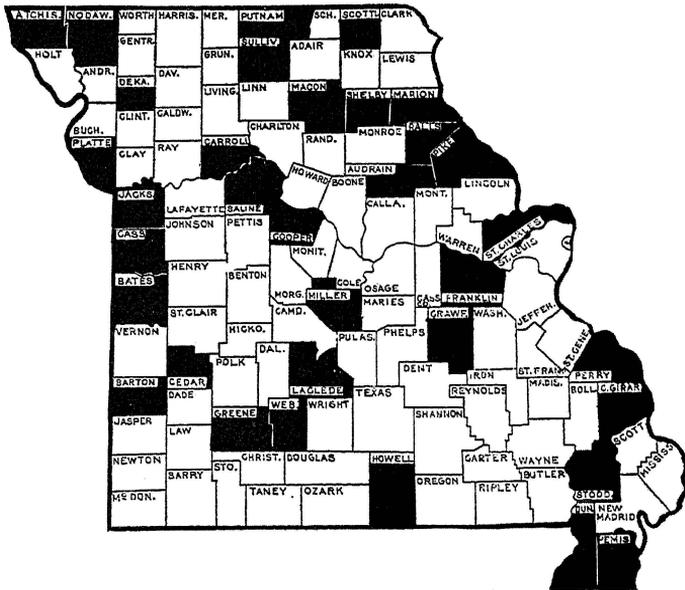


UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

Agricultural Experiment Station

BULLETIN No. 131



Showing the counties in which a detailed soil survey has been made

Work and Progress of the Agricultural Experiment Station

for the Year Ending June 30, 1914

COLUMBIA, MISSOURI
April, 1915

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

Agricultural Experiment Station

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(1) In the service of the U. S. Department of Agriculture.

TO HIS EXCELLENCY, HONORABLE ELLIOTT W. MAJOR,
GOVERNOR OF MISSOURI.

Sir: The Federal Statutes establishing agricultural experiment stations provide that: "It shall be the duty of each of said stations annually, on or before the first day of February, to make to the Governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner (now Secretary of Agriculture) and to the Secretary of the Treasury of the United States."

The record of work performed during the year covered by this report is notable. In no previous year in the history of this Agricultural Experiment Station has the station staff accomplished so large an amount of investigational work. The results of these investigations have not only been of great practical value to the farmers of Missouri but have also resulted in distinct contributions to the fundamental sciences upon which all agricultural operations are based.

In accordance, therefore, with the law of Congress approved March 2, 1887, I have the honor to submit herewith the annual report of the Missouri Agricultural Experiment Station for the year ending June 30, 1914.

Respectfully submitted,
F. B. MUMFORD, *Director.*

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THE AGRICULTURAL EXPERIMENT STATION

F. B. MUMFORD, DIRECTOR

The activities of the farmer and the relation of these activities to the progress of agriculture are attracting wide attention at the present time. It has come to be generally recognized that no nation can hope to become industrially efficient and at the same time maintain conditions which result in an unprosperous agriculture. The prosperity of the farmer is fundamental to the development and prosperity of every other industry. All classes of people are dependent upon the farmer for the supply and availability of the fundamental necessities of life.

Agriculture Is Basic. It cannot be denied that the development of commerce, manufacturing, and transportation is intimately associated with and dependent upon the amount of agricultural production and the prosperity of the people who are responsible for such production. The larger the yields of farm crops, the greater the production of domestic animals, the greater the commerce, the larger the need of transportation and the better the supply of raw materials for manufacturing. It is also of fundamental importance to all these industries that the food supply from the farms should be ample and easily available for the workers in the industries other than agricultural.

But agricultural development and increased production, so necessary to commerce, transportation and manufacturing cannot be permanently guaranteed unless the conditions of country living and the profits from farming are as attractive and satisfactory to the people who cultivate the soil as are the attractions of other industries. Increased agricultural production secured at the expense of the farming class will not solve the rural problem. We must have increased agricultural production. We must make farming more profitable and country living more satisfactory.

How can the agricultural class respond to the great demands made upon them for greater production and at the same time solve the more fundamental problems of maintaining permanently the fertility of soils, making farming as a business more profitable and at the same time surround the rural community with such conditions of living that trained men of highest efficiency will find in agricultural pursuits the same opportunity for success and service as is now to be found in other vocations?

The Problem of the Experiment Station. It is the function of the Agricultural Experiment Station to discover the truth. Why is agricultural production comparatively low? Why is farming unprofitable? Why are rural conditions such as to influence many country people to move to town? Why is soil fertility declining? It is the function of the Agricultural Experiment Station to answer these questions and others even more fundamental to the permanency of agriculture in America. Great progress has already been made and a much clearer understanding of the tremendous difficulties confronting the farmer has resulted from the investigations of the Agricultural Experiment Stations.

It is more important than ever before that the Agricultural Experiment Station, which is the only federal and state endowed institution whose declared function it is to discover the actual truth and fearlessly publish the results, be adequately supported. In recent years great interest in the affairs of the farmer has developed. Individuals and organizations are engaged in promoting better farming campaigns, increased yields, and rural organizations. It is in the highest degree important that an unprejudiced institution supported by the people themselves should be available as a final authority on questions of such grave moment to the whole commonwealth.

How the Agricultural Experiment Station is attempting to solve the agricultural problems of this commonwealth can be judged by an examination of the pages of this report. An effort has been made to give a brief but fairly complete statement of the various activities of the Agricultural Experiment Station.

The publications of the Agricultural Experiment Station, which are free, contain the records of completed investigations. These publications may be had so long as the supply lasts by writing to the Director of the Agricultural Experiment Station, Columbia, Missouri.

CHANGES IN STATION STAFF

During the year twenty new men have been appointed to the College of Agriculture and Agricultural Experiment Station staff. Five members of the staff have resigned to accept positions elsewhere or to engage in other work.

NEW APPOINTMENTS

FREDERICK DUNLAP, M.F., Professor of Forestry.

L. F. CHILDERS, B.S. in Agr., M.S. in Agr., Extension Assistant Professor of Agronomy.

- S. T. SIMPSON, B.S. in Agr., Extension Instructor in Animal Husbandry.
- F. L. BENTLEY, B.S. in Agr., Assistant in Agronomy.
- R. H. BESSE, B.S. in Agr., Assistant in Farm Management.
- A. J. DURANT, B.S. in Agr., Research Assistant in Veterinary Science.
- J. F. HAMILTON, Assistant in Veterinary Science.
- M. I. HURLEY, Assistant in Farm Management.
- E. H. HUGHES, B.S. in Agr., Assistant in Animal Husbandry.
- E. R. SPENCE, B.S. in Agr., Assistant in Veterinary Science.
- A. C. STANTON, B.S.A., Assistant in Dairy Husbandry.
- C. A. WEBSTER, B.S.A., Assistant in Poultry Husbandry.
- C. C. WIGGANS, B.S. in Agr., M.A., Assistant in Horticulture.
- J. F. BARHAM, Photographer.
- T. D. STANFORD, Clerk.
- E. A. COCKEFAIR, B.S. in Agr., M.S. in Agr., Farm Adviser for Greene County.
- H. B. DERR, B.S.A., Farm Adviser for Scott County.
- PAUL V. MARIS, A.B., B.S. in Agr., Farm Adviser for Saline County.
- A. W. TERRILL, B.S. in M.E., B.S. in Agr., Farm Adviser for St. Francois County.
- J. D. WILSON, B. Pe., Farm Adviser for Cooper County.

RESIGNATIONS

- W. H. CHANDLER, B.S. in Agr., M.A., Ph.D., Assistant Professor of Horticulture.
- L. B. BURK, B.S. in Agr., Assistant in Animal Husbandry.
- J. B. LATSHAW, B.S. in Agr., Assistant in Veterinary Science.
- H. H. LAUDE, B.S. in Agr., Farm Adviser for Marion County.
- E. G. WOODWARD, B.S. in Agr., M.A., Assistant in Dairy Husbandry.

ADDITIONS TO EQUIPMENT

Two new green houses have been built during the year for the use of the Departments of Horticulture, Farm Crops and Soils. They are used for both experimental and instructional purposes, and are an important addition to the equipment of these departments.

Work was begun on a new hog cholera serum plant. It is being built on a tract of land two and one-half miles north of Columbia. When completed the plant, including the land purchased for it, will

cost \$50,000. It will be one of the most modern plants of its kind in the United States, with a capacity of 50,000,000 cubic centimeters of serum a year with which the station will be able to meet any emergency. It will be possible to keep at one time 1500 hyper-immune hogs at this plant.

A 120-acre farm has been leased for the use of the Department of Animal Husbandry. This farm is about four miles south of Columbia. Some experimental work is being conducted on this farm, but it is largely used to maintain part of the live stock kept for instructional purposes. The horse barn, which was designed originally for a beef cattle barn but which has been used for a combined beef cattle and horse barn for several years, has been remodeled and is now used exclusively for horses. The sheep barn has been moved and remodeled.

A considerable increase in departmental equipment has been made thruout the Agricultural Experiment Station. This has been required by the natural development of the experimental work. It includes a large variety of laboratory and field supplies and some live stock. The agricultural library has added during the last year, 787 new books on agriculture. In addition to this 223 agricultural journals have been bound and 106 bound volumes of publications have been received as gifts and exchanges. The agricultural library now contains 12,300 volumes.

CHANGES IN ORGANIZATION

In March, 1914, the Department of Agronomy was divided to form the Department of Farm Crops and the Department of Soils. The lands remaining from those acquired by the College of Agriculture under the provisions of the first Morrill Act, amounting altogether to 50,000 acres and consisting principally of timber land in the Ozarks, have been placed in charge of the Department of Forestry. A reconnoissance survey of these lands is being made. A number of forest guards have been appointed to patrol these tracts.

In June, 1914, the Agricultural Extension Service was organized. Up to this time no separate organization for the administration of extension work existed. As rapidly as possible a staff of trained, extension workers is being organized. Under the organization of the extension service the extension workers are responsible to the various departments of the station and college for the subject-matter they teach. The secretary of the Agricultural Extension Service is responsible for the administration of the work.

FREE MAILING LISTS

The mailing list of the Missouri Agricultural Experiment Station includes the Agricultural Experiment Station officers and members of the United States Department of Agriculture. The list was classified in the following manner at the end of the fiscal year of 1913-14.

CLASSIFICATION OF FREE MAILING LISTS

	General List		Official List	
	Missouri	United States	College	U. S. Dept.
Fertilizers.....	1967	315	310	24
Dairy Husbandry.....	1943	565	591	33
Animal Husbandry.....	3854	826	698	29
Farm Crops and Soils.....	4696	893	976	97
Horticulture.....	2022	539	717	81
All Publications.....	2567	628	346	50

In addition to the above, all bulletins are sent to the following unclassified lists:

Libraries.....	427
Presidents, Deans, and Directors.....	115
Foreign (Outside United States).....	213
Missouri Newspapers.....	796
Missouri Farm Journals.....	40
United States Agricultural Journals.....	538

There are 14,000 names on the station mailing list, all of which are reached at different times by publications.

Of all bulletins and circulars published the number sent out to the regular mailing list represents approximately two-thirds of the whole number distributed. The balance are sent out in response to individual requests from farmers of Missouri and other states.

PUBLICATIONS

During the year six new circulars, nine reprints of circulars, six new bulletins, four bulletin reprints and eight research bulletins have been issued. The size of the editions have been somewhat increased in order to meet the demands of a larger mailing list. The above represents a total of 5,140,500 pages of printed matter issued during the year. In addition to the above, thirty press bulletins were sent to newspapers, farm journals, libraries and to officials of the Agricultural Experiment Stations and United States Department

of Agriculture. The College of Agriculture thru the University Publisher, has also supplied a full page of material for plate matter every three weeks. This material is widely circulated among the counties of the state.

Following is a list of the publications issued during the fiscal year:

NEW CIRCULARS

- No. 64, Directions For Testing Cream.
- No. 65, Advantages From Use of Pure Bred Ram.
- No. 66, Cotton Seed Selection for Southeast Missouri.
- No. 67, How to Build a Gurler Silo.
- No. 68, The Seeding of Meadows and Pastures.
- No. 69, The Fertility of the Soil.

REPRINTS OF CIRCULARS

- No. 59, The Farm Adviser in Missouri.
- No. 62, The Chinch Bug and its Control.
- No. 40,* The Seeding of Alfalfa.
- No. 56, Some Factors in Wheat Production.
- No. 53, The Seeding of Cowpeas.
- No. 66, Cotton Seed Selection for Southeast Missouri.
- No. 65, Advantages from Use of Pure-Bred Ram.

NEW BULLETINS

- No. 113, Commercial Fertilizers for Strawberries.
- No. 114, Corn Versus Oats for Work Mules.
- No. 115, Rations for Fattening Western Yearling Sheep.
- No. 116, Inspection of Commercial Fertilizers.
- No. 117, Report of the Director for the Year Ending June 30, 1913.
- No. 118, Drainage Investigations on the Northeast Missouri Prairie.

BULLETIN REPRINTS

- No. 107, Farm Poultry House Construction.
- No. 103, The Silo for Missouri Farmers.
- No. 115, Rations for Fattening Western Yearling Sheep.
- No. 106, Co-Operative Experiments with Alfalfa.

*Reprinted twice during the year.

NEW RESEARCH BULLETINS

- No. 7, Nutrients Required for Milk Production.
- No. 8, The Killing of Plant Tissues by Low Temperature.
- No. 9, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part I.
- No. 10, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part II.
- No. 11, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part III.
- No. 12, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part IV.
- No. 13, Lactochrome—The Yellow Pigment of Milk Whey.
- No. 14, Sap Studies with Horticultural Plants.

PRESS BULLETINS

20. Keeping Up the Milk Flow, by W. M. Regan.
21. The Poultry Mite, by H. L. Kempster.
22. The Use of Fertilizers for Wheat, by M. F. Miller.
23. A Cheap Silo for Missouri Farmers, by P. M. Brandt.
24. The Concrete Silo, by P. M. Brandt.
25. Treatment of Seed Wheat to Prevent Sticking Smut, by C. B. Hutchison.
26. Filling the Silo, by P. M. Brandt.
27. A Serum for All Fruit Tree Complaints, by L. Haseman.
28. Select Your Seed Corn Now, by T. R. Douglass.
29. Cheap Rations for Dairy Cows, by P. M. Brandt.
30. Making Fence Posts Last, by E. C. Pegg.
31. Treatment of Seed Oats for Smut, by C. B. Hutchison.
32. The Seed Corn Situation in Missouri, by C. B. Hutchison.
33. Directions for Spraying Apple Trees, by W. L. Howard.
34. Directions for Spraying Peach Trees, by W. L. Howard.
35. Directions for Spraying Cherry Trees, by W. L. Howard.
36. Growing Perfect Grapes, by W. L. Howard.
37. How to Prepare Spraying Solutions, by W. L. Howard.
38. The Clover-Leaf Weevil, by L. Haseman.
39. More Money from Eggs, by H. L. Kempster.
40. Care of Your Chicks, by H. L. Kempster.
41. Controlling the Chinch Bug, by L. Haseman.
42. Controlling the Hessian Fly, by L. Haseman.
43. Dry Weather Starts Army Worm, by L. Haseman.
44. Moulds Fatal to Poultry, by H. L. Kempster.
45. Save Egg Losses During Hot Weather, by H. L. Kempster.

46. Grain Louse on Wheat not Serious, by L. Haseman.
47. Keep Up the Chinch Bug Fight, by L. Haseman.
48. Keep the Chinch Bug Out of the Corn, by L. Haseman.
49. State Nursery and Orchard Inspection, by L. Haseman.

SYNOPSIS OF EXPERIMENT STATION PUBLICATIONS ISSUED DURING THE YEAR ENDING JUNE 30, 1914

In the paragraphs following there is given a brief summary of all Agricultural Experiment Station publications which have been issued during the year. This synopsis attempts to record in briefest form the important contents of each publication. Copies of these publications which are still available may be had by writing to the DIRECTOR OF THE AGRICULTURAL EXPERIMENT STATION, COLUMBIA, MISSOURI.

Circular No. 64, Directions For Testing Cream, by L. G. Rinkle. 8 pp., 14 ill. A discussion of the directions to be followed and cautions to be observed in testing cream by the Babcock method. The importance of accurately taking and properly preserving the sample is emphasized. The use of the composite sample is discouraged. Cream should be weighed and not measured into the test bottle. Farmers testing their cream at home should bear in mind that testing cream with a milk testing outfit does not give accurate results. A more accurate reading of the fat column can be made if white mineral oil is used to level the meniscus at the top of the column.

Circular 65, Advantages From Use of Pure Bred Ram, by Howard Hackedorn. 12 pp., 8 ill. A report of an experiment in feeding lambs from Western ewes. A shipment of Western ewes was divided into two lots. One lot was bred to a "scrub" ram and the other to a pure bred ram. The lambs from the pure bred ram made a greater average gain in three months than did those from the scrub ram in four months. It required 88.78 pounds of grain to produce 100 pounds of gain on the lambs sired by the inferior ram as compared to 52.81 pounds of grain required to produce 100 pounds of gain on those sired by the good ram. Lambs sired by the good ram sold for \$7.35 per 100 pounds as compared to \$4.50 per 100 pounds received for those sired by the inferior ram.

Circular No. 66, Cotton Seed Selection for Southeast Missouri, by A. R. Evans. 4 pp., 2 ill. A discussion of the important factors to be considered in the selection of cotton seed for Missouri. The earliness and general character of the plant, the number, size and uniformity of ripening of the bolls, the amount, length and uniformity, and strength of staple and the yield of seed are to be considered in the selection of seed for improvement. The use of gin run seed is discouraged. Early varieties should be selected for Missouri. Co-operation between gin owners and farmers is urged in order that better seed can be saved.

Circular No. 67, How to Build a Gurler Silo, by P. M. Brandt. 12 pp., 10 ill. This circular is mainly a revision of Circular No. 48, by H. E. McNatt. The low cost of erecting this silo, especially in those parts of Missouri where native lumber is plentiful, was the cause of considerable demand for more detailed directions and plans for building which are given in this circular. This silo can be built from ordinary lumber. A bill of materials is included in the circular.

Circular No. 68, The Seeding of Meadows and Pastures, by C. B. Hutchison. 8 pp. This circular includes a discussion of the methods of seeding the principal meadow and pasture mixtures for Missouri. A complete discussion of the seeding of timothy and clover which is

used chiefly as a meadow mixture in Missouri is given. The use of a nurse crop is suggested when the land is foul with weeds. The use of alsike clover and orchard grass for meadows is discussed. In seeding pastures and meadows the use of fertilizers and manure is advised when seeding soil low in fertility. Grass mixtures are given for the different soil regions of the Ozarks.

Circular No. 69, The Fertility of the Soil, by M. F. Miller. 20 pp., 3 ill. A discussion of the composition of soil and the methods of maintaining soil fertility. A table shows the elements contained in the top seven inches of typical Missouri soils. A rotation of crops including a legume is urged as a means of maintaining soil fertility. Crop rotation experiments at the Missouri Agricultural Experiment Station, where land that had been in corn continuously for seventeen years produced at the rate of 11.8 bushels an acre, while after a rotation of corn, wheat and clover for seventeen years 60.7 bushels of corn to the acre was produced, are cited as examples of the value of rotations. Missouri farmers are urged to plan their rotations to build up the supply of organic matter and phosphorus in the soil. Fertilizer alone is recommended only for those who must have immediate returns.

Bulletin No. 113, Commercial Fertilizer for Strawberries, by W. H. Chandler. 22 pp., 6 ill. This bulletin includes a brief discussion of certain factors influencing the growth of strawberries, including low temperature, methods of planting, mulching, renewing, etc., and some experimental data gathered on strawberry fields near Sarcoxie, Mo. Experiments were conducted to test the effects of applications of nitrogen, potassium and phosphorus, on both old and new strawberry beds. The indications are that when strawberries are planted on new land the best time to apply fertilizers most profitably is at renewing time following the picking of the first crop.

The following recommendations are made:

(a) That, in the Sarcoxie section (the results will apply to the Southwest Missouri strawberry district) from 250 to 300 pounds of acid phosphate, or steamed bone meal, be used for fertilizer preferably one year before the crop is harvested, on all but the very richest strawberry soils;

(b) that no form of nitrogen-bearing fertilizer be used on strawberry beds, except on small trial plots;

(c) that potassium be used only on small trial plots.

The bulletin includes reports on the cost of growing strawberries from four growers located in the Sarcoxie district.

Bulletin No. 114, Corn Versus Oats For Work Mules, by E. A. Trowbridge. 21 pp., 3 ill. The investigation reported in this publication covered a period of two years. Four mules were divided into two lots of two mules each. During the first 364-day period the animals in Lot I received corn as their grain ration and those in Lot II received oats as their grain ration. The lots were then reversed so that the mules that received oats during the first 364-day period received corn during the second period of the same length, and vice versa. Three weeks were allowed in which to make this change. All the mules received timothy and clover hay of practically the same quality throughout the experiment.

Some of the conclusions are here given:

The mules which received corn and mixed hay maintained their weight slightly better than did the mules fed oats and mixed hay.

The mules receiving corn and hay endured hard work in hot weather as well as did those receiving oats and hay.

No difference in spirit could be detected between the different lots of mules.

No abnormal effect could be noticed in any of the mules receiving either ration.

The mules in the two-year test were maintained 28 per cent more economically on a ration of corn and timothy and clover hay than on one consisting of oats and timothy and

clover hay, the corn being valued at 50 cents a bushel and the oats at 40 cents a bushel and the hay at \$10 a ton.

Bulletin No. 115, Rations For Fattening Western Yearling Sheep, by F. B. Mumford, E. A. Trowbridge and H. Hackedorn. 20 pp., 1 ill. This bulletin contains a report of an experiment carried on to determine the relative value of various rations and the effect of different conditions on the fattening of western yearling sheep. The 140 Wyoming yearlings used in this experiment were selected especially as to uniformity of size, quality and condition and were divided into seven lots of twenty sheep each.

The different rations were:

Shelled corn and timothy hay;

Shelled corn and clover hay;

Six parts shelled corn, one part linseed oil meal (by weight) and clover hay;

Shelled corn, six parts, cotton seed meal, one part (by weight), and clover hay;

Shelled corn, corn silage and clover hay;

Shelled corn and clover hay (self feeder); and

Shelled corn and clover hay without shelter.

All lots except one were fed in the sheep barn in pens 6½ feet by 34 feet in size. Each pen had doors opening to the south into an exercise lot 6½ feet by 61 feet in size.

Tables are given showing for each lot the average initial and final weights, total gains, daily gains, daily rations, shrink per head from Columbia to National Stock Yards, weight per head at stock yards, cost per head in Columbia at \$4.25 per 100 pounds, cost of feed per head, selling price per head in Columbia, profit per head, the feed required for 100 pounds gain, the cost of 100 pounds gain, the selling price per 100 pounds, the dressing per cent and the grade of the carcasses.

With hay at \$10 a ton, corn silage at \$3.50 a ton, corn at 40 cents a bushel, linseed oil meal at \$32 a ton and cotton seed meal at \$28 a ton, the ration of shelled corn, clover hay, and corn silage was the most economical with that of shelled corn and clover hay ranking second.

As the price of corn and hay increases it was found that it is economical to add a nitrogenous supplement. In the trials reported linseed oil cake was superior to cotton seed meal. With shelled corn as grain ration, clover hay was greatly superior to timothy hay in the trials reported. The data shows that feeding sheep in an open lot without shelter from winter rains and snows is a poor practice.

Bulletin No. 116, Inspection of Commercial Fertilizers, by P. F. Trowbridge. 53 pp. This is a report of the year's work under the Fertilizer Inspection Law. More fertilizer was sold in the state during 1913 than any previous year. Several firms sold fertilizer without the Agricultural Experiment Station tags being attached. In every case the tags were attached or the fertilizer withdrawn from sale when the attention of the manufacturer was called to the matter. Four firms sold fertilizer in the state without registering. More than 800 samples of fertilizer were collected and about 500 of these were analyzed. The analyses of these samples when compared with the manufacturers' guarantee shows a marked improvement over the average analysis of the last five years and indicates a general tendency on the part of the manufacturers to put out goods more nearly in accordance with the guarantee. The economy of buying a high grade fertilizer is emphasized.

Bulletin No. 117, Report of the Director for the Year Ending June 30, 1913, by F. B. Mumford. 43 pp., 1 ill. This report shows twenty-four additions to the College of Agriculture and Agricultural Experiment Station staff during the year and nine resignations. Schweitzer Hall, designed primarily for the laboratory of the Department of Agricultural Chemistry, was completed during the year. During the year 273 new books on agricultural subjects, 549 farm journals and 1579 other publications were added to the Agricultural Experiment Station library, bringing the total number of volumes in the library up to 10,000.

The list of publications issued during the year includes eight new circulars, ten reprints of circulars, eight new bulletins, one bulletin reprint, one research bulletin and two indexes. In addition nineteen press bulletins were sent out. During the year four experiment station projects were completed, ten new projects were added and forty-eight begun prior to July, 1912, were continued thruout the year. The progress of investigation on the principal projects carried thru the year is given.

In cooperation with the United States Department of Agriculture a detailed soil survey of five Missouri counties was completed during the year making a total of thirty-one counties that have been surveyed in detail. The seed-testing laboratory operated in cooperation with the U. S. Department of Agriculture tested 1337 samples of seed during the year. Of this number 751 were from farmers and 586 from seedsmen.

The Agricultural Experiment Station is conducting eighteen soil and crop experiment fields out in the state. During the fiscal year, two fields were added. There was distributed to the farmers 208,619 doses of hog cholera serum to 3389 farms located in ninety-nine counties of the state during the year. It is estimated that approximately 175,000 hogs were saved by the use of this treatment, which represents at ruling prices more than one million dollars' worth of pork.

The report shows that the Agricultural Experiment Station is cooperating with farmers in practically every county of the state. Twenty-five distinct lines of investigation or demonstrative work is being carried on. The Departments of Agronomy, Dairy Husbandry' Entomology, Horticulture, Forestry and Farm Management are engaged in this cooperative work. The work as demonstrated with large varieties of corn such as Boone County White give the heaviest yields for averaged Missouri conditions. Fulcaster is the highest yielding variety of bearded wheat and Fultz occupied the same place among the smooth wheats. Cooperative experiments indicate that alfalfa is well adapted to the well-drained bottoms and uplands and that inoculation is usually beneficial but not necessary on upland soils and that lime sometimes is beneficial.

Eleven Branch Short Courses were held during the year. At special farmers meetings, 30,000 people were reached in thirty-three counties in the state. On three special trains running through twenty-five counties of the state. 134 addresses were made to more than 15,000 people. The various departments of the College of Agriculture wrote 65,138 letters during the year.

In helping the rural schools in the organization of agricultural instruction, 163 addresses were made to 18,304 people. Fully 3000 teachers were reached. Agricultural agents are employed in counties in cooperation with the United States Department of Agriculture and the county courts of the counties concerned. Educational exhibits in agriculture were made at eleven fairs during the year. The total attendance at these fairs was 195,319 people.

Bulletin No. 118, Drainage Investigations on the Northeast Missouri Prairie (first report), by M. F. Miller, C. B. Hutchison, T. R. Douglass and R. R. Hudelson. 53 pp., 5 ill. The bulletin reports the results of tile drainage experiments conducted at Vandalia, in Audrain County, at Monroe City, in Monroe County, and the experience with tile drainage of forty men representing twelve counties in the Northeast Missouri prairie section. The plan adopted for the experiments was to select uniform and level prairie land, divide it into two parts, thoroly tile drain one part and leave the other part untilled. On the Vandalia field each division was divided into seven plots, the plots running across the drained and undrained areas. The plots on each division were given the following treatments:

- Plot 1, Barnyard manure; rock phosphate, cowpeas turned under.
- Plot 2, Barnyard manure; cowpeas turned under.
- Plot 3, Cowpeas turned under.
- Plot 4, Cowpeas turned under, bone meal.
- Plot 5, Cowpeas turned under; bone meal; potassium chloride.

Plot 6, No soil treatment.

Plot 7, Cowpeas turned under; bone meal; potassium chloride; lime.

A rotation of corn, oats, wheat and clover was adopted for the field. The addition of plant food paid best on the undrained areas. The legume was the only one that paid on the drained land. Drainage without fertilizer on the Vandalia field gave an increase per acre in all crops for six years following the laying of the tile almost sufficient to pay for the cost of installation of the drainage system.

Similar experiments at Monroe City failed to give any material difference in returns which is probably due to the prairie at Monroe City being naturally fairly well drained.

Information gathered from forty men from twelve counties in Northeast Missouri who had had sufficient experience to be considered indicates that tile drainage pays on the very level prairie land and in the "swales" of the rolling prairie.

Research Bulletin No. 7, Nutrients Required For Milk Production, by C. H. Eckles. 50 pp. A detailed study of the nutrients required to produce milk of varying richness. The purpose was to secure data under more carefully controlled conditions and covering longer periods of time than has been the case in other investigations on this subject. Data was taken from eight cows in milk for an entire year and for two others for shorter periods. Data is presented giving the feed consumed with chemical analyses and of milk produced with complete analyses. The milk of these cows ranged from 3.4 per cent to 6.09 per cent fat. These cows were all fed a ration of practically the same composition. The quantity fed was regulated so as to maintain a uniform weight.

All cows were kept farrow to exclude the use of nutrients to grow the foetus. A maintenance trial was made for seven cows using a ration of the same composition as when in milk. A 10-day digestion trial was made for each cow when in full flow of milk and again when on maintenance. The data bears out the results of others that more energy is required in the ration for rich milk than for milk lower in fat.

The maintenance requirements of the seven cows averaged close to Armsby's Standard. It was found that for 1 lb. of milk with 3.4 per cent fat, energy to the amount of .245 therms were used in excess of maintenance, while for 6.09 per cent milk .524 therms were used. The data shows that every cow used more nutrients than called for by the Haecker standard and that the deficiency was the most marked with the richest milk.

The digestion trials showed that in every case the cow on maintenance digested considerably more of her feed than when on full feed. The total energy in the feed was slightly less per pound fat produced, in the richer milk. However, after subtracting maintenance, the energy per pound of fat is consistently higher for the richer milk. The cheaper production of fat in the richer milk was found to be due to the fact that the cows producing the richer milk are smaller and therefore have a smaller ration of maintenance per unit of fat produced.

The production of rich milk requires an increase in feed in excess of the increase in energy value of the milk.

The following tentative standard is given for milk production in addition to maintenance:

Per cent fat.	Dig. protein per lb. milk.	Energy per lb. milk therms.
3.00	.056	.26
3.50	.052	.28
4.00	.055	.30
4.50	.058	.33
5.00	.062	.36
5.50	.066	.40
6.00	.070	.45
6.50	.075	.50

Research Bulletin No. 8, The Killing of Plant Tissue by Low Temperature, by W. H. Chandler. 166 pp., 3 ill., 1 chart. The density of the sap in a large number of fruit trees and other plants was determined. Determinations were made to show the differences in density of sap in different parts of the tree and in different stages of the development of the tree and fruit tissues, as well as in trees or parts of trees which have been grown under different conditions.

The density of the sap has an important bearing upon the temperature required to injure the tissue. The greater the density the sap of a plant or of a given part of the plant, the lower the temperature required to injure it. As it is possible by methods of orchard management to favor or oppose density of the plant sap, these fundamental investigations have important bearing upon orchard practices.

It was found that rapid freezing of plant tissues in each case tried, caused greater injury than reducing the plants to the same temperature slowly.

Water on the surface of the plant at the time it is subjected to dangerously low temperatures, greatly favors injury to the plant. The drier the surface of the plant the less injury it will suffer from being exposed to low temperatures.

With reference to the water content inside the plant it is found that slow wilting or partial withholding of water through a long period will greatly increase the resistance of plant tissue to low temperatures. Rapid wilting of the plant by subjecting it to marked drying influences for a brief period just before its temperature was lowered did not generally increase its resistance to cold. This has a particularly important bearing upon the preparation of plants for transplanting from the greenhouse to open field. Those grown under as low a water supply as will maintain health and vigor previous to being transplanted, endure the low temperatures outdoors much more successfully than do plants grown succulent with an abundance of water before transplanting.

The parts of a tree above ground are capable of enduring a very much lower temperature than the roots below ground. Of the above ground parts, the pith and fruit buds are more easily killed. The larger part of the roots nearest the surface of the ground are more resistant than smaller portions which lay deeper beneath the surface.

It was also found that the rapidly enlarging portions of a fruit tree in the angles where the root branches out from the base of the trunk, ripen much later in fall and are much more susceptible to injury from cold than are other portions of the body and branches of the tree. This no doubt accounts for such injuries designated as "collar rot" being due to exposure of this unripened tender tissue at the collar of the tree. It suggests the desirability of such treatment as will cause earlier ripening of susceptible varieties and supplying protections at the base of the trunk on the approach of early winter.

While it was found that the most important factor determining resistance of injury from cold on the part of peach wood is thoro ripening of the tissue, observations covering a series of years show that from Missouri southward it is not best to attempt to induce peach trees to ripen their wood early in the fall. The reason is because fully dormant tissues are much less injured in late winter when our coldest weather usually prevails than are tissues which have passed their rest period. Peach trees pass the winter more safely if they continue growth late in the season, go into their rest period late and therefore remain dormant until a later period in spring.

Research Bulletin No. 9, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part I, by L. S. Palmer and C. H. Eckles. 26 pp. An introduction to a series of four bulletins reporting an investigation, in cooperation with the Dairy Division, U. S. Department of Agriculture, of the nature of the natural yellow pigment of milk and butter, and of the blood serum, body fat and corpus luteum of the cow, and the relations of these pigments to each other and to the carotin and xanthophylls of green plants. An extensive review of the

literature concerning yellow plant and animal pigments is given in this bulletin. A bibliography of sixty-six references is appended.

Research Bulletin No. 10, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part II, by L. S. Palmer and C. H. Eckles. 51 pp., 4 ill. A study of the chemical and physiological relations of the pigments of milk fat to the carotin and xanthophylls of green plants. It is shown that the fat of cow's milk owes its natural yellow color to the pigments carotin and xanthophyll, principally carotin, the yellow vegetable pigments found accompanying chlorophyll in all green plants. The carotin and xanthophylls of the milk fat are not a synthetic product of the cow's body but are merely taken up from the food and secreted in the milk fat. It is possible to vary the color of the milk fat from a deep yellow to colorless by selecting feeds for the cow that are rich or very deficient in the carotin and xanthophyll pigments. A study of the relation of the breed of the cow to the color of the milk fat is reported. The well known difference among the several breeds in respect to the maximum color of the milk fat under equally favorable conditions for the production of a high color is confirmed by experiment. Each breed of cows, however, is shown to undergo the same variation in the color of the milk fat which follows a withdrawal or addition of carotin and xanthophylls, especially carotin to the food. Under some conditions the apparent breed characteristic largely disappears. This is especially true, under normal conditions immediately after parturition. The pigment of the colostrum milk is shown to be entirely in the fat, and to be identical with the normal pigment of milk fat. The high color always found is due merely to a high concentration of the pigment in the fat.

Research Bulletin No. 11, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part III, by L. S. Palmer and C. H. Eckles. 22 pp. A study of the pigments of the body fat, corpus luteum and skin secretions of the cow. It is shown that these natural yellow pigments, like that of the milk fat, are composed principally of a pigment identical with the carotin of green plants. Like the carotin of the milk fat they have their origin in the plants that comprise the food of the cow. An experiment is reported in which a Jersey cow is made to put colorless fat on her body by fattening her on a ration devoid of carotin. The body fat of Jersey and Guernsey cows has a higher yellow color than cows of other breeds. This explains why cows of these breeds may sometimes show a much slower elimination of the pigment from the milk fat on a carotin-free ration during the winter months. In these cases the body fat furnishes a source of the pigments for the milk fat. A study of the pigments of the new-born Jersey calf shows that carotin and xanthophylls are absent. This is taken as further proof of the physiological relation of the yellow body pigments to the plant carotin.

Research Bulletin No. 12, Carotin—The Principal Natural Yellow Pigment of Milk Fat—Part IV, by L. S. Palmer and C. H. Eckles. 38 pp. Part "A" is an investigation of the yellow pigment of the blood serum of the cow. This pigment, like the other yellow pigments of the body, is found to be identical with the carotin of plants. As in the case of the milk fat, the amount of carotin carried by the blood serum is shown to vary with the presence or absence of carotin in the food of the cow, and also with the amount of carotin secreted in the milk fat, thus indicating the manner in which the carotin is transmitted from the food to the milk glands. The carotin of the blood serum is found to be in firm combination with a water soluble albumin of the serum. The name caroto-albumin is proposed for this new chromoprotein of the blood. It is probably of importance in the formation of the milk fat, body fat and corpus luteum of the cow. The lactalbumin of cows' milk may be related to the color of the milk fat. There appears to be a special relation here in connection with the high color and the high albumin content of colostrum milk.

Part B of this bulletin discusses the fate of the plant carotin and xanthophylls during digestion. Carotin is assimilated from the food in preference to xanthophylls partly because

of its greater stability in the presence of the juices of the digestive tract. Xanthophylls are much more soluble in bile than carotin, which probably accounts for their appearance in the fat of the blood. The xanthophylls are probably incapable of forming a compound with protein like the caroto-albumin of the blood serum.

Part C. The pigments of human milk fat are shown to be identical with the carotin and xanthophylls of plants, with a greater proportion of xanthophyll to carotin than in the case of the pigment of cows' milk. It is noted that the colostrum fat of human milk is characterized by a high yellow color as in the case of the colostrum fat of cows' milk.

Research Bulletin No. 13, Lactochrome—The Yellow Pigment of Milk Whey, by L. S. Palmer and L. H. Cooleidge. 37 pp., 4 ill. This bulletin reports a study in cooperation with the Dairy Division, U. S. Department of Agriculture of the yellow pigment of milk whey. The pigment, called lactochrome, is shown to be very closely related in chemical and physical properties to urochrome, the specific yellow pigment of urine, and is very probably identical with it. The presence of lactochrome is found to be characteristic of the milk of all breeds of cows tested, i. e., Ayrshire, Jersey, Holstein, and Shorthorn. The amount of lactochrome appears to be largely a breed characteristic with the Ayrshire, Jersey, Holstein and Shorthorn, with the Ayrshire and Jersey breeds ranking considerably above the Holstein and Shorthorn. The presence of comparatively large amounts of lactochrome in the milk of some animals is of considerable importance in imparting to milk its characteristic yellow color. It is noted that lactochrome is found in sheeps' milk, often in much greater quantities than in cows' milk, and is also found in traces in human milk.

Research Bulletin No. 14, Sap Studies with Horticultural Plants, by W. H. Chandler. 62 pp., 13 ill. A record of the freezing point determinations of the sap of a large number of plants and the relation of sap density as determined by the freezing point injury, especially from cold.

The conclusion was reached that a molecular concentration, as determined by the freezing point, seems a fair measure of the condition of nutrition of trees and especially of their root system. The molecular concentration is generally greatest toward the terminals or peripheral parts of the tree and diminishes downward thru the trunk of the tree and root system. There were a few apparent exceptions to this. The molecular concentration of the sap in very long leaves of fruit trees at the growing point was not so great as in the older fully matured leaves.

The molecular concentration of the leaves of fruit trees is considerably greater than that of the fruit. This is especially true where the fruit is green and growing. Some species of fruit like cherries and currants have a markedly increased molecular concentration of their fruit as the latter reaches the ripening stage. This fact results in the ability of the leaves literally to draw water out of the fruit in a dry period. Branches of apple, peach, other fruits and gourds containing both fruit and leaves, were severed from the parent plant. Similar branches were severed and the fruit removed. In the case of branches containing the fruit the leaves remained measurably turgid without wilting until the water was drawn out of the fruit, causing the latter to shrivel. Similar leafy branches containing no fruit had their leaves wilt and dry up promptly. This ability of a plant in a dry time to withdraw water from fruit to supply the leaves, explains why trees that make an abnormally vigorous leafy growth in early spring previous to a drouth, will not often mature their fruit to proper development. A normal twig and leaf growth in early spring favors better development of the fruit in a subsequent drouth.

EXPERIMENT STATION PROJECTS

All of the investigational work in the Agricultural Experiment Station is organized by departments. The investigational work within the department is organized by projects. Before an experiment can be undertaken by any department a complete plan of the investigation including a statement of the reasons for such investigation is filed with the Director. This plan includes a statement of the probable cost, time required for its completion, and person or persons who are to conduct the investigation. If the investigation is approved it becomes an authorized project of the Agricultural Experiment Station.

The investigational projects now in progress in the Agricultural Experiment Station are listed below. It is of course true that the name of a project gives little information as to the real character and extent of the investigation. Among the projects listed, many are of the greatest fundamental significance. A few should probably be classed as minor projects.

Eight projects have been completed, eleven new ones have been added, and forty begun prior to July 1, 1913, were continued thru the year. Four projects were suspended for the year but will be taken up at some future time.

PROJECTS COMPLETED

ANIMAL HUSBANDRY

1. Preparation of Corn for Fattening Steers (second trial).
2. Relative Efficiency of Pregnant Mares for Farm Work.
3. Improvement through Use of Pure Bred Ram.

DAIRY HUSBANDRY

1. Nutrients Required to Develop the Foetus.
2. Factors Influencing the Normal Composition of Milk.
 - (a) Natural Yellow Pigments of Milk.

ENTOMOLOGY

1. Distribution of Insect Pests in Missouri—Preventive Control.
 - (a) Unspotted Tentiform Leaf-Miner on Apple.

HORTICULTURE

1. The Rest Period of Plants.
2. Bud Selection for Increasing Yields—Strawberries.

NEW PROJECTS

AGRICULTURAL CHEMISTRY

1. Retarded Growth.

ANIMAL HUSBANDRY

1. Feeding Wheat to Fattening Swine.
2. A Study of the Residual Effects of Forage Crops for Swine.
3. Self Feeders for Fattening Swine.

DAIRY HUSBANDRY

1. Silage Investigations.

ENTOMOLOGY

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

FARM CROPS

1. A Study of the Inheritance of the Quantitative Characters in Wheat.

FARM MANAGEMENT

1. The Distribution of Farm Labor.

HORTICULTURE

1. Treatment of Apple-Canker Diseases.
2. Examination of Buds in Winter for Forecasting Probable Bloom.

SOILS

1. Relation of Cowpea Growing to Wheat Production on Continuously Cropped Land.

PROJECTS BEGUN PRIOR TO JULY 1, 1913, AND STILL IN PROGRESS

AGRICULTURAL CHEMISTRY

1. Administration.
2. Use of Feed Experiment—Chemistry.

ANIMAL HUSBANDRY

1. Age as a Factor in Animal Breeding.
2. Use of Feed Experiment—Animal Husbandry.
3. Preparation of Corn for Fattening Steers.
4. Forage Crop Rotations for Pork Production.

BOTANY DEPARTMENT

1. Physiological Relations of Powdery Mildews to their Hosts.
2. Grain Smut Infections and Control.
3. Effect of Toxic Substances on Soil Organisms.
4. Classification of Local Rusts.
5. Micro-Organisms in Silage.

DAIRY HUSBANDRY

1. Factors Influencing the Normal Composition of Milk.
 - (b) Influence of Plane of Nutrition.
 - (c) The Effect of Cotton Seed Meal and Cotton Seed By-products.
2. Factors Influencing the Development of Dairy Heifers.

ENTOMOLOGY

1. The Cause of "Stop-back" on Nursery Stock and Methods of Prevention.
2. Investigation of the Life History, Development, Injury and Remedies for the Apple Leaf Hopper.
3. Distribution of Insect Pests in Missouri—Preventive Control.
 - (a) A Study of the Distribution and Control of San Jose Scale, Peach Tree Borer, Stripped Cucumber Beetle and Chinch Bug in Missouri.

FARM CROPS

1. Experiments with Cowpeas and Soybeans.
2. Experiments with Various Spring and Fall Sown Forage Crops.
3. Factors Influencing the Development of the Maize Plant—Field Studies of the Plants.
4. Cultural and Varietal Experiments with Sweet Clover.
5. Corn Breeding and Variety Tests.
6. Experiments with Alfalfa Varieties and Alfalfa Culture.
7. Wheat and Oat Breeding and Variety Tests.

FARM MANAGEMENT

1. Farm Cost Accounting.
2. Farm Management Survey of Johnson County, Missouri.
 - (a) Cost of Family Living on the Farm.

FORESTRY

1. An Investigation of the Method of Culture and Varieties of Basket Willows for Missouri.
2. The Effect of Storage Conditions on the Vitality of Forest Tree Seeds.
3. A Study of Prolonging the Service of Wood Fence Posts.

HORTICULTURE

1. Fruit Bud Development of Fruit Trees as Influenced by Treatments.
2. Orchard Heating (in years when spring frosts occur).
3. Self Fertility and Self Sterility of Fruits.
4. Asparagus Selection.
5. Fall vs. Spring Planting of Trees.
6. Spraying Fruits for Insect and Fungus Diseases.
7. Peach Breeding for Hardy Sorts.
8. Apple Breeding for Late Blooming Habit.
9. Bud Selection for Increasing Yields—Apples.
10. Orchard Tillage—Sod, Clear Cultivation, Mulch, Combined Cultivation and Cover Crops.
11. Orchard Nutrition.

SOILS

1. Experiments in Crop Rotations.
2. Experiments in the Associated Growth of Corn and Cowpeas.
3. Effect of Various Crop Rotations on the Physical Character of the Soil.
4. Factors Influencing the Development of the Maize Plant—Nutrition and Moisture.
5. Relation of Cowpea Growing to Wheat Production on Continuously Cropped Land.

VETERINARY

1. Study of Contagious Abortion.
 - (a) Complement Fixation Test.
 - (b) The Methylene Blue Treatment.
2. Transmission of Tuberculosis in Cattle and Swine.
3. A Study of Internal Parasites of Swine, and the Efficiency of Various Vermifuges.
4. Experiments on Complement Fixation—(Hog Cholera.)

ZOOLOGY

1. Sex-Linked Inheritance in Poultry.

PROJECTS SUSPENDED DURING THE YEAR

ANIMAL HUSBANDRY

1. Fall Forage for Lambs.
2. A Comparison of Warm Feed and Water, to Cooked and Uncooked Feed and Cold Water for Swine.

FARM CROPS

1. Pasture Fertilization and Pasture Rejuvenation Experiments.

VETERINARY

1. A Study of the Organ Extracts of Swine Affected with Hog Cholera and Highly Immunized Swine.

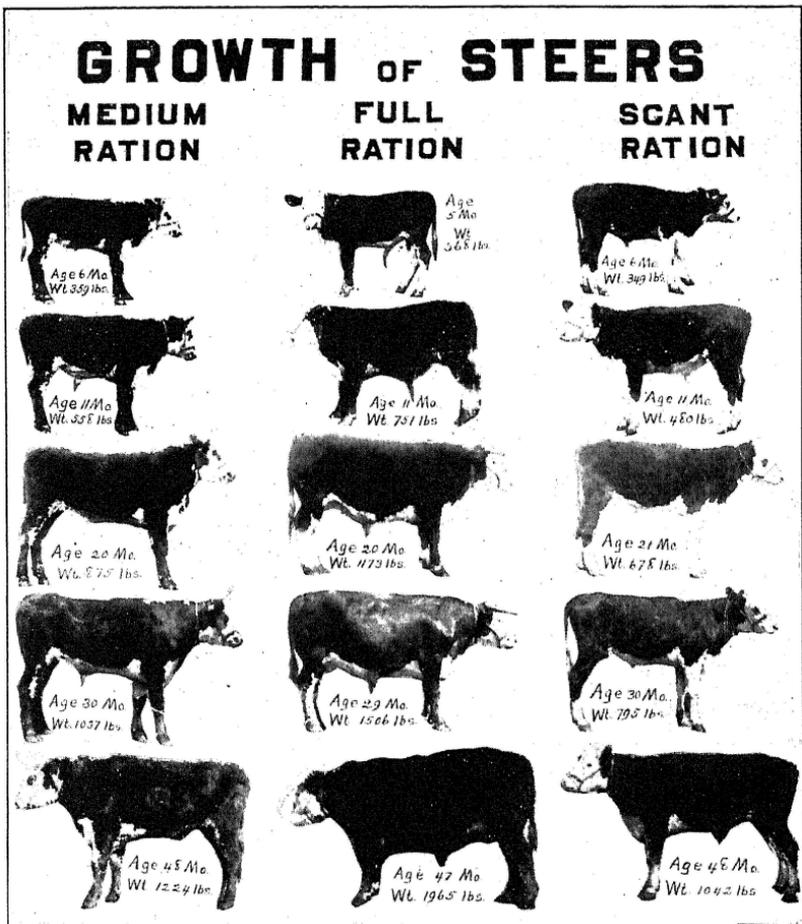
DEPARTMENT REPORTS ON THE PROGRESS OF INVESTIGATION

It is desirable to record annually the progress of investigation in connection with the various authorized projects of the Agricultural Experiment Station. Such a record not only has great historic value, but presents a birdseye view of the activities of the entire Agricultural Experiment Station organization. It is a definite attempt to place on record the research activities of the Experiment Station in a brief but somewhat comprehensive way. It is believed that one may secure by reading the following account of the progress of investigation during the year, an intelligent notion of the important problems which are receiving the attention of the station staff.

The reports of progress are compiled from the reports made by the chairmen of departments to the Director. The relation of the individual members of the station staff to the various projects is indicated in the text.

AGRICULTURAL CHEMISTRY

Use of Feed Experiment—Chemistry (P. F. Trowbridge, C. R. Moulton, L. D. Haigh). During the year eight calves were secured at birth and slaughtered to furnish a study of their composition



Illustrations of cattle fed in the "Use of Feed" experiment showing the effects of continued feeding on a scant ration, medium ration and full ration.

as a basis for the study of changes produced by feeding under different conditions. The hoof, horns and teeth of all animals slaughtered on this project in the past have been held for analysis until this year when the analyses were made. Considerable of the data obtained in this study was used in the Graduate School of Agriculture in 1914 and is now being prepared for publication.

Administration (P. F. Trowbridge, C. R. Moulton, L. D. Haigh, E. E. Vanatta, O. C. Smith). During the year the laboratory received for analysis more than 1500 samples. There were ninety-one from the Department of Animal Husbandry, twenty-five from the Department of Dairy Husbandry, eighty-six from the Department of Agronomy, thirty-three from the Department of Poultry Husbandry, four from the Department of Horticulture. In addition to the 500 samples of fertilizer analyzed in the Fertilizer Control work, 137 various other samples originated in the Department of Agricultural Chemistry. Many of these samples represent more than one analysis.

Retarded Growth (F. B. Mumford, P. F. Trowbridge). This project was inaugurated in May, 1914. It will run six or seven years.

ANIMAL HUSBANDRY

Age as a Factor in Animal Breeding (F. B. Mumford, L. A. Weaver). Results seem to indicate that early pregnancy and lactation causes arrested development in the mother. It was demonstrated during the year that pregnancy itself does not cause retarded growth. The growth curves of young pregnant sows follow the same general direction as the growth curves of young non-pregnant sows when each was subjected to the same conditions of food, shelter and exercise. The growth curves of young sows with suckling pigs compared with the growth curves of non-suckling sows of similar age and breeding gives evidence of the retarding effect of lactation on the growth.

Use of Feed Experiment—Animal Husbandry (H. O. Allison). The purpose of this experiment is to compare the influence of various planes of nutrition upon breeding cattle. Nine pure-bred Hereford heifers were divided into three equal groups, each group being maintained on a different plane of nutrition. The first calves were dropped from these heifers during the last year. Because of the small number of animals involved and the short duration of the investigation no definite conclusions can be drawn at the present time, but indications are that the higher the plane of nutrition the more food there is required for beef production.

Preparation of Corn for Fattening Steers (H. O. Allison). In the second trial of this investigation to determine the best method of preparing corn for fattening steers five lots, each comprising six choice two-year-old steers, were fed a ration composed of corn silage, hay, cotton seed meal, and corn prepared in various ways. The proportion of corn to cotton seed meal fed was six parts by weight of corn to one part by weight of cotton seed meal. Pigs were permitted to follow the cattle in the various lots and a record made of their gains in live weight. It was found during the year that the steers receiving finely ground corn chop made the highest average daily gain and the greatest profit per steer. More beef and pork was produced from a bushel of corn by the lot which received broken ear corn. This lot produced the second highest profit per steer. This project will be continued at least another year.

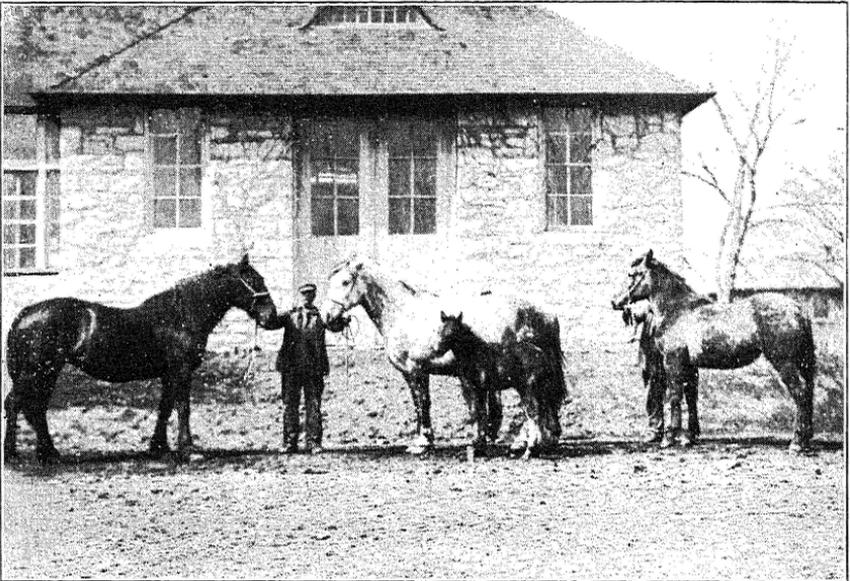


Hogs on rape pasture in the "Forage Crops for Pork Production" experiment.

Forage Crop Rotations for Pork Production (L. A. Weaver). During the year results were obtained which give additional emphasis to the value of rape as hog forage. After deducting the gain put on by corn fed to hogs grazing on different forage crop plots the return per acre with pork at 7 cents a pound was as follows:

Rape, oats and clover.....	\$47.04
Rape and Oats.....	44.10
Rape in rows (cultivated)	44.95
Rape broadcasted.....	34.09

Relative Efficiency of Pregnant Mares for Farm Work. (E. A. Trowbridge, E. H. Hughes, S. T. Simpson). The investigation indicates that draft mares can produce healthy and normal foals and still do their share of ordinary farm labor. Mares with suckling foals show a greater loss in weight in the spring and summer season than do mares not suckling. Mares nursing foals make very rapid gains in weight after weaning.



Two of the mares used in the investigation on the "Relative Efficiency of Pregnant Mares for Farm Work." The gray mare is the dam of the foal and the yearling filly at the right.

Feeding Wheat to Fattening Swine (L. A. Weaver). In the tests made during the year, wheat when combined with corn tankage in the proportion of corn 5 parts, wheat 5 parts, tankage 1 part and also in the proportion wheat 10 parts, tankage 1 part, made very economical gains on swine. When wheat was fed in one of the above combinations more gain was produced than when it was fed alone or with corn only, and more gain was produced than by corn alone or corn 10 parts, tankage 1 part. This project will probably be completed in 1915.

A Study of the Residual Effects of Forage Crops for Swine (L. A. Weaver). The first year's work shows that there is but slight advantage in feeding hogs that have been previously on pasture as compared to hogs that have been previously kept in a dry lot.

Self Feeders for Fattening Swine (L. A. Weaver). In this experiment fourteen hogs were divided into two lots of seven hogs each. One lot was fed regularly and the other by a self feeder. Slight advantage is shown in favor of the self feeder. This work is being continued.

BOTANY DEPARTMENT

Grain Smut Infections and Control (G. M. Reed). This investigation has included work with the bunt of wheat (*Tilletia foetens*) and the loose smut of oats (*Ustilago levis*). In testing pure strains of wheat which have been developed by the Department of Farm Crops, there was found a wide degree of susceptibility. The results of these tests also indicate a high degree of efficiency in the method of inoculation used which was simply dusting the seed with the dry spores of the bunt. In a test of the susceptibility of three common varieties of wheat, the variety Treadwell was found to be less susceptible than the varieties Red Cross and Early Ripe. Tests to determine the effect of late planting have not as yet brought out in any striking fashion the common contention that late planting results in a high percentage of smut. It has been shown conclusively that soil highly contaminated with smut spores causes a development of smut in the subsequent crop.

In the experiments with the loose smut of oats results indicate the necessity for annual seed treatment. Tests designed to determine the effect of inoculation on different varieties show a wide variation in the percentage of infection. Some of the varieties supposed to be highly resistant to the smut do not appear to be so. The common method of treating seed oats by using one pound of formalin to forty gallons water is absolutely effective in preventing the smut.

Classification of Local Rusts (J. P. Bennett). There are now collected and identified sixty-seven different species of rusts occurring on 127 hosts obtained from 443 different collections. This work was completed in June, 1913, and reported in a thesis. During the last year about a dozen new species have been discovered. This project will be continued from season to season. It is probable that less than half the total number of rust species occurring in Boone County have been collected.

Physiological Relations of Powdery Mildews to Their Hosts (G. M. Reed). Some of the conclusions reached in this work are as follows:

1. There is a marked decrease in the infection of barley and wheat by their powdery mildews when the hosts are grown in the

absence of light. The etiolated plants are not completely free from the fungus, but there is a very marked retardation in its development, and a lengthening of the incubation period. There is also a marked correlation between the development of chlorophyll in etiolated plants and vigor of infection.

2. Wheat and barley grown in the light but in an atmosphere devoid of carbon dioxide remain entirely free of the mildew. Infection evidently is intimately connected with the process of photosynthesis.

3. Partial immunity to the mildew is brought about by mineral starvation but only indirectly, and only so far as the general health and vigor of the host is influenced. The plants suffer from the lack of certain mineral elements and in proportion the mildew fails to develop.

4. There are some evidences that such substances as manganese sulphate, potassium sulphate, and lithium bromide, when added to the soil in which the host plants are grown, produce a slight increase of immunity in the host.

5. Growing host plants under conditions where the mineral content of the soil water is high, thus producing dwarfing of the plants has no effect upon either the resistance or the susceptibility.

6. In general any condition that favors the vigorous development of the host favors the development of the fungus. Lack of vigor in the host results in only a partial or no development of the fungus. There is, therefore, intimate relation between normal, healthy development of the host, and successful attack on the part of the fungus.

Micro-Organisms In Silage (Emma B. Mundy). During the year a thoro investigation of the physiological characteristics of *Monascus purpureus*, a red mold which is common in silage, was made. The main conclusions reached are as follows:

1. The fungus grows vigorously on a neutral or slightly acid medium and only feebly on an alkaline medium. Organic acids such as lactic and acetic are more favorable than inorganic acids such as hydrochloric.

2. Oxygen is absolutely essential for the development of the fungus.

3. Liquid and agar media do not seem to be particularly favorable for the development of *Monascus*. It grows best on a considerable number of complex organic compounds, various sugars being among the most suitable. The fungus also grows abundantly on starchy materials such as rice.

4. The production of the characteristic carmine-red pigment is dependent upon a variety of factors. A large production of color does not necessarily indicate abundant growth, for feebly growing cultures produced pigmentation, while others, giving a luxuriant mycelial development, have lacked the characteristic color.

5. The pigment is not due to simple oxidation. It is probably one of the end or by-products of metabolism within the cells. It is soluble in certain solutions as ethyl alcohol, methyl alcohol, ether, chloroform, glacial acetic acid, acetone, but insoluble in water, dilute acids, benzol, carbon bisulphide and xylol.

DAIRY HUSBANDRY

Silage Investigation (C. H. Eckles). These investigations begun in 1913 include the study of the temperature of silage, different types of construction in silos, the character of silage produced in these different types, the loss of nutrients as effected by the condition of silage when put in the silo, the weight of silage per cubic foot at different depths, the use of legumes for silage and the use of shock corn for making silage. Temperatures were measured by electrical thermometers placed at different depths in the silo and read from the outside without disturbing the silage. Results so far indicate that there is little difference in the temperature of silage preserved in silos built of concrete, wood or tile. The temperature of the silage rarely exceeds 100° F. unless the silage is deficient in moisture or air is present. The data concerning the weight per cubic foot shows exceptionally wide variation in weight, depending upon the amount of moisture and probably upon the amount of grain in proportion to stalk. Experiments in preserving shock corn in the silo show that reasonably good feed may be obtained in this manner if there is added an amount of water approximate to the amount of dry fodder used.

Factors Influencing the Normal Composition of Milk. The Effect of Cotton Seed Meal and Cotton Seed By-Products (C. H. Eckles, L. S. Palmer). Findings of this investigation during the year previous that the effect of cotton seed meal is due to its cotton seed oil content were further confirmed. Data has been gathered which indicates that the character of the roughage fed determines the effect of the cotton seed meal in the ration to a considerable extent. All the tests so far show a marked superiority in the keeping quality of butter made from a ration containing cotton seed meal. During the current year investigation with reference to feeding cotton seed meal to cows on pasture was made. Results confirming

the general opinion that butter is firmer when cotton seed meal is fed were secured. This project will probably be completed in 1915.

Factors Influencing the Development of Dairy Heifers (C. H. Eckles, T. C. Reed, W. M. Regan). The original plan of this investigation included a study of certain factors, especially the plane of nutrition when young, and the age at first calving, upon the size, milk production, and type of dairy animals. Forty-two animals were used in this investigation and the data is now complete, including a full record of all food consumed from birth until the animals have been, at least, two years in milk. Complete records have been made of weights by months, body measurements and production of milk and fat for at least two years. Some of the results of this work have already been reported in the Director's Annual reports for the years 1911, 1912, and 1913.

Mineral Requirements. In December, 1912, two six-month-old dairy heifers were started on a ration much below the normal in content of mineral matter; one received bonemeal and chalk in addition. After a year's feeding on this ration typical symptoms of calcium shortage were observed. It was found possible to restore the animals to normal condition by increasing the calcium in the ration. The results so far indicate that while it is possible to feed a growing dairy animal on a ration which will cause the animal to suffer from a lack of mineral matter, yet such a condition rarely occurs under practical conditions.

Protein Requirements. A study of the data obtained from the first part of these investigations seems to indicate that the energy in the ration is more often the limiting factor in growth than is the protein. The protein requirements for growing cattle have not been determined experimentally. The feeding standards which are in print are based mostly upon calculations made from the feeding of mature animals. This investigation was started in a preliminary way in August, 1913, and is still in progress. It has been found so far that an animal receiving approximately one-half of the protein as called for by the feeding standard is able to make a growth that is almost normal. From the limited amount of data at hand it seems the protein required is considerable less than that generally recommended.

Normal Growth. Experience in conducting investigations with growing animals has led to the conclusion that one of the essential things is to secure reasonably accurate data regarding the normal growth curve of dairy animals. A considerable amount of data is at hand from these investigations which can be used for this purpose. In addition in the spring of 1913 measurements were taken regularly

of all the calves and growing animals in the station herd. It will require at least two years more to secure the data on a sufficient number of animals to make it possible to give a normal growth curve. A study of the data so far shows that the different breeds follow the same curve with the exception that certain ones reach maturity quicker than others. It has also been found that the animal reaches maturity in skeletal growth very much quicker than it reaches maturity in weight. Holstein cattle reach their mature development of skeleton at the age of between four and five years, while they continue to increase in weight normally for at least two years longer.

Possible Error in Height Measurement The common way of measuring growth is by comparison of body measurements, especially that of height. The height at withers is probably the most used measurement to determine growth because it is the most easily taken and is supposed to be the most accurate. During the year certain facts regarding possible sources of error in measurements have been determined.

Upon examining the data taken for this measurement, fluctuations from one measuring to the next were found which were too large to be considered as errors. An animal would be shown as being two or three centimeters lower than it had been the month previous and it did not seem probable that the animal actually decreased in size. By examining the method of measurement, the reason for this apparent loss of growth was found. A close examination of an animal that was being measured showed that after being allowed to come to rest it immediately began to decrease in height. The backbone was observed to sink from an inch or so above the shoulder blades until the top of the shoulder blades instead of the backbone, was the highest point of the withers.

This is probably due to relaxation and stretching of certain large muscles which attach on the chest and shoulder blades and serve to hold the body up. Probably the muscles that are most concerned are the *anterior* and *posterior pectorals*, the *serratus thoracis* and the *senatus cervicis*.

When the animal is in motion these muscles are tense and hold the body well up between the shoulder blades but as soon as the animal comes to rest these muscles relax and this, together with a certain amount of stretching, allows the chest to be lowered slightly while the shoulder blades remain stationary. Upon resuming motion, they again contract, and the animal assumes its maximum height. A measurement taken from the top of the shoulder blade is more accurate, and is now being taken for the height at withers.

ENTOMOLOGY

The Cause of "Stop Back" on Nursery Stock and Methods of Prevention (L. Haseman). Last year the life history and development of the tarnished plant bug which causes stop back, was completely worked out. The work this year has been to determine the distribution of the pest and the extent of injury it produces. While the pest has been common in Missouri its injury until recently has been confined largely to the nurseries in the central part of the state. During the last year, it was found to be causing considerable damage thruout the entire state. The remedies for controlling it are now being worked out.

Investigation of the Life History, Development, Injury and Remedies for Apple Leaf Hopper on Nursery Stock (L. Haseman). During the year a portable insect trap consisting of painted shields mounted on wheels was tried out as a direct remedy for this pest. The winged hoppers are caught on the sticky canvas shields of the trap. This remedy is effective and economical where as much as fifty acres of nursery stock is concerned. The pest was found to have extended its activities and considerable damage has been done to the apple and Norway maples in the nurseries of Southern Missouri.

Distribution of Insect Pests in Missouri—Preventive Control (L. Haseman, T. J. Talbert).

(a) Unspotted Tentiform Leaf Miner on Apple—This work was finished during the fiscal year of 1912-13. The report is not yet ready for publication.

(b) Peach Tree Borer—The work on the preventive control of the peach tree borer during the last year has been confined largely to the testing of paints as remedies. Lime-sulphur, coal tar and lime, coal tar and two commercial paints have been tested. They have proven beneficial, but further investigation of their effectiveness is being made.

(c) Stripped Cucumber Beetle—Tests of arsenical poisons, lime sulphur, "Black leaf 40" and wood ashes made during the year were all decided failures.

(d) Chinch Bug—In a dozen counties of the state burning the harboring place of the pest during the winter was carried out with good results. The ditch and the log dust-strip as barriers during the summer migration were used in every infested county with success. Farmers in eighty counties cooperated during the year in an effort to control this pest.

(e) San Jose Scale—Tests have been made during the year on the relative value of fall, winter and spring application of sprays.

The best results were secured from fall and early spring applications. Investigations were begun to determine if it is possible to combine a spring application of spray for scale with the first spray or "Cluster Spray" for fruit diseases. Lime sulphur of the same concentration as used for winter applications was applied after the buds had opened. A survey shows that practically every county in the state is infested with the San Jose scale.

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, C. J. Talbert). These pests are also being studied to determine the injury produced by them on more mature stock. These two projects necessarily overlap to some extent. A list of the most important insect pests injurious to nursery stock as determined by original investigation during the year includes the following:

Scales

San Jose scale
Oyster shell scale
Scurfy scale
Cherry scale
Willow scale

Caterpillars

Apple Leaf miners
Apple leaf roller
Tussock moth
Peach tree borer
Leaf skeletonizer

Plant Lice

Woolly aphid
Green apple aphid

Beetles

Apple tree borer
Elm borer

Leaf-Hoppers

Apple leaf-hopper
Grape leaf-hopper

True Bugs

Tarnished plant bug
Red bugs

Grasshoppers

FARM CROPS

Experiments with Cowpeas and Soybeans (J. C. Hackleman). About seventy varieties of cowpeas and soybeans are being tested. Some varieties are superior as hay producers while others are much better for seed. The tests indicate that the proper width of row for seed production is from thirty to thirty-six inches. About sixty pounds of seed per acre of either cowpeas or soybeans gives a greater yield of hay than any other rate of seeding tried.

Experiments with Various Spring and Fall Sown Forage Crops (J. C. Hackleman). For spring crops a mixture of Canada peas

and oats is best, while rape or Canada peas are the best crops to sow alone, according to the results obtained so far. Sorghum appears to be the best crop for summer-sown forage. Of the fall-sown forage crops rye is a best individual crop, while rye and vetch make the best forage mixture. Crimson Clover is not as satisfactory for forage as vetch.

Experiments with Alfalfa Varieties and Alfalfa Culture (J. C. Hackleman). The alfalfa variety tests continue to indicate that Northern seed in general is superior to commercial seed and especially superior to seed from sub-tropical and warm humid climates. Under this project a minor investigation was started during the year to study the proper time to seed alfalfa in Missouri.

Factors Influencing the Development of the Maize Plant, Field Studies of the Plants (C. B. Hutchison, C. E. Neff). Owing to the severe drouth in 1913 the yield of grain from plantings of special selected corn was small and it was impossible to study the relation between kernel character and yield as planned. The work will be continued and statistical methods employed in studying the correlations between various characters.

Corn Breeding and Variety Tests (C. B. Hutchison, F. L. Duley). These tests have been continued without change including twenty of the more common varieties.

A Study of the Inheritance of Quantitative Characters in Wheat (C. B. Hutchison). This project was begun in the spring of 1914 when crosses were made in the field between the following varieties of wheat:

- Fulcaster x Turkey
- Fulcaster x Defiance
- Early Ripe x Turkey
- Early Ripe x Defiance
- Fultz x Fulcaster
- Fulcaster x Dawson's Golden Chaff
- Poole x Defiance
- Michigan Wonder x Turkey

Wheat and Oat Breeding and Variety Test (C. B. Hutchison). The oat breeding work with spring varieties was a failure on account of hot weather and drouth. The Kherson and Texas Red Rust Proof, two early maturing varieties of oats, which were able to mature before the warmest and dryest weather gave best results in the spring oat variety test. The winter Turf and Culberson of winter oat varieties survived the winter best. Seed selections were made and will be planted in the fall of 1914.

In the wheat breeding work about 170 hybrids and strains were planted for comparison. Some of the selected strains in 1913-14 gave increase of from 15 to 20 per cent above the commercial strain. In the wheat variety test about seventy varieties were planted. Among the best standard varieties of wheat for Missouri are Fulcaster, Mediterranean, Deitz, Rudy, Lebanon, Michigan Wonder, Early Ripe, and Poole.

FARM MANAGEMENT

Farm Cost Accounting (O. R. Johnson, W. E. Foard). This is a compilation of detailed farm records collected from all parts of the state by means of a farm diary. The report of this work up to date is being published. The project will continue indefinitely. The following are some of the statements made in the summary of the work at the end of the year.

The average cost per year of keeping a work horse on fourteen farms was \$88.33, the cost being divided as follows: feed, 77.4 per cent; labor, 10.7 per cent; miscellaneous, 11.9 per cent. The length of workday per man on twenty-eight farms varied from 8.9 hours in January to 10.57 hours in June, the average being 9.64 hours. It requires 3.76 man hours and 9.5 horse hours to plow an acre of ground with three-horse outfit, and 2.36 man hours and 4.32 horse hours to cultivate an acre of corn with a one row cultivator.

The cost of producing an acre of farm crops is as follows:

Corn,	\$13.52
Oats,	10.87
Wheat,	12.30
Clover,	8.10
Cowpeas,	13.60
Soybeans,	13.53

A summary of the various records showed that corn yielding less than thirty bushels an acre paid a very small profit per hour of man labor. Corn yielding more than thirty bushels paid a profit per hour of nearly thirty-eight cents. Corn is the most profitable of the various crops studied with clover, cow peas, soy beans, and wheat ranking in the order named. Oats showed a loss of eleven cents per hour of man labor.

Farm Management Survey of Johnson County, Missouri (O. R. Johnson, W. E. Foard). This work was done in the summer of 1913. The results of the investigation have been tabulated and studied from the standpoint of land tenure. The average value of all land in the region is \$71 per acre. Fifty per cent of the land is operated by owners and the remainder by tenants.

The tenant grows more grain crops and sells a larger Proportion than the owner.

The tenant keeps one animal unit for every five and a half acres of ground while the owner has one for every three and a half acres.

The tenant farms more land with a given labor equipment than the owner.

The tenant gets lower yields from grain crops than the owner and about the same from hay crops.

The annual labor income of the tenants is \$501, of the part owners \$456 and of the owners \$314. The tenant receives more for his work than does either of the other classes. The family living expenses of the tenant are \$354 as compared to \$413 for the owner.

A larger percentage of owners than tenants make a minus income. With the same labor income the tenant spends less for family living than does the owner.

With the same capital, the tenant makes the largest labor income, the part owner next and the owner makes the smallest labor income.

Tenants usually put in more productive hours of labor than do owners.

(a) Cost of Family Living on the Farm—This data is being collected and developed in connection with this survey. The following table has been drawn up giving certain facts in connection with this particular investigation.

Capital	Farm income	Cost of family living
\$2000 or less	\$218	\$189
2001-4000	373	246
4001-6000	502	320
6001-8000	652	348
8001-10,000	773	403
10,001-15,000	1125	419
15,001-25,000	1027	539
25,001-over	2728	636

The Distribution of Farm Labor (O. R. Johnson, W. E. Foard). Figures have been compiled which show the difference between live stock, crop and miscellaneous labor on twenty-one farms. The per cent of farm labor given these three divisions as an average for the year is as follows: in caring for stock, 35.2; in caring for crops, 39.8; miscellaneous labor, 35.1.

FORESTRY

An Investigation of the Method of Culture and Varieties of Basket Willows for Missouri (E. C. Pegg). In the spring of 1913 approximately 10,000 cuttings were made from the rods produced

the previous year. A large part of these were used in filling places where previous cuttings had failed to grow. Some were distributed to three farms in Missouri.

A Study of the Methods of Prolonging the Service of Wood Fence Posts (E. C. Pegg). About 550 posts representing twenty-seven species were set in 1913. Examination at the end of the first year showed no evidence of decay or fungus growth. Persimmon, Honey Locust and a few Coffee Bean posts showed damage by borers. The creosote had leached out and discolored the soil to certain extent around some of the cotton wood, willow and sycamore posts.

The Effect of Storage Conditions on the Vitality of Forest Tree Seeds (E. C. Pegg). The indications are that the vitality of forest tree seeds is low after they have been stored for two years and that the proper method of storing forest tree seeds will depend upon the species to which any particular seed may belong.

HORTICULTURE

Peach Breeding for Hardy Sorts (J. C. Whitten). In peaches the varieties having pale yellowish-green twigs are hardier than the purple twig varieties, altho they are poorer fruit producers. The best fruit producing varieties are of the purple twig strains. The object of this work is to produce if possible, by crossing the two types and offspring that will have the hardiness of the yellowish green twig varieties and the larger yellow fruit of the purple twig varieties. During the year an additional number of crosses have been secured between Rice's Seedling, a pale twig variety and Cameron, Champion and Elberta of purple twig, but fine fruit varieties. The results of all the crosses that have been made are to be propagated and studied.

Apple Breeding for Late Blooming Habit (J. C. Whitten). The flowers of some of the leading commercial varieties of apples grown in Missouri have been fertilized with pollen from the latest blooming varieties which can be secured. The object is to secure varieties which will blossom later and perhaps be less liable to injury from spring frosts than most of the present varieties. During the year an additional number of seeds have been secured representing crosses between Ingram and Rome, Beauty and Ingram and Darue. None of the crosses made have yet reached the bearing stage.

Bud Selection for Increasing Yields (J. C. Whitten).

(a) Strawberries: At the beginning of this experiment two plots of strawberry plants were started. The plants of one plot were

propagated from six very productive plants which produced nearly four times the fruit of six plants giving very low production from which the plants in the second plot were propagated. Each year production has been made by bud or runner selection from the least productive plants of the one plot and the most productive plants of the other. At the end of fifteen years there has been no gain in the total productiveness of the plots originated from high productive plants over the plots originated from the low productive plants. A wide variation has continued to exist in the individual plants in either plot. Selection from bud propagated strawberry plants has not limited the range of variation of the plants making the lower limit of production.

(b) Apples: In this experiment scions were propagated in two different lots. The scions in one lot were taken from a Ben Davis apple tree which was an exceptionally poor producer. Those from the other lot were taken from the Ben Davis apple tree which produced the largest and best apples of any tree of its variety on the experiment station grounds at that time. The trees in the two lots propagated from the two original trees, have yielded three crops. During this year there was no perceptible difference in size, color, grade or quality of the fruit from these two lots of trees. Impartial observers have been unable to make a choice as to quality between apples produced on the one lot as compared with those produced on the other. The total product from the trees in each lot showed a slightly higher average yield than those propagated from the high producing parent. The indications are that there is no more variation between the two plots than there is between individual trees in either plot.

Spraying Fruits for Insect and Fungus Diseases (W. L. Howard). During 1913 spraying experiments were carried on in five different commercial orchards. The labor was done by the orchardists under the direction and with the assistance of a representative of the station. In a number of the orchards the crop was small so that average profits per acre were lower than in normal seasons. The average net profit on unsprayed plots in these commercial orchards in 1913 was \$2.78 per acre; the average net profit on sprayed plots of these same orchards was \$57.65 per acre. One orchard yielded a net profit of \$161.12 per acre due to spraying. In the spring of 1914 plots of these commercial orchards sprayed in 1913 uniformly set a better crop of fruit and the trees were in healthier condition than were those of the unsprayed plots in the same orchard. It is believed that this was due to the sprayed trees holding their leaves later in the fall and storing up more plant food in the buds.

In the spring of 1914 this work was enlarged so that spraying experiments were conducted in twenty-five orchards. At the close of June, 1914, in every one of the orchards the sprayed trees were far freer from diseases and insects and a much greater proportion of the fruit was being set than on unsprayed trees in the same orchard.

Fruit Bud Development of Fruit Trees as Influenced by Treatments (C. C. Wiggans). This is an investigation of the tendency of certain varieties of fruit trees to bear fruit crops only in alternate years while other varieties tend to bear more regularly unless weather conditions interfere. The investigation includes the collection of data which will show whether the fruit spurs on an apple tree which set fruit in one year will at the same time mature fruit buds which can produce fruit the following year; or whether the fruit is borne on one set of spurs one year and on an entirely different set of spurs the next year. Work during the last year included trees of the Gano, Rome, and Jonathan apples. Each spur which produced fruit on each of the trees was labeled and numbered. Observations the following spring showed that in the case of the Gano, no blossoms were produced on spurs which had borne fruit the previous year. But very few blossoms were produced on the Rome and Jonathan trees on spurs that had produced fruit the previous year.

Fall versus Spring Planting of Trees (J. C. Whitten). Fall-planted trees at this Agricultural Experiment Station have reached their bearing habit approximately one year in advance of the spring-planted trees. In some instances the fall-planted trees set a considerably better first crop of fruit than the spring-planted trees. In every case the fall-planted trees have grown much better during the year than those planted in the spring. This was particularly true of cherries. In apples, fall-planted trees showed a greater growth of from 33 1-3 per cent to 150 per cent in excess of spring-planted trees. Spring-planted trees frequently make nearly as long a growth from a single terminal bud as do those planted in the fall, but the growth of the lateral buds is not so vigorous. The thicker trunk is produced by the fall-planted trees.

Self Fertility and Self Sterility of Fruits (C. C. Wiggans). Observation during the last year indicates that all the varieties of peaches commercially grown in Missouri are thoroly capable of self fertility and that it is not necessary to alternate different varieties in commercial planting for the sake of cross-fertilization. Only a few of the commercial apples give indications of being able to fertilize themselves. When it is determined what varieties of apples are not capable of fertilizing themselves, each variety will be studied

in detail to determine whether this failure is due to some mechanical hindrance.

The Rest Period of Plants (W. L. Howard). During the year a large collection of woody plants embracing a wide range in plant families and small enough in size to be grown in pots have been tested. The results indicate that in regard to the breaking of the rest period of fruit plants the buds respond to treatment when the whole plant is treated in the same way as do woody twigs cut from the trees and



A comparison of early fall, late fall and spring planted apple trees after one year of growth.

treated after removal. It has been determined that the hardiness of a plant depends very largely upon its state of rest. Alternate freezing and thawing and excessive drying tend to break the rest period. In orchard management it may be possible to handle the soil so as to retain considerable moisture and prevent the factor of dessication from causing an early break in the rest period.

Orchard Nutrition (J. C. Whitten, C. C. Wiggans). The peach is the only fruit which has so far shown any advantage from the application of fertilizer. On all plots fertilized with nitrogen,

whether alone or in combination, the number of peaches set was larger than on the other fertilized plots or on the check plots. The average increase in the number of peaches produced was 50 per cent. The size of the peaches fertilized with nitrogen was smaller, the average weight being only 60 per cent of the average weight of the peaches grown on the check plots receiving fertilizer other than nitrogen. The nitrogen fertilized trees carried a very heavy foliage as compared with others. An extreme drouth was experienced during this year. It is believed that the small size of the fruit is caused by the excessive evaporation through the leaves of the nitrogen fertilized trees. This is in agreement with other reports published at this station.

Examination of Buds in Winter for Forecasting Probable Bloom (C. C. Wiggans). The object of this is to work out a way by which the orchardist will be able to predict during the fall and winter the fruit crop for the following year with a fair degree of accuracy. From an observation based upon superficial examination of the buds of certain trees in the Agricultural Experiment Station orchard it was estimated that about 55 per cent of the terminal buds on fruit spurs had well developed fruit buds. Microscopic examination indicated that about 52 per cent of the buds observed were fruit buds. This method of observation was checked for accuracy by twigs being removed from trees, etherized to break the rest period and forced into bloom in the greenhouses. The number of twigs forced into bloom was about 50 per cent. At the regular blooming time of the tree about 53 per cent of the buds came into bloom. The observation made this year followed a severe drouth. Observation will be continued and especial attention will be paid to their accuracy following years of heavy rain fall.

Treatment of Apple Canker Diseases (J. C. Whitten). From a study of the location of canker on trees, it appears that sun scald on the exposed sunny side of the tree favors the entrance of canker. Whitening the trunks of trees with boiled lime sulphur or ordinary whitewash reflects the heat from the south side of the tree, so that there was no great rise in temperature on that side as compared with the shady side. In some instances the temperature at midday on the south side of a tree trunk was 70° F. while on the north side of the trunk of the same tree the atmosphere registered freezing. The indications are that the custom of whitewashing the trunks of trees protects them from the entrance of canker. Canker can be eradicated if treatment is commenced before it has gone so deep as to weaken the wood of the tree.

SOILS DEPARTMENT

Crop Rotation Experiments (M. F. Miller, C. A. LeClair). This year (1913) completes the twenty-fifth year of investigation on this rotation field. Some of the important results accumulated during the twenty-five years work are as follows:



Wheat on the experiment field at Columbia in a three year rotation of corn, wheat, clover. The plot shown above received manure, the one below no manure. The average yield of wheat on the manured plot during twenty-five years was 22.5 bushels, and that on the unmanured plot 14 bushels.

1. A rotation alone even including legumes is not sufficient to maintain soil fertility providing all crops are removed.

2. Rotation maintains productiveness very much better than continuous cropping of any kind.

3. A rotation of corn, oats, wheat, clover, timothy, timothy, manured at the rate of seven tons annually maintains the productiveness of the soil and is also financially profitable.

4. It was found profitable to apply manure to continuously cropped land. Continuous fertilizing with commercial fertilizers on continuous wheat at a rate sufficient to supply plant food for a forty bushel crop annually maintains the productiveness as high as does the seven tons of manure annually.

5. Continuous timothy with manure has been one of the most profitable treatments.

Effect of Various Crop Rotations on the Physical Character of the Soil (M. F. Miller, C. A. LeClair). Data collected during the year indicates that the system of cropping does not influence the mechanical composition of the upper four feet of soil. A system of rotation may influence the water retaining power of the surface soil by influencing the amount of organic matter present. The system of cropping apparently has no appreciable effect on the movements of air or water in the subsoil.

Experiments in the Associated Growth of Corn and Cowpeas (M. F. Miller, C. A. LeClair). When cowpeas are grown with corn either between the rows or in the row, the nitrates of the soil are not greatly reduced below the amounts present when corn or cowpeas are grown alone. Cowpeas grown with corn, does not seriously exhaust the soil moisture, although more water is used than in the case of corn alone. The average height of the corn plant is shortened about a foot when cowpeas are grown in the corn. The number of leaves on the corn plants grown with cowpeas is greater at the time of harvest than on the plants where corn is grown alone, but the yield of corn is slightly decreased when cowpeas are grown with corn.

Development of the Maize Plant—Nutrition and Moisture (J. C. Hackleman, A. R. Evans). It appears from data gathered during the last year that the most important period in the growth of the corn plant, from the standpoint of soil moisture, is the period from the time the corn is usually "laid by" until the ear is practically formed. There is a direct relation between the amount of moisture present in the soil and the amount of growth. Clay loam soil gives a larger root development than sandy loam. The growth of the vegetative part above the ground is not necessarily in proportion to the root growth.

The Relation of Cowpea Growing to Wheat Production on Continuously Cropped Land (C. A. LeClair). In a system of continuous wheat growing followed by cowpeas the same year, the effect of removing cowpeas from the land results in a gradual decrease in the wheat yield according to data collected during a period of twelve years. Better results are secured when the cowpeas are disked in rather than when plowed under.

VETERINARY

Study of Contagious Abortion (J. W. Connaway, A. J. Durant).

(1) **Complement Fixation Test**—This test has been found very reliable as a diagnostic method in contagious abortion, confirming results obtained at other experiment stations. The result of the test on some infected herds show that in old infected herds the per cent of re-acting animals runs from 60 to 90 per cent. The reliability of the test has been proven by the clinical history of the reacting animal "positive" reactions checking out very accurately with the history of an abortive.

(2) **The Methylene Blue Treatment**—Reports from owners of herds under experiment show good results (tho full, detailed reports are not yet available). In one herd where the loss from abortion in heifers carrying first calf averaged 58 per cent during the preceding two years the loss was reduced to 28 per cent—apparently from the methylene blue treatment.

Tuberculosis of Cattle and Swine—Transmission of Same (J. W. Connaway, J. B. Gingery, A. J. Durant). The observations during the year with post mortem examinations of experimental animals indicate that tuberculosis is not so easily transmitted from sows to their pigs as from cows to their calves and from cows to pigs. This is probably due to the destruction or mitigation of the virulence of the tubercle bacilli in infected swine by the prolific fat production of that animal. These observations may throw some light on the question of the therapeutic value of fat-producing foods in the treatment of tuberculosis in the human.

A Study of Internal Parasites of Swine and the Efficiency of Various Vermifuges (J. W. Connaway, L. S. Backus, T. T. Tucker). The experiments show that the condition of the infested animal is not a reliable guide to the extent of the parasitic infestation.

The diagnosis in some animals is readily made by noting the passage of worms. In others the presence of worms was detected only by finding ova in the feces by microscopic examination; and in other hogs, but slightly infested, the presence of worms was

detected only by post mortem examinations. When worms were present in large numbers, all the recognized vermifuges were effective in expelling the greater number of the parasites, but nearly all the "remedies" failed to expel all the worms. The most effective vermifuges tried in the experiment was turpentine, iron sulphate, copper sulphate, santonin, tobacco and areca nut. Copper sulphate was found to be the most efficient in expelling the thorn-headed worm. Each experiment animal was kept in a separate pen during the experiment and was slaughtered to determine the efficiency of the vermifuge administered.

Experiments on Complement Fixation—Hog Cholera (J. W. Connaway, A. J. Durant). In studying the properties of the blood of swine it was found that the blood serum was haemolytic for the red cells of experimental horse No. 1, goat No. 1, and cows No. 1 and 2, but not for cow No. 3 (a reactor to tuberculin). Haemolysis occurred whether the blood serum used was from normal hogs susceptible to cholera, hogs affected with acute cholera, or from hogs hyper-immunized to cholera.

In the attempts to prepare an "antigen," extracts were made from the blood of six pigs suffering from the acute haemorrhagic type of cholera; six alcoholic extracts, and six extracts with normal saline solution were used. The alcoholic extracts prevented haemolysis; but check experiments showed this to be due to the alcohol and not to an "antigenic content" of the blood. The normal saline extracts, from blood, also failed to show the presence of a deviating antigen.

Separate saline extracts from the spleens of six "virus-pigs" failed to prevent haemolysis. A saline extract from the spleens of virus-pigs gave a distinct deviation with the red cells of cow No. 3; and with the blood serum of a hyperimmune hog (No. 7), in quantities of .01 to .02 cubic centimeters of the spleen extract. The negative results were obtained with the serum from other hyperimmune hogs, and from sick pigs suffering from acute cholera.

The interpretation may be that the positive deviation with serum from hog No. 7 was caused by the *Bacillus suispestifer* antigen, and not by the filterable virus antigen, (culture of the *B. Suispestifer* were not made from the three spleens of this particular experiment, but pure cultures were obtained from one of the other spleens mentioned, and it is probable that this organism was present in the mixture of the three spleens used for an antigen), also that hog No. 7 in addition to being highly immunized to the filterable virus was also highly immunized to the *B. Suispestifer*. Further tests of the

latter will be made with serum from hog No. 7 and cultures of *B. Suipestifer*.

Extracts from kidneys of "virus-pigs" failed to show any "deviating" content.

ZOOLOGY

Sex-Linked Inheritance in Poultry (G. Lefevre). The work during the year has been confined to obtaining the second generations from the offspring of the original crosses, made in the spring of 1913, between the Silver Spangled Hamburg and the Brown Leghorn, and between the Seabright and Black Bantam breeds of poultry.

As stated in the report of progress last year, the results of the matings in the F_1 generation were as follows:

A. Silver Spangled Hamburg x Brown Leghorn:

The inheritance of the spangled pattern of the Hamburg is evidently sex-linked, but the pattern is not transmitted as a unit for the entire body. In all of the offspring showing spangling from the reciprocal matings, the tail is black and shows no spangling, but on the rest of the body the spangled pattern is inherited as a sex-linked character. From the Hamburg male and Leghorn female both cocks and hens are spangled, but from the reciprocal cross only the males are spangled, the females being black with scattered brown or golden markings. This is a typical sex-linked result.

In the spring 1914, the following matings were made:

1. Hamburg male x F_1 hybrid female (from Leghorn male x Hamburg female).

F_2 = Spangling in both sexes.

2. F_1 hybrid male x F_1 hybrid female (both from Hamburg male x Leghorn female).

F_2 = Spangled and non-spangled females; males show all degrees of spangling.

3. F_1 hybrid male x F_1 hybrid females (both from Leghorn male x Hamburg female).

F_2 = Spangling and non-spangling in both sexes.

It was not possible to make the other matings from lack of breeding space. So far as the results go, it is clear that a spangle factor is present in the Hamburg which is transmitted in a sex-linked fashion, but evidently the pattern is effected by other factors, as the spangling varies from a condition which is practically identical with that of the pure Hamburg to one in which the pattern is disturbed to a considerable degree both in its purity and its distribution over the body.

Further results are necessary for a complete analysis of this case.

B. Seabright Bantam x R. C. Black Bantam:

This cross was begun in 1913 with a view to determining the nature of the inheritance of the peculiar feathering of the Seabright cocks which lack the characteristic secondary sexual feathers of male fowls. The cocks are known as "hen-feathered" in this breed. The Seabright cocks, furthermore, show a greatly reduced fertility and possibly some correlation exists between the two conditions.

In 1913 the reciprocal crosses were made, with the following results:

Seabright male x Black female: This cross yielded only 4 birds, 1 cock and 3 hens. The cock possessed fully developed male feathers.

Black cock x Seabright hen: A number of birds were obtained from this cross, all of the males being hen-feathered, with a very slight tendency of the tail feathers to curve.

In the spring of 1914 the following crosses were made:

1. Black male x F_1 hybrid females (from Black male x Seabright female)

Let SS=full cock-feathered condition.

Let ss=hen-feathered condition of the Seabright.

Let Ss=intermediate condition between the two.

F_2 =SS, ss, and Ss males.

2. F_1 hybrid male x F_1 hybrid female (both from Seabright male x Black female).

F_2 =SS in all males.

3. F_1 hybrid male x F_1 hybrid female (both from Black male x Seabright female).

F_2 =SS, ss, and Ss males.

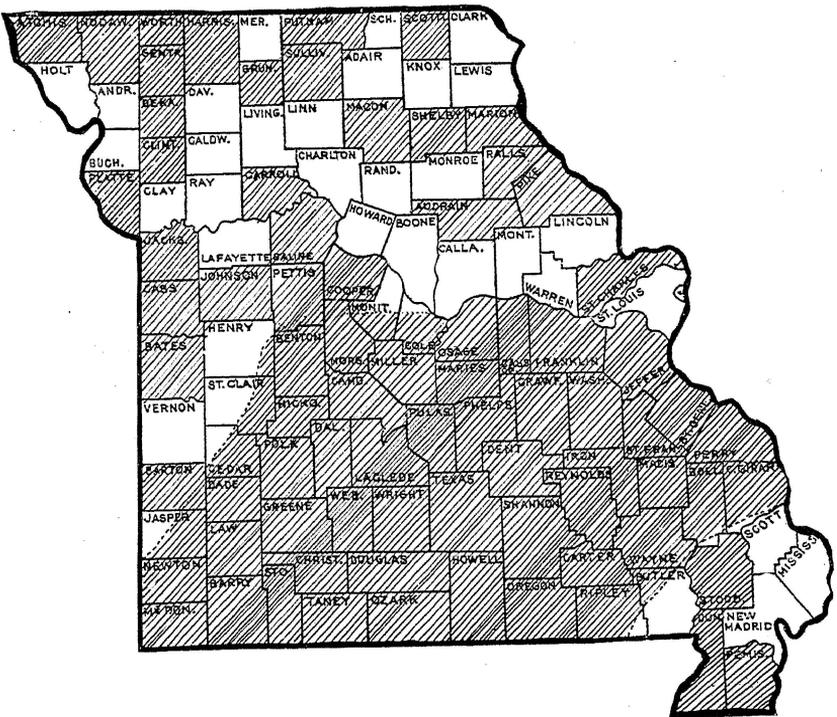
These results are not entirely clear, and it will be necessary to make other matings in order to arrive at an understanding of the mode of inheritance. It is proposed to make these crosses next spring, and also to attempt to obtain more birds from the cross of the Seabright male with the Black female, as the single cock resulting from this mating in 1913 is not enough to base any conclusions upon.

The investigation gives promise of interesting results.

COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE

The Missouri Agricultural Experiment Station and the United States Department of Agriculture are cooperating in the conduct of three projects.

Soil Survey. In co-operation with the Bureau of Soils of the United States Department of Agriculture, this station had completed at the end of this year a detailed soil survey of thirty-three Missouri counties. An average of five counties is being completed each



The shaded part of the map shows the progress made in the reconnaissance soil survey of Missouri.

season. During the last year complete surveys of Berry, Green, Nodaway, and Ralls counties were made and a part of Dunklin County was surveyed. In the spring of 1914 the survey of Harrison, Grundy, Pettis and Johnson counties was begun. The work in Dunklin County was finished after the end of the 1913-14 fiscal year. The Missouri Agricultural Experiment Station employs four

men and the United States Bureau of Soils assigns an equal number for soil survey work in Missouri.

For a number of years work has been done toward a systematic mapping of the soil areas of Missouri in the nature of a reconnoissance survey. Such a map of the Ozark Region was published in 1908 as a bulletin. The accompanying map indicates the parts of the state already covered by this general survey. Such a map, while dealing with main soil areas only, will be of much value to the student of soils as well as to those considering buying farms in the state.

County Agricultural Agents (Farm Advisers). During the year, three new counties were organized. At the end of the fiscal year eleven counties were employing a farm adviser in cooperation with the U. S. Department of Agriculture and this station. (See pages 502 and 507 for detailed report).

Seed Testing Laboratory. In cooperation with the Bureau of Plant Industry the station has been conducting a seed testing laboratory in which farm seeds are examined free. During the last year 1520 samples of various farm seeds were tested. Of these samples 875 were from farmers and 645 from seedsmen. Altogether 771 tests for purity, 1388 for germination, 100 for rough examination and 62 for identification were made. This service has been of great value to those parties who have availed themselves of the opportunity.

INVESTIGATION AND COOPERATION CONDUCTED OUT IN THE STATE

Soil Survey of Missouri Counties. The soil survey is fundamental to all soil investigation. The first appropriation for soil survey was made in 1905. Appropriations have been made by succeeding legislatures, and surveys have been made covering approximately 30 per cent of the agricultural area of the state. See page 490.

Soil and Crop Experiment Fields. The purpose of the Agricultural Experiment Station in establishing outlying experiment fields is to supplement the investigational work carried on locally by similar work carried on under the various climatic and soil conditions which obtain in the different soil areas of the state, thus adapting the investigations of the Agricultural Experiment Station to local conditions. Two new crop fields have been established during the last year. One of these is at Kennett in Dunklin County, and the other at Warrensburg, Johnson County. Two soil fields were discontinued during the year, one at Salem in Dent County and the other at Lamar in Barton County. Altogether nineteen experiment fields have been conducted during the year. Of these, six are crop fields, twelve are soil fields and one is a drainage field. They are located in eighteen counties of the state.

These various soil and crop fields have developed some very important information for the use of the farmers of Missouri. Following are some of the results summarized:

1. The corn variety experiments have indicated pretty definitely the varieties of corn adapted to the various soils of the state.
2. The wheat and oat variety experiments have given very definite indications of the best varieties of these crops for the various parts of Missouri.
3. The cooperative alfalfa experiments have demonstrated the requirements for alfalfa culture in most parts of Missouri.
4. Grass experiments have shown the best grasses for the Ozark region and have indicated the best systems of pasture management.
5. The drainage investigations have shown that tile drains can be profitably installed on the Northeast Missouri level prairie and on the Southwest Missouri level prairie.
6. The soil experiment fields demonstrated the following:
 - (a) Phosphorus is the element which can be applied with the largest net return on Missouri soils.

(b) The best form of phosphate to apply under average conditions is one of the available phosphates, such as bone meal or acid phosphate. Rock phosphate brings slower returns and is adapted largely to the man who has time to wait for results and capital to invest.

(c) Lime brings a small but rather consistent return on practically all the fields under experiment. These fields, however, are those more likely to need lime than a great many soils in Missouri.

(d) Barnyard manure is worth about \$1.65 per ton as measured by crop increase and as an average of all the experiments conducted.



Wheat on the experiment field at Lamar, Barton County, Missouri. The plot on the left was treated with a complete fertilizer at a cost of \$4.85 an acre and yielded 29.5 bushels an acre. The plot on the right was not treated with fertilizer and yielded 12 bushels an acre.

6. The crop experiment fields have been in operation too short a time in most cases to draw sweeping conclusions, but variety adaptations and the best cultural methods have been partially demonstrated in those parts of the state in which the fields are located.

Hog Cholera Serum Distribution. During the fiscal year of July 1, 1913, to June 30, 1914, 4,929,700 cubic centimeters of hog cholera serum were produced and distributed. This quantity at

the prescribed dosage of 25 cubic centimeters per cwt. was sufficient to vaccinate nearly two hundred thousand hogs each of 100 pounds weight. It is estimated that proper vaccination will save eighty-five per cent of the hogs vaccinated. This means that if all the hogs vaccinated were in immediate danger of contracting the disease in round numbers 167,000 hogs of 100 pounds each have been saved by the serum produced. At the prevailing prices during the year this would be a saving to Missouri farmers of more than \$1,300,000.

Cooperative Experiments With Farmers. The Agricultural Experiment Station is cooperating with 652 farmers of the state in thirty different projects. Almost every county of the state is represented in this cooperative work and the results will apply to the farmers of every county. The various lines of work included in this cooperative scheme are summarized below.

SOILS AND CROPS

1. Corn Variety Tests.
2. Wheat Variety Tests.
3. Oat Variety Tests.
4. Alfalfa Experiments.
5. Winter Vetch.
6. Grass Experiments.
7. Fertilizer Experiments With Potatoes.
8. Crimson Clover Experiments.
9. Corn Breeding Experiments.
10. Barley Variety Experiments.
11. Cotton Variety Tests.
12. Fertilizer Experiments With Cotton.
13. Sweet Clover.
14. Cowpeas and Soybeans.
15. Grain Sorghums.
16. Winter Oats.
17. Winter Barley.

DAIRY DEPARTMENT

1. Records of Dairy Herds.
2. Cooperative Bull Experiments.

ENTOMOLOGY DEPARTMENT

1. Chinch Bug Control.
2. Control of San Jose Scale.

HORTICULTURAL DEPARTMENT

1. Pruning and Spraying Apples.

FORESTRY DEPARTMENT

1. Tree Planting (Catalpa).

FARM MANAGEMENT DEPARTMENT

1. Farm Cost Accounting.
2. Farm Home Records.
3. Labor Distribution.
4. Management of Labor.
5. Work Stock Management (by circular to farmers).
6. Farm Survey.

A number of projects have been added to the soils and crop work, since the last report was made. They include experiments with cotton, sweet clover, cowpeas and soybeans, grain sorghums, winter oats and winter barley. In the next year's report there will appear a complete statement summarizing the results that have been accomplished with cooperative work along these lines since the beginning.

The Department of Entomology has had continued success in the control work with San Jose scale and chinch bug. Farmers in eighty counties of the state cooperated actively in the chinch bug control work. When proper cooperation is secured for work under these two projects the results are decidedly satisfactory.

The demonstration work in spraying and pruning apples continues to emphasize the importance of these two factors in orchard management. The results of this have already been reported on page 480. A bulletin (No. 124) is being prepared covering the details of the work on these projects and will be distributed in the near future. The cooperative work in dairy husbandry continues to show that when a community is properly organized the economic advantages from the use of pure bred sires, herd records and proper feeding methods are large.

COLLEGE OF AGRICULTURE EXTENSION SERVICE

The activities of the College of Agriculture are not alone confined to college teaching at Columbia. It has been the policy of the institution from the beginning to extend its educational opportunities as far as possible to persons who are actually cultivating the soil. The extension services which have been rendered by the College of Agriculture have been many and varied. It is the function of the Agricultural Experiment Station to solve the agricultural problems of the state. It is the function of the Agricultural Extension Service to bring a knowledge of the solution of these problems to the farmers themselves. The ways in which the college has attempted to carry this information to the people of the state is indicated in the following list of projects.

Some attempt has been made to give a fairly detailed account of the amount of work accomplished in this effort. It is true, however, that no mere collection of statistics or report on numbers of meetings held or schools organized or publications issued can give any adequate conception of the actual results secured, either when measured by the adoption of better farming methods, improved educational opportunities, or better living.

PROJECTS FOR EXTENSION TEACHING AND DEMONSTRATION

1. Branch Short Courses.
2. Farmers' Short Course.
3. Farmers' Institutes.
4. Special Trains.
5. Special Lectures.
6. Short Course for Boys and Girls.
7. Boys' Corn Growing Contest.
8. Boys' and Girls' Clubs.
9. Cooperation with Farmers.
10. Live Stock Shows Judged.
11. Judging at Corn Shows.
12. Spraying and Pruning Demonstrations.
13. Free Seed Testing.
14. Silo Help.
15. Educational Scoring of Butter.
16. Creamery Assistance.
17. Agriculture in Rural Schools.
18. Official Testing of Dairy Cows.

19. Cow-testing Associations.
20. County Agricultural Agents (Farm Advisers).
21. Agricultural Exhibits at Fairs.
22. Correspondence.

INSPECTION SERVICE

1. Fertilizer Control.
2. Nursery Inspection.

Organization. On June 8, 1914, the Board of Curators of the University established the Agricultural Extension Service. This was made necessary in order to administer the Smith-Lever funds appropriated by the national government. During the month of June plans of organization were completed, bringing all agricultural extension activities under the administration of the newly established Agricultural Extension Service, except such extension work as comes under the head of investigation and certain regulatory measures vested in the College of Agriculture.

The following is an itemized statement of the various extension activities of the College of Agriculture during the year covered by this report. The explanatory paragraphs describe the nature of the work. All statistical matter is brought together in the summary following the descriptive paragraphs.

Branch Short Courses. Two years' experience in conducting Branch Short Courses has demonstrated the efficiency of the five-day plan. With a limited field force, the project could be but slightly expanded over the preceding year. Another year in the work has emphasized the importance of having a relatively small number of instructors, giving each instructor two periods a day for five days to present his subject fully and effectively.

The following table gives in detail the distribution of Branch Short Courses in the winter of 1913-1914.

Town	County	Total Attendance	Number of Instructors
Kirksville	Adair	200	2
Callao	Macon	62	3
Pomona	Howell	250	3
Maywood	Lewis	50	2
Farmington	St. Francois	120	3
Palmyra	Marion	70	4
Orchard Farm	St. Charles	100	4
Malta Bend	Saline	380	4
Holden	Johnson	50	4
Shelbina	Shelby	125	4
O'Fallon	St. Charles	80	4
Urbana	Dallas	30	2

The Farmers' Short Course. The usual four days short course for farmers was given during Farmers' Week at Columbia in January, 1914. Special courses in Animal Husbandry, Agricultural Engineering, Dairy Husbandry, Entomology, Farm Crops, Farm Management, Horticulture, Home Economics, Soils, Poultry Husbandry, and Veterinary Science were given by members of the Agricultural Experiment Station staff during this week. Altogether 2240 farmers from ninety-two counties of Missouri and from eighteen other states attended. The farmers attending this short course have an opportunity to become intimately acquainted with the members of the Agricultural Experiment Station staff and the work of the station.

Farmers' Institutes. The Agricultural Experiment Station has continued the plan of cooperation with the State Board of Agriculture by furnishing lecturers to help at farmers' institutes. Most of the work done at farmers' institutes has been along special lines which has been called for by special communities. The Agricultural Experiment Station with men trained along all lines is in position to render special service when needed.

Special Trains. Reaching the people by special agricultural trains is a method that has played a large part in awakening people to the possibilities of scientific methods of farming. The Agricultural Experiment Station has adopted the policy of spending an entire day at each stopping place. A demonstration car is carried but is used only when a suitable hall cannot be obtained. It is not possible to do intensive work in connection with a train trip, but it is an effective way to reach a large number of people and lay the basis for future intensive work.

Special Lectures. Although most of the extension work of the College of Agriculture is carried on under well-defined and systematically organized projects, yet there is a large demand from schools, churches, farmers' clubs and others for individual lectures and demonstrations on agricultural subjects. The college attempts to answer as many of these calls as possible. In all cases, the expenses of the trip have been borne by the community receiving the service.

Short Courses for Boys and Girls. During Farmers' Week each year a special short course in agriculture and home economics is given for the benefit of boys and girls between the ages of ten and eighteen. The course continues for four days. Many of the facts that farm boys and girls ought to know are presented by the regular force of teachers and investigators in the College of Agriculture. The main purpose of the course, however, is to open the eyes of those who attend to the great possibilities in the farm and home. It

directs boys back to a lifetime on the farm and girls to a lifetime in the home.

Boys' Corn Growing Contest. Thru the active cooperation and financial support of the Missouri Corn Growers' Association, the Missouri Boys' Corn Growing Contest has experienced its usual success. Three thousand Missouri boys entered the contest in the spring of 1914 and received instructions in corn growing, from the testing of the seed for germination to the harvesting of the crop and the field selection of the seed for the succeeding crop.

Boys' and Girls' Clubs. On March 1, 1914, the work with rural schools assumed a new form and came under the Boys' and Girls' Club project. This extension project takes up the teaching of agriculture through the medium of school clubs. Club members are to be between the ages of ten and eighteen years. Six or more members constitute a club. Instruction and information sheets, together with permanent report forms are sent from the College of Agriculture to club members through county and local leaders. The county leader is usually the County Superintendent or the County Agricultural Agent. The local leader is usually the teacher of the school.

Cooperation with Farmers. All the teachings of the Agricultural Experiment Station are verified by actual tests on Missouri farms. More than six hundred farmers cooperated last year in carrying out scientific farm practices under direction of the Agricultural Experiment Station. As a rule, these cooperative tests concern only one or two phases of farming and do not include the entire farm organization.

Live Stock Shows Judged. Probably no one thing has done more to standardize live stock exhibits at county fairs in Missouri than has the practice of supplying live stock judges at county and district fairs. These judges, trained at the College of Agriculture, have a well-defined ideal and all have the same ideal. The result is uniformity in placing awards and the ideals of the exhibitor follow the awards of the judge. Similarly, the standard of the breeder is fixed by the standard of the show.

Judging at Corn Shows. What the Department of Animal Husbandry has done for live stock standards, the Department of Farm Crops has done for corn, forage crops, and small grains thru judging at fairs and corn shows. There is no way of directly calculating the influence of work of this type, but evidence is not lacking to show that in innumerable cases a higher community standard has obtained as a result of a local corn show at which a college trained judge has done the placing and explained his reasons.

The judge at the corn show is placed in a position where he can strike at a vital spot in the scheme of corn, grain, and forage crop improvement.

Spraying and Pruning Demonstration. In the orchard demonstration work, men from the College of Agriculture go right into orchards that need spraying and pruning and use the orchard as a laboratory to teach people how to prune and spray. These demonstrations have been carried on in every part of the state where the orchard industry is of especial importance. (See Bul. 124.)

Free Seed Testing. The College of Agriculture has continued its plan of cooperation with the U. S. Department of Agriculture in conducting a seed testing laboratory where farmers and seed dealers of Missouri may have farm seeds tested for identification, purity, and germinating power. This service is free.

Silo Help. For the benefit of farmers who want to build concrete silos, the College of Agriculture has been supplying blue prints, and specifications from which to build the forms and scaffolding. These blue prints have been accompanied by full instructions in regard to the mixing of concrete, reinforcing the walls, and the method of handling the forms. So far as time permits, a man from the college has gone out to help farmers start their silos in communities where several farmers are planning to build and where the one demonstration will serve to give the necessary instruction in silo building to the entire community.

Educational Scoring of Butter. The success of the dairy industry in some sections of Missouri is to a large extent dependent upon the success of local creameries, which in turn is dependent upon the quality of its product. In order to establish a standard of excellence for butter in Missouri and in order to enable creameries to standardize their own product, the college has continued the educational scoring project free to all creameries that wish to submit samples. Each creamery which enters the competition sends a sample of butter. The scoring is done without cost to the creamery and the score is sent to each competitor for his personal information.

Creamery Assistance. Of more direct help than the butter scoring contest for creameries has been the personal help to creamery men in their own creameries. This work has necessarily been limited because of lack of help to carry it on. The plan has been to have a man from the College of Agriculture spend one or two days in a creamery going through the mechanical routine and demonstrating methods of efficiency wherever the need exists.

Cow Testing Associations. Cow testing associations were formed in two counties during the year. One of these known as

the Mountain Grove Cow Testing Association was organized in August, 1913, among the farmers located near the towns of Mountain Grove and Cabool. The second was organized in May, 1914, in Jackson County. The association at Mountain Grove has proved of considerable value to the farmers belonging. One of the most prominent results is the actual demand for pure bred and high grade dairy cattle which has developed since the influence of the association has been felt.

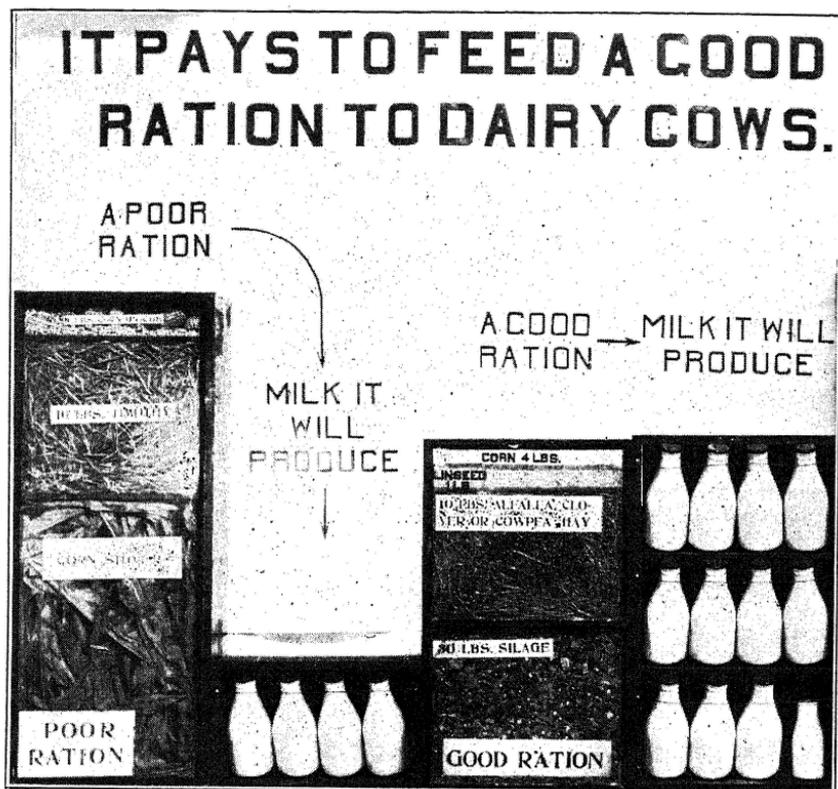
Official Testing of Dairy Cows. The official testing of dairy cows of all dairy breeds is placed in the hands of the Agricultural Experiment Station by the various breed associations. The increase in the interest of official testing as indicated by the increased calls for testers is gratifying. During the year 141 cows in eleven counties belonging to eighteen breeders were tested by representatives of the Agricultural Experiment Station.

Agriculture in Rural Schools. In order to help rural school teachers to more efficiently teach the subject of agriculture, the University of Missouri has employed a demonstrator who gives his whole time to this one field. While the work has been conducted mainly to encourage the teaching of agriculture in schools, it has, necessarily, included many details of organization and administration, efficiency in these respects being essential to the success of all phases of instruction, including agriculture.

County Agricultural Agents (Farm Advisers). This project is explained in detail in Circular 59 of the Missouri Agricultural Experiment Station. Since the issue of the last annual report of the Director, three new counties have been organized and the work thruout has been further systematized and extended. The following table shows the counties having farm advisers for the period covered by this report.

County	Date work began
Cape Girardeau.....	August 1, 1912
Pettis.....	January 1, 1913
Buchanan.....	March 1, 1913
Johnson.....	March 7, 1913
Dade.....	April 1, 1913
Audrain.....	April 1, 1913
Jackson.....	April 20, 1913
Marion.....	September 1, 1914
Scott.....	September 15, 1913
Cooper.....	September 24, 1913
Greene.....	January 19, 1914
Saline.....	June 15, 1914

Agricultural Exhibits at Fairs. Following the practice of previous years the College of Agriculture sent to ten agricultural fairs, including the Missouri State Fair, exhibits showing the results of investigations made by the Agricultural Experiment Station and presenting in graphic form some of the more striking lessons which



One of the exhibits at the Missouri State Fair.

the College of Agriculture is attempting to bring to the rural people of Missouri. Each exhibit was accompanied as heretofore by two demonstrators who thruout the continuance of each fair conducted an informal round-table discussion of agricultural topics using the exhibit material to illustrate their teachings.

The following fairs were included in the itinerary:

FAIR	COUNTY	ATTENDANCE
New Bloomfield.....	Callaway.....	6,000
Knox City.....	Knox.....	16,000
St. Joseph Inter-State.....	Buchanan.....	2,000

Bolivar.....	Polk.....	14,000
Butler.....	Bates.....	5,000
Troy.....	Lincoln.....	5,500
Trenton.....	Grundy.....	1,800
New Cambria.....	Macon.....	5,000
Montgomery City.....	Montgomery.....	8,000
Sedalia.....	Pettis.....	84,762

Correspondence. One of the most direct means of giving information in farm practice to the farmers of the state is thru the medium of correspondence—the direct question and answer method. Out of the 76,000 letters written by members of the Agricultural Experiment Station staff during the last year, fully 50 per cent were answers to questions of immediate and pressing importance to practical farmers. A large proportion of the remainder asked for bulletins on farm topics.

INSPECTION SERVICE

Fertilizer Control. The inspection of commercial fertilizers in Missouri is vested by law with the Agricultural Experiment Station. The results of the inspection for 1913 were reported in Bulletin 116. Through this service the farmers are enabled to know whether the fertilizer they buy contains the plant food which the manufacturer guarantees. The result of this year's work shows that there is a marked improvement in respect to the guaranteed chemical composition of the fertilizers sold in Missouri. The manufacturers of fertilizer are putting out goods more nearly in accordance with the guarantee.

Nursery Inspection. This is the first full year during which the nursery inspection has been conducted. During the year 125 nurseries were inspected. These were located in forty-five different counties. Of this number 114 received inspection certificates. Of the smaller nurseries twenty-three that had been regularly inspected previous to the passage of the law, establishing the inspection service were found to be infested with the San Jose Scale and required treatment before certificates could be issued. There are nearly 3000 acres of nursery stock in Missouri.

STATISTICAL SUMMARY OF AGRICULTURAL EXTENSION ACTIVITIES

The following statistical report is valuable as indicating the amount of work which has been accomplished by the staff of the College of Agriculture; some of the results achieved, and particularly

the number of people that have been reached by the various extension activities. From the reports summarized below it is apparent that the College of Agriculture has reached directly 737,264 people in one year. There can be no doubt that these persons, representing as they do a very large per cent of the agricultural people of Missouri, have been powerfully influenced in the direction of better farming, higher ideals, and better living thru the services rendered by the College of Agriculture.

Branch Short Courses.

Number given.....	12
Number of instructors.....	16
Total enrollment.....	1522
Average daily attendance.....	57

The Farmers' Short Course.

Number courses offered.....	11
Number of lectures in short course.....	128
Number of instructors giving work.....	37
Number persons attending.....	2240
Number Missouri counties represented.....	92
Number states represented.....	19

Farmers' Institutes.

Number of institutes attended.....	10
Number of counties.....	10
Number of addresses given.....	20
Number of people addressed.....	1715

Special Trains.

Number of trains.....	4
Number of cars.....	14
Number of counties.....	31
Number of addresses.....	107
Number of people addressed.....	12,500

Special Lectures.

Total number of addresses.....	27
Total number of counties.....	11
Total number of people addressed.....	3895

Short Course for Boys and Girls.

Total length of course.....	4 days
Number of boys and girls.....	65
Number of counties represented.....	13
Number of instructors.....	20

Boys' Corn Growing Contest.

Number of boys enrolled..... 3000
 Number of counties represented..... 107
 Number of samples exhibited..... 725

Boys' and Girls' Clubs (March 1, 1914, to June 30, 1914).

Number of clubs organized..... 123
 Number of members..... 1642
 Number of circulars sent out..... 30,283

Cooperation with Farmers.

Department	Number of Projects	Number of Cooperators	Number of Counties Cooperating
Soils.....	1	19	19
Farm Crops.....	17	149	68
Entomology.....	4	400	80
Dairy.....	2	7	7
Farm management	4	45	28
Forestry.....	1	3	3
Horticulture.....	1	29	14
Totals.....	30	652	219

Live Stock Shows Judged.

Number of shows..... 57
 Number of counties..... 42
 Number of days judging..... 146
 Number of animals judged..... 8051
 Number of people attending..... 380,736

Judging at Corn Shows.

Number of shows judged..... 21
 Number of counties..... 18
 Number of days judging..... 31
 Number of exhibits judged..... 1982
 Number of people attending..... 130,900

Spraying Demonstrations Given.

Number of orchards sprayed..... 29
 Number of counties visited..... 14
 Average cost of spraying..... \$ 16 per acre
 Average net profit from spraying..... \$176 per acre

Free Seed Testing.

Number of tests:	
Germination.....	1288
Purity.....	771
Identification.....	62
Rough Examination.....	100
Total tests.....	2221
Number of samples:	
From farmers.....	875
From seedsmen.....	645
Total.....	1520

Concrete Silos.

Plans supplied for concrete silos.....	150
Construction supervised.....	10

Educational Scoring of Butter.

Number of contests held.....	6
Number of creameries taking part.....	23
Number of samples scored and analyzed.....	58

Creamery Assistance.

Creameries visited.....	12
Cream shipping stations visited.....	2
Ice cream factories visited.....	2
City milk plants visited.....	1

Cow Testing Associations.

Number of cows tested.....	500
Number of owners.....	42
Number of associations.....	2

Official Testing of Dairy Cows.

Number of cows tested.....	141
Number of breeders.....	18
Number of counties.....	11

Agriculture in Rural Schools (July 1, 1913-Mar. 1, 1914).

Number of schools visited.....	82
Number of addresses.....	150
Number of teachers addressed.....	3000
Number of people addressed.....	15,329
Number of teachers meetings attended.....	36

County Agricultural Agents (Farm Advisers).

Number of new counties organized.....	3
Total number of counties having county agents	13
Number of farms visited.....	3,516
Number of farmers' meetings attended.....	1,056
Attendance of farmers at farmers' meetings....	104,210
Organizations perfected.....	50
Members of organizations perfected.....	2,550
Articles written and published.....	1,287
Letters written.....	40,487
Schools assisted in giving agricultural instruction.....	537
Pupils reached.....	13,515
Silos constructed.....	159
Acres of corn influenced by County Agents....	144,979
Acres of wheat influenced by County Agents....	24,917
Acres of oats influenced by County Agents....	9,200
Farmers influenced to grow alfalfa.....	646
Acres alfalfa affected.....	4,031
Registered sires secured.....	73
Hogs vaccinated.....	32,632
Anti-hog-cholera clubs organized.....	30
Tons of lime used.....	2,546
Local sources of lime developed.....	9
Acres of soybeans and cowpeas grown.....	16,759
Amount of business done through co-operative organizations.....	\$16,010
Cattle vaccinated for blackleg.....	452
Report from eleven men only. One man died and one just started in work.	
Average length of service for eleven men....	11.4 mo.

Agricultural Exhibits at Fairs.

Total number of fairs.....	10
Total attendance.....	148,062

Number of Letters.

Animal Husbandry.....	7,033
Farm Crops.....	6,419
Soils Department.....	3,155
Poultry Husbandry.....	1,000
Dairy Husbandry.....	4,461
Entomology.....	3,542

Horticulture.....	3,319
Farm Management.....	3,600
Forestry.....	500
Agricultural Chemistry.....	1,600
Veterinary Science.....	5,585
Dean's Office.....	30,959
Rural Education.....	3,000
<hr/>	
Total.....	76,173

Inspection Service

Fertilizer Control.

Number of samples collected.....	800
Number of samples analyzed.....	500

Nursery Inspection.

Number of nurseries inspected.....	125
Number of certificates granted.....	114
Counties in which inspection was made.....	45

FINANCIAL STATEMENT

The Missouri Agricultural Experiment Station, in account with
the United States Appropriation
1913-14

	Dr.	Cr.
To receipt from Treasurer of the United States as per appropriation for the year ending June 30, 1914, under the acts of Congress approved March 2, 1887, and March 16, 1906.....	\$30,000.00	
By Salaries.....		\$17,624.59
By Labor.....		3,197.51
Publications.....		975.34
Postage and Stationery.....		115.17
Heat, Light and Water.....		15.40
Chemical Supplies.....		932.15
Seed, Plants and Sundry Supplies.....		1,381.82
Fertilizer.....		121.88
Feeding Stuffs.....		2,776.55
Tools, Implements and Machinery.....		258.60
Furniture and Fixtures.....		8.80
Scientific Apparatus.....		659.41
Live Stock.....		741.89
Traveling Expenses.....		509.50
Contingent Expenses.....		22.00
Building and Repairs.....		659.79
	\$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 Missouri Agricultural Experiment Station for the fiscal year ending June 30, 1914, that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been \$30,000, and the corresponding disbursements \$30,000, 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.

THOMAS J. WORNALL, Chairman,
J. C. PARRISH,
SAM SPARROW.