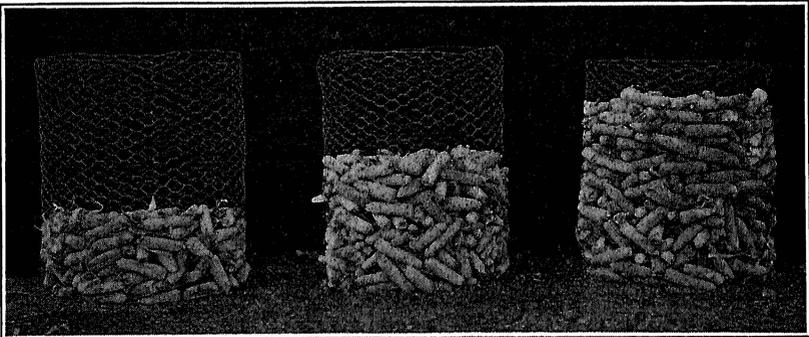


UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BULLETIN 172

WORK AND PROGRESS OF THE Agricultural Experiment Station

For the year July 1, 1918, to June 30, 1919



Average results of 25 years' cropping on Missouri experiment station field. From left to right the treatments are: corn continuously, no treatment; corn, oats, wheat, clover rotation, no treatment; corn, oats, wheat, clover rotation, manure.

COLUMBIA, MISSOURI

JUNE, 1920

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

Agricultural Experiment Station

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L. S. BACKUS, D. V. M., Assistant Professor
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ZOOLOGY

GEORGE LEFEVRE, Ph. D., Professor

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J. C. McLACHLAN, Herdsman, Animal Hus-
bandry
H. A. BALL, Herdsman, Dairy Husbandry

*As of June, 1919.

To His Excellency,
HONORABLE FREDERICK D. GARDNER,
Governor of Missouri.

Sir:

I submit herewith a report of the progress of the more important activities of the Agricultural Experiment Station of the College of Agriculture of the University of Missouri, for the year ending June 30, 1919.

This report is submitted to you in accordance with the provisions of the Federal Law which require an annual report to the Governor of the State, including a statement of receipts and expenditures of Federal funds.

The present report includes a very brief and concise statement of the significant work of the Station, particularly the investigations in progress, the publications issued, changes in the Station staff and the general condition of the Agricultural Experiment Station.

The Director of the Station has during the past year, served as Chairman of the Missouri Council of Defense and as Federal Food Administrator for Missouri. The duties of these positions have to a considerable extent, prevented the Director from giving his undivided attention to the affairs of the Experiment Station, but the work has been successfully and efficiently administered by my colleagues and particularly by Acting Director, M. F. Miller.

Respectfully submitted,

F. B. MUMFORD,

Director.

The Missouri Agricultural Experiment Station

F. B. MUMFORD, *Director*

The soundness of the policies followed in the development of the work of the Agricultural Experiment Station have been demonstrated by the war emergency thru which the nation has recently passed. The increased production campaigns were based entirely upon demonstrated methods which had been determined thru the investigations of the Experiment Station. No further experiment was necessary. The facts had been determined and the methods essential to maximum production were quickly and successfully applied.

It is undoubtedly true, however, that the important fundamental investigations of the Experiment Station suffered as a result of the disturbance caused to all established institutions by war conditions. A number of investigators left the service of the Experiment Station temporarily to engage in military or other war activities. The investigators remaining were all actively engaged in patriotic service of some kind. All of this resulted in decreasing the well-organized efficiency of the Experiment Station.

The continually increasing prices of all commodities essential to good work has made it increasingly difficult to meet the necessary expenses of the Experiment Station with the funds which have been available. A larger income is essential if the Station is to continue to maintain its high standards of work.

The word research has been used in a vague and indefinite sense. It is difficult to define the term so that it may mean a definite type of knowledge. We cannot limit research to investigation in natural science, nor indeed can we properly exclude from the classification investigations which are not properly classified as fundamental research. Research may be good or bad. It may be mediocre or it may ascend to the highest plane of intellectual achievement. It is as varied as human knowledge. It cannot well be standardized. Unfortunately, research does not lend itself to quantity production.

It is in my judgment exceedingly unwise to stamp with our approval only those investigative achievements of an important fundamental character which have had a profound influence upon the development of human knowledge and human affairs and at the same time mark for disapproval those more modest investigations which may not have great fundamental significance, but which do at the same time extend the limits and broaden the field of intellectual enterprise and incidentally contribute to the solution of fundamental problems. After all it must be clearly recognized that if we are to depend alone upon the exceptional genius for the extension of our knowledge, we can hope for only a limited development. The vast majority of intellectual workers do not belong in the class with Galileo, Newton, Darwin or Kelvin. The advancement of human knowledge must after all depend upon the faithful, accurate and industrious labors of the man of average ability. It is this type of investigator that needs encouragement and must be surrounded with favorable conditions if we are to secure the greatest output of new knowledge.

The distinction between pure and applied science is much overworked. There is no essential fundamental distinction between these two types of research. As Dr. J. R. Angell has said, any difference that may exist is chiefly one of motivation. Investigations in applied science are purposeful. They have a definite object and that is to solve problems thru scientific investigation.

The scientific method applied to the solution of such problems may oftentimes yield results of a most important and fundamental character. Research in pure science is not necessarily undertaken as the result of an immediate and pressing need. The motive may or may not have any important application to present day problems. These distinctions are after all not of great significance. The two types of research are alike in that they must be based upon the same fundamental principles of science and must be conducted in accordance with the well-recognized methods of science. Each requires the same qualities of mind and the same unvarying devotion to truth.

It is admitted that most institutions have failed, thru various causes, to make real contributions to knowledge and such must always be dependent, both for their ideals and their trained workers, upon those institutions which are the centers of productive, intellectual achievement. It may not be wholly incorrect to designate such institutions as consumers rather than producers of knowledge. It is very clear that if an institution is to have any standing in the intellectual world as a center of learning, it must make real contributions to knowledge. It must perform a real service in extending the ever-widening boundaries of truth. Its intellectual activities must result in productive learning. It must create new knowledge. It can accomplish none of these except thru fundamental and original research. I cannot conceive of an institution making real contributions to knowledge that performs the work of teaching only, even tho it may be highly efficient in the performance of this function. The teacher himself must be a productive scholar. He must be a student. He must be an investigator if he would continue to grow individually, to contribute to the development of his subject and to the standing and reputation of his institution.

What are the conditions of research? Why do some individuals make important contributions to science while others under similar conditions fail to do so? Why are certain institutions recognized as centers of productive learning? It is certain that one condition is always a fundamental essential to successful research and that is adequate training in fundamental subjects. It is true that training alone does not insure productive research but lack of training is almost inhibitory. This is so clearly self-evident that it needs no discussion.

But the most general complaint among university men who have the necessary training is that they are so burdened with teaching and administrative duties that they have no time or energy remaining for research. This complaint is made so frequently by men whose judgment in other matters is generally accepted as sound that we cannot lightly ignore it in any effort to improve conditions. I have no doubt that much investigational work of value is really prevented in this manner. It is certainly true that teaching large numbers of underclassmen is not conducive to the higher type of fundamental research. It seems to me that administrative officers must make a more systematic effort to give a greater opportunity to men of ability. The difficulty which confronts the administrative officers is to discover the men of genius who should be given encouragement in their efforts to increase intellectual production. Men must really do research before they can be definitely set apart for this type of achievement. They cannot do research if they are too much burdened with teaching and other duties and thus men of really great possibilities may never have the favorable opportunity to develop their talents for productive scholarship. It seems to me, therefore, that it is desirable from an administrative standpoint to expect every teacher to make some contribution to knowledge

however small, in the hope that such a policy may result in a survival of the fittest and a consequent selection of those competent to succeed. When such men are discovered the administration should not hesitate to give them maximum salaries and every facility for investigation.

Research thrives on appreciation. No institution can hope to attain any sort of standing in the intellectual world if it fails properly to value the achievements of men of science. There must exist a proper atmosphere which in itself is a constant invitation to supreme effort. The creation of such an atmosphere can be greatly encouraged by the administrative officers.

The tools of research are essential. Apparatus, equipment, laboratories and supplies must be readily available at the proper time. It is nothing short of an intellectual calamity for an important investigation to be held up for lack of a piece of apparatus or a few dollars for ordinary labor or other assistance.

But more important than any material condition or mechanical arrangement, is the spirit of research. There must be in the individual a divine zeal—an unquenchable fire which cannot be put out and which will urge the individual to a continual search for truth. With such a zeal the investigator may be certain to find ample opportunity and the institution will find the means.

CHANGES IN THE STATION STAFF

NEW APPOINTMENTS

- Mrs. Mary Cochran Farris, B. S. in Agr., Assistant in Agricultural Chemistry
 V. R. Gardner, B. S., M. S. A., Professor of Horticulture
 D. J. Griswold, B. S. in Agr., A. M., Research Assistant in Animal Husbandry
 Henry D. Hooker, B. A., M. A., Ph. D., Assistant Professor of Horticulture
 John Harwood Longwell, B. S. in Agr., Research Assistant in Animal Husbandry
 M. F. Miller, B. S. in Agr., M. S. A., Professor of Soils, appointed Acting Dean during Dean Mumford's absence
 C. R. Moulton, B. S. in Ch. E., M. S. in Agr., Ph. D., Professor of Agricultural Chemistry
 A. C. Ragsdale, B. S. in Agr., Professor of Dairy Husbandry
 O. W. Weaver, B. S., Agricultural Editor

RESIGNATIONS

- H. O. Allison, M. S., Assistant Professor of Animal Husbandry
 M. N. Beeler, B. J., B. S. in Agr., Agricultural Editor
 E. L. Dakan, B. S. in Agr., Assistant in Poultry Husbandry
 C. H. Eckles, B. S. in Agr., M. Sc., D. Sc., Professor of Dairy Husbandry
 Mrs. Mary Cochran Farris, B. S. in Agr., Assistant in Agricultural Chemistry
 M. H. Fohrman, B. S. in Agr., Assistant in Dairy Husbandry
 D. J. Griswold, B. S. in Agr., A. M., Research Assistant in Animal Husbandry
 Howard Hackedorn, B. S. in Agr., Assistant Professor of Animal Husbandry
 Helen Johann, A. B., A. M., Research Assistant in Plant Pathology
 W. H. Lawrence, M. S., Professor of Horticulture
 H. F. Libbey, B. S. in Agr., Assistant in Veterinary Science
 Leroy S. Palmer, B. S. in Ch. E., Ph. D., Professor of Dairy Chemistry
 E. C. Pegg, Assistant Professor of Forestry

- V. T. Payne, A. B., Assistant in Agricultural Chemistry
 L. G. Rinkle, M.S.A., Assistant Professor of Dairy Husbandry
 C. R. Thompson, B. S. in Agr., Assistant in Animal Husbandry
 P. F. Trowbridge, Ph. D., Professor of Agricultural Chemistry
 J. C. Whitten, Ph. D., Professor of Horticulture
 C. C. Wiggans, Assistant Professor of Horticulture

PUBLICATIONS

Three series of publications are issued by the Agricultural Experiment Station—bulletins, research bulletins, and circulars. Bulletins consist largely of definite reports 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 for the benefit of any who wish to adopt them or profit by them. Research bulletins are essentially scientific papers presenting technical information for the investigator or the man well advanced in agricultural knowledge. The circulars are popular reports of experiments, or a summarization of the best information extant, relative to some phase of practical agriculture. The Station has issued within the year eight new bulletins, and three reprints, six new research bulletins, three new circulars and four reprints.

Bulletins

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| 114. Corn vs. Oats for Work Mules (reprint) | 160. Inspection of Commercial Fertilizers, 1918 |
| 132. Control of the San Jose Scale in Missouri (reprint) | 161. Combining Dormant and First Summer Spray in Apple Orchards Infested by San Jose Scale |
| 133. The Silo and Its Use (reprint) | 162. Legumes, Sudan Grass and Cereal Crops for Silage |
| 156. Milk Production Costs and Milk Prices | 163. Work and Progress of the Agricultural Experiment Station, 1917-1918 |
| 157. Fertilizer Trials — Wentzville Experiment Field | |
| 158. Winter Rations for Dairy Heifers | |
| 159. Profits from Milk Cows on General Cornbelt Farms | |

Research Bulletins

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| 29. The Tarnished Plant Bug and Its Injury to Nursery Stock | 32. Some Factors Favoring or Opposing Fruitfulness in Apples |
| 30. Composition of the Beef Animal and Energy Cost of Fattening | 33. An Investigation in Transplanting |
| 31. Some Factors Influencing Growth and Size of Dairy Heifers at Maturity | 34. The Preservation of Milk for Chemical Analysis |

Circulars

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| 57. Keeping Records of Dairy Cows (reprint) | 83. The Home Vegetable Garden (reprint) |
| 58. Docking and Castrating Lambs (reprint) | 86. Soil Inoculation for Legumes |
| 80. The Missouri Poultry House (reprint) | 87. Growing Tomatoes for the Canning Factory |
| | 88. Raising Calves on Farms where Whole Milk is Sold |

SYNOPSIS OF NEW PUBLICATIONS

Milk Production Costs and Milk Prices, R. M. Green, D. C. Wood and A. C. Ragsdale (Missouri Exp. Sta. Bul. 156 (1918), pp. 3-36, figs. 1).—A bulletin based on the methods of producing and marketing milk by farmers in the St. Louis, Kansas City and St. Joseph areas. The cost figures obtained from 101 representative milk producers are in terms of quantity of feed and labor as well as in terms of dollars and cents. The application of new prices to the quantity figures will furnish information approximately correct for any year when similar methods are followed.

Fertilizer Trials—Wentzville Experiment Field, M. F. Miller and F. L. Duley (Missouri Exp. Sta. Bul. 157 (1918), pp. 3-23, figs. 5).—The results of experiments conducted in St. Charles County to determine the most profitable system of soil treatment and management for soil fairly typical of Putnam silt loam, are reported in this bulletin. The results should apply to practically all the average prairie land of northeast Missouri.

Winter Rations for Dairy Heifers, C. H. Eckles (Missouri Exp. Sta. Bul. 158 (1918), pp. 3-54, figs. 16).—This publication gives data that were taken during experiments which cover six winters with regard to rations for wintering growing heifers. Observations and data on seventy-seven Jerseys, Holsteins, and Ayrshires are included. Groups of dairy heifers were placed on experiment in successive winters for periods of from 150 to 180 days. The results are measured by daily gains in live weight, and by increase in height at withers. The most suitable rations for maintaining a normal growth are discussed.

Profits From Milk Cows on General Cornbelt Farms, O. R. Johnson and R. M. Green (Missouri Exp. Sta. Bul. 159 (1918), pp. 3-20, figs. 5).—A study to determine from farmers' experience the costs and certain related factors pertaining to the milk business as a subsidiary enterprise on farms organized to do a general farming business. The greater part of the data is from detailed records on forty-one farms. The data cover a total of 158 head of milk cows and 128 head of calves. The figures presented suggest practices of most important application on the small to medium-size family farm where a satisfactory annual income depends more upon the practice of numerous small economies than upon some one or two heavily financed enterprises.

Inspection of Commercial Fertilizers, 1918, F. B. Mumford and L. D. Haigh (Missouri Exp. Sta. Bul. 160 (1919), pp. 3-31, figs. 1).—A report on the analysis of 553 official samples representing 158 different brands of commercial fertilizers offered for sale in Missouri. The power of limestone and similar materials to neutralize soil acidity is expressed in percentage of calcium carbonate for 42 samples tested. The brands and guaranteed analysis of fertilizers registered for sale in Missouri in 1919 are listed.

Combining Dormant and First Summer Spray in Apple Orchards Infested by San Jose Scale, T. J. Talbert (Missouri Exp. Sta. Bul. 161 (1919), pp. 3-15, figs. 1).—Experiments and observations extending over a period of four years, as reported in this bulletin, show that the dormant or San Jose scale spray consisting of commercial lime-sulphur, testing 33 degrees Baume, may be applied to apple trees at a dilution of 1 to 7 or 1 to 8 after

growth starts and until the trees begin to bloom, without material injury to leaves or flower buds. This late concentrated spray will take the place of the first summer spray. It is effective in killing many of the sap-sucking and leaf-eating insects.

Legumes, Sudan Grass and Cereal Crops for Silage, C. H. Eckles (Missouri Exp. Sta. Bul. 162 (1919), pp. 3-25, figs. 1).—A discussion of the silo as a means of preserving forage crops other than corn, and the possibility and advisability of so using them. Numerous trials with legume and cereal crops and Sudan grass are reported. This bulletin does not advocate the making of silage from the crops discussed, but reports the results of experiments from which it is possible to draw conclusions as to the conditions necessary in order to preserve the crops successfully in the silo.

Work and Progress of the Agricultural Experiment Station (1917-1918), F. B. Mumford (Missouri Exp. Sta. Bul. 163 (1919), pp. 3-78, figs. 21).—This bulletin is the annual report of the Director and covers briefly the work of the Experiment Station, its publications and a financial statement for the year ended June 30, 1918.

The Tarnished Plant-bug and Its Injury to Nursery Stock, L. Hase-man (Missouri Exp. Sta. Res. Bul. 29 (1918), pp. 3-20, figs. 9).—The tarnished plant-bug is described as causing the injury to nursery stock commonly known as "stop-back" or "bush-head." A history and a life history of the pest are included. The injury to nursery stock is described and remedial measures suggested.

Composition of the Beef Animal and Energy Cost of Fattening, P. F. Trowbridge, C. R. Moulton and L. D. Haigh (Missouri Exp. Sta. Res. Bul. 30 (1918), pp. 3-106, figs. 39).—This bulletin is a continuation of the series reporting the "Use of Food" experiment begun in 1907 to determine the chemical composition of the gain made by 3-year-old steers in the process of being fitted for market; and to determine what changes take place in the form of the animal in the fattening process.

Some Factors Influencing the Growth of Dairy Heifers, C. H. Eckles and W. W. Swett (Missouri Exp. Sta. Res. Bul. 31 (1918), pp. 3-36, figs. 16).—This bulletin presents in a more or less complete form certain data concerning the factors which influence the growth of dairy heifers. The data were taken on animals in the dairy herd of the University of Missouri over a period of twelve years. Size of calf at birth, breed, liberality of the ration, gestation, lactation, combination of early calving and light rations, and calcium in the ration, are all discussed in determining the factors that influence growth.

Some Factors Favoring or Opposing Fruitfulness in Apples, C. C. Wiggans (Missouri Exp. Sta. Res. Bul. 32 (1918), pp. 3-60, figs. 7).—This investigation deals with the variation of fruitfulness of the apple tree from year to year. The author observes that certain varieties tend to bear crops in alternate years, and some varieties alternate heavy and light crops. An extensive study of the fruit spur as related to this phenomenon is reported. The effects of girdling, of fertilizers, of tillage, and of pruning are all reported in this investigation.

An Investigation in Transplanting, J. C. Whitten (Missouri Exp. Sta. Res. Bul. 33 (1919), pp. 3-73, figs. 5).—This is primarily a report on inves-

tigations covering a period of ten years to determine the best season of the year in which to transplant fruit trees. Results from early and late fall plantings and early and late spring plantings of the most important varieties of fruits are compared to show how their development is influenced by the season of transplanting. Several minor studies relating to transplanting are grouped as a second part in this report. They deal with effects of mulching fall-planted trees, the relation of soil and atmospheric temperatures to fall and spring planting, relation of wounds to the activity of adjacent buds, the time to prune transplanted trees, the depth to plant, orientation of the tree, shaping the tree, importance of protecting young tree roots from freezing and drying, and transplanting garden vegetables.

The Preservation of Milk for Chemical Analysis, L. S. Palmer (Missouri Exp. Sta. Res. Bul. 34 (1919), pp. 3-31).—In this bulletin a detailed study of the preservation of milk for chemical analysis is reported, particularly with reference to the preservation of the protein constituents. The experiments carried out were designed to show the influence of the following factors upon the preservation of milk: the kind of preservative, the temperature of preservation, the development of bacteria and enzymes in causing decomposition, and the minimum quantity of the best preservative to use. The preservatives selected were formaldehyde, mercuric chloride, potassium dichromate, copper sulfate, thymol, and toluene.

Soil Inoculation for Legumes, W. A. Albrecht (Missouri Exp. Sta. Circular 86 (1919) pp. 15, figs. 6).—This is a popular explanation of the necessity for inoculating legumes in Missouri, and a detailed summary of the best methods by which it can be done.

Growing Tomatoes for the Canning Factory, J. T. Rosa, Jr. (Missouri Exp. Sta. Circular 87 (1919) pp. 16, figs. 4).—This circular describes all steps to be taken in producing tomatoes on a large scale such as can be practiced in Missouri. The importance of good plants of desirable varieties, well started in the field, is emphasized. Methods of culture and the prevention of loss by insects and diseases are discussed.

Raising Calves on Farms Where Whole Milk Is Sold, W. W. Swett (Missouri Exp. Sta. Circular 88 (1919) pp. 13, figs. 1).—This circular is a guide to the dairyman who seeks to maintain his dairy herd by retaining the heifer calves, rather than buying heifers on the market. Three feeding plans are suggested: (1) Feed the calf a minimum amount of milk and some grain, using sufficient milk to give the calf a good start; (2) give the calf whole milk for a short time and then change to a ration of calf-meal gruel; and (3) give the calf a good start on milk, then withhold the milk at the end of two months and put the calf on a hay and grain ration. The last two plans are recommended.

DISTRIBUTION OF PUBLICATIONS

The mailing list for Experiment Station publications is divided into seven classifications which total 14,180 names. The classes are: Commercial fertilizers, dairy husbandry, animal husbandry, farm crops and soils, horticulture, poultry, and home economics. Publications are distributed according to these lists as soon as they are received from the printer. More than 104,000 copies of Station publications were so disposed of dur-

ing the last fiscal year. About two-thirds of this number were sent to persons whose names are on the mailing list. The other one-third were mailed in answer to individual requests.

The mailing list has increased annually until larger editions of popular bulletins and circulars are necessary. In some cases, the edition of the publication has been exhausted long before its period of usefulness has passed, and a reprint has been ordered. This healthy growth in the mailing list is an index to the increasing number of farmers who are studying the farming business.

The Station sent many of its publications to hospitals where requested, many of them going to England, and some to Canada, France, and Australia. Requests from army camps for bulletins to be placed in libraries, were honored. Many requests are now being received from high schools operating under the Smith-Hughes act for bulletins and circulars in quantity. The Missouri State Board of Agriculture is supplied with copies of bulletins requested.

Articles by Members of the Staff Published in Scientific Journals—10 c & sc

"The Availability of the Energy of Food for Growth," by C. R. Moulton. *Journal of Biological Chemistry* 31, pp. 389-394.

"Cattle versus Crops as Soil Depleters," by C. R. Moulton. *Corn Belt Farmer* 6, No. 9, p. 4.

"Physiological Specialization of Parasitic Fungi," by George M. Reed. *Brooklyn Botanic Garden Memoirs* Vol. 1, pp. 348-409, July 6, 1918.

"Milk as a Galactagogue," by L. S. Palmer and C. H. Eckles. *New York Medical Journal* cviii, No. 9, 375, 1918.

"The Physicochemical State of the Proteins in Cow's Milk," by L. S. Palmer and Robert G. Scott. *Journal of Biological Chemistry*, xxxvii, No. 2. 271, 1919.

"A Study of the Birth Rate of Calves," by C. H. Eckles. *Journal of Biological Science*, Vol. 2, No. 3, May 1919.

PROGRESS OF INVESTIGATIONAL WORK

It has been customary for a number of years to make brief progress reports of investigations in the Experiment Station. Only the more important investigations are summarized in this report of active work. Such a report has value in indicating the character of investigations and the progress which is being made from year to year. There has been some disturbance of the Experiment Station activities due to the general unrest after the war. Such disturbance has not been serious and the work accomplished has on the whole been satisfactory.

It should be clearly understood that the summaries presented herewith are not complete records of all the work undertaken by the departments named. They do represent the major projects and are therefore, indicative of the achievements of the Station staff during the year.

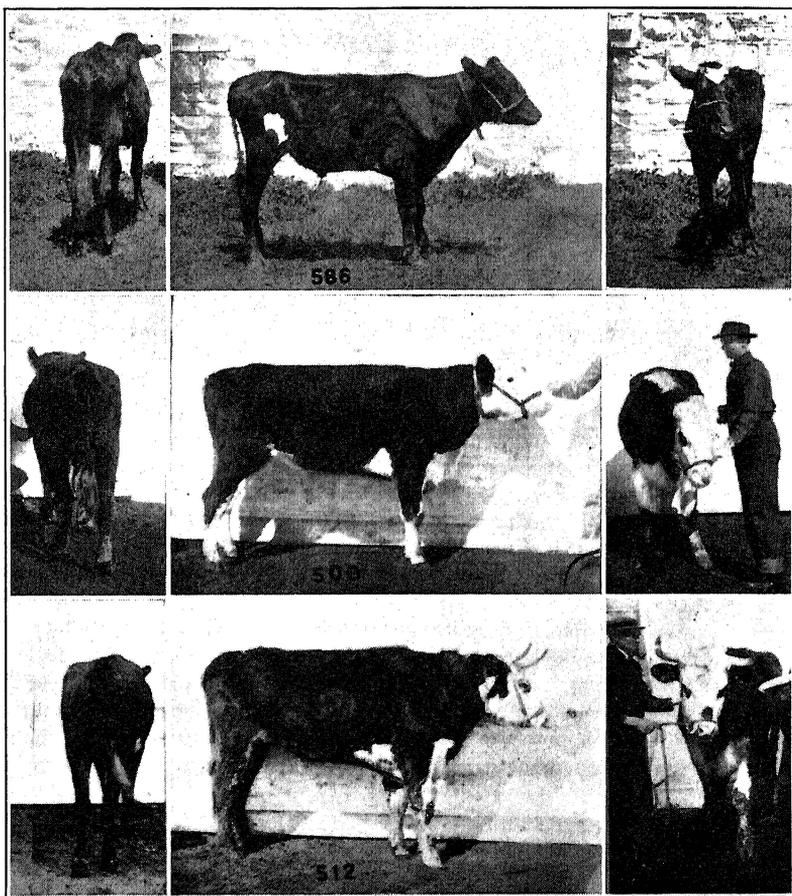
AGRICULTURAL CHEMISTRY

Use of Food Experiment (C. R. Moulton, L. D. Haigh, S. B. Shirkey).—The work during the year has consisted largely of the preparation of the data for four research bulletins which are rapidly assuming form.

Factors Influencing Normal Rate of Growth in Domestic Animals and the Permanency of the Effects of Arrested Development (F. B. Mum-

ford, C. R. Moulton, S. B. Shirkey, W. S. Ritchie).—One Group III animal, No. 580, was fed out from the 1140th day to the 1500th day and another Group III animal, No. 586, was slaughtered while still on the low ration at about 1500 days.

The steer fed out consumed during its life about as much dry matter as Group III Use-of-Food steer. The low plane animal consumed one-sixth less dry matter. On this amount of feed steer No. 580 attained a body weight equal to a Group III Use-of-Food steer, i. e., about 1100 pounds, while steer No. 586 attained a weight of only about 600 pounds. Steer No. 580 had gained 940 pounds during the 1500 days of the trial while steer No. 586 had gained only 430 pounds. A Group III Use-of-Food steer had gained about 800 pounds.



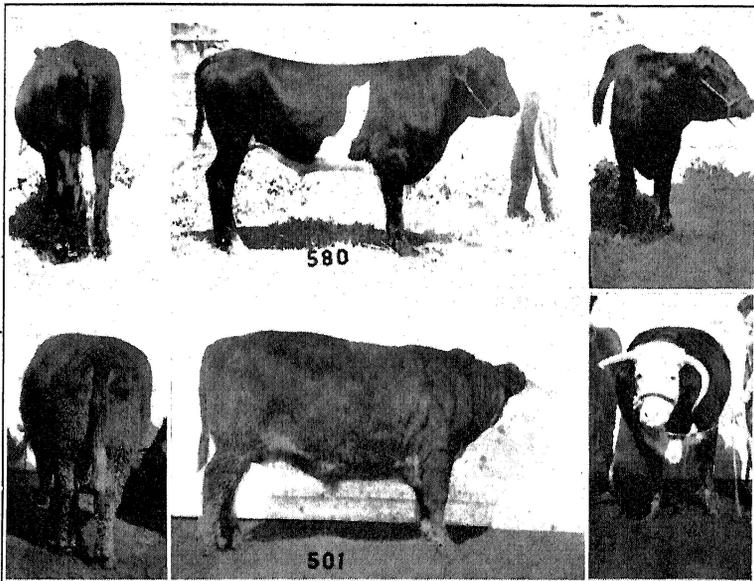
Steer No. 586 (Group III, retarded growth) Fed to gain ten pounds a month
 Steer No. 500 (Group III, use of food) Fed to gain one-half pound daily
 Steer No. 512 (Group II, use of food) Fed liberal ration from beginning of experiment

The growth of steer No. 580 in length, width and circumference was about equal to a Group III Use-of-Food steer, while steer No. 586 was very much behind. In height however, steer No. 580 had gained but little more than steer No. 586, and both were far behind the Group III Use-of-Food animal.

Steer No. 580 made economical gains while the gains of steer No. 586 were very expensive.. The maintenance costs of the two animals were strikingly lower than the average costs of the Use-of-Food steers. The low plane of nutrition is considered the cause of the economy.

In composition of quality of carcass steer No. 580 recovered to a Group II Use-of-Food condition (or a Group I Retarded Growth).

Permanence of the stunting of the low plane Retarded-Growth steers



Steer No. 580 (Group III, retarded growth) Fattened at three years of age
Steer No. 501 (Group I, use of food) Fed all he would take from beginning of experiment

is indicated by some of the data but not proved since the animal fed out was still gaining at a rate more rapid than that shown by animals continuously on a better plane of nutrition.

AGRICULTURAL ENGINEERING

Investigations to Determine the Draft of Various Farm Implements and the Cost of Different Operations With Them (E. W. Lehmann).—Draft tests were made on Avery Six Shovel Cultivator. This test was made on the Farm Crops experiment field, which is a variable sand and clay loam soil. The crop under cultivation was soybeans, and the instrument used was an Iowa dynamometer.

Test	Counter-readings		Foot-pounds	Time sec.	Horse-power	Pounds pull (approx.)	Remarks
	start	stop					
1	176	195	19,000	14	2.47	470	Clay loam—up grade Sandy loam "down" Same as No. 1 Up grade-sandy loam
2	195.	210.4	15,400	16	1.75	375	
3	210.4	229.5	19,100	14	2.48	450	
4	229.5	246.3	16,800	16	1.91	400	

An Investigation of Sanitary Conditions on Farms and Experiments to Determine the Best Types of Sanitary Equipment (E. W. Lehmann, C. C. Taylor).—Data have been taken from fifty farms. Water samples have been collected from each farm and both chemical and bacteriological analyses have been made. Forty-eight samples of the water tested were taken from cisterns, one from a spring, and another from a shallow well. Results of the bacterial count show presence of B. Coli in forty-four of the fifty samples tested. The chemical analysis showed that practically all the samples of water showed contamination. Free ammonia was present in practically all the samples. This is considered an indication of recent contamination, especially of animal origin. The presence of nitrogen as nitrates also indicates impurities and shows that oxidation is taking place, caused by the presence of bacteria. Practically all of the samples would be condemned from a sanitary standpoint as a result of the chemical analysis. The presence of B. Coli as shown by the bacterial analysis indicates a clear case of some form of sewage contamination. While such water may not cause disease, it is yet possible that disease germs may appear at any time and cause ill health. It is found out of fifty homes surveyed, forty were occupied by owners, seven by renters and three by hired men. On the farms surveyed, the water was drawn in one place by a pump. On the farm where the spring was a source of supply, water was pumped to watering troughs for live stock, but not into the home. In five places the water was lifted by means of a bucket and rope, and in two places by means of a pitcher pump. On the remaining farms water was obtained directly from cistern or well by means of chain pump.

ANIMAL HUSBANDRY

Age as a Factor in Animal Breeding (F. B. Mumford, J. H. Longwell).—The most significant fact developed during the year was concerning Factor 90. This gilt represented the ninth generation of swine bred at the first heat period, and farrowed thirteen pigs June 28, eleven of which are still living. This is the largest litter ever farrowed in this experiment. The average weight for the pigs was 2.31 pounds, or 0.07 pounds above the average weight for the pigs of this experiment.

Animals now on experiment and number of pigs farrowed and raised are as follows:

Factor	Generation	Pigs Farrowed	Pigs Raised
50	5th	6	6
60	6th	8	5
70	7th	7	6
80	8th	11	2
90	9th	13	11

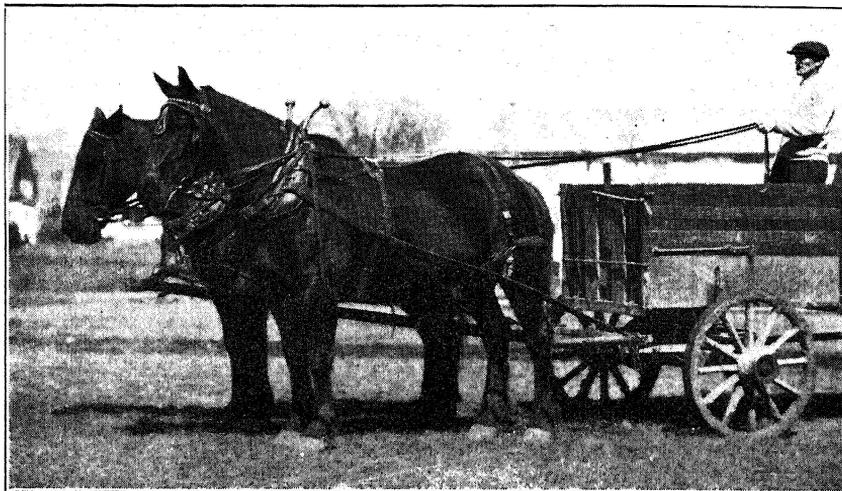
Heavy and Light Grain Rations When Fed in Connection With Corn Silage and Clover Hay for Fattening Steers (H. O. Allison).—Forty head of two-year-old steers were put on feed January 13, 1919, and fed for 83 days, on rations containing silage. At the end of 83 days, the silage was eliminated and all five lots of steers were full fed on shelled corn, linseed oil cake and clover hay for 38 days, the test ending May 14, 1919. For the first 83 days of the test, the cattle were fed the following rations:

- Lot I. —Shelled corn (full feed)
 Linseed oil meal (1 lb. to 6 lbs. of corn)
 Corn silage
 Clover hay
- Lot II. —Shelled corn (one-half feed)
 Linseed oil meal (same quantity as fed Lot I)
 Corn silage
 Clover hay
- Lot III.—Shelled corn (full feed after first 60 days)
 Linseed oil meal (same quantity as fed Lot I)
 Corn silage
 Clover hay
- Lot IV.—Linseed oil meal (same as Lot I)
 Corn silage
 Clover hay
- Lot V. —Linseed oil meal (average about 5 lbs. per day)
 Corn silage
 Clover hay

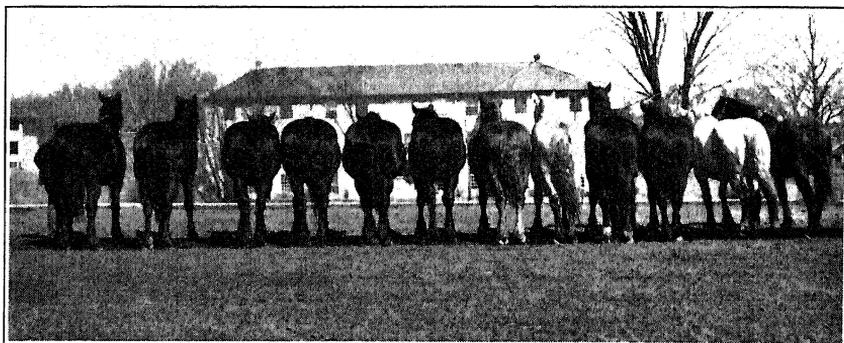
The cost of gain on these cattle was greatly reduced during the first 83 days of the feeding period by the reduction and elimination of corn, other than that contained in the silage. Gains in live weight and the resulting finish were also diminished. Whether the economy effected by the elimination of corn from the ration is justified will depend upon the higher price paid on the market for the additional weight and finish obtained by the corn-fed cattle.

Oat Straw as Winter Roughness for Farm Work Horses Fed in Conjunction With a Grain Ration of 2 Parts Corn, 2 Parts Oats, 1 Part Bran and Linseed Meal to Balance the Ration (E. A. Trowbridge).—Twelve horses doing winter farm work were fed oat straw as roughness and a grain ration of 2 parts shelled corn, 2 parts oats, 1 part bran and a small quantity of oil meal for a period of 70 days, beginning January 3, 1919. The horses used in this test were ten purebred Percheron mares, and two grade draft geldings. Eight of the mares were in foal.

Average initial weight	1488.33 lbs.
Average final weight	1516.66 lbs.
Average gain in weight during test	28.33 lbs.
Average daily grain mixture	14.75 lbs.
2 parts shelled corn	
2 parts oats	
1 part bran	
Linseed meal .....	.464 lbs.
Oat straw	15.7
Average daily labor	4 hours



Horses owned by the University of Missouri which worked an average of 4 hours daily on an average daily ration of 14.75 lbs. of grain (2 parts shelled corn, 2 parts oats, 1 part bran by weight), and .46 lbs. linseed meal and 15.7 lbs. oat straw during the winter 1918-1919. Photograph taken at close of experiment.



Horses owned by the University of Missouri which worked an average of 4 hours daily on an average daily ration of 14.75 lbs. of grain (2 parts oats, 2 parts shelled corn, 1 part bran) .46 lbs. linseed meal, 15.7 lbs. oat straw, during the winter of 1918-1919. Photograph taken at close of experiment.

The above data and the results of former tests indicate clearly that oat straw can be used advantageously as roughness for farm horses doing farm work in the winter months.

Hominy Feed vs. Corn for Fattening Swine on Forage (L. A. Weaver).
 —Economic conditions warranted the conducting of feeding trials to determine the value and limitations of some by-products which might be successfully used as substitutes for corn in swine feeding. A direct comparison was made with hominy feed and corn with two lots of ten hogs each. Both lots were fed on bluegrass pasture.

The ration for Lot A was: Hominy feed, 9 parts; shorts, 2 parts; tankage, 1 part.

The ration for Lot B was: Ground corn, 9 parts; shorts, 2 parts; tankage, 1 part.

The experiment was begun June 1 and was continued for 86 days. The average initial weight of the hogs used was between 40 and 45 pounds. The average daily gain of hogs in Lot A was 0.9 pounds. The hogs in Lot B eating corn instead of hominy feed gained 0.97 pounds daily. It required 4.77 pounds of hominy feed, shorts and tankage to produce one pound of gain (Lot A) and 4.58 pounds of corn, shorts and tankage to produce one pound of gain (Lot B). Results indicate that hominy feed makes a satisfactory substitute for corn, altho the hogs receiving hominy feed gained a little less rapidly and it took slightly more feed to produce a given amount of gain than was the case of the hogs fed corn.

Two lots of 17 hogs each, one grazing on alfalfa and the other on rape, were also fed a ration of hominy feed, 9 parts; shorts, 2 parts; tankage, 1 part. It was impossible to make a direct comparison of hominy feed with corn fed to hogs on alfalfa and rape pasture because there was but one lot of alfalfa and one lot of rape fed. The results substantiate the conclusions drawn from the comparison mentioned above, to the effect that hominy feed is a satisfactory substitute for corn.

Semi-solid Buttermilk vs. Tankage as a Protein Supplement in Rations for Fattening Swine (L. A. Weaver).—The forty purebred pigs used in this test were farrowed in the fall of 1918. They were the offspring of Poland China and Duroc Jersey sows in the University herd. Two series of two lots each were used in the experiment. There were ten shotes in each of four lots. The experiment began March 11, 1919, and closed April 29, 1919, extending over a period of 49 days. The following rations were fed:

Lot I. —Ground corn, 9 parts
Shorts, 2 parts
Tankage, 1 part

Lot II. —Ground corn, 9 parts
Shorts, 2 parts
Semi-solid buttermilk, 1.5 parts

Lot III.—Ground barley, 9 parts
Shorts, 2 parts
Tankage, 1 part

Lot IV.—Ground barley, 9 parts
Shorts, 2 parts
Semi-solid buttermilk, 1.5 parts

The hogs weighed about 130 pounds at the beginning of the test. At the close of the experiment they weighed in the neighborhood of 225 pounds. The average daily gain for Lot I was 1.93 pounds; for Lot II, 1.94 pounds. The hogs in Lot I required 409.9 pounds of feed to make 100 pounds of gain, while those in Lot II required 423.84 pounds of feed. The result showed little difference in either rate or economy of gain. One

pound of tankage had the same feeding value as one and one-half pounds of semi-solid buttermilk.

The relative value of tankage and semi-solid buttermilk shown by the results of the second series, Lots III and IV, where barley was used instead of corn, were similar to those obtained from Lots I and II. The average daily gain for Lot III was 1.85 pounds, and for Lot IV was 1.87 pounds. The hogs in Lot III required 426.60 pounds of feed to produce 100 pounds of gain, while those in Lot IV required 434.14 pounds of feed. In this series there was little difference in either the rate or economy of gain caused by substituting one and one-half pounds semi-solid buttermilk for one pound of tankage.

Barley vs. Corn for Fattening Swine (L. A. Weaver).—The animals used for this project were the same as those used on the "semi-solid buttermilk vs. tankage" project. It will be seen from the report on that project that the four lots were so arranged that opportunity was given to compare two lots getting corn with two lots getting barley, as well as to compare semi-solid buttermilk with tankage. In this case, instead of comparing Lots I and II and Lots III and IV with each other, the comparison is made between Lots I and III and Lots II and IV.

The average daily gain for Lot I (corn, shorts and tankage) was 1.93 pounds as compared with 1.85 for Lot III (barley, shorts and tankage). More feed was required by the hogs fed barley for 100 pounds gain,—426.60 pounds as compared with 409.90 pounds.

Similar results were obtained with the other series of lots. The shots in Lot II (corn, barley and semi-solid buttermilk) made an average daily gain of 1.94 pounds while those in Lot IV (barley, shorts and semi-solid buttermilk) gained on the average 1.87 pounds per day per head. It required 434.14 pounds of barley ration to produce 100 pounds gain as compared with 423.84 pounds of corn. Summarizing the results of both series, it is true that while ground barley made a very satisfactory substitute for corn, that the hogs fed barley gained a little less rapidly and somewhat more feed was required to produce a given amount of gain when barley was used instead of corn.

Fishmeal vs. Tankage as a Supplement to Corn in Rations for Fattening Swine (L. A. Weaver).—The merits of fishmeal as a feeding stuff for pigs have become more and more appreciated in European countries. Only recently in the United States has there been any interest shown in using this as a feeding stuff. The composition of fishmeal shows it to be very high in protein and ash. This would make it particularly valuable as a supplementary feed where corn or some other carbonaceous grain is used in the feeding operation. Since the use of tankage is increasing rapidly, and since the supply is necessarily limited, it is important that other supplements be found which can be used for this purpose.

Forty head of purebred Poland China, Duroc Jersey and Berkshire pigs, farrowed in the spring of 1918, were divided into four lots of ten hogs each and were fed for a period of 49 days, the trial beginning September 21 and closing November 9. Rations and manner of feeding were as follows:

Lot I. —Ground corn 9 parts
 Shorts 2 parts by weight
 Tankage 1 part
 Mixed with water just before feeding and fed as a slop twice daily

Lot II.—Ground corn 9 parts
 Shorts 2 parts by weight
 Fishmeal 1 part
 Fed same as Lot I

Lot III.—Ground corn, shorts, tankage.
 Each feed placed in a separate self-feeder and hogs allowed to select feeds as they wish

Lot IV.—Ground corn, shorts, fishmeal.
 Fed same as Lot III.

The results obtained indicate that fishmeal makes a satisfactory substitute for tankage, since in all cases the hogs receiving fishmeal gained more rapidly and required less feed to produce a given amount of gain than when tankage was used. Hogs fed corn 9 parts, shorts 2 parts, and fishmeal 1 part, gained an average of 1.76 pounds a head daily, while those getting corn, shorts and tankage gained 1.45 pounds a head daily. In the former case, 4.41 pounds of feed were required to produce 1 pound of gain. In the latter, it required 5.17 pounds of feed to produce 1 pound of gain. The fishmeal used in this test was furnished by the Bureau of Animal Industry, U. S. Department of Agriculture.

PLANT DISEASES

Grain Smuts Investigation and Control (W. E. Maneval, Helen Johann).—The particular phases of the grain smut project which the Department has been investigating for a number of years have now been practically concluded. Final data are being secured regarding the field tests for the present season. In these tests 45 varieties of barley, 20 of wheat and about 150 of oats are being used.

A Study of Certain Fusarial Diseases of Plants (W. E. Maneval, Helen Johann).—Isolations of fungi were made from scabby wheat received from Missouri, Iowa and Minnesota. Isolations were made of corn received from Missouri. Forty different strains of fusaria have been kept growing in pure culture. In addition, several other organisms which may be of importance were isolated, particularly *Gibberella saubienettii* and *diplodia*. These fungi were studied with possible reference to cultural characteristics, their relation to temperature and their ability to cause disease in wheat and corn. Scabby wheat grains were treated by various methods to determine means of disinfecting such seed. The treatments consisted of the use of formaldehyde, mercuric chloride, copper sulphate, calcium hypochlorite and hot water. The pathogenicity of some of the fungi isolated were tested in the laboratory and greenhouse with plants under sterile condition. The results are summarized as follows:

1. It is possible to kill a large percentage of the scab organisms in infected wheat seed by means of hot water treatment.
2. Shrivelled grains from scabby heads are not necessarily infected.

This condition may possibly be due to the cutting off of the food supply during the growth of the grain.

3. The optimum temperature for vegetative growth of all but one of the wheat organisms studied varies from 25 to 28 degrees C. The optimum temperature for diplodia is between 30 and 35 degrees C.

4. *Giberella saubinettii* will kill corn seedlings grown under sterile conditions in the laboratory at room temperature.

DAIRY HUSBANDRY

Factors Influencing the Composition of Milk.—*The enzymes of milk and their relations to abnormal flavors* (L. S. Palmer).—The experimental work carried out during the year has been confined almost entirely to a study of the lipase content of normal milk. Further study has been directed particularly to methods of determining the lipase content of milk. It was found that milk presents a number of special problems in connection with the determination of lipase activity because of its lactose and protein content and the formation of titratable acidity from these substances thru the action of bacteria and enzymes. It was found also that the inorganic compounds of milk are factors of importance in the determination of the acidity of milk, particularly when it is attempted to determine the lipase activity of the milk by the usual method of titrating to neutrality in the presence of antiseptics and then repeating the titration after lipase has presumably split off fatty acids from the neutral milk fat. It was found further that when pancreatic lipase is allowed to act upon the fat in milk the usual method of titration of the liberated fatty acids in the aqueous media with an aqueous solution of alkali gives only a partial measure of the total fatty acids liberated.

These results led to an extensive search for the proper antiseptic to use in lipase studies with milk and also for a suitable method for the determination of lipase activity when encountered in cow's milk, by which the total liberated fatty acids would be determined and the various factors entering into the results, especially with milk, would be controlled. Between 30 and 40 experiments were carried out in connection with these studies. Particularly successful results were secured in these investigations by studying the action of pancreatic lipase on artificial milk prepared by emulsifying butter fat into gum arabic. The emulsion thus produced gave on dilution with water a highly suitable "milk," which was free from the vitiating influence of lactose, proteins, and inorganic phosphates.

Most interesting data were secured on the action of various antiseptics toward the activity of pancreatic lipase when using this artificial "milk." Chloroform, which has been adopted by most investigators for lipase studies with milk, was found to retard greatly the activity of lipase, as low as 2 per cent chloroform retarding the lipase 50 to 60 per cent. In a study of acetone solutions of iodoform as antiseptic it was found that both the acetone and the iodoform retarded lipase activity when fresh solutions of the salt in the reagent were used, and that solutions of iodoform containing very small amounts of iodine inhibited lipase activity completely. Formaldehyde was found to be the best antiseptic to use for lipase studies, concentrations as high as 1:1,000 having no retarding effects whatever.

It was found, in fact, that a concentration of formaldehyde as high as 1 per cent has no retarding effect on lipase, while the concentrations of 0.1 and 0.05 per cent actually had a slight accelerating effect on lipase activity.

Regarding a suitable method for determining the total fatty acids liberated from milk fat by lipase, it was found that excellent results could be secured by adding 4 volumes of a mixture of acetone and ether, 2:1, and titrating with an 0.1 N. alcoholic solution of KOH, using phenolphthalein as indicator. The former method most generally used for lipase activity in milk wherein the milk is neutralized, incubated, titrated to neutrality and the procedure repeated until no further increase in acidity is secured, was abandoned in favor of allowing a suitable sample of milk to develop its acidity due to lipase under normal conditions, using a suitable antiseptic, and determining the acidity at intervals, as well as at the beginning of incubation, on aliquot portions of the milk. It is believed that this method gives a more accurate measure of the actual lipase activity.

The work has not progressed to the point where it can be stated with assurance whether or not lipase is a normal constituent of milk. Further indications were secured, however, that the bitter milk which frequently characterizes the close of the lactation period of single cows is due to the action of lipase on the milk fat. This phase of the problem was not studied extensively during the year.

The influence of the condition at parturition on the composition of milk and butterfat.—Cow No. 9 calved July 23, 1918, in excellent flesh and with a body weight of 750 to 800 pounds. She was kept on a high protein plane of nutrition until September 16. Following the observations on this animal made in three previous years, which indicated that a poor condition at parturition and low protein plane of nutrition depressed the fat and protein content of the milk, it was expected that the combined good condition and high protein plane of nutrition in this year's experiment would induce a higher protein and fat content in the milk following parturition. The analyses of milk composites taken at suitable intervals showed a slightly higher protein content in the milk, the average being about 3.5 per cent after the normally higher level of the milk following parturition had disappeared, as compared with a protein percentage of about 3.0 to 3.1 for the previous years. The fat on the milk, however, averaged scarcely 3.5 per cent, which was no higher than that following parturition in a poor condition and on a low plane of protein.

The conclusion was drawn that it was not advisable to continue the project with this animal, inasmuch as the results secured in the previous three year's work were apparently due to the individuality of the animal, as much as to the experimental conditions to which she was submitted.

The abnormally low protein and fat content of the milk of this animal is apparently independent of the fact that she calved in poor condition or was kept on a low protein plane for a period following parturition. Our data do indicate, however, that an increase in the protein content of the ration may be beneficial in raising the fat and protein content of the milk if the animal has been on a low protein plane and is giving milk with a low fat and protein content.

Influence of Nutrition of Heifers and the Age of Breeding Upon Their Subsequent Development.—*Protein requirements for growth* (A. C. Rags-

dale, W. W. Swett).—Twelve animals were used this year. After another year's work, it is evident that animals of either Holstein or Jersey breed cannot make normal gain on 8 per cent protein plane. On a 15 per cent protein plane we have been successful in getting practically a normal gain with a few of our Holsteins but we have not been successful on even a 15 per cent protein plane with Jerseys.

A plane of 20 per cent protein or about 75 per cent of that prescribed by the Wolff-Lehman standard, was on the average approximately adequate to promote normal gain in our Holstein heifers. On a 25 per cent protein plane most of the Holsteins made gains somewhat above normal, while the Jerseys were inconsistent and on the average made only about normal gains. A 35 per cent protein plane was tried in a few cases. Holsteins on this plane made gains greatly in excess of the normal, while Jerseys ran only slightly above.

It would appear that for some reason the Jerseys cannot make normal gains on a ration, which, figured on the same basis, is adequate for Holsteins. It is much more difficult to get the Jerseys adjusted to their experimental feed and handling than it is to start the Holsteins. Whether or not there is a physiological difference in the requirements of the two breeds is not certain. The Jerseys seem more delicate and seem more particular about what they eat. No explanation can yet be offered for the difference in results between Jerseys and Holsteins.

It is noticeable that the effect of a change in ration is much more pronounced on the weight than on the skeletal measurements. An animal will continue to grow in height even on a very low plane and when the animal is almost at a standstill in weight.

It has been observed in our work that the young animal does not make as good gains on a given plane as an older animal. In a few cases the calves have been slightly below normal in size when started on experiment. This has handicapped them. Great care has been taken recently to select only calves that are of normal size. A question presents itself concerning the requirements of animals of different ages. Possibly a plane that is suitable for an animal twelve months of age is not suitable for one six months of age. We may need to establish a "sliding scale" of requirements.

Raising calves on milk substitutes.—The results of the experiments during the year lead to the following conclusions:

Calves can be weaned at the age of sixty to seventy days and will continue to make approximately normal gains when fed on a suitable grain mixture and alfalfa hay.

Alfalfa hay used to supplement the grain ration gave more satisfactory results than timothy hay.

Blood meal has no pronounced nutritional value when fed on the grain mixture to calves more than two months old.

Ground corn 4 parts, wheat bran 1 part, and linseed meal 1 part, when fed in conjunction with alfalfa hay, make a satisfactory grain mixture for calves from two to six months of age.

Raising calves by weaning at sixty days of age and subsequently feeding them grain and alfalfa hay is more economical than feeding skim milk, grain and hay until the animals are six months old.

Silage Investigations (A. C. Ragsdale, M. H. Forhman).—A compari-

son of the loss of nutrients in the silo and in the field was continued. The weather during the winter of 1918-1919 was mild and there was more rainfall than during the previous winter, and while not exactly normal, it may be said the grain left in the field was subject to average conditions. The mice damaged somewhat that part of the grain which remained in the field longest.

SILAGE EXPERIMENT 3, 1918-1919

Data on four shocks of Leaming corn left in the field

Pile or shock No.	Original weight	Percent grain	Weight when taken out	Percent shrunk	Weight into Silo		
					Corn	Water	Total
	<i>Lbs.</i>		<i>Lbs.</i>				
5	733.5	12.8	336.5	54.87	352.25	390.0	742.25
6	698.0	12.8	315.0	54.1			
7	706.5	12.8	253.25	*64.2	244.0	305.25	549.25
8	737.0	12.8	276.0	*62.5			

*Some loss due to mice.

The silage from shocks 4 and 5 which were put into the silo December 6, 1918, were dried out thoroly and water was added on the basis of corn 1.00 to water 1.11. When taken out of the silo May 14, 1919, some of the water settled to the bottom making the lower part of the silage wet. All of this silage kept excellently, was bright in color, had a sharp acid taste and was very palatable. Shocks 7 and 8, which were put into the silo April 4, 1919, were in good condition, except that the mice had damaged the corn somewhat. Water was added on the basis of corn 1.00, water 1.25. When removed from the silo, May 14, 1919, silage was bright and very palatable, moisture evenly distributed, and all kept in excellent condition.

The corn from four shocks, Numbers 1, 2, 3, and 4, was put into different silos October 2, 1918. Corn was in good condition, about right for the silo but rather uneven, some being dented and some in the dough. Silage from the first silo was removed December 5, 1918, the silage being very good, altho a bit dry. The silage from the second silo was removed April 3, 1919, and was in excellent condition altho a little dry. It was not cut quite fine enough.

Work on sweet clover was continued. A sample of sweet clover silage was secured for examination, and was of excellent quality, very palatable, and was readily consumed by cattle.

More data were secured and the conclusion reached that ears of corn too soft for cribbing can be stored and preserved in the silo. Some late corn which was retarded in growth by dry weather in the summer was in the milk stage at silo filling time and was used for the soft corn test, as representative of the condition in which so-called soft corn is usually

caught by frost. The corn kept perfectly, had an acid taste, shrinkage was small, and there was no waste.

Additional data on silage from corn with ears removed were secured by the use of a small experimental silo. The silo was filled October 2, 1918, and when removed May 13, 1919, the silage had kept perfectly except for some white mold in the bottom and at the edge in a few places. This may have been due to the fact that silage was not cut fine enough.

The tests on the yield of special silage corn compared with regular field varieties, begun in 1917, were continued. The season was unfavorable and as a result the yield of all was much decreased. Weights were taken by cutting and weighing certain rows running the entire length of the field. The data on the varieties used is given in the following table:

DATA ON VARIETIES OF CORN USED FOR SILAGE—1918

Variety	Yield per Acre	Percentage		Percentage		Percentage Grain only	
		Water	Air-dry matter	Grain	Stover	Water	Air-dry matter
Eureka	16.680 lb	67.0	33.0	10.7	89.3	59.1	40.9
Cocke's Prolific	19.320 lb	66.6	33.4	7.9	92.1	53.7	46.3
Biggs Seven Ear	15.300 lb	65.4	34.5	13.1	86.9	47.0	53.0
Leaming	11.940 lb	66.7	33.3	9.1	90.0	42.2	

The Chemistry of Churning (L. S. Palmer).—A limited amount of experimental work, only, was done on this project during the past year.

Further observations were made regarding the character of the emulsion in cream and butter, respectively. It was found that cream which was treated with 17.5 per cent of strong acetone solution of Sudan III and Fuchsin, that the fat globules readily took up the red Sudan III stain and the casein particles the purple Fuchsin stain. Under the microscope the cream thus stained showed the red fat globules in an aqueous field containing particles of purple colored protein. When this cream was churned and washed like normal cream the resulting butter gave the microscopic picture of clear aqueous drops, many of which contained particles of purple colored protein, in a field of red stained fat. The experiment was repeated several times with the same result. It seems to confirm Fischer's theory that milk and cream are emulsions of fat in an aqueous media containing protein, but butter is the opposite type of emulsion, namely one of protein solution in fat, the process of churning being changing from one type of emulsion to the other.

ENTOMOLOGY

An Investigation to Determine the Life-History, Development and Habits of the Corn-Ear Worm and Practical Methods of Controlling Its Ravages (L. Haseman, K. C. Sullivan).—During the summer an experimental plot of corn was grown at Columbia to determine the effect of dust-

ing and spraying on the corn-ear worm. Three varieties of sweet corn, one variety of pop corn, and five varieties of field corn were used. These varieties were used in the test to find out, if possible, the relative susceptibility to the attacks of the corn-ear worm. Dusts were applied twice, and two sprays of different strengths were applied. The year's results indicate that it is cheaper to dust than to spray, and there was much less damage to the treated than to the untreated corn. Dusting and spraying did not entirely keep the corn-ear worm from working.

Injurious Insect Pests of Melon and Related Crops (L. Haseman, K. C. Sullivan).—Watermelons, muskmelons, cucumbers, squashes and pumpkins were grown on the Entomological experiment field and the study of the different pests attacking these crops was made. The melon aphid, also the striped cucumber beetle, the squash stink bug and squash vine borer received special attention. Nicotine sulphate was found to control effectively



Testing various sprays on vegetables at the Missouri Agricultural Experiment Station.

the melon aphid. An arsenate spray made by mixing two pounds of arsenate of lead in fifty gallons of water gave very good results, where applied early enough as a control of the striped cucumber beetle. An attempt was made to control the squash stink bug by using contact sprays, including a miscible oil, nicotine sulphate and two proprietary chemicals. While none of these sprays was entirely effective, the nicotine sulphate gave the best results.

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).—In May, 1918, a test was made in the Station orchards to determine the pressure and the kind of nozzle to be used in applying a spray. A standard Bordeaux nozzle and an angled disc nozzle were used at the varying pressures of 200 pounds, 145 pounds and 85 pounds. The spray used was arsenate of lead. In the fall apples were picked and the results are indicated in the following table:

NOZZLE	PRESSURE	PER CENT ENDWORMS
Bordeaux nozzle	200 lbs.	11.01
Disc nozzle	200 lbs.	8.74
Bordeaux nozzle	145 lbs.	8.80
Disc nozzle	145 lbs.	3.09
Bordeaux nozzle	85 lbs.	2.31
Disc nozzle	85 lbs.	1.89

An Investigation to Determine What Insects Are Injurious to Nursery Stock in the State, Their Life Histories, Distribution, Injury and Methods of Control (L. Haseman, K. C. Sullivan).—San Jose scale is the most important nursery stock pest in Missouri. The San Jose scale, however, has been practically eradicated from Missouri nurseries. In 1915-16, twenty-four nurseries were found infested with this scale. In 1916-17, twenty-two were found infested. In 1917-18, fifteen were found infested, and in 1918-19, the number was reduced to two. These striking results have been secured by: First, a careful and thoro inspection of every nursery of the state during the growing season. Where infested stock was found, it was destroyed. Second, closer cooperation between the nurseryman and those in charge of the work in the destruction of infested stock and in spraying, fumigating and dipping of all stock where there was the least possibility of being infested. Third, by keeping the nursery premises free from all plants which might serve as a host and harbor the San Jose scale.

FARM CROPS

Cultural Experiments With Soybeans (W. C. Etheridge, C. A. Helm).

—Results from experiments to find the relation between yield and the rate and method of seeding, were:

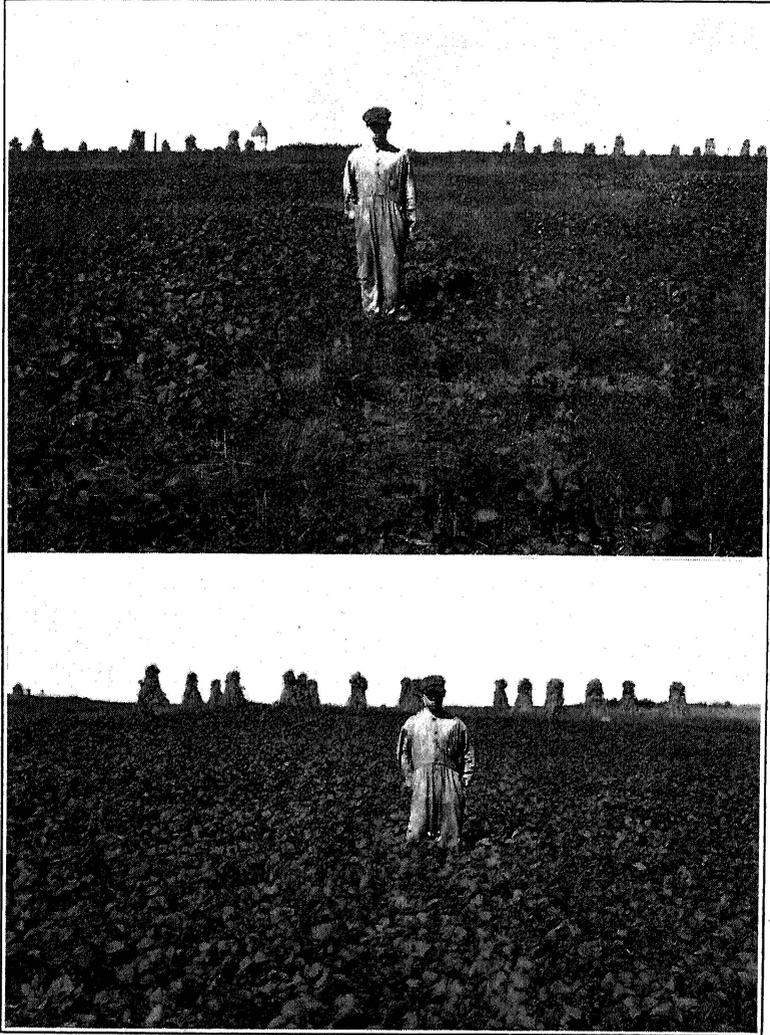
1. Soybeans planted in rows spaced 42 inches and 32 inches apart, and under each spacing planted at the rate of 15, 20, 25 and 30 pounds to the acre, showed no substantial differences in yields of either seed or hay.
2. When planted in rows spaced 16 inches apart all rates of seeding—15, 20, 25 and 30 pounds to the acre—gave yields of hay and seed materially lower than those from rows spaced 32 and 42 inches apart.
3. Seeding at the rates of 40, 50, 60 and 90 pounds to the acre, in 8-inch (grain drill) rows, gave yields of seed and hay which were insignificant when compared to yields from seeding at the lower rates in 32 and 42-inch rows.

These results are of much practical significance, indicating as they do that a moderate rate of seeding soybeans, 15 to 20 pounds to the acre in rows spaced the distance of ordinary corn rows, is likely to give maximum yields of both seed and hay. Such a crop is easily planted and cultivated with the ordinary corn machinery.

A Study of the Cultural Requirements and Adaptations of Sudan Grass (W. C. Etheridge, C. A. Helm).—At Columbia a crop of Sudan grass sown May 1 at the rate of 5 pounds of seed to the acre, in rows spaced 3 feet apart, gave from three cuttings a total yield of 10.2 tons of cured hay. Another crop sown at the same time, with a grain drill (the rows spaced

8 inches apart), at the rate of 25 pounds of seed to the acre, yielded from three cuttings a total of 9.3 tons of cured hay. The method of seeding this crop produced a finer quality of hay (due to the smaller stems) altho a lower yield than was produced by the other crop seeded in wider rows.

A summer sown (July 10) crop of Sudan grass produced only one cutting, that of 1.6 tons to the acre. At Warrensburg a crop sown July 12 gave from its single cutting a yield of 1.1 tons.



The proper way to secure a good yield of soybean hay from a catch-crop sown after wheat. Above: Soybeans sown on wheat stubble which had been disked. Below: Soybeans sown on wheat stubble which had been given a light top-dressing of manure, then plowed and harrowed. Under the first treatment the acre yield was less than one-quarter of a ton of bean hay, crabgrass and weeds. Under the second treatment the acre yield was one and one-half tons of clean bean hay with well-developed seed pods

A Study of the Adaptations of the Important Varieties and Selections of Cowpeas to the Various Soil Types of the State (W. C. Etheridge, C. A. Helm).—Ten varieties of cowpeas were tested at Columbia for seed and hay. In view of the fact that soybeans are rapidly displacing cowpeas in Missouri it is interesting to make the following comparison of the yields of the best six varieties of each crop:

Soybeans	Bushels of seed per acre	Cowpeas	Bushels of seed per acre
Taha	21.87	Groit	13.77
Ebony	19.69	New Era	12.69
Sable	18.97	Cream	11.77
Morse	18.15	Early Ramshorn	9.75
No. 612	17.60	Iron	9.28
Mikado	17.49	Black	8.10
Average	18.96	Average	10.89

Soybeans	Tons of cured hay per acre	Cowpeas	Tons of cured hay per acre
Taha	4.60	Brabham	3.86
Chiquita	3.87	Groit	3.61
Buster Brown	3.49	Black	3.60
Tarheel Yellow	3.42	Clay	3.50
Arlington	3.40	Whippoorwill	3.44
Sable	2.53	Red Ripper	3.23
Average	3.47	Average	3.54

It is evident from these data that soybeans will heavily outyield cowpeas in seed. The hay yields of the two crops were nearly the same, but the abundant seed production of soybeans makes the hay of this crop much more valuable, pound for pound, than cowpea hay.

A Study of the Adaptations of the Important Varieties of Wheat for Missouri Conditions (W. C. Etheridge, C. A. Helm).—In 1918, tests of commercial varieties of wheat were conducted only at Warrensburg and Maryville. At Maryville the varieties were so thoroly winter-killed that no yields were secured. The following data show the yields of the leading varieties at Warrensburg:

Variety	Bushels of grain per acre
Jones Red Wave	24.4
Michigan Wonder	21.6
Fulcaster 15	20.9
Michigan Amber	19.5
Harvest King	18.8

There was a difference of 13.2 bushels between the acre yields of the highest and the lowest yielding varieties. This is a striking illustration of the importance of varietal adaptation.

A Study of the Important Varieties of Oats for Missouri Conditions (W. C. Etheridge).—Commercial varieties of oats were tested at Warrensburg and at Maryville. The Warrensburg crop was poor; the Maryville

crop good; which is the usual result with oats in these sections. The data on yields follow and show that Texas Red and Burt, medium early varieties, were outstanding in their yields in both sections:

Variety	Bushels of grain per acre	
	Warrensburg	Maryville
Texas Red	10.9	60.8
Burt	17.0	53.2
Kherson	7.7	48.6
Silvermine	12.5	53.1
White Shonen	7.1	44.5
American Banner	9.6	36.3
Swedish Select	10.9	53.4

A Study of the Adaptations of the Important Varieties of Spring Barley for Missouri Conditions (W. C. Etheridge).—In the favorable season of 1918, spring barley yielded an average of 20.6 bushels an acre at Columbia, and 37.0 bushels at Maryville. Of two varieties tested, Oderbrucker was the better in each section. Accumulating results are indicating that spring barley is a fairly safe crop for north Missouri; an uncertain crop for central Missouri, succeeding here only in favorable seasons; and generally a failure in south Missouri.

A Study of the Adaptations of the Important Varieties of Cotton for the Southeast Missouri Lowlands (W. C. Etheridge, C. A. Helm).—A successful comparison of six important types of cotton was carried out in 1918. The late fall of last season was relatively favorable to the varieties which require the longest possible growing season. As the following data will show, Cleveland Big Boll and Mebane Triumph, both late, big balled types, outyielded the early, small balled types, King Improved and Simpkins Prolific.

Variety	Pounds of lint per acre
Mebane Triumph	395
Simpkins Prolific	324
Cleveland Big Boll	374
Webber Long Staple	297
King Improved	319
Boykin	338

Cultural Experiments With Cotton (W. C. Etheridge).—In the spring of 1918, the fertilizer tests with cotton were renewed in connection with a cropping system of corn, cotton and legumes. In beginning the system, fertilizer was applied to cotton on land which has not in recent years received a stock of organic material from the crops produced. All plant material except the stubble has been removed from the land. The following yields resulted:

Fertilizer Treatment per acre	Pounds of lint per acre
300 lbs. acid phosphate	} 436
35 lbs. potassium chloride	
No fertilizer	390
300 lbs. acid phosphate	430
200 lbs. acid phosphate	423

Factors Influencing the Development of the Maize Plant.—Field studies of the plant (W. C. Etheridge, E. M. McDonald).—Studies of the effect of an associated growth of soybeans on the development and yield of corn were successfully continued thru a season of extreme drouth. As in 1917, a material growth of beans, by whatever method combined with corn, always caused a material reduction in the yield of corn. Beans planted late, by any method and in any manner, in all cases failed to make a material growth and had no effect on the yield of corn.

Wheat Breeding Investigations Including the Improvement of Commercial Varieties by the Pure Line Method of Breeding and Hybridization and Subsequent Selection (W. C. Etheridge, L. J. Stadler).—In general this project is making good progress. Hybrids and pure line selections made at this Station are yearly compared with a large number of other hybrids and selections and commercial varieties. By yearly elimination of the less worthy kinds, the strains of outstanding merit are rapidly being narrowed to a small group. Within a year or two seed stocks of a few of the best strains will be increased for a wider test in various parts of the state. The comparative value of some of the selected strains may be suggested by the case of Fulcaster Selection 8-Y, which during the years 1914 to 1918 inclusive, yielded a yearly average of 6.1 bushels more to the acre than the commercial variety from which it was selected.

A Study of Certain Spring, Summer and Fall Sown Crops for Forage (W. C. Etheridge, C. A. Helm).—In the season of 1918, summer sown forages gave the following yields at Columbia and Warrensburg:

Crop	Tons cured hay per acre	
	Columbia	Warrensburg
Sudan grass	1.58	1.12
Sudan grass and soybeans	1.22	2.48
Amber sorghum	2.41	.....
Amber sorghum and soybeans	2.88	3.30
Amber sorghum and cowpeas	2.44	.....
Kaffir and cowpeas	2.63	.....
Cowpeas	1.39	.....
Soybeans	1.06	.....
Millet and cowpeas	0.68	.....
Millet and soybeans	0.81	.....

The fall sown forages at Columbia yielded as follows: rye, 0.61; rye and winter vetch, 0.93; winter vetch, 0.75 tons of cured hay per acre.

At both Columbia and Warrensburg a mixture of oats and Canada field peas was the best of the spring sown forages, yielding in cured hay 1.51 and 1.86 tons.

Cultural Experiments With Corn (W. C. Etheridge).—The investigation of cultural methods for corn was continued in 1918 at the Maryville and Warrensburg fields. The season was extremely unfavorable; one of the most severe drouths in the history of the state caused a practical failure of the corn crop in both of the sections in which the investigation was carried out. Yields produced under various cultural treatments follow:

Treatment	Yield per acre	
	Warrensburg	Maryville
Corn, surface planted, 3 shallow cultivations	0.42 bu.	1.67. bu.
Corn, surface planted, 4 shallow cultivations	0.39 bu.	3.71 bu.
Corn, surface planted, 3 deep cultivations .....	.....	4.97 bu.
Corn, list planted, 3 shallow cultivations	0.43 bu.	.....
Corn, surface planted, surface scraped 5 times	0.57 bu.	8.44 bu.
Corn, surface planted, no cultivation....	0	.....

The most significant result is that from frequent scraping of the surface. This method of cultivation while extremely shallow, kept the crop much cleaner than the deeper, less frequent cultivations, and by its greater efficiency in the removal of competitive plants (weeds and grass) made a much more favorable condition for the growth of corn in a season of extreme drouth.

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).—Thirty-one varieties and selected strains of soybeans were tested at Columbia in 1918. Some of the leading varieties of this group were tested also at Kennett, Maryville, Warrensburg, and Kirksville.

The yields of the best six varieties at Columbia follow:

Variety	Bushels of seed per acre	Variety	Tons of cured hay per acre
Taha	21.97	Taha	4.16
Ebony	19.69	Chiquita	3.87
Sable	18.97	Buster Brown	3.49
Morse	18.15	Tarheel Yellow	3.42
No. 612	17.60	Arlington	3.40
Mikado	17.49	Sable	2.53

At Warrensburg, Mikado, Morse and Medium Yellow were the leading varieties among six tested. Their respective yields were 6.82, 5.46 and 5.19 bushels to the acre. Chiquita, Mikado, and Morse were the leading varieties for hay, yielding respectively 3.42, 2.55 and 2.46 tons to the acre.

At Maryville, Virginia, Black Beauty and Wilson were the leading seed varieties. Their respective yields were 4.46, 4.10, and 4.10 bushels to the acre. No yields of hay were secured.

At Kirksville, Wilson, Morse and Medium Yellow gave the best yields, these being in the order of varieties, 4.02, 2.68, and 1.34 bushels to the acre. As at Maryville, no yields of hay were recorded.

Investigations With Winter Oats, Including Variety Tests and Improvement (W. C. Etheridge, C. A. Helm).—Seed of a few plants which survived the winter of 1917-18 were planted at Columbia, in the fall of 1918. No plants survived the winter. Since repeated trials of winter oats at Columbia and in south Missouri have clearly demonstrated their failure in average seasons, and their barely moderate success in unusually favorable seasons, this project is now closed with the conclusion that winter oats are not to be regarded as a useful and reliable crop in this state.

FARM MANAGEMENT

General Plans of Farm Organization and Operation in Different Sections of the State (R. M. Green).—Records from southwest Dade County and northwest Saline County were tabulated, from the standpoint of what farmers are able to do with different amounts of capital. The two regions under study represent respectively a typical grain section of the state where wheat is a principal crop, and a typical livestock feeding section where corn is the main crop but is marketed largely thru livestock. The farms in the Saline county area whose operators had in 1914 only \$2,500 capital or less, have been studied. Fifty-six such farms were studied. Only three farmers out of fifty-six with this small amount of capital were owners, and these three farmers fell in the lowest income group. Of the fifty-six farms, thirty-one were making an average labor income of \$269.19 each. The other twenty-five farms averaged \$1,083.46 labor income each. This difference in income in favor of the more successful farms was accounted for as follows:

Larger crop yields	30.0 per cent
Larger size of enterprise	29.4 per cent
Saving in running expenses	15.5 per cent
Better net returns from livestock	11.4 per cent
More acres in farm	11.0 per cent
Less interest charge on investment	2.2 per cent
Larger price for crop sold	0.5 per cent

Utilization of Labor on the Farm (R. M. Green).—A study of the fluctuation in amount of labor done month by month on different farms is being made. On the farms studied in 1917 actual fluctuations varied from 8.8 per cent on a 320-acre farm to 37.4 per cent on a 240-acre farm in an adjoining county. The first farm has been more successful in fitting together its livestock and crop enterprises, and the other necessary maintenance and miscellaneous farm work. This farm is paying a hired man \$80.00 a month, furnishing him a house and other accommodations. A good cropping system, hog feeding, production of some purebred hogs, and a herd of purebred Shorthorn cattle are worked together in a very successful farm business. A small flock of sheep has been recently added to the business without requiring the addition of any extra help.

HORTICULTURE

Peach Breeding for Hardy Sorts (V. R. Gardner).—Fruit buds on many of the seedling trees that have been produced in the course of this investigation survived the winter for the first time since they have reached bearing age. The trees showed great variations in hardiness and suitable records on this point were made in the spring of 1919. Tho many buds were killed by freezing, most of the trees will bear some fruit this year and some will bear a full crop. Suitable records will be made of tree and fruit characters of each plant as this season advances. Furthermore, advantage will be taken of the opportunity to secure a large number of seeds for second-generation trees. Fortunately, weather conditions have been such that

considerable progress upon this project is possible during the calendar year of 1919.

Fruit Bud Development of Fruit Trees Influenced by Treatment (H. D. Hooker).—Research bulletin 32, *Some Factors Favoring or Opposing Fruitfulness in Apples*, has been issued. The project is being continued along related lines but from a new angle. Approximately 350 young apple trees are being subjected to various pruning treatments and chemical analyses of the fruit spurs are being made with a view to finding means of affecting fruit-bud development and observing the synchronous alterations in the chemical composition of the fruit spurs. A chemical study is being made of the spurs of mature trees, some bearing heavily, others bearing little or no fruit.

The Nutrition of Fruits With Special Reference to Their Hardiness (V. R. Gardner, H. D. Hooker).—A study of the nutrition of the strawberry and the apple is being made, which involves both experimental treatment and chemical analyses.

Spurs of young apple trees under treatment are being analyzed with respect to total nitrogen, ash, phosphorus, potash, moisture, reducing sugars, non-reducing sugars, starch, polysaccharides, total acidity, and hydrogen ion concentration. The changes in chemical composition produced by treatment are being noted with a view to gaining a knowledge of favorable and unfavorable metabolic conditions.

The same determinations are being made in fruit spurs of full-grown apple trees collected at regular intervals during the year. The samples are taken from trees which represent a wide variety of metabolic states. Other trees are being treated with fertilizer to bring about extreme conditions.

The phase of this project dealing with the fertilization and nutrition of the strawberry is being continued. Thru the use of fertilizers, different soil types, and shading experiments, an attempt is being made to control nutritive conditions within the plant. Records of general plant behavior together with chemical analyses should serve (1) to throw light upon the conditions within the plant that are associated with vegetative activities, fruit-bud formation, and fruit production, and (2) to suggest methods of culture useful in securing the best balance between vegetative and reproductive activities from a production standpoint.

A Study of the Factors Influencing the Rest Period of Horticultural Plants (H. D. Hooker).—The study of the factors influencing the rest period of horticultural plants has been confined to the peach during the past year.

Chemical analyses and microscopic examination of nodes with buds that survived and with buds that died from the cold last winter have been made to find the condition of metabolic equilibrium that favors hardiness. Determinations of total nitrogen, total ash, phosphorus, potash, moisture, reducing sugars, non-reducing sugars, starch, polysaccharides, total acidity and hydrogen ion concentration were made. Microchemical tests for nitrates, starch, protein and sugars have also been made.

A plot of 105 peach trees on the Experiment Station grounds is being given fourteen different kinds of pruning treatment. At the same time chemical analyses of the new growth under each of the different treatments are being made to determine the effect of treatment on the physiolo-

gical condition of the trees. This will be correlated with the ability of the various lots of trees to withstand the cold next winter.

Transplanting Investigations With Vegetables (J. T. Rosa, Jr.).—During the past year this project has been followed closely with a series of plants in field and greenhouse. One hundred and ten samples have been gathered for chemical analysis and a large number for sectioning and staining. Considerable time has been spent in determining hydrogen ion concentration and acidity of the sap of plants subjected to various degrees of hardening off. It has been found that the condition of hardness in plants can be brought about as effectively by withholding moisture or by decreasing supply of available plant food, as by exposure to low temperature.

Positive differences in behavior of plants in the field have been observed in point of vegetative growth and fruitfulness. At the same time, data of practical value to the truckgrower are being accumulated, relative to methods of transplanting vegetable plants.

Cooperative Tomato Investigations (J. T. Rosa, Jr.).—Work was begun in accordance with the outline of the project. Series of fertilizer tests have been placed with one grower in Livingston, three in St. Louis, three in Greene, three in Newton, four in Howell counties. Use of straw mulch is being tested cooperatively by several growers in St. Louis County. Several growers have agreed to use seed selected from their own fields, such selections to be made under direction and with the assistance of the vegetable specialist.

Four growers in Howell, two in Newton, and one in Greene counties are testing varieties adapted for canning purposes. Seed of wilt-resistant varieties has been distributed to thirty-one growers in the state who suffered loss from this disease last year. Arrangements have been made with a cannery at Neosho to pulp selected tomato fruit, returning the seed to the growers in good condition, and paying the grower for the pulp.

Several fields have been offered by growers for the purpose of making seed selections for local adjustment, as well as resistance to wilt and blossom-end rot.

POULTRY HUSBANDRY

The Relation of Plant Carotinoids to Poultry Production—Relation to growth, fecundity and reproduction (H. L. Kempster, L. S. Palmer).—White Leghorn chicks have been raised from hatching to maturity on rations containing the merest traces, if not entirely devoid, of plant carotinoids. The full-grown hens have shown normal fecundity, and no abnormalities with respect to fertility and hatchability have developed. A second generation of chicks, free from carotinoids at hatching, has been started with every evidence of being normal except for the absence of yellow pigmentation of the skin. It is concluded that the natural yellow pigment of fowls which is derived from the xanthophyll of the food bears no important relation to fecundity and reproduction, at least for one generation.

Physiological relation between fecundity and the natural pigmentation of certain breeds of fowls.—Cockerels fed on a carotinoid-free ration when fed xanthophyll immediately began to show yellow pigmentation of the

visible skin parts and male birds with yellow shanks, beaks, etc., when given rations devoid of xanthophyll, gradually lost the yellow pigmentation until it finally disappeared. Histological examination of the skin shows the xanthophyll to be deposited in the epidermis, of the skin, beak, shanks, and ear lobes, largely in a granular form with little or no fat associated with it. It is found chiefly in the rete of the Malpighi but also along the blood capillaries of the subcutaneous tissue. As fading occurs the gradual movement of the pigment (xanthophyll) is toward the surface where it is worn off by reason of the normal replacement of the outer cells by those lower down, or is oxidized (decolorized) because of the closer contact with air.

The shanks of laying hens fade when fecundity occurs. If the fecundity is continuous, the shanks of yellow-skinned varieties will in time be entirely free from pigment. Hens which had been raised from hatching to maturity on carotinoid-free rations and were laying eggs free from carotinoids were fed rations rich in xanthophyll. It was observed that no matter how rich the ration was in xanthophyll, it was impossible for the hen to accumulate yellow pigment in her shanks. Even the body fat failed to take up xanthophyll.

The results of this experiment indicate that former explanations of why the shanks, beak, ear lobes, etc., of yellow-skinned varieties of fowls fade when laying occurs are unsatisfactory. The hypothesis which has been advanced and generally accepted in explanation of the relationship which has been observed between fecundity and pigmentation is that the growth of the egg abstracts pigments from the body tissue with the resulting negative correlation between egg production and the quantity of yellow pigment present in the ear lobes, beak, shanks, etc. The fading of the above-mentioned parts during fecundity is due to the fact that fecundity deflects the normal path of excretion of the xanthophyll from these parts of the egg yolk. The fading of the ear lobes, shanks, etc., as a result of laying is an indication of continuous fecundity only, and not heavy egg laying, while yellow color in these parts at the end of the laying season indicates intermittent fecundity or a more or less recent loss of fecundity for a period of time sufficient for the xanthophyll to be restored to body. Birds which stop laying soon accumulate xanthophyll in the beak, earlobes, and shanks while the fading is as rapid with mediocre as with heavy laying.

Influence of specific feeds and certain pigments on the color of egg yolk and body fat of fowls.—Chickens which had been raised from hatching to maturity on rations devoid of carotinoids were fed certain pigments and feeds and the following observations were noted:

Carotin and the orange yellow pigment of the annatto seed are without influence on the color of the adipose tissue and visible skin parts of fowls.

Sudan III colors the adipose tissue only of non-laying fowls. It also colors the egg yolk, but is without effect on the visible skin parts of non-laying or laying fowls.

Xanthophyll, fed in the form of yellow corn, has an immediate effect on the color of the adipose tissue and visible skin parts of fowls of the type of the White Leghorn.

The relative xanthophyll content of various chicken feeds was tested by feeding to laying hens raised on carotinoid-free rations and laying eggs with xanthophyll-free yolks. Yellow corn and green feed were found to be rich in xanthophyll and showed highly colored yolks after a period of three weeks. A little coloration of egg yolks was observed by feeding hemp seed, barley, gluten feed and red corn. Wheat, wheat bran, oats, cottonseed meal, rape seed, meat scrap, and blood meal were found to contain negligible quantities of xanthophyll, as indicated by the color of the egg yolks which were faintly tinted with yellow after a period of four weeks.

Value of Sour Milk, Beef Scrap, Cottonseed Meal, Gluten Meal, and Oil Meal in Rations for Egg Production (H. L. Kempster).—During 1918-19, a study of cottonseed meal as compared with meat scrap was made. Ten pens of White Leghorn hens were used in this test. Each pen contained ten hens, which were selected on the basis of their trap nest records. They were fed rations, the mash of which contained either meat scrap or cottonseed meal, or neither, in varying amounts. The scratch feed was the same for all pens. Meat scrap, or cottonseed meal, was added to a basal mash of 2.2 pounds bran and 4.4 pounds shorts.

Pen	Protein Concentrates added to basal mash	Eggs	Grain	Mash	Lbs. feed to produce 1 doz. eggs
1	Meat scrap, 3.4 lbs.....	1135	509	318	8.7
2	Cottonseed meal, 6.0 lbs.....	378	493	169	21.
3	Cottonseed meal, 6.0 lbs. Bone meal, 0.66 lbs.	676	467	195	12.
4	.....	595	343	254	12.
5	Meat scrap, 1.13 lbs. Cottonseed meal, 4.02 lbs.....	1063	462	242	8.1
6	Meat scrap, 1.13 lbs. Cottonseed meal, 4.02 lbs. Bone meal, 0.66 lbs.	998	474	224	8.37
7	Meat scrap, 1.13 lbs.	1045	487	255	8.55
8	Meat scrap, 2.26 lbs. Cottonseed meal, 2.0 lbs.....	1099	468	205	7.5
9	Meat scrap, 2.26 lbs. Cottonseed meal, 2.0 lbs. Bone meal, 0.66 lbs.	1151	484	240	7.5
10	Meat scrap, 2.26 lbs.	1052	460	232	8.01

It is observed that the most economical egg production came from the pens in which the mash contained approximately 25 per cent meat scrap. The use of cottonseed meal as a supplement to meat scrap apparently did not materially increase egg production. In Pen 2, where cottonseed meal alone was fed, a deleterious effect was observed. The egg production was 22 eggs per hen less than in Pen 4, where no protein concentrate was added to the basal mash. Results for this experiment from November, 1918, to June 30, 1919, are given below.

As in the previous experiment, the efficiency of the ration depends upon including a protein concentrate from animal sources. Where no animal food was used it required from 12.3 to 14.25 pounds of grain to produce a dozen eggs, and when animal food was fed the amount of feed required ranged from 8.25 to 9.05 pounds.

Pen	Protein Concentrates added to basal mash	Eggs	Grain	Mash	Lbs. feed to produce 1 doz. eggs
1	Meat scrap, 3.3 lbs.	747	425	200	10.05
2	Meat scrap, 3.3 lbs.	976	415	259	8.25
3	.....	560	370	296	14.26
4	.....	588	385	272	14.1
5	Meat scrap, 1.13 lbs. Cottonseed meal, 4.02 lbs....	720	380	227	10.27
6	No-protein concentrate plus bone ash	594	375	241	12.3
7	Meat scrap, 1.13 lbs.....	865	380	225	8.4
8	Meat scrap, 2.27 lbs. Cottonseed meal, 2.0 lbs....	770	385	232	9.3
9	Sour milk given as a drink	745	464	96.7	9.0
10	Meat scrap, 2.27 lbs.	729	370	329	9.0

As in the previous experiment, the use of cottonseed meal did not increase the efficiency of the ration. Sour milk appears to be equal to meat scrap, altho in the foregoing figures the amount of milk is not included.

SOILS

Crop Rotation and Fertilizer Experiments (M. F. Miller, R. R. Hudson, F. L. Duley).—The 1918 crop was the twenty-ninth grown in this experiment. It was a good season for wheat, but very hot and dry for other crops. The six-year rotation plots were in wheat and the records show very good results for the various methods of soil management.



The effect of fertilizers on wheat in the Experiment Station field at Columbia. Lot on left, no treatment; lot on right, 165 lbs. of 2-12-2 fertilizer.

Treatment	Yield, bushels per acre
Six-year rotation with chemicals to make 40 bu. wheat	34.18
Six-year rotation with half chemicals and half manure	39.20
Six-year rotation with manure and rock phosphate	33.48
Six-year rotation with manure and bone meal	33.50
Six-year rotation with manure and acid phosphate	38.97
Six-year rotation with manure alone	34.30
Six-year rotation with no fertility added	16.80

Plots 22 and 23 which have been in timothy for twenty-nine years gave striking testimony to the value of manure on grass.

Plot 22, which gets six tons manure annually, yielded 2240 pounds good quality hay, while plot 23 with no fertility added yielded only 490 pounds hay, about half weeds.

Determination of the Relative Values of Different Forms of Phosphorus Upon the Soil at Columbia (M. F. Miller, R. R. Hudelson, F. L. Duley).—This project was continued according to plan and a crop of clover harvested. Arranged in order of yield beginning with the highest, the different phosphates stand as follows: Calcined phosphate, acid phosphate, basic slag, rock phosphate, bone meal.

The Effect of Different Amounts and Different Methods of Applying Commercial Fertilizer on the Corn Crop (M. F. Miller, R. R. Hudelson, F. L. Duley).—The records for 1918, which is the third year of this experiment, bear out those of the preceding year in showing the best yield where 300 pounds of fertilizer was drilled ahead of the planter with an ordinary grain fertilizer drill. Next in order was the use of 50 to 75 pounds of fertilizer in the row with the fertilizer attachment on the corn planter. This was contrary to the preceding year's records. One hundred and fifty pounds in the row was too much and caused a reduction in the yield. Fertilizer applied along the row at the second and third cultivations was only fairly satisfactory during this season.

The Effect of Cowpea Land Handled in Various Ways on the Growth of Wheat Following (M. F. Miller, R. R. Hudelson, F. L. Duley).—The 1917 cowpea crop made practically no growth due to drouthy conditions. The 1918 wheat yields were as follows:

Treatment	Yield, bushels per acre
Peas removed, land disked and rolled	13.65
Peas removed, land disked but not rolled	16.68
Plowed early, but no peas sown	11.91
Peas plowed under, disked and rolled	14.08
Peas disked under, land rolled	13.86

The land without cowpeas shows a consistently lower yield thruout the experiment.

The Production and Distribution of Bacteria for Legumes (Wm. A. Albrecht).—During the year legume cultures were distributed to 1,225 different farmers. A total of 7,764 cultures were sent out. These were for many different legumes, distributed as follows:

Soybeans	4,474
Alfalfa	1,769
Sweet clover	658
Cowpeas	454
Red clover	269
Canada peas	63
Velvet bean	51
Field pea	5
Alsike clover	13
Navy bean	6
Peanut	2

7,764

As a result of this project, with its distribution of information, the new legumes are being carefully inoculated and better success obtained. Reports from inquiries sent to the farmers indicate that the cultures have been highly successful.

Experiments to Determine the Value of Bat Guano as a Fertilizer (Wm. A. Albrecht).—Since the south half of the state had numerous caves of which many are reported to contain bat guano, it was deemed advisable to test the value of this material as a fertilizer, especially for its value as a carrier of nitrogen.

The state has been surveyed for the caves and samples of guano were collected and analyzed. Great variations in composition of the material were found, especially in its nitrogen. Irregularities are due to four factors: (1) Rock and extraneous matter, (2) moisture variations, (3) age or stage of decomposition, and (4) leaching. Significant deposits were found and the owners interested in marketing them for fertilizer.

Fertilizer tests and decomposition were made on a good grade of guano. In comparison with dried blood and tankage its ammonia production in soil was the equal of these two common fertilizer ingredients. In producing nitrates it was not the equal of blood but superior to tankage. In pot culture of oats guano supplying 100 pounds of nitrogen per acre was the equivalent of dried blood and tankage applied at twice that rate, or ammonium sulfate put on at the same rate.

In field tests with oats the following increases in yields were obtained:

	Increase per acre
200-pound application of air-dry guano	4.09 bushels
400-pound application of air-dry guano	4.45 bushels
100-pound application ammonium sulfate	0.32 bushels

Fertilizer tests indicate that good bat guano is an excellent fertilizer and should be used whenever it can be obtained at reasonable cost.

Studies on the Longevity of *P. Radicicola* in the Soil (Wm. A. Albrecht).—*Pseudomonas radicola* is the bacterium which produces the nodules on the roots of the legumes and enables these plants to feed on the nitrogen of the atmosphere in addition to that in the soil. When the proper bacteria are not present, the soil must be inoculated or the bacteria introduced. How long these nodule-producing organisms live in soil when once introduced, or how often artificial inoculation is necessary is an open question. In this study attempt is being made to answer these questions and to see how long the legume bacteria will live in soil under various treatments.

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 dried in the sunlight, and some in the dark, and later stored so as to be free from chance contamination. At intervals of a half year these soils are planted with their respective legumes whose seeds were sterilized to see if there are enough bacteria in the soil to produce good root infection.

Tests have been run at intervals of six months for the past year and will be continued for some time. The results indicate clearly that even

tho the soil may have been dried in the sun there are enough viable bacteria to produce as good an infection as the soil which was dried in the dark, or that left out of doors. In gathering an infected soil with which to inoculate a new field there is no such great danger in exposing this inoculating material to the sun as has once been suggested. Drying in the sunlight and storing in the dry state for six to twelve months seems to have no seriously injurious effect on the inoculating power of the soil as compared to a soil left in its natural condition out of doors. With this fact established one can gather a well-infected soil in the season when nodules of the legume are plentiful and store that soil in the dry state for use as inoculating material the next year.

The following table giving the nodule production on plants grown in soils differently treated shows that the destructive action by sunlight is not so serious.

Treatment	Nodules per plant	
	Soybean	Red clover
Dried in the sun, stored six months.....	4	8
Dried in the dark, stored six months.....	6	8
No treatment, fresh field soil used for test	7	4

Effect of Weathering and Storage Upon the Composition of Barnyard Manure (M. F. Miller, F. L. Duley).—In this experiment one ton of mule manure that had been trampled down in barn during the winter was stored in a galvanized iron pan, ten feet square and six inches deep. Another ton was placed in a similar pan, but a drainage tub was provided to carry away the leachings from rain water. A third ton of the same manure was placed on the ground in a conical pile.

The manure was thoroly mixed and sampled at the beginning and again at the end of the experiment. The samples were analyzed for their plant-food value and it was found that after five months' exposure to the weather the manure stored in a pan without drainage or in a conical pile lost about one-third of the dry matter, while the pan having drainage lost 45 per cent of the dry weight. The loss of nitrogen in the conical pile was slightly less than in the undrained pan, but the loss of potash was nearly five times as great. The greatest loss of potash occurred in the drained pan, which roughly represented the condition of an open barnlot. In this case the potassium loss was 47 per cent.

It was found from the manure in the drained pan that only a very small amount of nitrogen is lost in the leachings. A much greater amount of this element is lost in a gaseous form to the air thru fermentation.

Studies of Water Absorption, Runoff, Percolation, Evaporation, Capillary Water Movement and Soil Erosion Under Field Conditions (M. F. Miller, F. L. Duley).—A summary of two years' results to May 1, 1919, shows that land plowed eight inches deep lost nearly two and one-half times as much soil as land having no cultivation, except that the weeds were pulled. Land plowed four inches deep lost nearly as much as that plowed eight inches deep. This great loss of soil from the deeply plowed land was undoubtedly due to the fact that several of the rains were very heavy and came in downpours. When rains are light and well distributed there is always more erosion as well as much greater runoff from the

unplowed land. This is due to the greater absorptive capacity of the loose soil. The usefulness of deep plowing for preventing erosion, however, will depend very largely upon the character of the rainfall. Sod land was most efficient in preventing erosion and at the same time absorbed a greater percent of the rainfall than any of the other plots. Land in continuous wheat is almost as efficient, but may lose considerable soil when the land is first broken and when the wheat is small. The land having a rotation of corn, wheat and clover has lost very little soil except during the time the land was in corn. The land in continuous corn has lost about the same amount of soil as the uncultivated land, and less than half as much as the land plowed to the same depth and having no crop.

About 60 per cent of the rainfall has been absorbed on the uncultivated soil, about 74 per cent on the plowed soil, and about 87 per cent on the sod land.

Nitrate Production in a Soil as Affected by the Crop and Cultivation (Wm. A. Albrecht).—The results of the past two years indicated the following:

1. The most significant influence of the crops is that of removing the nitrates. The accumulation of nitrates is related to the growth of the crop. For corn, the nitrates increase to considerable concentration until late June and early July, or until the crop makes a vigorous growth, and then they are rapidly exhausted. On soil with grass crop, the nitrates increase in early spring with warming weather, but these are soon reduced to a low level, in fact, so low as to be scarcely detectable. They remain low during the entire season, and increase only in the spring before the growing crop can draw on them. Oats and wheat exhaust the nitrates most completely by June. Following the crop there is usually a small increase, but the concentration never reaches the level attained in the uncropped soil. Low nitrate in cropped soil cannot be due to a toxic inhibition by the plant, but is due to removal since crops like corn allow nitrates to increase until the crop is making its maximum growth. Were the effects of the roots toxic, this increase should not be noticed.

2. Plowing has a very significant effect toward increasing nitrates. The plot which was plowed and kept free of weeds by scraping was continually higher in nitrates than the adjoining plot unplowed and weed-free. Two plots with similar soil treatment but cropped to corn show similar results in accumulations of nitrates previous to the rapid growth of the corn, but when the crop develops rapidly it removes the nitrates more completely. This is due to better root penetration by the crop. The fact that plowing increases nitrate production is of much significance to emphasize early plowing. Plowing early for wheat has perhaps its biggest advantage in causing nitrates to accumulate for some time so as to start the plants vigorously after seeding and thus pass the winter better than on soil plowed late.

3. Cultivation of the surface soil reduces the nitrate in the upper seven inches of soil. Plots, both the plowed and unplowed, which were scraped to remove weeds, had higher amounts of nitrates present regularly than plants whose surface was cultivated during the season. This may be due to the removal of moisture from the surface so that layer prohibited nitrate production. Drawing a seven-inch sample gets only a small part of

the moist soil, too small to give significant amounts even tho the concentration may have been greater than that in the uncultivated soil. This indicates that tillage may hold down nitrate production in the immediate surface and even in the upper seven inches there may be less nitrates on cultivated soil than in the scraped soil. This indicates that our surface cultivation should be shallow to remove the weeds and allow nitrates to increase. Shallow cultivation is better than the deep cultivation so far as the nitrogen feeding of the plants is concerned.

4. The most outstanding result obtained is the depressive effect of the mulch on nitrate accumulation. At no time during two years has the fallow mulched soil contained significant amounts of nitrate nitrogen. The maximum accumulation was 27 pounds following four weeks of very dry weather. Of all the fallow plots this has been the lowest, going no higher than 27 pounds of nitrate nitrogen an acre.

Moisture seems to be the factor that is responsible either directly or indirectly by influencing the temperature. The moisture content and the nitrate content are negatively correlated. The average temperature of the mulched soil from June to August 1918 was 25.35° C. as compared to 33.06° C. and 33.92° C. for the fallow plots plowed and unplowed. The low nitrate content of this plot is very characteristic, and mulching could scarcely be good practice with crops that have a high nitrogen need.

5. Nitrates are affected by the rainfall of the season. Long continued rains remove the nitrates, especially in tilled soils, while downpours are not so serious as one might expect. Significant reductions in nitrate follow continued rains on open soils.

6. Another interesting fact is the high concentration of nitrates reached in a fallow soil. In 1917 the plowed but uncultivated plot reached a concentration of 204 pounds of nitrogen as nitrate an acre, while in the year following it went as high as 236 pounds of this form of nitrogen. In terms of sodium nitrate this latter figure would be equivalent to more than 1,400 pounds of sodium nitrate to the acre. Such high concentrations emphasize the activities of the bacteria which produce the nitrate form of nitrogen.

Experiments to Determine the Best Systems of Soil Management for the Most Important Soil Types in Missouri (M. F. Miller, F. L. Duley).—
The following fields have been in operation during the past fiscal year:

Field Name	County	Soil Type
Billings.....	Christian.....	Crawford silt loam
Cuba*	Crawford.....	Lebanon silt loam
Chillicothe	Livingston.....	Wabash clay
Eldorado Springs*	Cedar.....	Bates silt loam
Hurdland†	Knox.....	Grundy silt loam
Kirksville	Adair.....	Lindley silt loam
Maryville	Nodaway.....	Marshall silt loam
Morley	Scott.....	Sarpy sandy loam
Poplar Bluff	Butler.....	Waverly silt loam
Potage des Sioux	St. Charles.....	Wabash clay
St. James	Phelps.....	Gerald silt loam
Strafford	Greene.....	Lebanon gravelly loam
Union	Franklin.....	Union silt loam
Vandalia	Audrain.....	Putnam silt loam
Willow Springs	Howell.....	Clarksville silt loam
Windsor	Pettis.....	Oswego silt loam

*Established during year. †Closed during year.

During the year farmers meetings have been held at St. James, Willow Springs and Union. Some other meetings were postponed on account of the wet weather and the farmers getting behind with their work. These meetings are proving one of the best ways to interest farmers in the results of the experiment fields. The meetings are usually held in cooperation with the Extension Service and after the farmers are conducted over the field a general meeting is held for discussion and lecture upon various topics.

During the year a new field has been established on the Bates silt loam at Eldorado Springs. While no figures have been obtained the wheat showed some very remarkable results from the use of acid phosphate. Another field was opened at Cuba in Crawford County on the Lebanon silt loam. This field is in conjunction with the work carried on at the same place by the Field Crops department.

The results obtained on the various fields have been in harmony with those obtained in previous years. The three things giving most consistent and economic returns are manure, soluble phosphates, and limestone. An average of the results showing the effect of manure in a four-year rotation applied at the rate of eight tons an acre before corn, is shown in the following table:

Crop	No. of trials	Inc. from manure	Value at 1918 prices	Value at normal prices
Corn	61	10.50 bu.	\$13.12	\$ 6.30
Oats	35	5.17 bu.	3.36	2.07
Wheat	57	5.24 bu.	10.48	5.24
Clover	13	937 lbs.	11.71	5.62
Total value of increase in four-year rotation.....			\$38.67	\$19.23
Increase for each ton manure			\$ 4.83	\$ 2.40

Bone meal has increased the yield of wheat by 5.5 bushels an acre, and corn 4.3 bushels. This would mean an increase of approximately \$18 an acre on these crops alone for an investment of about \$6.50. In addition to this, the residual effect of this same fertilizer has been 4.6 bushels of oats and about one-half ton of clover hay.

The return from acid phosphate has been approximately the same except the residual effect has been somewhat less. On certain thin Ozark soils bone meal has shown a very decided advantage over acid phosphate in the residual effect it exerts upon the growth of clover.

An average of all the results obtained from the use of raw rock phosphate shows that it has scarcely paid the cost of application. In justice to this material, however, it should be stated that on certain soils this form of phosphorus has given satisfactory returns.

The use of ground limestone has brought good returns on the more acid soils of the state, particularly the level prairies of northeast and southwest Missouri, and over the greater part of the Ozark region. Some attention has been given the furthering of the use of limestone on the more

acid types occupied by these fields. In some communities home crushers are being installed.

In summarizing the results with the various fertilizers it is very evident that the profits to be expected from those that give increased returns are decidedly greater at the present time with the high prices of farm products than they were a few years ago with lower prices of fertilizers and normal prices for crops. All evidence goes to show that it is more profitable to use fertilizer now than it has been in the past.

The Determination and Mapping of Missouri Soil Types (M. F. Miller, H. H. Krusekopf, Wm. DeYoung).—A constant effort is being made to map the soils of the state with more detail and accuracy, and great improvement has been made over the earlier work. One of the difficulties encountered is that new and inexperienced men must be used, and require from two to three years of training before they can do the most proficient work.

Reynolds and Chariton counties have been surveyed during the year. Soil survey reports were prepared for Knox, St. Francois, Reynolds and Chariton counties. St. Francois county was surveyed in 1915, but on account of the resignation of the man in charge of the party, and on account of lack of data, the preparation of the report was delayed.

VETERINARY SCIENCE

Contagious Abortion Investigations (J. W. Connaway, A. J. Durant, H. G. Newman).—Serological tests, including retests, were made on 1,260 blood samples from 51 herds comprising 587 animals. The number of positive reacting animals was 171; the number of negative was 416. The infection was found in 35 herds, while the blood samples from 16 other suspected herds were found to be negative.

Other experiments were made to determine: (a) The specificity of the *Bacillus abortus* Bang; (b) Whether this organism can invade the healthy uterus after pregnancy has occurred, and after the so-called "uterine seal" has formed; (c) Whether the Bang bacillus can invade the pregnant uterus thru various channels, namely, thru the vagina, thru the blood stream after entry into the alimentary tract by way of the mouth, or after entry into the udder thru the teats; or after hypodermic injection of live cultures into the subcutaneous tissues.

The artificial infections were carried out as follows: Two heifers were fed cultures of *Bacillus abortus* Bang; two heifers were infected by injection of *Bacillus abortus* Bang cultures into the udder thru the teats after inserting a sterile milk tube. Cultures of the *Bacillus abortus* Bang were injected into the vagina of only one heifer (the experiment mate had died). Two heifers were injected subcutaneously with a saline suspension of *Bacillus abortus* Bang culture. Only one animal was available for infection by contact exposure. This cow was exposed daily by contact with two heifers which aborted after being fed cultures of *Bacillus abortus* Bang. Every female in the experiment developed positive reaction to the blood tests for abortion disease, and have remained reactors. Milk from all the heifers from which milk could be obtained, gave positive reaction to the *Bacillus abortus* Bang antigen. All the living calves showed a positive

reaction to the test at birth, but in time ceased to react, as is true of calves from naturally infected mothers in farm herds.

Serological tests with Bacillus abortus Bang antigen.—Six pregnant sows were inoculated with cultures of *Bacillus abortus* Bang of bovine origin, one intra-muscular, two intra-axillary, and two by vaginal injection. Of the four pregnant sows inoculated with *Bang abortus* bacilli by means of the hypodermic syringe (intravenously, intra-axillary and intra-muscularly) two sows aborted, another which was a positive reactor had a dead pig (six apparently healthy living pigs) and one had four runty pigs. Two of these four sows showed a distinctly positive reaction to the serological test for abortion disease. The two pregnant sows which were given a vaginal injection of the *Bang* abortion bacilli did not abort nor show any reaction to the abortion test.

MISCELLANEOUS ACTIVITIES OF THE STATION

Seed Testing Laboratory (W. C. Etheridge, Mrs. Norma Cardinell, Miss Helen Averitt).—Number of samples received from Missouri, 2251; Kansas, 325; Nebraska, 132; Iowa, 109; South Dakota, 73; Colorado, 21; Arkansas, 13; New York, 4; Illinois, 1; Custom House, 26. Total number samples received, 2955.

Number of tests made for	
Purity	963
Germination	2710
Examination	32
Identification	92
Custom House	52
Total	3849
Number of samples received—	
July 1, 1917, to June 30, 1918	4464
July 1, 1918, to June 30, 1919	2955
Decrease	1509

The difference is due to the fact that in 1917-18 a campaign for the testing of seed corn was carried out, which resulted in 2182 tests of seed corn by the laboratory. In 1918-19 there was no such campaign and only a few samples of corn reached the laboratory. The work of the laboratory therefore dealt only with clover, grasses and small grains. With this class of seeds 791 more tests were made in 1918-19 than in 1917-18. The primary purpose of the laboratory is to test the class of seeds whose value cannot readily be determined by the farmer himself, and along this line there was a substantial increase during the past year.

A project in seed testing cooperative with the county agents has proved very successful. County agents collect and send to the laboratory samples of seed sold in their respective territories. Duplicate reports are sent to the agent and to the person or firm from whom the sample was collected. By noting the success of the seed from which the sample was collected the agent, knowing also the laboratory analysis of the seed, gains a talking point for the use of good seed. He may learn also the sources from which

seed of a given grade have been consistently supplied and may recommend the purchase of seed from the best sources. This project, started late in the year, is very popular with the agents, who at once realized its possibilities, and it promises to develop into one of the most useful extension projects of the College of Agriculture.

In cooperation with the county agents the laboratory is also engaged in a practical survey of the farm weeds of the state. The agents collect and send to the laboratory the important noxious weeds of their territories. The laboratory identifies the weeds and advises the agents of methods for control. When the survey is completed a list of all weeds received from various parts of the state, together with methods for their control, will be sent to each agent. Thru this project the agents will gain much valuable information on weed identification and control, and the department of Farm Crops will become informed on the location of the various noxious weeds of the state.

The equipment of the laboratory has been largely increased by the Bureau of Plant Industry during the past year, and the Bureau has at all times kept the laboratory well supplied with competent analyses.

Fertilizer Control (F. B. Mumford, Director; L. D. Haigh, E. E. Vanatta, Chemists).—The analytical work of the state fertilizer control ends in December of each year. The annual report is published as promptly as possible after the close of the year. The report for 1918, Bulletin 160, was issued in January, 1919. Five hundred and fifty-three samples were collected. The inspectors visited 113 towns in 46 counties. Two hundred and fifty-three samples were analyzed and reported. There were also sent in by farmers 42 samples of limestone and related material used for correcting soil acidity. These were tested for their neutralizing power, and report made.

The results show that the compositions of fertilizers this year varied more than they should under normal conditions. The great demand for fertilizer due to war conditions coupled with the difficulty of obtaining basic materials of uniform composition largely explain this condition. The average result in plant-food valuation of all samples analyzed shows, however, plant food to the value of \$1.07 a ton in excess of the value of the amount guaranteed.

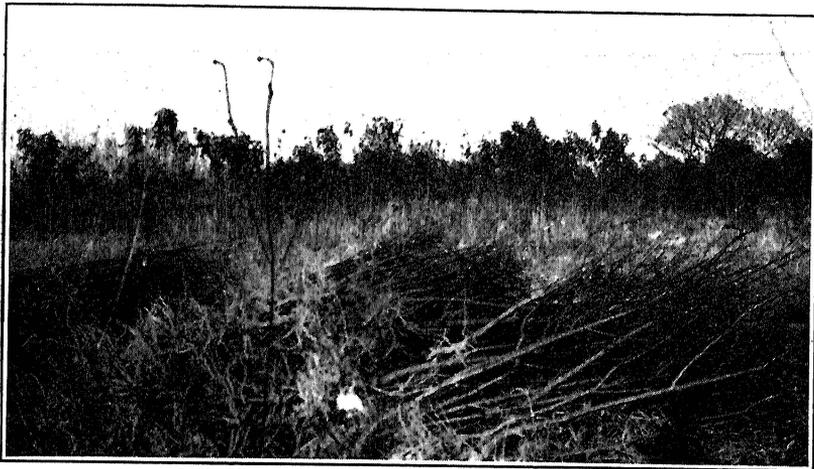
Official Testing of Dairy Cows (A. C. Ragsdale, M. H. Fohrman).—During the year just completed 403 cows were officially tested for 32 breeders in 13 counties of the state. Supervisors made 232 visits to breeders and conducted 1830 two-day tests and 50 seven-day tests. Despite the increased railroad fare and hotel meal rates, the cost to breeders of conducting these tests were held down so that it compares favorably with previous years as is indicated in the following tables:

Year	2-day tests	Cost for a test	7-day tests	Cost for a test
1915-1916	1683	\$1.09	17	\$10.20
1916-1917	1920	1.01	42	13.25
1917-1918	1343	1.12	114	10.60
1918-1919	1930	1.24	50	9.73

The following tabulation shows the progress of this work for the past four years:

	Fiscal year ending June 30,			
	1916	1917	1918	1919
No. cows tested	336	413	349	403
No. breeders represented.....	24	26	28	32
No. 2-day tests	1744	2072	1473	1830
No. 7-day tests	22	47	25	50

Nursery Inspection (L. Haseman, K. C. Sullivan).—For the last three or four years, owing to a general setback in the matter of fruit tree propagation, the list of Missouri nurserymen has gradually grown less and less. Due to ever increasing vigilance in the matter of inspection and the condemnation of scale infested and diseased stock, the nurseries have been freed from San Jose scale to a very large extent.



Nursery stock which has been condemned by the inspector.

Nurseries inspected	96
Nurseries certified	90
Nurseries found infested with San Jose scale.....	2
Total acreage of nursery stock inspected.....	1,303
No. of counties in which nurseries were inspected....	40
No. of men making inspection	3
No. of cases imported nursery stock inspected.....	127
No. of foreign plants inspected	319,631
No. of counties in which these shipments were inspected	9

CERTIFICATES AND PERMITS ISSUED

Inspection certificates issued	103
Dealers certificates	47
Agents permits issued	131
Growers permits issued to outside nurseries.....	169

FINANCIAL STATEMENT

The Missouri Agricultural Experiment Station in account with the United States Appropriation—1918-19

	Dr.	Cr.
To receipts from Treasurer of the U. S. as per appropriation for the year ending June 30, 1919, under the Acts of Congress approved March 2, 1887, and March 16, 1906	\$30,000.00	
By salaries		\$17,321.49
Labor		4,153.12
Postage and stationery		215.97
Freight and express		715.35
Heat, light, water, and power		81.07
Chemicals and laboratory supplies		847.98
Seeds, plants, and sundry supplies		637.83
Fertilizers		8.50
Feeding stuffs		3,257.46
Tools, machinery, and appliances		337.62
Furniture and fixtures		921.54
Scientific apparatus and specimens		537.81
Live stock		421.70
Traveling expenses		43.36
Buildings and land		499.20
	\$30,000.00	\$30,000.00

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, Missouri Agricultural Experiment Station, for the fiscal year ended June 30, 1919; that we have found the same well kept and classified as above; that the receipts for the year from the treasurer of the United States are shown to have been \$30,000.00, and the corresponding disbursements \$30,000.00 for all of which proper vouchers are on file and have been by us examined and found correct.

And we further certify that the expenditures have been solely for the purpose set forth in the Acts of Congress approved March 2, 1887, and March 16, 1906.

Attest:

J. G. BABB
Secretary

EDWARD E. BROWN,
Business Manager,
Acting as Auditor for the Board of Curators