conclude that there is little if any actual gain of fat. An apparent gain of 5.94 per cent ash was found on an average for all silos which is probably accounted for by the downward wash of soluble matter resulting in difficult sampling since it is not probable that there is any gain or loss in the inorganic matter. The crude fiber content remained practically unaltered, showing the slight loss of 1.95 per cent. The nitrogen-free extract, consisting principally of starch and sugar, showed a loss averaging 10.29 per cent. In view of other experimental work it appears probable that the starch content remains constant and that the loss in nitrogen free extract is chiefly a loss in the soluble sugar. It has been shown that the production of acid takes place at the expense of the sugar.

The loss of dry matter of corn shocked in the field was found to be approximately twice that for all silos and almost four times as great as that of green corn. The loss in nitrogen-free extract was twice as great.

**Standards of Growth for Dairy Cattle** (A. C. Ragsdale, Samuel Brody).—*Skeletal Growth*.—It has been found that under normal conditions there was a linear relation between the increase in different skeletal measurements with age.

*Intra-uterine growth.*—The increase in weight of seventeen gestating Jersey cows was not as rapid during the 6th and 7th month as during the other months of the gestation period. This was interpreted as indicating a junction between two growth cycles.

*Growth during the first two months after birth.*—Calves of the Jersey, Holstein, and Ayrshire breeds were weighed daily following birth. The calves did not lose weight at any time after birth but made gains with remarkable regularity.

*Standards of growth for male calves.*—Table 7 shows the average growth of male calves of the Jersey and Holstein breeds by months.

TABLE 7.—AVERAGE GROWTH OF MALE CALVES

Age Mos.	No. calves weighed	Weight in lbs.	No. calves measured	Height at withers in cm.
<b>Jersey</b>				
Birth	16	61	23	68.3
1	15	82	23	72.7
2	15	113	23	77.3
3	15	156	24	82.9
4	13	211	23	88.8
5	14	268	22	93.7
6	14	324	20	97.6
7	13	352	14	100.8
8	13	400	15	103.3
9	13	456	13	105.9
10	11	495	12	108.2
11	9	537	8	109.2
12	6	542	5	110.0
13	4	535	4	112.3
14	4	591	4	112.7
<b>Holstein</b>				
Birth	17	90.2	22	74.5
1	17	125.7	22	78.6
2	16	173.2	20	83.0
3	17	231	21	89.8
4	17	296	21	95.5
5	17	343	19	100.0
6	17	436	17	104.4
7	16	494	15	107.9
8	14	573	13	110.2
9	12	631	12	114.1
10	9	688	9	116.8
11	7	757	9	118.8
12	7	796	7	121.0
13	7	861	7	123.9
14	6	893	7	125.7
15	5	944	5	122.3
16	4	982	4	127.0
17	3	1033	3	127.0
18	2	987	3	129.5
19	2	1028	2	128.3
20	2	1067	1	126.2
21	2	1125	1	129.4
22	1	1285	1	130.0
23	1	1360	1	131.5
24	1	1410	1	138.8

*The rate of growth of the dairy cow after the age of two years.*—Weight records have been compiled on 15,680 Jersey cows. It is shown that the average Jersey cow weighs

960 pounds at maturity and that she reaches this mature weight at between 8 and 9 years of age.

It was found that the "growth impulse" dies out as the young cow matures at the constant ratio of approximately 74 per cent with each year of age.

*A weight-height-age curve as a measure of the state of nutrition and of growth of the dairy cow.*—Investigations at this Station have shown that the growth in height of withers of an animal will not vary except in the case of a long continued lack of sufficient nutrition. Height at withers may therefore, be taken as a measure of the hereditary size of the animal at any age except in very unusual cases. The relation between height and weight under normal conditions has been established. With this relation established it is easy to determine from the height, what should be the corresponding weight of an animal. This growth curve is given in figure 12.

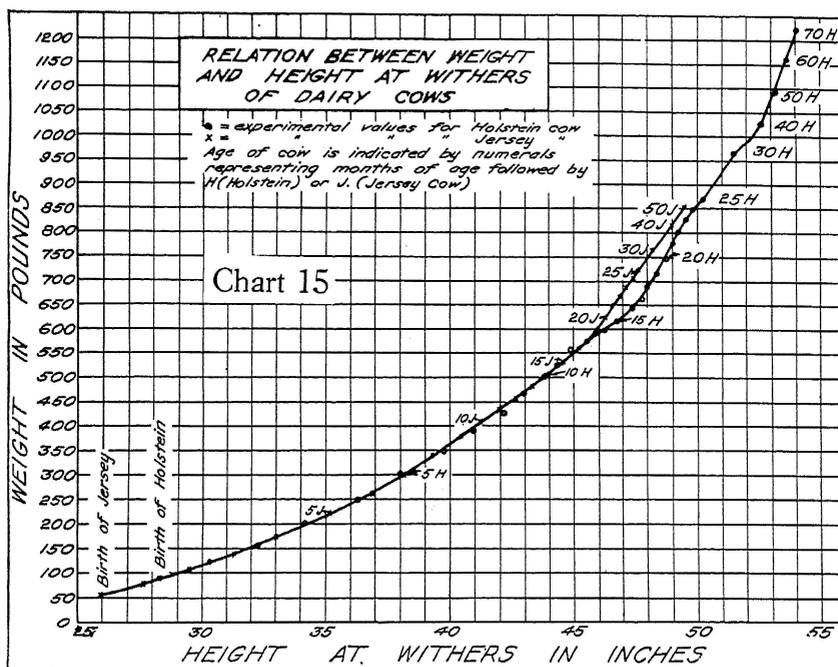


Fig. 12.—Weight-height-age curve showing that for a given height under "normal" conditions there is a definite weight.

**Minimum Protein Requirements for the Growth of Dairy Heifers** (A. C. Ragsdale, W. P. Hays).—All animals of both Jersey and Holstein breeds made on the average normal growth in weight when receiving 82.1 per cent and 64.4 per cent respectively of the Wolff-Lehmann and Armsby protein standards.

Normal growth in weight was made by Holstein heifers when 11.0 per cent, by Jersey heifers when 18.4 per cent and on the average by all animals when 13.4 per cent of the total net energy for maintenance plus growth was furnished by the protein in the ration. The animals receiving an excess of energy made normal growth when 10.8 per cent of the total net energy for maintenance plus growth was furnished by

the protein in the ration, as compared to 17.8 per cent when only a normal energy supply was given.

Higher protein planes were much more efficient in promoting growth in weight with Holsteins than with Jerseys. The Holsteins made approximately 118 per cent of the normal growth in weight on a protein plane far below that on which the Jerseys made a gain weight of only approximately 98 per cent. There was a decided advantage in favor of excessive energy for Jerseys on all protein planes and for Holsteins on all except the very low planes. The "protein plane" here referred to indicates the percentage of energy for growth which was derived from the protein of the ration.

**Raising Calves on Milk Substitutes** (A. C. Ragsdale, C. W. Turner).—Growth at a rate approximately 70 per cent of normal for calves under 6 months of age can be secured by weaning thrifty dairy calves when 60 to 70 days old and feeding thereafter a good quality alfalfa or soybean hay and a suitable grain mixture. Following the change to grain and hay poor growth is made until the calves become accustomed to dry feed. After the first two months on such a ration there is a tendency for large gains to be made. However, the gains are not large enough to enable the calves to return to normal weight and height before they reach 6 months of age.

Holstein calves make more nearly normal gains when fed by this method than do Jerseys. With few exceptions the Holstein calves reach normal weight and height by the ninth or tenth month, while the Jerseys do not reach normal weight and height until about one year of age.

The amount of grain and hay consumed by dairy calves is an excellent indication of the rate at which growth is made.

**Relative Vitamine Content and Growth Promoting Properties of Heated, Dried and Filled Milk Preparations** (Wm. H. E. Reid, D. H. Nelson).—Using four-week-old rats seven lots of 10 animals each were fed on diets made up of 50 grams of unbolts white cornmeal mixed with equal amounts (based on total solids) of (1) fresh pasteurized whole milk, (2) fresh whole milk powder, (3) fresh pasteurized skimmed milk, (4) fresh skimmed milk powder, (5) fresh evaporated milk, (6) fresh sweetened condensed milk, (7) fresh filled milk. Diets 1, 3, 5, 6, and 7 were diluted with distilled water to the same consistency. Diets 2 and 4 were fed dry. Weights of the individual rats were taken twice each week.

Groups 1 and 2 made practically normal growth in weight, had the largest reproduction and continued in the best health and vigor. Groups 3 and 4 gave practically the same rate of growth during the first two months as did Groups 1 and 2. Beginning with the third month Group 3 showed a greater susceptibility to disease, particularly pneumonia and there was very little reproduction. Group 4, however, made gains in weight and reproduction second only to Groups 1 and 2. Group 5 made very small gains and the rats did not reach normal size. There was no reproduction although the rats continued in apparently good health. Group 6 made good gains for the first 10 days then the growth curve flattened out rapidly. The rats remained in apparent good health but did not reproduce. Group 7 made very slow gains from the start and after the first 10 days the growth curve was nearly flat. There was no reproduction.

**The Effect of Each Ingredient in the Manufacture of Ice Cream** (Wm. H. E. Reid, D. H. Nelson).—One hundred eighty-two experimental freezings have been made which confirm results previously reported. These studies have been along three lines. 1. Studies showed great accuracy for the type of experimental freezer used. 2. A study of the effect of different percentages of sugar on the physical properties of ice cream revealed (a) a direct relation between the percentage of sugar added to the

mixture and the hardness of the finished ice cream, and (b) a direct relation between the quantity of sugar used in a mixture and its ability to with stand exposure to summer temperatures existed. 3. It was found (a) that with increased increments of butterfat the viscosity showed a gradual increase, (b) the time required for the mixture to begin freezing varied directly with the fat content, (c) the time required to whip the mixture was decreased with increased fat contents, resulting in a decrease of the total time required to freeze, (d) the overrun increased slightly with increased viscosity, (e) ice cream containing the higher percentages of butterfat retained their original form over a longer period of time, (f) with increased overruns but with no increase in the fat content the ice creams lost their stability to a greater degree, (g) ice creams containing 10 to 12 per cent of butterfat gave best satisfaction regarding flavor, body, texture, and salable condition.

## ENTOMOLOGY

(L. HASEMAN, *Chairman*)

**An Investigation of the Malarial Mosquito Plague in Missouri** (L. Haseman and K. C. Sullivan).—A large number of mosquitoes have been obtained from different sections of the State and added to the collection, which now contains 31 different species of mosquitoes, most of which are common in Missouri. Some of these species are found only in Southeast Missouri. Only two malarial species have been found in Missouri; *Anophele Quadrimacalatus*, *Anophele Punctipennis*. These two species have been obtained from several widely separated sections of the State, and they seem to be more widely distributed than any other species.

**An Investigation of Methods of Controlling the Chinch Bug** (L. Haseman, K. C. Sullivan and O. C. McBride).—The use of hydrocyanic acid gas for the control of the chinch bug was made possible by the development and manufacture of calcium cyanide. Calcium cyanide upon coming in contact with either soil moisture or moisture from the air gives off hydrocyanic acid gas which is a deadly poison. The gas is given off slowly and being heavy, clings to the surface of the ground. Calcium cyanide is manufactured in three forms—flakes, granules and dust. The flakes proved the most satisfactory for use against migrating chinch bugs. One of the best features of the calcium cyanide is that it kills the bugs immediately. Its cost is somewhat more than either dust barriers or chemical barriers. The most effective way found to use calcium cyanide was to plow a deep furrow between the wheat and corn, throwing the dirt toward the corn. In the bottom of this furrow a line of calcium cyanide flakes was placed using 1 pound for every 60 feet. The flakes should be placed in the furrow during the early part of the afternoon. It was necessary to renew the calcium cyanide practically every day. It was often necessary to maintain the barrier for about 10 days.

Good results were also obtained by dragging a log in the furrow. This method when properly carried out is effective and considerably cheaper than calcium cyanide.

A barrier of crude oil or creosote also proved effective.

The calcium cyanide dust gave excellent results when applied to growing corn badly infested with chinch bugs. The cyanide dust was applied with a knapsack duster at the rate of 15 pounds per acre. With heavy infestations it was found necessary to make two applications about three days apart to get effective control.

**The Annual Life Cycle of the Hessian Fly in Missouri and Its Control** (L. Haseman, K. C. Sullivan and O. C. McBride).—Plats at Maryville, Kirksville, Hannibal, Columbia, Webster Groves, Cuba, Charleston and Springfield were maintained. From six to seven seedings were made at each place. At Maryville a 50 per cent infestation was obtained on wheat sown on September 26, while wheat sown on

or after October 1 was free from infestation. The infestation at Kirksville was very light and no infestation was obtained after October 2. At Hannibal and Columbia the infestation was not heavy and there was no infestation on wheat sown after the fly-free date. There was a partial third brood and slight infestation on wheat sown three days after the fly-free date at Webster Groves, Cuba and Springfield. It may be necessary to change the fly-free date a few days in these sections. At Charleston there was very little infestation. Wheat seeded after October 1 was not infested. October 15 is the fly-free date at Charleston.

**Injurious Insect Pests of Melon and Related Crops** (L. Haseman, K. C. Sullivan and O. C. McBride).—The following materials were tested for the control of the striped cucumber beetle on young squash and melon vines: Nicotine dust in three strengths (0.5, 1, and 2 per cent), calcium cyanide flakes (one teaspoonful per hill), calcium cyanide granules (one teaspoonful per hill), calcium cyanide dust (one teaspoonful per hill), calcium cyanide dust mixed with equal parts of air slaked lime one teaspoonful per hill), naphthalene balls.

Several applications of the above materials were made during the season. The 0.5 per cent nicotine dust had no effect on insects and no injury to plants. The 1 per cent nicotine dust gave no effect on insects and no injury to plants. The 2 per cent nicotine dust killed for a short time only, with no injury to plants. Calcium cyanide flakes killed both insects and plants. Calcium cyanide granules killed both the insects and plants. Calcium cyanide dust killed both insects and plants. Equal parts of calcium cyanide dust and air slaked lime gave fairly good control of insects and no injury to plants. The naphthalene balls, using one, two, and three balls per hill, pressed lightly into the soil beneath the plants, did not injure the plants and in no case was there any injury to the plant by the striped cucumber beetle or by any other insect. The naphthalene balls lasted and seemed to be effective for a period of about six weeks. This is the first season that naphthalene balls have been used as a means of controlling the striped cucumber beetle. They have not yet been tried on a commercial scale.

**An Investigation to Determine the Life History, Development and Habits of the Corn Ear Worm and Practical Methods of Controlling Its Ravages** (L. Haseman and K. C. Sullivan).—The corn varieties, St. Charles White, Bloody Butcher, Ninety-Day Yellow, Leaming, Reids Yellow Dent, Boone County White and Silver Mine were grown. One seeding was made on June 1, the other June 26. Each seeding was divided into three equal parts, one of which was sprayed with arsenate of lead, 1 pound to 50 gallons of water; the second dusted with arsenate of lead, 15 parts of arsenate of lead to 85 parts hydrate of lime; and the third was left untreated as a check. Each treated plot was treated once, the early seeding on August 9, and the late seeding on September 5. In no case was the control good enough to warrant the use of a spray or a dust on a large scale. The late seeded corn was damaged the most by the corn ear worm.

**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 and O. C. McBride).—A great variation has been noted in the length of time required for the first brood of the Codling Moth to complete its cycle. This has resulted in the overlapping of generations, making the control of the later brood more difficult. This season in many sections of Missouri the application of two July sprays for the control of the later broods would have been advisable.

In the testing of arsenical sprays at various pressures with different nozzles, the calyx spray was applied with a disc nozzle, a bordeaux nozzle and a spray gun at 175 pounds and 250 pounds pressure respectively. While there was some variation in the

results obtained, there was not enough difference in the type of nozzle used and the amount of pressure used to be significant.

An Investigation to Determine What Insects are Injurious to Nursery Stock in the State; Their Life History, Distribution, Injury and Methods of Control (L. Haseman, K. C. Sullivan, O. C. McBride and Neely Turner).—San Jose scale is the most important of nursery pests in Missouri. A number of standard spray materials have been tested along with the new lubricating oil emulsions. The accompanying table shows the results which were obtained with standard sprays.

TABLE 8.—RESULTS FROM SPRAYING PEACH TREES WITH STANDARD SPRAYS

Date sprayed	No. of test	Materials used	Strength solution	Tree treated	Date examined	Percentage dead
1-13-23	1	Scalecide	1 gal. to 15 gals.	Peach	1-20-23	99.6
1-13-23	2	Sherwin-Wm. dry lime-sulphur	12 lbs. to 50 gals.	Peach	1-20-23	85.0
1-13-23	3	Sherwin-Wm. dry lime-sulphur	20 lbs. to 50 gals.	Peach	1-20-23	89.0
1-13-23	4	Glidder's dry lime-sulphur	12 lbs. to 50 gals.	Peach	1-20-23	80.0
1-13-23	5	Lighting dry lime-sulphur	15 lbs. to 50 gals.	Peach	1-20-23	86.0
1-13-23	6	Dow's dry lime-sulphur	12 lbs. to 50 gals.	Peach	1-20-23	89.0
1-13-23	7	Dow's dry lime-sulphur	20 lbs. to 50 gals.	Peach	1-20-23	90.0
1-13-23	8	Niagara dry lime-sulphur	20 lbs. to 50 gals.	Peach	1-20-23	87.0
1-13-23	9	Grasselli liquid lime-sulphur	6 gals. to 50 gals.	Peach	1-20-23	93.0
1-13-23	10	Check	-----		1-20-23	43.4

It will be noted that none of the lime sulphur solutions gave satisfactory kill. The oil spray (Scalecide) being the only one to give good results. The following table shows some of the results which have been obtained with the new lubricating oil emulsions against San Jose scale.

TABLE 9.—RESULTS FROM SPRAYING WITH LUBRICATING OIL EMULSION

Date sprayed	No. of test	Materials used	Strength solution	Trees treated	Date examined	Percentage dead
4-26-23	1	Bordeaux-oil emulsion	1% oil	Apple	5-23-23	64.49
4-26-23	2	Soap-oil emulsion	1% oil	Apple	5-23-23	68.5
4-9-23	3	Bordeaux-oil emulsion	2% oil	Peach	5-1-23	97.4
4-9-23	4	Soap-oil emulsion	2% oil	Apple	5-1-23	97.2
4-4-23	5	Kayso-oil emulsion	2% oil	Apple	5-3-23	94.7
4-3-23	6	Bordeaux-oil emulsion	4% oil	Apple	5-4-23	86.4
4-4-23	7	Soap-oil emulsion	4% oil	Apple	5-1-23	85.6
4-4-23	8	Bordeaux-oil emulsion	10% oil	Apple	4-30-23	97.5
4-4-23	9	Soap-oil emulsion	10% oil	Apple	4-30-23	96.4
-----	10	Check	-----		5-4-23	13.9

It will be noted that 1 per cent oil emulsion did not give satisfactory results. The 2 per cent solution in general gave just as good results as 4 per cent and 10 per cent solutions.

Table 10 shows some of the results which were obtained with different sprays for control of the Grain Aphis (*Aphis Avenae*) in different varieties of apples.

TABLE 10.—EFFECT OF VARIOUS SPRAYS ON THE CONTROL OF THE GRAIN APHIS

Variety	Materials used	Date sprayed	Strength	Date examined	Percentage killed
Jonathan	Check	-----	-----	4-18-23	12.8
Jonathan	Bordeaux-oil emulsion	4-12-23	1%	4-18-23	47.6
Jonathan	Bordeaux-oil emulsion	4-12-23	2%	4-18-23	85.9
Jonathan	Liquid lime-sulphur	4-9-23	1-7%	4-12-23	22.5
Jonathan	Soap-oil emulsion	4-4-23	10%	4-25-23	86.2
Jonathan	Kayso-oil emulsion	4-10-23	2%	4-18-23	95.0
Ben Davis	Check	-----	-----		0
Ben Davis	Bordeaux-oil emulsion	4-12-23	1%	4-24-23	80.0
Ben Davis	Bordeaux-oil emulsion	4-12-23	2%	4-24-23	94.0
Ben Davis	Liquid-lime sulphur	4-9-23	1-7%	4-12-23	20.3
Ben Davis	Soap oil emulsion	4-4-23	10%	4-24-23	86.08
Ben Davis	Kayso oil emulsion	4-10-23	2%	4-11-23	95.0
Grimes	Check	-----	-----	4-17-23	5.9
Grimes	Bordeaux oil emulsion	4-12-23	2%	4-18-23	81.7
Winesap	Check	-----	-----	4-18-23	4.4
	Bordeaux oil emulsion	4-12-23	1%	4-16-23	70.2

TABLE 11.—RESULTS FROM THE USE OF PARADICHLOROBENZENE AGAINST PEACH TREE BORERS

No. of trees treated	Plot No.	Date treated	Amount	Date examined	Larva dead	Larva alive	Burrows
<b>Five-year-old trees</b>							
11	1	5-12-23	.6 oz.	7-7-23	12	0	11
10	2	5-12-23	1 oz.	7-7-23	7	0	11
5	3	-----	Check	7-7-23	0	15	6
<b>Eight-year-old trees</b>							
2	1	5-19-23	.5 oz.	7-7-23	5	0	11
2	2	5-19-23	1 oz.	7-7-23	9	0	9
2	3	5-19-23	1.5 oz.	7-7-23	1	0	7
3	4	5-19-23	2 oz.	7-7-23	5	2	21
2	5	5-19-23	Check	7-7-23	0	16	0

## FIELD CROPS

(W. C. ETHERIDGE, *Chairman*)

**A Genetic Analysis of Maize** (W. H. Eyster).—The following general problems have been studied:

1. The relation of the various pericarp colors and patterns in maize and their method of inheritance.
2. The inheritance of abnormalities in various parts of the plant.
3. The inheritance of deficiencies and chlorophyll (some of these deficiencies are lethal, while others at least reduce the vigor of the plant.)
4. The chemical nature of chlorophyll deficiencies and the relationship between pigmentation and the chloroplastids and the synthesis of the carbohydrates.
5. The linkage of inherited factors.
6. The development of strains superior in yield.

**Cultural Experiments with Corn** (W. C. Etheridge, C. A. Helm).—Eleven years of investigation of methods of preparing the seedbed for corn on deep, fertile Marshall silt loam of Northwest Missouri, have shown that planting in a list furrow, 6 to 8 inches deep, or even in a shallow furrow opened with disk planter, has invaria-

bly increased the yield of corn. When compared with surface planting, the planting in shallow furrows increased the average acre yield 4.2 bushels, while the planting in the deep list furrow increased it 7.4 bushels.

In 1922, on fertile Grundy silt loam soil in Northeast Missouri, late and deep cultivation apparently decreased the yield slightly. On Marshall silt loam in Northwest Missouri spring plowing and shallow cultivation produced better yields than fall plowing and deep cultivation; but on Hagerstown silt loam in Southwest Missouri spring plowing was decidedly unfavorable, causing a loss of nearly 7 bushels to the acre. On Summit silt loam in Central Missouri, there was little or no difference between the yields from spring plowing and fall plowing.

**A Study of the Important Varieties of Oats for Missouri Conditions** (L. J. Stadler, C. A. Helm).—In 1922, an extremely unfavorable season for oats, the leading varieties yielded (in bushels per acre) as follows:

Sterilis Selection.....	32.3
Burt.....	30.7
Fulghum.....	29.5
Green Russian.....	29.0
Early Champion.....	29.0
Sixty Day.....	28.4
Kherson.....	27.5

These results agree with those of recent years in showing the superiority of varieties of the *Sterilis* species. The Station's strains of Burt and Fulghum, in particular, have been consistently high yielders. At the end of this harvest there will be seed stocks large enough to begin the distribution of these strains.

**A Comparison of the Most Important Grain Sorghums with Corn for Grain and Forage Production** (W. C. Etheridge, C. A. Helm).—Comparisons of yields in three years of corn, kafir and sorgho, on upland soil of the Ozark section, have emphasized the remarkable value of kafir there. The best varieties of these three crops have produced the following per acre: corn (White Pearl) 8.3 bushels of grain or 1.0 ton of cured forage; kafir (Sunrise and Dawn) 29.1 bushels of grain or 1.3 tons of cured forage; sorgho (Amber and Orange) 18.9 bushels of grain or 1.6 tons of cured forage.

On moderately productive soil in the gray prairie section of Southwest Missouri corn (Commercial White) in 1922, yielded per acre 42.7 bushels of grain or 2.8 tons of cured forage; kafir (Sunrise and Dawn) 45.5 bushels of grain or 2.8 tons of cured forage and sorgho (Amber and Orange) 37.3 bushels of grain or 2.9 tons of cured forage. This, the first comparison of these crops in Southwest Missouri, did not indicate for the gray prairie soils the superiority of kafir and sweet sorghum that is so clearly shown for Ozark upland.

**Wheat Breeding Investigation, including the Improvement of Commercial Varieties by (1) The Pure Line Method of Breeding, (2) Hybridization and Subsequent Selection** (L. J. Stadler).—Four of the Station's improved strains of wheat were among the five highest yielding varieties in the tests of 1922. The yields of these five were much above those of other varieties, and in bushels per acre were as follows:

Michigan Wonder 209.....	36.1
Blackhull.....	36.1
Fulcaster 15.....	33.5
Michigan Wonder 54.....	33.4
Michigan Wonder 96.....	33.0

These strains are receiving the highest praise from farmers. First distributed in 1918 they are now grown on tens of thousands of acres.

In addition to improved strains of wheat, this project has afforded a basis for studies in the technic of field experimentation.

**Cultural Experiments with Cotton, Including Fertilizer Tests** (W. C. Etheridge, C. A. Helm).—Five years of investigation of the value of fertilizers for cotton on the Lintonia fine sandy loam of Southeast Missouri, have shown that an average net profit of \$6.60 per acre resulted from the acre application of 300 pounds of acid phosphate. This increased the earliness of the crop about 10 per cent. There was no further profit from the addition of 35 pounds of potassium chloride.

**A Study of the Adaptation of the Important Varieties of Spring Barley for Missouri Conditions** (L. J. Stadler).—Because of the extremely unfavorable season of 1922 the yields of all barley varieties were low, none exceeding 8 bushels to the acre.

**A Study of the Cultural Requirements and Adaptation of Sudan Grass** (W. C. Etheridge, C. A. Helm).—At Columbia on upland soil of average productivity the highest yields of Sudan grass resulted from seeding with an 8-inch grain drill at the rate of 25 pounds of seed to the acre; but at Cuba, on very thin upland soil, 30 pounds of seed produced a much larger yield than 25 pounds.

At Columbia Sudan grass and soybeans sown together with a grain drill nearly doubled the yield of these crops sown in alternate rows 32 inches apart.

**A Study of the Adaptations of the Important Varieties of Cotton for the Southeast Missouri Lowlands** (W. C. Etheridge, C. A. Helm).—The average yields of varieties tested since 1918 indicated the superiority of Acala, Mebane Triumph, and Cleveland Big Boll. These are all big-boll varieties, medium late to mature. Yields of the early small-boll varieties—King, Trice and Simpkins Prolific—were not impressive, though the lowest of all yields were from Webber 49, the only long staple variety in the list. It is particularly interesting to note the poor performance of Rowden, in view of the great popularity of this variety among the cotton growers. Not only was it an ordinary yielder, but it was also later than even the other big-boll varieties in the list.

This test has not been conducted long enough to justify a final conclusion on the best varieties even for sandy ridge land in Southeast Missouri, but the indication of the high value of Acala, Mebane Triumph, and Cleveland Big Boll was strong enough to make reasonably safe the recommendation for their use. In this connection it is well to note that Acala, although a new variety, is rapidly growing in popularity among cotton farmers. The extent to which the yields of these varieties on Sandy land may indicate their relative yields on heavy land is uncertain; but it is believed that one of these three—Acala, Mebane Triumph or Cleveland Big Boll—will be found satisfactory for all well drained sandy or medium loam soils.

**Comparison of Soybeans and Cowpeas for Hay and Seed Production** (W. C. Etheridge, C. A. Helm).—Two leading varieties of soybeans—Virginia and Morse—were compared in yields of seed and hay with two leading varieties of cowpeas—New Era and Whippoorwill. When all varieties were planted in rows 40 inches apart, the soybeans slightly outyielded cowpeas in both seed and hay. When all varieties were sown with an 8-inch grain drill, soybeans still made slightly higher yields of hay than cowpeas and more than doubled the yields of cowpeas in seed. Yields of soybeans were slightly larger in both seed and hay when the crop was sown with a grain drill. When cowpeas were sown with a grain drill they yielded far more hay but only half as much seed as when sown in rows 40 inches apart. These results show the su-

periority of soybeans as a hay crop, especially when they are sown thick on clean, fertile soil.

**A Study of the Adaptation of the Important Varieties and Selections of Soybeans to the Various Soil Types of the State.** (W. C. Etheridge, C. A. Helm).—The results from tests of varieties of soybeans in 1922 confirmed those of the previous six years in showing Virginia as especially suitable for soils of medium and lower than medium fertility, Wilson as superior for seed and hay on Central Missouri soils somewhat above the average in fertility, while Morse and Mikado seemed best adapted to the fertile soils of Northeast and Northwest Missouri respectively.

**A Morphological Classification of the Varieties of Soybeans** (W. C. Etheridge, C. A. Helm).—More than 200 kinds of soybeans have been distinguished from about 800 samples of so-called varieties collected from the experiment stations and seedsmen of the country. Colors of the bloom, testa, cotyledons, and pubescence of the stems and pods provided the principal basis for classification. Further means of distinction, less important in character, were size and form of seed, color pattern and



Fig. 13.—Soybeans on Cuba (Crawford County) experiment field. This plot was treated with manure, acid phosphate, and lime.

polish of the testa, size and color of the hilum, and color of the pods. An economic quality, such as the length of the growth of the period, sometimes distinguished an individual.

In general the classification, when complete, will subordinate the question of genetic relationship to the convenience of identifying agronomic varieties. For this convenience the classification will proceed as far as possible on the basis of characters clearly visible at maturity.

**Cultural Experiments With Soybeans, Including (1) Time of Seeding, (2) Method of Seeding, (3) Rate of Seeding** (W. C. Etheridge, C. A. Helm).—Maximum yields of both seed and hay by the leading varieties of soybeans resulted from planting between May 15 and June 1. Crops planted earlier or later than this period made lower yields. In a comparison of rates of planting, Morse and Wilson repre-

senting respectively the seed and hay types, made maximum yields when planted in rows  $3\frac{1}{2}$  feet apart, at the rate of 20 pounds of seed per acre. All varieties made larger yields when they were cultivated level and shallow, than when cultivated deep or in ridges.

**Cultural Experiments With Wheat, Including (A) Methods of Preparing the Seed Bed, (B) Rate of Seeding** (W. C. Etheridge, C. A. Helm).—On Gray prairie soil in Southwest Missouri, land plowed early produced nearly twice as much wheat per acre as land plowed late. Variations in the subsequent treatment of either early-plowed or late plowed land had no significant effect upon yield.

Simply harrowing soybean stubble land in preparation for wheat made 7.1 bushels per acre more than rolling, 2.7 bushels more than rolling and disking, and 7.8 bushels more than no treatment.



Fig. 14.—Soybeans on same experiment field as those shown in figure 13. This plot had no soil treatment.

## HORTICULTURE

(T. J. TALBERT, *Chairman*)

**Identification and Study of Factors Determining Hardiness and Methods of Increasing It** (H. D. Hooker Jr.).—A correlation has been found between hardiness and the rate at which plant tissues lose water in an oven. Although tender plant tissues usually contain more water than hardy tissues they lose it more quickly and can be completely dried in a shorter period of time. It is assumed that the “free” water is driven off first and more readily than the water in “colloidal combination”.

Evidences of winter injury associated with immaturity have been observed in certain apple varieties and in grapes. Observation on a young orchard planted from nursery stock that had been injured by low temperatures showed that the trees did

not heal properly and fungi gained entrance. As a result the trees may be lost from disease unless they are carefully disinfected and all wounds painted. Since it has been found essential that injured wood should not be exposed it may be inadvisable to expose it by any pruning whatever.

**Orchard and Strawberry Nutrition** (H. D. Hooker Jr.).—The late summer and fall nitrogen treatments have been repeated and their effect on fruit bud differentiation has been observed. There are indications that fall application of sodium nitrate favor blossom bud formation the following spring. The value of this procedure in correcting the alternate bearing habit is being investigated. A plot of York apple trees so treated blossomed this spring for the third consecutive year, while check trees fail to bloom.

The sulphur studies have been extended to include tomatoes. The inverse relation between sulphur and phosphorus was also found in these plants. Tomatoes contain even larger percentages of sulphur than apple tissues. Fertilizer experiments with peaches have been started to determine the relative value of sodium nitrate and ammonium sulphate and to ascertain the best time to make the application. Results indicate that applications made before the trees bloom increase the subsequent work of thinning.

**Walnut Grafting Investigation** (T. J. Talbert).—A few of the improved varieties of walnuts fruited for the first time last year. One or two varieties gave very promising results. The new grafting work has been successful.

**Cabbage Seed Selection for Disease Resistance** (J. T. Quinn).—No marked difference in the resistance of early standard varieties of cabbage to the "yellow" caused by *Fusarium Conglutinans* has been observed. Losses of from 35 to 75 per cent are reported from the older and badly invested fields.

**Investigations of the Method of Culture and Varieties of Basket Willows of Missouri** (T. J. Talbert, A. M. Burroughs).—The first planting of willows was in rows, one variety to the row. Fairly good land was used for this experiment. From the available data it might be concluded that there is little to choose between butts, middles and tips of cuttings in starting a willow holt. The results of this first work indicated that the American Green and the Yellow Osier varieties were best adapted to Missouri conditions. A willow holt on flood land was planned for the purpose of testing whether or not basket willows could be grown successfully on waste flood land, the soil of which was largely sand. The following varieties were planted in blocks: Caspian, American Green, Patent Lamley, Yellow Osier and American.

The Caspian and American Green varieties have well established root systems and produced a very strong growth every year. The commercial value of the group, however, has been destroyed by flooding and by the ravages of the cottonwood leaf beetle, *Lina Scripta*, Fabr. This pest, by destroying the terminal bud, caused the rods to branch and thus rendered them valueless for basket making. The Caspian appeared to be harmed less by this pest. Results indicated that the Patent Lamley, Yellow Osier and American varieties of basket willows were not adapted to waste flood land. Caspian appeared to be well adapted to this type of soil, as it made from 6 to 8 feet of growth per year and produced a fair percentage of unbranched rods. American Green made a good growth—from 5 to 6 feet—but is quite susceptible to insect attack. These two varieties—Caspian and American Green—might be profitably grown on waste land if spraying were practiced.

**Spraying Fruits for Insect and Fungus Disease** (H. G. Swartwout).—A number of brands of dry lime-sulphur in amounts varying from 2 pounds to 50 gallons of water to 5 pounds to 50 gallons of water have been tried. The liquid lime-sulphur

used in the experiment was standard commercial 33° Baume, the tests were conducted in a commercial orchard on a commercial scale. Indications are that dry lime-sulphur when used at the rate of 2 or 3 pounds to 50 gallons of water (amount usually recommended by manufacturers) is not as effective in controlling apple scab as the 33° Baume commercial liquid lime-sulphur, diluted at the rate of 1½ gallons to make 50 gallons of spraying material. However, it appears that about 5 pounds of dry lime-sulphur to 50 gallons of water will give the same control of apple scab as the standard liquid lime-sulphur solution.

Certain "spreaders" for spray materials, especially for lime-sulphur, have been investigated in the control of apple scab. The materials tried were pectin, a saponin-kerosene emulsion, a commercial miscible oil, and a home-made calcium caseinate. The calcium caseinate and miscible oil did not improve the control, but the pectin and saponin-kerosene emulsion gave better control than where the lime-sulphur was used alone.

**Treatment of Apple Canker Disease** (H. G. Swartwout).—The mixture of white lead and linseed oil in which were dissolved bichloride of mercury and mercuric cyanide has not been effective in the control of Illinois or blister canker. The canker has reappeared sooner or later on every one of the treated wounds. The cleaning and painting of the cankered spots was, however, of some value in checking the disease and prolonging the serviceable life of the trees. It also had value in checking the spread of the disease to healthy trees.

**Nutrition and Plant Response of Vegetables** (J. T. Quinn).—The fertilizer experiments indicated that phosphorus was a primary limiting factor not only in the production of Irish potatoes but also in tomatoes. Percentage of nitrogen was correlated with the early growth of the tomato plant and with the yield of early fruit. This work has been extended to include tomatoes grown in the green house during the winter months.

**Investigations With Seed Potatoes.** (J. T. Quinn).—The use of fall home-grown seed for the spring crop has given very satisfactory results. The practicability of growing a fall crop of potatoes under the average farm conditions in Missouri has been shown. Fall home-grown potatoes of the early varieties may equal northern grown potatoes as seed for the spring crop. Certified northern seed continued to produce more profitable crops than non-certified northern seed. A considerable variation was shown between strains of northern grown potatoes.

**Breeding Apples for Late Blooming Habit** (A. M. Burroughs).—Fruit was secured from a few of the seedling apple trees in 1922. Three seedlings bore fruit which was fair to good in quality and several bore fruit medium in quality. The seedling orchard has set a good crop this year. Complete blooming records were taken. It is believed that this year's work will tell whether or not any new late blooming, good quality, varieties have been developed.

**Peach Breeding for Hardy Sorts** (A. M. Burroughs).—Practically all the first generation seedlings bloomed in the spring of 1923. Complete blooming records were taken. There were no late blooming individuals in the planting.

## HOME ECONOMICS

(Miss JESSIE CLINE, *Chairman*)

**A Study of the Factors Affecting the Texture of Cakes** (Louise Stanley, Minnie Madeline Kennedy).—A study was made to determine the effect of the various ingredients on the texture of cakes; the effect of the baking temperature upon the

texture of cakes in relation to the composition of the batter; and the effect of manipulation on texture with reference to the method and amount of mixing in relation to the various constituents used.

It was found that sugar prevented the development of gluten and caused the texture to be finer. It raised the temperature of coagulation of the batter. This allowed the escape of gas and steam and thus prevented the formation of tunnels.

Too little liquid tended to make the texture coarse and bread like. Too much liquid increased steam formation.

Baking powder affected the texture of the cakes in three ways: by its action as a leavening agent, by its effect on steam distribution, and by increasing the porosity of the crust and the size of the cells thus increasing evaporation from the crust and the surface for evaporation within the cake itself.

\*Cakes made from pastry flour were coarser and more breadlike. There was less of a tendency to tunnel formation. The specific volume was increased.

Fat decreased the specific volume and made the texture finer if it was uniformly distributed throughout the batter. When not uniformly distributed it increased steam formation, and thus increased the tunnels.

distributed it increased steam formation, and thus increased the tunnels.

Too low a temperature made the cakes coarse. The cells became very large before a temperature was reached inside the cake that would coagulate the cell walls. If an excess of baking powder was used, the cakes fell.

Too high a temperature caused the cakes to peak and crack open. This was due to two factors: The coagulation of the batter forming a crust around the edge, and the increased steam formation.

Cakes containing a high proportion of flour required a low temperature for baking, because of the low coagulation point of the batter due to the large amount of gluten. The same was true of those containing a high proportion of egg.

The optimum oven temperature for butter cakes appeared to be between 175° C. and 195° C.

With optimum proportions, the high oven temperature did not increase tunnel formation provided the cake was thoroughly mixed. If an excess of liquid was used the batter was not homogeneous throughout. There was an increased tendency for tunnel formation with a high oven temperature, while if the oven temperature was lower the texture was uneven and large holes were formed.

The method of combining was important if a homogeneous mixture was to be obtained with a minimum amount of labor and time.

Fat, when added to the flour and sugar or to the sugar alone, was more easily combined than melted fat in any of the methods tried.

Melted fat tended to toughen the cake and to form tunnels.

**The Effect of Salt Upon the Loss of Iron in Cooking Vegetables** (Louise Stanley and Mabel Clare Stienbarger).—The vegetables cooked in salted water contained less iron than those cooked in clear water. The amount of loss was sufficient to cause concern. Salt in the cooking water of vegetables should be avoided if the liquor is to be discarded.

**The Wear of Hosiery** (Louise Stanley and Agnes Emberson Filler).—Cotton lisle stockings will stand thorough cleaning and hard wear. Stockings made from a good quality of virgin wool and stockings made from a combination of such wool and cotton or such wool and silk wear well. All other stockings labeled as wool do not wear well. Light-weight silk plated stockings give moderate service. The medium-weight silk usually out-wear any other stockings. High-priced silk stockings are not de-

pendable; they may or may not wear well according to the amount of weighting. Fibre silk gives poor wear.

Stockings wear best when washed daily. Fibre silk stockings are an exception to this rule since they are weakened by excessive washing. All stockings except cotton should be washed in lukewarm water, with milk soap, and should be dried slowly. Laundry soap, boiling water and the washboard may be used on cotton stockings.

Darning should be done daily as any break occurs. If parts of the stockings are subjected to unusual wear and are reinforced with fine cambric or knitted fabric, the wear is increased. In darning, thread the same weight as that of the stocking should be used.

Stockings wear well only when large enough. The foot length should be  $\frac{1}{2}$ -inch longer than the foot.

Medium-priced silk stockings are the best investment in silk hosiery. Inexpensive cotton lisle stockings wear with great satisfaction. High price is not an indication of wearing qualities.

## POULTRY HUSBANDRY

(H. L. KEMPSTER, *Chairman*)

**Value of Sour Milk, Beef Scrap, Cottonseed Meal, Gluten Meal and Oil Meal in Rations for Egg Production** (H. L. Kempster, E. W. Henderson).—A scratch food consisting of one part corn and one part oats by weight was supplemented with mashes containing protein concentrates. The basal mash consisted of equal parts by weight of bran, shorts, and cornmeal to which were added the various protein concentrates and the amounts as indicated in Table 12. Soft limestone grit and oyster shell were kept before the birds.

TABLE 12.—VALUE OF CERTAIN PROTEINS IN RATIONS FOR EGG PRODUCTION

Pen No. and Ration	Av. egg production	Grain per hen per year	Mash per hen per year	Feed (lbs.) to produce one dozen eggs
1 Tankage 20%	132	48+	37+	7.7
2 Meat Scrap 20%	151	44+	33+	6.1
3 Dried Buttermilk 35%	129	42+	34+	7.
4 Tankage 15%	163	50+	38+	6.5
5 Tankage 15%	128	43+	30+	6.8
Cottonseed Meal 5%				
6 Tankage 10%	147	42+	34+	6.1
Cottonseed Meal 10%				
7 Tankage 10%	125	50+	38+	8.3
8 Tankage 5%	126	44+	36+	7.6
Cottonseed Meal 15%				
9 Tankage 5%	130	44+	31+	7.
10 Sour Milk	130	48+	34+	7.7*

\*Does not include milk.

Hens which have passed through at least one laying season were used. There was very little difference in the efficiency of the various rations.

**Age as a Factor in Poultry Breeding** (H. L. Kempster, E. W. Henderson).—Table 13 shows the weight of the progeny of White Leghorn pullets from hens which had passed through one laying season as compared to those from pullets in their first laying season.

TABLE 13.—WEIGHT OF PROGENY FROM HENS AND FROM PULLETS

Month hatched	Number and Weight of Female Progeny November 1			
	From hens		From Pullets	
	No.	Wt. in lbs.	No.	Wt. in lbs.
February	55	3.2	12	3.2
March	56	3.1	15	2.9
April	92	2.7	37	2.8
May	45	2.4	15	2.2
June	31	2.2	3	2.6
Average	--	2.73	--	2.75

Only eggs of suitable size were used for incubation purposes.

White Leghorn pullets hatched from hens in the hatching season of 1920-21 averaged 31.5 eggs during the winter months, November 1 to February 28 inclusive, and 148 eggs for the year. The mortality was 24.2 per cent. Pullets hatched from eggs produced by pullets for the same years averaged 31 winter eggs and 150 eggs for the year. The mortality was 23.8 per cent. The percentage of pullets laying 200 eggs or more was 10 per cent from the progeny from hens and 7 per cent from those from pullets.

Of 896 eggs produced by White Leghorn hens, 17 per cent were infertile and 45.1 per cent hatched. Of 928 eggs from pullets kept in the same pens, 6.28 per cent were infertile and 47.2 per cent hatched. Of the fertile eggs the hatchability of eggs from hens was 54.4 per cent and from pullets 50 per cent

**Time of Moulting as an Index to Productivity of Hens** (H. L. Kempster, E. W. Henderson).—Table 14 shows two seasons' egg production of 200 White Leghorn pullets as compared to the time of moulting.

TABLE 14.—EGG PRODUCTION AS RELATED TO TIME OF MOULTING

Month moulted	Total eggs first year	Winter eggs following year	Total eggs following year	Total eggs for two years
July	122	22.4	103.5	225.5
August	132	19.8	114.5	246.5
September	142.4	23.1	122.7	265.1
October	157.7	28.6	139.	296.7
November	166.7	19.1	119.	285.7
After Nov. 1	195.	34.5	146.3	341.3

Table 15 shows the average egg production as related to the month in which the hens stopped laying.

**Studies in Regard to Xanthophyll, the Natural Yellow Pigment of the Egg Yolk, Body-fat and Blood-serum of the Hen** (H. L. Kempster, E. W. Henderson).—Chicks fed rations devoid of xanthophyll showed complete absence of yellow coloring in the visible skin parts. The ration in one case contained as high as 30 per cent butterfat which is rich in carotin. This is further proof that chicks are unable to utilize the yellow pigment carotin.

TABLE 15.—EGG PRODUCTION AS RELATED TO TIME HENS STOP LAYING

Month stopped laying	No. hens	Days vacation	Total egg production	Winter egg production
July	4	182	109	18.
August	8	151	134	18.6
September	25	143	137.4	17.4
October	121	94	153	17.3
November	59	69	170.6	22.
December	11	45	174.	33.8

## RURAL LIFE

(O. R. JOHNSON, *Chairman*)

**Utilization of Labor on the Farm** (O. R. Johnson).—All data on the influence of size of field, of labor cost, of growing corn from 1915 to 1919 inclusive have been summarized. These data cover more than 3,600 acres of corn. Table 16 shows the actual hours required to grow an acre of corn on fields of different sizes and the cost of this labor.

Table 17 shows saving in both labor cost of larger fields as compared to the smallest one on a per cent basis.

TABLE 16.—EFFECT OF SIZE OF FIELD ON UTILIZATION OF LABOR IN GROWING CORN

Size group	Labor required per acre		Cost of labor per acre	
	Man hours	Horse hours	Man labor	Horse labor
5 acres or less	33.8	55.6	\$5.90	\$6.12
5.1 acres to 10A.	29.9	50.2	4.98	5.28
10.1 acres to 15 A.	26.6	45.5	4.09	4.46
15.1 acres to 25 A.	20.8	37.0	3.51	4.12
Over 25 acres	17.2	27.8	2.91	3.83

TABLE 17.—PERCENTAGE OF SAVING IN LABOR AND COST ON FIELDS OF DIFFERENT SIZE IN GROWING CORN

Size group	Percentage saving in labor		Percentage saving in cost	
	Man hours	Horse hours	Man labor cost	Horse labor cost
5 acres or less	33.8 Hrs.	55.6 Hrs.	\$5.90	\$6.12
5.1 acres to 10 A.	11.5%	9.7%	15.6%	13.7%
10.1 acres to 15 A.	21.3	18.2	30.7	27.1
15.1 acres to 25 A.	38.5	33.5	40.5	32.7
Over 25 acres	49.1	50.0	50.7	37.5

NOTE.—The labor required for the smallest field is taken as the base, or 100 per cent.

**Beef Cattle Production in Missouri** (B. H. Frame, R. S. Springgate, and O. E. Palmer).—The result of the 1921-22 records have been summarized and a detailed statement sent back to each feeder who cooperated in this work. Thirty herds are included, nine of them being in Pettis County and twenty-one in Saline County. The

thirty herds contained 2,198 head purchased and 2,183 head sold, the other 15 having died. Table 18 shows a combined financial statement on all of the herds.

Complete detailed records have been kept on forty herds during the feeding season of 1922-23. Eighteen of these herds were in Pettis County and twenty-two in Saline. These herds contained 3,444 head of cattle, most of them purchased in October and November. Only 289 head had been sold by the first of June.

TABLE 18.—COMBINED FINANCIAL STATEMENT ON THIRTY HERDS

Debits and Credits	On all cattle	Per head	Percentage of entire cost
<b>Cost items:</b>			
Cost at beginning, 2,198 head	\$110,467.65	\$50.26	52.61
Total feed cost	76,553.29	35.07	36.71
Man labor cost	3,196.14	1.46	1.53
Horse labor cost	2,404.50	1.10	1.15
Equipment cost	1,023.20	.47	.49
Loss from death; 15 head		.35	.37
Veterinary expense	198.00	.09	.10
Insurance on cattle	42.00	.02	.02
Taxes on cattle	1,182.98	.54	.57
Incidentals	71.30	.03	.03
Marketing expenses	7,145.46	3.27	3.42
Interest on cattle	5,630.02	2.58	2.70
Interest on equipment	632.00	.29	.30
<b>TOTAL COST</b>	<b>\$208,546.54</b>	<b>\$95.53</b>	<b>-----</b>
<b>Credits</b>			
MANURE CREDIT	4,741.63	2.17	-----
PORK CREDIT	14,520.45	6.65	-----
<b>Summary</b>			
NET COST	189,284.46	86.71	-----
SELLING PRICE	216,310.64	99.09	
NET PROFIT	\$27,026.18	\$12.38	-----

**Cost of Producing Farm Products Under Farm Conditions** (B. H. Frame).—Twenty-two farm records have been summarized for the past year. Data on the cost of producing the following crops were obtained: Corn, 367 acres; wheat 158 acres; oats 144 acres; clover 113 acres; timothy 99 acres; alfalfa 37 acres; soybeans 27 acres; miscellaneous crops 215 acres. From production factors obtained since this project was started, the costs of producing the 1922 crop of wheat, oats, and corn in Missouri were \$1.37, 66, and 68 cents per bushel respectively.

**Rural Training Laboratory; A Study of the Rural Primary Groups of Boone County, Missouri** (E. L. Morgan).—A house to house census was made to determine the primary allegiance (neighborhood choice) of all families concerning whom there was some question as to which neighborhood they belonged. In this way a county map showing exact boundary of each neighborhood was constructed. Neighborhoods were then studied to ascertain what organizations or institutions they possessed; such as church, school, store, blacksmith shop, natural phenomenon, etc. The intensity of group consciousness being determined in part by the number of services or loyalty media found within the neighborhood boundary.

Each organization or institution was studied in an effort to determine what contribution to group consciousness each made. This resulted in every organization or institution being rated on the basis of what appeared to be its contribution. This ranged from the school, being rated as high plus, down to natural phenomenon, being rated as low minus.

It appeared that farm organizations were low as a determinant. Some institutions, such as the church, appeared to be losing, while the school was gaining. It was found that while in some instances neighborhood spirit and loyalty were high, neighborhood boundaries are crossed frequently out of loyalty to school, church, or lodge located in another neighborhood.

A study of secondary population groups (communities) was made, determining the trade area, fraternal order membership, the consolidated school district and high school patronage, as well as such institutions as the blacksmith shop, mill, elevator, barber shop, and the physician.

It was found that neighborhoods were divided in their allegiance to the various services rendered by communities; that is, some of the residents of a given neighborhood traded or belonged to a fraternal order of one community, while others affiliated in another community.

The study clearly shows which neighborhoods would need to be dealt with as dependent units in county extension work and which ones can be ignored and drawn in with a larger community. It also shows the neighborhoods in which the school or church might be developed through a more comprehensive unit, that is, through a consolidated school or a large community church.

**Cost of Family Living on the Farm** (O. R. Johnson).—A computation has been made of the cost of living on 28 farms which have kept records from 1912 to date. These cost figures are presented in Table 19.

TABLE 19.—SUMMARY LIVING COSTS ON TWENTY-EIGHT FARMS

Class of expenditure	Amount	Percentage of total
Groceries .....	\$159.69	16.32
Use of house .....	179.46	18.33
Dry goods and clothing .....	124.92	12.76
Household equipment.....	70.02	7.15
Meat bought .....	13.34	1.36
Benevolences .....	21.68	2.21
Educational.....	27.27	2.79
Doctor and Dental.....	34.87	3.56
Travel, amusement and recreational.....	71.32	7.28
Fuel.....	14.39	1.47
Labor (hired).....	36.22	3.70
Life insurance .....	33.95	3.47
Correspondence.....	2.42	.25
Phone.....	3.07	.31
Miscellaneous.....	26.04	2.66
Products used in home.....	160.21	16.38
Total.....	\$978.87	100.00

**The Standard of Living on the Farm as a Factor in Cost of Production** (O. R. Johnson).—Table 20 gives a comparison of farm price index for the amount of money spent for family living (data on 28 farms) and the index of cost of producing wheat

and corn per bushel for the last 13 years. The period of 1910-1914 is used in each case as the base, or 100 per cent.

TABLE 20.—RELATION BETWEEN GENERAL PRICE LEVEL. MONEY SPENT FOR FAMILY LIVING PLUS COST OF PRODUCING TWO MAJOR CROPS ON MISSOURI FARMS.

Year	Farm price index*	Money spent for family living (28 farms)	Cost of producing major crops	
			Wheat, per bu.	Corn, per bu.
1910-14	100 %	100 %	100 %	100 %
1914	101	101.0	100.0	108.0
1915	101	74.0	138.6	84.7
1916	118	65.9	197.4	149.5
1917	179	100.4	156.5	101.0
1918	205	105.3	164.2	140.7
1919	214	136.8	256.3	174.8
1920	215	118.8	279.7	165.9
1921	120	107.4	290.0	115.3
1922	124	96.7	175.6	122.6
1923	-----	-----	161.8	-----

\*From United States Bureau of Statistics.

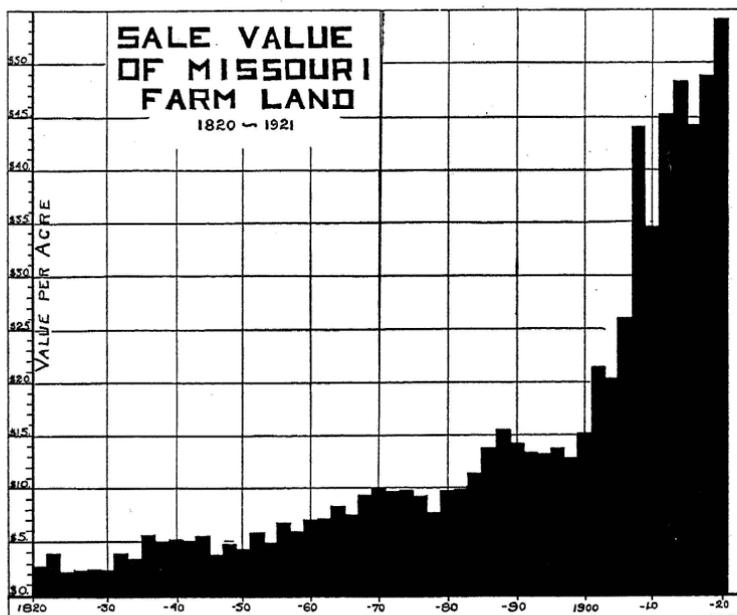


Fig. 15.—A century of land sale prices in Missouri. The average sale price of farm land in seven counties is shown by two-year periods.

The Agricultural and Market Value of Missouri Farm Lands (O. R. Johnson)  
—The tabulation has been completed showing average value of farm lands in seven counties by one- and two-year periods. The accompanying graph (Fig. 15) shows the trend of values from 1820 up to 1921.

## SOILS

(M. F. MILLER, *Chairman*)

Experiments to Determine the Best Systems of Soil Management for the Most Important Soil Types in Missouri—Soil Experiment Fields. (M. F. Miller, F. L. Duley).—New grass experiment fields have been established at Cuba and St. James. Twelve experiment fields in addition to the central station at Columbia were operated in different sections of the State. On the Willow Springs and Strafford fields, both of which are located on the Ozark upland, a fair crop of clover has been obtained each year since the fields were started in 1916. This has been true only on those plots where manure, phosphate, and lime have been added.

Two additional experiments have been started to determine the best methods of producing permanent pastures on Ozark upland farms.

Orchard grass, reedtop, Bermuda, and bluegrass were each mixed with Japan and Alsike clovers and seeded on separate plots. Across these plots were run soil treatments of acid phosphate, and acid phosphate with manure. During the first



Fig. 16.—Effect of manure on wheat yields in a 3-year rotation. This plot received 9 tons of manure per acre before corn in the rotation. The wheat yield was 27.18 bushels per acre.

three months growth the fertilized soil gave the grass an excellent start in all cases. The untreated land produced a poor stand with very slow, early growth. The differences in growth of grass were as significant as were the differences in the growth of grain crops on treated soil.

It has been demonstrated on most of the experiment fields on the thin soils that manure applied before corn in a four-year rotation does not remain in the soil in sufficient amount to give very great benefit on the third and fourth crops. By far, the greatest stimulus was on the first and second crops following its application.

**Crop Rotation and Fertilizer Experiments** (M. F. Miller, F. L. Duley).—The past year was the 34th cropping season since these rotation and manuring experiments were begun. The field has been named Sanborn Field by the Board of Curators of the University, in honor of Prof. J. W. Sanborn who was director of the Station and who started the experiments in 1888.



Fig. 17.—This plot had the same rotation as that shown in figure 16, but received no manure. The yield of wheat was only 10.62 bushels per acre.

The plots growing corn were planted with four different varieties, the rows running across the plots. Commercial White made the highest yield on thirteen plots, and Boone County White was highest on two plots. In comparing the average yields of corn from manured plots receiving different phosphate, it was found that land having rock phosphate yielded 65.03 bushels per acre; bone meal 63.46 bushels; and acid phosphate 60.09 bushels. The plot receiving no manure or phosphate produced only 36.98 bushels.

The plot which has been kept in continuous wheat with commercial fertilizers produced 23.28 bushels while the plot which received 6 tons of manure annually produced 24.22 bushels. It has been found possible to maintain yields of corn, oats, wheat, clover, and timothy practically as well with heavy applications of chemical



Fig. 18.—The 34th consecutive crop of timothy on experiment field at Columbia. This plot received 6 tons of manure annually per acre and the crop here shown was 6,678 pounds of hay per acre.



Fig. 19.—Timothy in the same experiment as that shown in figure 18. This plot had no soil treatment and its 34th consecutive crop of timothy was 1,904 pounds of hay per acre.

fertilizers as by the use of 6 tons of manure annually. The untreated plot of timothy yielded 1,905 lbs. an acre; while the land that was manured produced 6,678 pounds. The effect of manure was shown both in yield and quality of hay. The untreated plot had only about 5 per cent timothy plants, while the manured plot had approximately 90 per cent timothy.

**Studies of Water Absorption, Run-off, Percolation, Evaporation, Capillary Water Movement and Soil Erosion Under Field Conditions.** (M. F. Miller, F. L. Duley).—This investigation was designed to determine the relative loss of soil from land under different systems of management. The run-off water and eroded soil from 1/80-acre plots were caught in concrete tanks and measured. The experiment has been in operation for more than six years and Table 21 shows a summary of the data obtained.

It is evident that keeping a crop on the land is a very effective way of cutting down both the erosion and run-off. Not only has the sod reduced erosion but the presence of a wheat crop has helped a great deal. A corn crop has reduced the erosion about 50 per cent as compared to land plowed in a similar way and having no crop.

TABLE 21.—SOIL EROSION AND RUN-OFF UNDER DIFFERENT CONDITIONS

Plot	Treatment	Total tons eroded per acre	Years to erode 7 in.	Percentage rainfall as run-off
1	Uncultivated	207.8	28.8	48.9
2	Plowed 4 inches and fallowed	247.3	24.2	31.2
3	Plowed 8 inches and fallowed	214.2	28.0	28.3
4	Sod	1.6	3546.7	11.5
5	Wheat continually	39.9	150.2	25.1
6	Rotation, corn, wheat, and clover	13.7	436.9	14.1
7	Corn	106.5	56.3	27.3

The rotation of crops has effected a great saving of surface soil. The average rainfall during the six years of the experiment has been 35.86 inches but the variation has been very great. One rain of 2.18 inches on April 23, 1923 caused more erosion from some of the plots than occurred during the entire preceding year.

The Rate of Accumulation and Cost of Nitrogen and Carbon in Soils Under Different Systems of Green Manuring and Cropping (M. F. Miller, F. L. Duley).— This project was designed to determine at what rate a soil may actually be built

TABLE 22.—INCREASE OF NITROGEN IN SOIL FROM SOIL BUILDING PROCESSES

Plots	Treatment	Nitrogen Percentage 1917	Nitrogen Percentage 1921	Increase of Nitrogen Percentage in 4 years
1 and 9	Corn, wheat, clover, all crops removed	0.136	0.136	0.000
2	Corn, wheat, clover, all crops removed. 4 tons manure on corn	0.138	0.140	0.002
3 and 11	Rye turned under in spring. Cowpeas turned under in fall.	0.134	0.144	0.010
4 and 12	Rye turned under in spring. Land fallowed during summer	0.134	0.128	-0.066
5 and 13	Red clover; all crops removed	0.141	0.141	0.000
6 and 14	Red clover; all crops put back on land and plowed under	0.134	0.144	0.010
7 and 15	Alfalfa; all crops removed	0.129	0.134	0.005
8 and 16	Sod; grass clipped	0.122	0.124	0.002

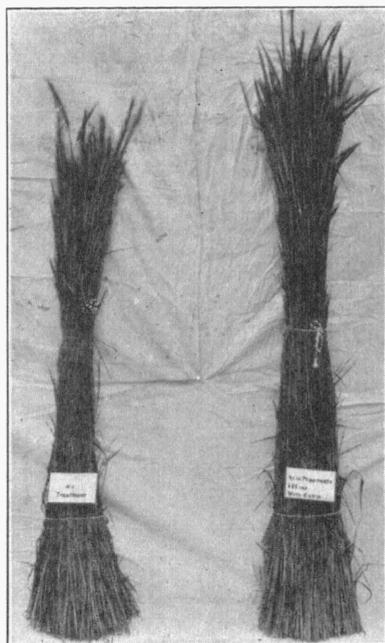


Fig. 20.—Residual effect of acid phosphate on the following rye crop. At right, no treatment; at left, 105 pounds of acid phosphate.

up by commonly accepted soil improvement processes. The plots were sampled at the beginning in 1917 and again four years later in 1921. Table 22 shows the results of these analyses in regard to nitrogen.

**Studies on the Longevity of *B. Radicicola* in the Soil** (W. A. Albrecht).— This investigation was designed to determine how long legume bacteria will live in the soil in the absence of the crop that nourishes them.

Two different soils on which soybeans and red clover had grown with plenty of nodules were stored under different conditions. Samples were left out of doors protected from contamination. Others were aired in the sunlight and some in the dark, and later stored so as to be free from chance contamination. At intervals of one-half year these soils were planted with their respective legumes whose seeds were sterilized.

Tests have been run for five years and show that the legume bacteria are still living, though the number of nodules produced per plant is growing less. In spite of the drying of the soil in the sun, there are enough living bacteria still left to produce plenty of nodules.

It is safe to conclude that when a soil is once well inoculated for either soybeans or

red clover, it will not need to be reinoculated when these crops come around again in a four-year or even five-year rotation.

**The Determination of the Relative Values of Different Forms of Phosphorus Upon the Soils at Columbia** (M. F. Miller, F. L. Duley).—In 1922, rock phosphate increased the yield of corn more than other forms of phosphorus. In previous years calcined phosphate has been the most profitable form. In this experiment 125 pounds of acid phosphate increased the yield of wheat 8.81 bushels an acre. The use of 166 pounds of 2-12-0 fertilizer, carrying the same amount of phosphorus as the acid phosphate and the nitrogen in addition, has given an increase of 10.51 bushels. This is an increase of 1.7 bushels of wheat due to the application of a small amount of nitrogen. The addition of 2 per cent potash in a 2-12-2 fertilizer has given a very slight increase. When the acid phosphate, the 2-12-0, and the 2-12-2, were all used at the uniform rate of 150 pounds an acre, the acid phosphate gave a larger increase than either of the other fertilizers.

**Nitrate Production in a Soil as Affected by the Crop and Cultivation** (W. A. Albrecht).—This year's work has further confirmed the results previously reported, namely:

That the crop was of significant influence in removing nitrates, and their accumulation is almost reciprocal to the rate and season of crop growth.

That early spring tillage, especially plowing, increases nitrate accumulation, but surface tillage lessens it, at least in the surface 7 inches, and emphasizes importance of shallow cultivation.

That a straw mulch has a decided effect in holding down nitrate accumulation.

Early fall plowing for wheat allowed nitrates to accumulate in the fall, possibly through the killing and prohibition of weeds that remove nitrates. The grain yield of wheat on the early plowed plots was much higher and the general growth of straw larger than on the later plowed plots. Early nitrate accumulation in the fall may be correlated with, or responsible for part of this better growth.

Ammonia accumulation on the straw mulch was high, while the nitrate content was low.

**Effects of Different Soil Treatments, Long Continued, Upon Bacterial Activity in the Soil** (W. A. Albrecht).—Four plots were used in this investigation. One in cowpeas with manure; one in cowpeas without manure; one in wheat with manure; and one without manure. The results indicate that limestone was important as a means of increasing nitrate accumulation whether they had been manured or not; that the addition of new organic matter was essential to increase the nitrates; that the manured soils accumulated more nitrates than did the unmanured.

Limestone has been outstanding as a means of increasing nitrification on all crops and for all the fertilizer treatments. With different crops and with these fertilizer treatments there has been some difference in the degree of response. In no case tested has the power of nitrate production been lost, although in a few instances the rate of accumulation was quite low. The cultivated soils have shown considerably lower rates of nitrate accumulation than the soils more often left in sod crops.

**The Effect of Different Amounts and Different Methods of Applying Commercial Fertilizer on the Corn Crop** (M. F. Miller, F. L. Duley).—The use of fertilizers applied directly to the corn crop has not given very great increases of net profits. The fertilizer usually gives the corn a much more rapid start in the early part of the season, but frequently droughts during July and August cut down the yield. The best results have been obtained with 300 pounds to the acre of 2-10-2 fertilizer applied with a fertilizer drill ahead of the corn planter. The corn was alternated with soy-

beans. If the increase on the soybean crop was taken into consideration, a fair net profit was realized.

Sweet clover has been substituted for soybeans in this work.

**Effect of Weathering and Storage upon the Composition of Barnyard Manure** (M. F. Miller, F. L. Duley).—Chemical analyses showed that manure in a flat pile 6 inches deep on the ground lost 39.5 per cent nitrogen during five months exposure from April to September. The loss from a conical pile on the ground was 26.55 per cent during the same period. The greater part of the nitrogen lost was in a gaseous form and only a comparatively small amount was lost in the leachings due to rains.



Fig. 21.—High school students visiting the Eldorado Springs experiment field. Students in vocational agriculture make much use of the outlying experiment fields operated in many parts of the State by the Experiment Station.

**Studies of the Tight Clay Layer in the Soils of the Level Prairies of Missouri** (R. Bradfield).—Results of the investigation of the effect of different electrolytes upon the rate of percolation of water through heavy clay subsoil has been unsatisfactory because of their inconsistencies. Duplicates could not be made to check closely enough to permit attaching any great significance to the results.

In investigating the chemical reactions of colloidal clays, studies were made of the effect of the hydrogen-ion concentration upon the amount of the different electrolytes required to flocculate the colloidal clay. Titration curves were made by titrating standard solutions of strong bases with weak colloidal clay acid by both the conductance and hydrogen electrode method. A study was also made of the effect of the concentration of the colloidal clay upon its hydrogen-ion concentration; and some preliminary studies upon the variation in the absorption and exchange of bases with changes in the hydrogen-ion concentration were made. All of these studies indicated that the colloidal clay of an acid soil is a true acid which was neutralized, giving a characteristic end-point and forming a colloidal salt when the concentration of OH ions becomes sufficiently great.

## VETERINARY SCIENCE

(J. W. CONNAWAY, *Chairman*)

**Infectious Abortion in Cattle and Swine** (J. W. Connaway, A. J. Durant and H. G. Newman).—The same herds of cattle and swine mentioned in the previous report were continued on experiment during the fiscal period ending June 30, 1923. The work included the results of breeding abortion-infected cows and non-infected exposed cows, serological tests for reaction to the Bang abortion antigen, bacteriological studies and infection experiments with afterbirths and colostrum milk of permanent reactors; studies on the occurrence and passive retention of abortion antibodies in young animals, as well as the persistence of the reaction and living infection in *artificially* inoculated cattle.

**Experimental Cattle Herd, No. 1.**—This herd now consists of more than 100 dairy cattle, mature and young (Jerseys and Holsteins). It was once badly infected with the Bang abortion disease; but under systematic serological tests and special handling since 1915, and with gradual elimination of reactors, now has only one reactor, a 14-year-old cow, which during her early breeding history aborted three times, but became a regular breeder, and has again during the present fiscal year, carried her calf full time. She transmitted the specific reacting antibodies to the calf through the colostrum milk, as she had likewise done at previous normal calving. This cow has been a persistent reactor since 1913. Isolation and disinfection for a few weeks at the calving period have prevented the spread of infection from this cow. A systematic serological test of every animal in the herd, 110 animals, shows all to be negative for abortion antibodies, except the one cow and calf mentioned. No abortions have occurred in this herd during the year, although the reacting cow ran with the herd the greater part of the year.

This experiment adds further confirmation to the conclusions previously reported: that an immune "abortion reactor" does not as a rule discharge the Bang abortion infection in dangerous quantity except for a short period coinciding with the last several days of gestation, and the cleaning period of approximately four to six weeks following parturition. Moreover, the continued freedom of this herd from new reactors and from abortions has demonstrated the feasibility and practicability of getting rid of the disease in a herd without the loss of valuable qualities that have been developed by selective breeding; that is, by adopting the plan of making systematic serological tests of all the cattle of breeding age in the herd, and by proper isolation of reactors, and destruction of infectious discharges, and by the ultimate elimination from the herd of all positive reactors, as rapidly as this can be done without loss in the progeny of qualities which it may be desirable to conserve in the herd.

**Experiment Cattle Herd, No. 2.**—This herd consists of a portion of a group of cows that had been *artificially* infected in 1918 with laboratory cultures of the *B. abortus* (Bang), and which has been kept isolated from other cattle, except their own progeny and a non-reacting bull from a clean herd.

Of the five original cows R1, R2, R3, R6, R7, which had been retained for further experiments, all were still persistent reactors to the serological tests for abortion antibodies at the close of the year—five years after *artificial* infection. Four of the five cows had either calved or were safely pregnant at the close of the fiscal period. The other cow, R1, which had aborted during her first pregnancy, but had carried her second calf full time, failed to come in heat during the year and was not bred. No treatment was given for retained *corpus luteum*. The blood reaction for *B. abortus* antibodies, from the time of last calving, 17 months previous to the close of the fiscal

year, was persistently positive; except for a short negative period beginning about a month after calving and continuing about a month. The last blood test for the fiscal year, made June 27, 1923, was also negative.

The experiments to date, so far as they concern the persistency of the serological reaction for *B. abortus* (Bang) antibodies, in cattle that have been *artificially* inoculated with the living cultures of the Bang abortion organism, show that the inoculated cattle have continued to react: (1) in cases where abortion had occurred, following the inoculation; (2) in cases where abortion did not occur; (3) in the case of sterility where the cow was repeatedly bred; (4) in the case of sterility where ovulation and heat periods were absent.

In addition to showing that the reaction to the serological tests to the *B. abortus* antigen had persisted in these artificially infected cattle for five years, it was also shown that the living germs, *B. abortus* (Bang), had continued to propagate in this experimentally infected and isolated herd. Cultures of *B. abortus* (Bang) were obtained from the colostrum milk of two of the experiment cows during the year; cows R2, and R3. The first of these had been infected in the summer of 1918 by the injection of laboratory cultures of the Bang abortion organism into the vagina, late in pregnancy, but without producing abortion. This cow had had no opportunity during the five years to become re-infected by natural exposure to other than the original strain of infection harbored by her experiment mates, which had also been artificially infected at the same time either by ingestion, or by hypodermic inoculation with identical cultures. From this cow, moreover, cultures of *B. abortus* had been obtained at the time of the first calving, five years before; and again from the milk in the seventh month of lactation. Two and one-half years later, following the second calving, cultures of *B. abortus* were again isolated from the milk during the eighth month of lactation; and, for the fourth time, by inoculation of guinea pigs with colostrum milk, cultures were again isolated at the third calving, which occurred during the present year.

In the case of Cow R3, this animal, it should be recalled, aborted her first calf in 1918, following the ingestion of laboratory cultures of the Bang abortion organism. Thereafter she remained sterile until the present year, when she again conceived and carried a living calf full time. This cow, although sterile for a long period, continued to react to the serological test for abortion antibodies, and at time of calving, (which occurred after the close of the fiscal period, but before going to press with this bulletin), the colostrum milk gave a positive reaction for abortion antibodies; the blood of the calf after nursing also gave the specific reaction; and guinea pigs which were inoculated with the colostrum milk developed the typical lesions usually produced by the *B. abortus* (Bang). Moreover, these micro-organisms were isolated in pure culture from the spleen or liver of the guinea pigs.

The foregoing experimental facts, and the conditions under which they were established, justify the statement that the long persistence in an animal of the specific serological reaction to the *B. abortus* (Bang) antigen, is dependent on the persistence in the same animal of the living *B. abortus* Bang micro-organisms; and that they are present in an excretable condition.

*Infectiousness of afterbirths of abortion reactors.*—In the experiments of this group of artificially infected cattle an attempt has been made from the beginning to secure the afterbirths and make a bacteriological study of same. But as this herd has run at pasture, the afterbirths in a number of cases were not secured. Many cows swallow their afterbirths very soon after parturition; and if the herdsman is not at hand the placental tissues are lost. During the year only two afterbirths from Herd No. 2 were studied. This study yields some points of interest in connection with the data

from previous years. The cows from which the afterbirths were obtained were R2 and R7, both of which calved normally; and both of which have been persistent reactors to the complement fixation test for *B. abortus* antibodies. The afterbirths presented a healthy appearance; and in each case scrapings were made from the surface of several cotyledons. The scrapings were diluted with normal saline solution and injected intraperitoneally into guinea pigs.

In the case of cow No. 2, one cubic centimeter of the afterbirth emulsion was injected into each of four guinea pigs. All of these survived the inoculation and were slaughtered on the 49th day. Two of the guinea pigs showed no lesions; and no growths were obtained on culture media inoculated from the spleen or liver. The blood serum of these guinea pigs was negative for *B. abortus* antibodies. The other two pigs showed lesions—one an abscess involving the spleen, and from this cultures of *B. pyogenes* were isolated; but no *B. abortus*. The other guinea pig showed a pulmonary lesion, from which *B. proteus* was isolated. The *B. abortus* was not found. The blood serum of these two pigs showing lesions was negative to the *B. abortus* antigen. Moreover, the *B. pyogenes* and the *B. proteus* tested as antigens against the blood serum of cow R2 and other abortion reactors gave no specific serological reaction.

In contrast with the foregoing, the results of inoculating guinea pigs with the colostrum milk from the same cow are very interesting. On the same day that guinea pigs were inoculated with the afterbirth emulsion, four other guinea pigs were injected in the same manner with 2 cubic centimeters each of colostrum milk. All survived and were slaughtered on the 49th day. The blood serum of all four guinea pigs gave a positive reaction for *B. abortus* antibodies. *B. abortus* cultures were isolated from two of the guinea pigs. One of these showed a subcutaneous abscess, about the size of a pea, located in the pubic region. A pure culture of *B. abortus* was obtained from this abscess. The spleen and liver showed no pathological change that would attract attention; the spleen, however, yielded a pure culture of *B. abortus* (Bang), as did likewise the spleen of another guinea pig. No growths were obtained from the other two guinea pigs, whose visceral organs were apparently normal, but whose serum gave the specific reaction for the *B. abortus* antibodies. These guinea pigs were doubtless infected notwithstanding the failure to isolate the micro-organisms.

In the case of Cow R7, the afterbirth was not in as good condition as that of Cow R2, and only half the amount of saline suspension (0.5 cc.) was injected into each of six guinea pigs. Two died from sepsis. The other four survived and were slaughtered on the 29th day after inoculation. None showed any well marked visceral lesions; nor did the blood serum of any give the reaction for *B. abortus* antibodies. The livers of each was cultured, but no growths were recovered that could be identified as *B. abortus* (Bang). The *staphylococcus aureus*, and a large bacillus grew in culture tubes inoculated from three of the guinea pigs. These may have been contaminations. They did not react specifically with the blood serum of Cow R7, or other abortion-infected cows.

The colostrum milk from Cow R7 in two cubic centimeter doses, administered intraperitoneally, caused no lesions in two guinea pigs which were inoculated at the same time. It should be observed that these guinea pigs were killed on the 29th day, while those inoculated with materials from Cow R2 were not killed until the 49th day. As a rule, however, lesions will develop from *B. abortus* infection in from 21 to 30 days.

While the afterbirth of R7 yielded no growths of the Bang organism this year, nor were cultures from the colostrum obtained, cultures were obtained from the afterbirth of this cow at her first calving in 1918, which calving was a few days premature. From another cow, No. 21, mentioned in a previous report, cultures of the

Bang organism were obtained from the afterbirth at the time of normal parturition; this cow had been *artificially* infected through the teats.

This study of the infectiousness of the afterbirths of cows artificially inoculated with the Bang organism, was carried a step further by feeding the fresh afterbirths of the positive reactors, cows R2 and R7 to a pregnant non-reactor, Cow R9. The entire afterbirth of Cow R7 was ground, mixed with hydrant water, and given as a drench to Cow R9 on the 248 day of gestation, or 34 days before she was due to calve. Twenty-nine days later, or five days before this cow was due to calve she was fed the afterbirth of Cow R2 which had just calved, and whose colostrum milk as shown above contained the living *B. abortus* organisms. Four days after the last feeding with the placental tissues, Cow R9 dropped a living calf. The calving was only one day premature. A blood sample from the cow was negative to the serological test for *B. abortus* antibodies (as is frequently true at calving time even in the case of quite persistent abortion reactors), but the milk of the cow, as well as a blood sample from the calf, which had nursed before the blood sample was drawn, showed a positive reaction. The blood of this cow, however, did not show a positive reaction at any of the subsequent monthly tests, and the antibodies in the blood of the calf had disappeared before the end of the month. A like short period of reaction has, however, been observed in the calves nursed by naturally infected mothers.

Since the afterbirth of Cow No. 2 was fed only a few days before No. 9 calved, there is a question as to whether the antibodies which occurred in her milk and transferred to her calf by nursing were produced in the body of this cow by the activity of abortion germs which were introduced at the feeding of the afterbirth of Cow R7, or whether these antibodies were preformed in the afterbirth of Cow R2, and were merely absorbed and stored up in the udder. For while our experiments have shown that blood pressed out of the umbilical cord attached to the placenta is, as a rule, free from the antibodies, juice expressed from the attached placenta may give the reaction. This perhaps is derived from the blood of the dam contained in the interlacing *maternal* capillaries which are torn away from the uterine cotyledons or carunculae, and not from the fetal capillaries of the cotyledons.

In the previous report a record was given of feeding a non-reacting heifer, carrying her first calf, the afterbirths of two positive reactors for abortion antibodies. One of the afterbirths which was fed was obtained from Cow R7, which also supplied one of the afterbirths used in the experiment just mentioned. Another afterbirth was also fed the same day; this was obtained from Cow No. 64 of experimental herd No. 1. This cow it will be recalled had become infected by natural exposure, and had been a persistent reactor since 1913. In this case the blood of the pregnant heifer developed the reaction between the 62nd and 89th days after portions of the afterbirths of the two cows had been administered as a drench. Subsequent observations extending into this fiscal period showed that the milk of this heifer gave a positive reaction four months or more after she was fed the afterbirths, while the blood serum did not show the reaction so long. The suckling calf also became a reactor after nursing the mother. Blood samples drawn before the calf had suckled showed that the abortion antibodies were not present in the prenatal state.

The long period that elapsed after the feeding of the afterbirths to the young pregnant heifer before the blood reaction appeared indicates that an active infection in this cow stimulated the production of the specific antibodies; and that these antibodies were not merely stored up from the ingested afterbirths. Otherwise the appearance of these antibodies would have occurred soon after the ingestion of the afterbirths. This interpretation is strengthened by the fact that a calf several days old, when allowed to suckle the colostrum milk of an abortion reactor, does not become a

reactor, the gastric juice seemingly having the power to destroy the ingested antibodies; while the newborn calf whose gastric digestive function is as yet undeveloped absorbs the antibodies unchanged.

The feeding experiment of the present year as compared with that of the previous year seems not to have produced as strong an effect on the Cow No. 9 as was produced on the young Jersey heifer, in the previous experiment. It is not certain how this difference can be accounted for. The feeding of the afterbirths this year, however, occurred later in the gestation period, and the experiment animal was a grade Hereford, carrying her second calf, and was moreover out of an infected dam, and theoretically it may be assumed that she had acquired some resistance from having nursed an infected mother for several months. The question of the development of herd immunity or resistance, without at the same time acquiring permanent infection, and showing the specific reaction for antibodies is a matter which has not been definitely determined, and it is doubtful whether the facts presented here afford any valid support for the "herd-immunity" notion. The facts developed here rather point to the view that there is a weakening in the virulence of the infection after it has been carried for a number of years by a persistent reactor. On the other hand, the fact that old reactors may lose their resistance, and abort indicates the probability that the abortion infection may regain full virulence and produce disastrous results.

These are some of the problems which are being studied with the artificially infected and isolated herd No. 2. The female progeny is being kept for breeding purposes, and for exposure in different ways to the older infected cattle. One of the mature non-reactors of this group died from accident during the early part of the year, but there remain eight non-reactors, six of which are of breeding age, for exposure to the five artificially infected animals. Seven bull calves have been castrated and disposed of from time to time. The study of the effect of fallowness on the abortion infection harbored by the original five animals, in addition to the abortions and incident sterility as well as the large percentage of bull calves, in the crop of the present year, accounts for the rather small number of females that have been added by breeding since the beginning of this experiment. The purpose of the experiment, however, is not to show cattle raisers how to raise cattle, but to work out in as conclusive a manner as conditions will permit, what is yet unknown about abortion disease, and to establish more firmly the truth concerning this infection which has already been revealed.

**Record of Herd, No. 3.**—This is a herd of purebred beef cattle, which during the previous year afforded an opportunity to record data of value concerning the rapid spread of abortion infection through a herd when the aborting animals remain for a time in contact with the healthy animals of the herd. This herd was tested for the presence of abortion infection at a time when only three reactors were in the herd; and one of these was a nurse cow that had been purchased from a dairy herd where abortion disease existed. It is probable that this nurse cow introduced the infection. But as she gave birth to a living calf a short time after purchase, the fact that she was a carrier and potential spreader of the infection was not taken into serious account by the herdsman.

It was reported that, in 18 months, the number of reactors had increased from 3 reactors to 45, in a herd of 57 breeding cows. Several of the least valuable of these animals were sent to the butcher market. Among those remaining were 10 cows which had previously aborted, and 23 more which were reactors or became reactors before the close of the present fiscal period. There were in all 33 reactors and 6 non-reactors; or a total of 39 cows of breeding age in the herd during the year. Before the

close of the fiscal year, 5 of the 10 abortion reactors, which had previously aborted, gave birth to living calves; while 3 of the reactors were regarded as hopelessly sterile, and were shipped to the butcher market. Another reactor which had suffered from long sterility finally conceived and proved to be safely pregnant at the close of the fiscal year. Of the remaining 23 reactors, which had not previously aborted, 4 lost their calves from abortion during the year; and 4 more were sold to the butcher as non-breeders; while 15 of these reactors dropped living healthy calves. All of the 6 healthy non reactors of breeding age had living calves.

In percentages, the calf crop among the reactors of the herd was 63.6—per cent; while the few non-reactors showed 100 per cent breeding efficiency.

Although about 20 per cent of the reactors that became pregnant aborted, (not considering the sterile cows, some of which probably conceived but aborted early in gestation), the great increase of the calf crop over the preceding year was encouraging; there being 26 calves this year to 13 calves the preceding year. The indications are that there is a lessening of the virulency of the infection in the herd, or that an increased resistance has developed. The elimination of mass infection by the disposal of a considerable number of carriers and aborters may be a favorable factor in the case. Some further losses from abortion will, in all probability occur; and some of the infected animals will doubtless become sterile. But a clean herd can be built up from this infected foundation by proper handling of the progeny; and by the gradual elimination of the reactors. Proper pasture facilities for separating the animals into appropriate groups will greatly facilitate the cleaning of this herd and others in like condition from abortion disease.

## FINANCIAL STATEMENT

UNIVERSITY OF MISSOURI AGRICULTURAL EXPERIMENT STATION

In account with

THE UNITED STATES APPROPRIATIONS, 1922-23

Dr.		Hatch Fund	Adams Fund
To balance from appropriations for 1921-1922	•	-----	-----
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1923, under acts of Congress approved March 2, 1887 (Hatch Fund) and March 16, 1906 (Adams Fund) -----		\$15,000.00	\$15,000.00
Cr.	Abstract		
By Salaries -----	1 -----	\$10,389.04	\$6,018.00
Labor -----	2 -----	1,766.91	1,638.79
Publications -----	3 -----		-----
Postage and stationery -----	4 -----	105.97	28.23
Freight and express -----	5 -----	136.11	207.77
Heat, light, water, power -----	6 -----	44.44	176.91
Chemicals and laboratory supplies -----	7 -----	169.11	864.97
Seeds, plants, and sundry supplies -----	8 -----	590.35	406.95
Fertilizers -----	9 -----	82.33	13.24
Feeding stuffs -----	10 -----	1,187.32	3,797.73
Library -----	11 -----	17.00	-----
Tools, machinery, and appliances -----	12 -----	95.75	127.47
Furniture and Fixtures -----	13 -----	5.12	12.01
Scientific apparatus and specimens -----	14 -----	141.87	1,185.73
Live stock -----	15 -----	78.30	175.05
Traveling expenses -----	16 -----	131.50	-----
Contingent expenses -----	17 -----	-----	-----
Buildings and land -----	18 -----	58.88	344.90
Balance -----		-----	-----
Total -----		\$15,000.00	\$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the *University of Missouri Agricultural Experiment Station* for the fiscal year ended June 30, 1923; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was \$ none on the Hatch Fund and \$ none on the Adams Fund; that the receipts for the year from the Treasurer of the United States were \$15,000.00 under the act of Congress of March 2, 1887, and \$15,000.00 under the act of Congress of March 16, 1906, and the corresponding disbursements \$15,000.00 and \$15,000.00 for all of which proper vouchers are on file and have been by us examined and found correct, leaving balance of \$ none and \$ none.

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

Signed:

Attest:

LESLIE COWAN,  
Custodian

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