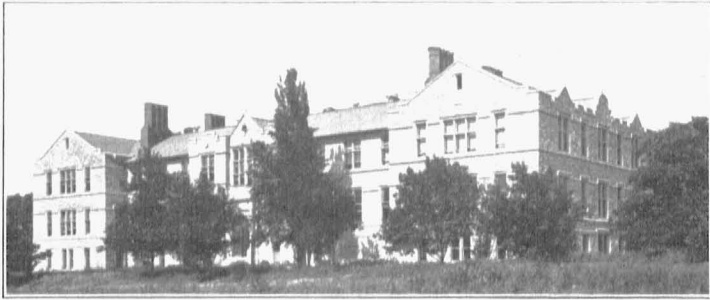


UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

Agricultural Experiment Station

BULLETIN No. 117



SCHWEITZER HALL

Report of the Director

for the Year Ending June 30, 1913

COLUMBIA, MISSOURI
February, 1914

UNIVERSITY OF MISSOURI
COLLEGE OF AGRICULTURE
Agricultural Experiment Station

BOARD OF CONTROL.
THE CURATORS OF THE UNIVERSITY OF MISSOURI.

EXECUTIVE BOARD OF THE UNIVERSITY.
THOMAS J. WORNALL, Chairman,
Liberty.

J. C. PARRISH,
Vandalia.

SAM SPARROW,
Kansas City.

ADVISORY COUNCIL.
THE MISSOURI STATE BOARD OF AGRICULTURE.

OFFICERS OF THE STATION.
THE PRESIDENT OF THE UNIVERSITY.
F. B. MUMFORD, M. S., Director, Animal Husbandry.

J. W. Connaway, D.V.S., M.D., Veterinary Science.
Frederick Dunlap, F.E., Forestry.
C. H. Eckles, M.S., Dairy Husbandry.
W. L. Howard, Ph.D., Horticulture.
C. E. Hutchison, M.S.A., Agronomy.
M. F. Miller, M.S.A., Agronomy.
G. M. Reed, Ph.D., Botany.
E. A. Trowbridge, B.S.A., Animal Husbandry.
P. F. Trowbridge, Ph.D., Agricultural Chemistry.
J. C. Whitten, Ph.D., Horticulture.
H. O. Allison, M.S.A., Animal Husbandry.
H. L. Kempster, B.S.A., Poultry Husbandry.
A. J. Meyer, Assistant to Director.
L. S. Backus, D.V.M., Veterinary Science.
T. R. Douglass, B.S.A., Agronomy.
J. B. Gingery, D.V.M., Veterinary Science.
Howard Hackedorn, B.S.A., Animal Husbandry.
J. C. Hackleman, M.A., Agronomy.
L. D. Haigh, Ph.D., Agricultural Chemistry.
Leonard Haseman, Ph.D., Entomology.
O. R. Johnson, M.A., Farm Management.
H. F. Major, B.S.A., Landscape Gardening.
C. R. Moulton, Ph.D., Agricultural Chemistry.
L. S. Palmer, Ph.D., Dairy Chemistry.
L. G. Rinkle, M.S.A., Dairy Husbandry.
L. A. Weaver, B.S.A., Animal Husbandry.
P. L. Gainey, M.S., Assistant, Botany.
R. R. Hudelson, B.S.A., Assistant, Agronomy.
C. A. LeClair, M.S., Assistant, Agronomy.
E. C. Pegg, M.S., Assistant, Forestry.
C. E. Brashear, B.S.A., Assistant, Animal Husbandry.
C. E. Deardorff, B.S.A., Assistant, Soil Survey.
A. J. Durant, B.S.A., Research Assistant, Veterinary Science.
A. R. Evans, B.S.A., Assistant, Agronomy.
W. E. Foard, B.S.A., Assistant, Farm Management.
J. F. Hamilton, Assistant, Veterinary Science.
Elmer H. Hughes, B.S.A., Assistant, Animal Husbandry.

F. Z. Hutton, (1) B.S.A., Assistant, Soil Survey.
M. A. R. Kelley, B.S. in Agr., Assistant, Agronomy.
E. W. Knobel, B.S.A., Assistant, Soil Survey.
H. H. Krusekopf, B.S.A., Assistant, Soil Survey.
T. C. Reed, B.S.A., Assistant, Dairy Husbandry.
W. Regan, B.S.A., Assistant, Dairy Husbandry.
Helman Rosenthal, B.A., Assistant, Agricultural Chemistry.
O. C. Smith, A.B., Assistant, Agricultural Chemistry.
A. C. Stanton, B.S.A., Assistant, Dairy Husbandry.
E. R. Spence, B.S.A., Assistant, Veterinary Science.
A. T. Sweet, (1) A.B., Assistant, Soil Survey.
Boleslaus Szymoniak, B.S.A., Assistant, Horticulture.
Thomas J. Talbert, B.S.A., Assistant, Entomology.
B. W. Tillman, (1) B.S.A., Assistant, Soil Survey.
T. T. Tucker, B.S.A., Assistant, Veterinary Science.
E. E. Vanatta, M.S.A., Assistant, Agricultural Chemistry.
E. S. Vanatta, (1) B.S.A., Assistant, Soil Survey.
W. I. Watkins, B.S.A., Assistant, Soil Survey.
C. C. Wiggans, A.M., Assistant, Horticulture.
C. A. Webster, B.S.A., Assistant, Poultry Husbandry.
George Reeder, (1) Dir. Weather Bureau.
Flora G. Ernst, (1) A.M., Seed Testing Laboratory.
J. G. Babb, M.A., Secretary.
R. B. Price, B.S., Treasurer.
R. H. Gray, Accountant.
T. D. Stanford, Clerk.
Valley Boyce, A.B., Stenographer.
J. F. Barham, Photographer.
Arthur Rhys, Herdsman, Animal Husbandry.
C. M. Pollock, Herdsman, Dairy Husbandry.

(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."

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, 1913.

Respectfully submitted,
F. B. MUMFORD, Director.

TABLE OF CONTENTS

	PAGE
Changes in Station Staff	404
New Buildings and Equipment	405
Free Mailing Lists	405
Publications	406
Synopses of Experiment Station Publications	408
Experiment Station Projects	413
Progress in Investigation	416
Agronomy	416
Animal Husbandry	418
Botany	420
Department of Dairy Husbandry	421
Entomology Department	423
Farm Management Department	425
Forestry Department	426
Department of Horticulture	427
Department of Zoology	430
Co-operation with the United States Department of Agriculture..	431
Investigation and Co-operation out in the State	432
College Extension Service	435
Summary of Various Extension Activities	440
Financial Statement	443

REPORT OF THE DIRECTOR.

F. B. MUMFORD

The work of the Experiment Station is fundamental. The future progress of the practice of agriculture, as well as the science upon which practice is based, depends upon the efficient organization and conduct of the Agricultural Experiment Station. It is particularly important that this fact be emphasized at the present time. The interest in agricultural teaching, which has resulted in a great increase in the enrolment of students at the colleges of agriculture and the introduction of the subject of agriculture into secondary schools throughout the United States, has greatly emphasized the demand for the teaching of this subject. The colleges and experiment stations also are called upon for a variety of services. Demands are made on experiment station men for lectures at farmers' meetings, for advice upon methods of farming, requests for assistance in the organization and administration of farm projects, and for many other similar services. So insistent are these demands that men engaged in serious teaching and investigation are no longer able to perform the amount of extension work required.

The function of the Experiment Station is fundamental research. The investigators engaged in research should not be called upon to do extension work. The best type of extension work, however, is based upon original investigation, and the work of the Experiment Station, therefore, will become the basis of all effective extension work as it has been the basis of effective college teaching in the technical subjects of agriculture.

The time has come when more definite organization and differentiation between teaching in the college, research in the experiment station and extension work should be made. A more definite differentiation of these various activities will result in more effective investigational work. It will be the policy of the Missouri Experiment Station to emphasize more and more fundamental research.

CHANGES IN STATION STAFF.

During the year twenty-four new men have been appointed to the College and Experiment Station staff. Nine members have resigned to accept positions elsewhere or to engage in other work.

New Appointments

- J. B. Gingery, D. V. M., Assistant Professor of Veterinary Science.
 Howard de Forest, M. F., Acting Assistant Professor of Forestry.
 E. C. Pegg, M. F., Instructor in Forestry.
 P. L. Gainey, M. S., Instructor in Botany.
 M. A. R. Kelley, B. S. in M. E., Assistant in Agronomy.
 A. R. Evans, B. S. A., Assistant in Agronomy.
 L. B. Burke, B. S. A., Assistant in Animal Husbandry.
 Joseph B. Latshaw, B. S. A., Assistant in Veterinary Science.
 R. R. Hudelson, B. S. A., Assistant in Agronomy.
 W. E. Foard, B. S. A., Assistant in Farm Management.
 T. C. Reed, B. S. A., Assistant in Dairy Husbandry.
 C. E. Deardorff, B. S. A., Assistant in Soil Survey.
 Helmar Rosenthal, B. A., Assistant in Agricultural Chemistry.
 Wm. E. Regan, B. S. A., Assistant in Dairy Husbandry.
 W. I. Watkins, B. S. A., Assistant in Soil Survey.
 E. W. Knobel, B. S. A., Assistant in Soil Survey.
 L. O. Muench, Research Assistant in Veterinary Science.
 S. M. Jordan, Farm Adviser for Pettis Co.
 H. H. Laude, B. S. A., Farm Adviser for Marion Co.
 E. J. Rodekohr, B. S. A., Farm Adviser for Dade Co.
 F. W. Faurot, B. S. A., Farm Adviser for Buchanan Co.
 E. A. Ikenberry, B. S. A., Farm Adviser for Jackson Co.
 E. W. Rusk, B. S. A., Farm Adviser for Audrain Co.
 C. M. Long, B. S. A., Farm Adviser for Johnson Co.

Resignations.

- J. A. Ferguson, M. A., M. F., Professor of Forestry.
 G. C. White, B. S. A., Instructor in Dairy Husbandry.
 C. E. Wilson, B. S. A., Assistant in Veterinary Science.
 L. E. Morgan, A. B., Assistant in Agricultural Chemistry.
 W. W. Wobus, B. S. A., Assistant in Dairy Husbandry.
 E. C. Hall, B. S. A., Assistant in Soil Survey.
 H. G. Lewis, B. S. A., Assistant in Soil Survey.
 L. V. Davis, B. S. A., Assistant in Soil Survey.
 W. E. Camp, Research Assistant in Veterinary Science.

NEW BUILDINGS AND EQUIPMENT.

The completion of Schweitzer Hall adds to the College and Station equipment a number of laboratories and class rooms which were much needed. Schweitzer Hall is a building one hundred seventy-six feet long and sixty-three feet wide. It comprises two stories with a high, well-lighted basement. Besides the necessary offices, it contains five student laboratories, four class rooms, special research laboratories, and laboratories for the chemical work of the Agricultural Experiment Station. The entire first floor together with a part of the basement is devoted to Agricultural Chemistry. In the south wing of the basement is a well equipped nutrition laboratory. Besides this laboratory, there is a meat demonstration room and a refrigerating room. The latter is eighteen by twenty feet in size and has a capacity for several dressed beeves at one time.

The development of the work of investigation has made necessary an increase in the departmental equipment throughout the Experiment Station. Much of this equipment is of a permanent character. This equipment includes a large variety of laboratory and field supplies.

The agricultural library has added during the past year 273 new books on agricultural subjects. In addition to this 549 farm journals and agricultural reports have been permanently bound and 1579 publications have been added as exchanges or gifts. The total number of volumes now in the library is 10,001.

FREE MAILING LISTS.

The plan of classifying the Experiment Station mailing list has been extended so as to include all Experiment Station officers and members of the United States Department of Agriculture. At the close of the fiscal year 1912-13, the number of names appearing under the various classifications is as follows:

Classification of Free Mailing Lists.

	Farmer List		Official List	
	Missouri	United States	College	U. S. Dept.
Fertilizers	1748	327	266	18
Dairy Husbandry	1670	548	457	22
Animal Husbandry	3459	604	540	26
Farm Crops and Soils	4293	871	815	76
Horticulture	1752	625	661	67
All publications	2499	588	424	48

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

Libraries	336
Presidents, Deans and Directors	137
Foreign	74
Missouri Newspapers	700
Missouri Farm Journals	37
United States Agricultural Journals	551

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 eight new circulars, ten reprints of circulars, eight new bulletins, one bulletin reprint, one research bulletin and two indexes have been issued. The size of the editions have been somewhat increased in order to meet the demands of a larger mailing list. Altogether these publications contained a grand total of 3,713,600 pages. In addition to the above, nineteen press bulletins were sent out to newspapers, farm journals, libraries and to officials of the Experiment Stations and United States Department of Agriculture. The College, through 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. 56, Some Factors in Wheat Production.
- No. 57, Keeping Records of Dairy Cows.
- No. 58, The Missouri Fertilizer Law.
- No. 59, The Farm Adviser in Missouri.
- No. 60, The County Farm Adviser Plan.
- No. 61, Docking and Castrating Lambs.
- No. 62, The Chinch-bug and Its Control.
- No. 63, Inspection Service, Control of Insect Pests and Plant Diseases.

Reprints of Circulars.

- No. 37, Variations in Cream Tests.
- No. 40, The Seeding of Alfalfa.
- No. 41, Directions for Testing Milk on the Farm.
- No. 42, The Seeding of Clovers and Grasses.
- No. 44, Feeding for Milk Production.
- No. 46, Factors Influencing the Yield of Oats.
- No. 47, Raising Calves on Skim Milk.
- No. 50, Selection of Corn for Seed and for Show.
- No. 51, How to Prolong the Life of Fence Posts.
- No. 53, The Seeding of Cowpeas.

New Bulletins

- No. 105, Partial Bibliography and Index of Publications of the College of Agriculture and the Agricultural Experiment Station.
- No. 106, Co-operative Experiments with Alfalfa.
- No. 107, Farm Poultry House Construction.
- No. 108, Grass Investigations in the Ozark Upland.
- No. 109, Inspection of Commercial Fertilizers.
- No. 110, Forage Crop Rotations for Pork Production.
- No. 111, Report of the Director for the Year Ending June 30, 1912.
- No. 112, Corn Silage for Fattening Two-Year-Old Steers.

Bulletin Reprints

- No. 103, The Silo for Missouri Farmers.

New Research Bulletins

- No. 6, The Distribution of Farm Labor.

Miscellaneous

Index to Bulletins, 97 to 104.

Index to Research Bulletins, 1 to 3.

Press Bulletins

1. Filling the Silo by P. M. Brandt.
2. The Fall Army Worm by L. Haseman.
3. Seed Testing for Missouri Farmers by M. F. Miller.
4. Keeping up the Milk Yield by P. M. Brandt.
5. Fighting the Chinch Bug with Fire by L. Haseman.
6. Silage for Breeding Ewes by H. Hackedorn.
7. Corn Varieties for Missouri by T. R. Douglass.
8. Missouri Should Grow More Cowpeas by M. F. Miller.
9. The Supply of Organic Matter in the Soil by M. F. Miller.
10. Discing Corn Land Before Breaking by J. C. Hackleman.
11. Controlling the Chinch Bug by L. Haseman.
12. Soybeans a Coming Crop by J. C. Hackleman.
13. Fire Blight of the Apple by J. C. Whitten.
14. Eradicating Dodder by J. C. Hackleman.
15. The Concrete Silo by P. M. Brandt.
16. Save Corn by Shallow Cultivation by F. B. Mumford.
17. Gapes and Its Cure by H. L. Kempster.
18. To Help Farmers Build Silos by P. M. Brandt.
19. Produce Infertile Eggs by H. L. Kempster.

SYNOPSIS OF EXPERIMENT STATION PUBLICATIONS

Bulletin No. 105, Partial Bibliography and Index of the College of Agriculture and the Agricultural Experiment Station, by H. O. Severance. 19 pp.—Gives a list of all bulletins and circulars issued formerly as Missouri State Agricultural College Farm Bulletins and later as publications of the Agricultural Experiment Station. An index is supplied for forty-five of the first circulars published and eighty-two of the first bulletins. This bulletin makes available the material published by the College of Agriculture and the Agricultural Experiment Station prior to the publication of bulletin No. 83 which has already been indexed in connection with the second volume of the Agricultural Experiment Station bulletins.

Bulletin No. 106, Co-Operative Experiments with Alfalfa, by M. F. Miller and C. B. Hutchison. 37 pp., 6 ill.—This bulletin records the work of the Experiment Station in one hundred and eleven trials with alfalfa on the various soil types of the State. As a result of these trials the following conclusions are drawn:

1. The best alfalfa lands in Missouri are the well drained silt and sandy loam bottom lands underlaid with porous subsoil;
2. The level prairie lands of the State show poor adaptation to alfalfa growing;
3. A liberal application of manure is uniformly beneficial and often necessary to secure a satisfactory stand of alfalfa on most upland soils;
4. The use of bone meal has aided in securing a profitable stand and increasing a yield of hay;

5. Inoculation of the soil with nitrogen-gathering bacteria has been found beneficial or necessary on the majority of soils tested.

Bulletin No. 107, Farm Poultry House Construction, by H. L. Kempster. 34 pp., 35 ill.—A discussion of the essentials of a poultry house with detailed descriptions of several types of houses which supply these essentials. The importance of locating a poultry house away from other farm buildings and on well drained soil is emphasized. The portable colony house is recommended as an essential to a complete poultry equipment. For quick shade, corn or sunflowers are advised although fruit trees and bushes are recommended for permanent use. The value of concrete floors from the standpoint of ready means of disinfection, dryness and freedom from vermin is pointed out by the writer. Form of ventilation by the open front poultry house, the straw loft or muslin frame is strongly advised. The King System of ventilation is too expensive to be practical under ordinary conditions. Tight walls are considered absolutely necessary in order to prevent drafts. The bulletin gives drawings, showing the different types of ordinary nests and also of trap nests. Special emphasis is laid upon the interior arrangement of the poultry house so as to save time in feeding and caring for fowls.

Bulletin No. 108, Grass Investigations in the Ozark Upland, by M. F. Miller and C. B. Hutchison. 47 pp., 20 ill.—This publication publishes the results of seventeen experiments in thirteen of the Ozark counties of Missouri. In these experiments, thirteen different kinds of clovers and grasses were used in an attempt to ascertain the adaptation of each to the particular locality and the peculiar soil formations characterizing portions of the Ozarks. The results of the investigations recorded show that orchard grass is especially well adapted to the greater portion of this region. Red top, Kentucky bluegrass and timothy rank next in order, from the standpoint of general adaptation. Of the clovers, the alsike and white have proven quite generally adapted to all but the driest lands, where Japan clover is better suited. The application of manure shows a universal benefit. Commercial fertilizers particularly in the form of bone meal have shown good results but dried blood has not been a paying proposition. In only one investigation did lime prove of value. For permanent pastures a mixture of grasses is recommended. In the better class of soils the following mixtures are offered:

1. Kentucky bluegrass, 8 pounds; orchard grass, 5 pounds; timothy, 5 pounds; red top, 3 pounds; red clover, 2 pounds; alsike and white clover, 2 pounds each.
2. Kentucky bluegrass, 8 pounds; timothy, 5 pounds; red top, 4 pounds; alsike clover, 2 pounds.
3. Kentucky bluegrass, 8 pounds; orchard grass or timothy, 6 pounds; red clover, 2 pounds; white clover, 2 pounds.

For the dryer, gravelly lands, mixtures such as the following are recommended:

1. Orchard grass, 8 pounds; Kentucky bluegrass, 5 pounds; red clover, 3 pounds.
2. Orchard grass, 8 pounds; Kentucky bluegrass, 5 pounds; red top, 4 pounds; red clover, 2 pounds; white clover, 1 pound.

Spring seeding is almost invariably to be preferred and the seeding should be done without disturbing the ground other than to burn the leaves where they are heavy. If the land is reasonably free from stumps a little harrowing after seeding is desirable.

Bulletin No. 109, Inspection of Commercial Fertilizers, by P. F. Trowbridge. 38 pp.—A review of the year's work under the fertilizer inspection law. The bulletin records the analysis of seven hundred samples of fertilizers, each sample representing from a few sacks to a car load or more. Special attention is called to certain brands of fertilizers which have been found to be either low in plant food value or not to have the relative amounts of plant food which are guaranteed. The bulletin serves as a valuable guide to prospective purchasers of commercial fertilizers in any form.

Bulletin No. 110, Forage Crop Rotations for Pork Production, by F. B. Mumford and L. A. Weaver. 29 pp., 7 ill.—Five years' work in the investigation of the relative value of

forage crops for pork production is recorded. The investigations reported include not only the actual value of different crops but the productive value of a given area under different systems of rotation. Measured in terms of pork produced, bluegrass shows the best average return per acre. The three-year rotation of rape, oats and clover followed by clover the second year and corn the third year gives practically equal results with bluegrass. Cropping continuously with corn and cowpeas ranks third in average return per acre, although there is evidence to show that continuous cropping in this manner would gradually make the system less profitable. If barnyard manure were to be applied each year, continuous cropping of corn and cowpeas would no doubt give satisfactory results. In order to supply a continuous forage during the entire growing season, it is necessary to combine two or more rotations. When fed on green pasture a bushel of corn proved to be worth \$1.10 as compared to 66 cents when fed to hogs in dry lot under otherwise comparable conditions. Of the single forage crops, clover proved to be the most profitable, with the combination of rape and oats next in value. A good system of forage crop rotation for Missouri is a three-year rotation of rape, clover and corn in conjunction with permanent bluegrass pasture.

Bulletin No. 111, Report of the Director for the Year Ending June 30, 1912, by F. B. Mumford. 46 pp.—This report shows fourteen additions to the staff of the Experiment Station and five resignations. The completion of the new dairy barn, a breeding and exhibition house for the Poultry Department, a seed house for the Agronomy Department together with a number of small buildings is a partial record of the additions to the equipment of the Station. Twenty-one new publications and three reprints representing a total of 2,888,500 pages is the record of the Experiment Station publications for the year. The report shows fifty-seven old projects which have been continued during the year, ten projects which are new and six projects closed. The extension work in the College of Agriculture is classified under the head of Investigation which includes five distinct lines of work, Teaching and Demonstration, which includes fourteen lines of work and Inspection which includes Fertilizer Control and Nursery Inspection. During the year under consideration 63,680 letters and post cards were received and answered by members of the Station staff; this being an increase of 21.5 per cent over the preceding year. Members of the College staff delivered 741 addresses during the year, reaching a total of 109,577 people. Ninety-two corn and live stock shows were judged by men from the College. This required the services of twenty-three men, and represents a total of one hundred and sixty days' work. There were 7026 animals judged and nearly 2000 samples of grain were passed upon. The shows were attended by 365,645 people. Two hundred and four farmers co-operated with the Experiment Station, mainly with the Agronomy Department. The co-operators represented nearly every county in Missouri. During the year 160,000 doses of hog cholera serum were sent out from the College and used in 2313 herds. Five-day Branch Short Courses were held at nine different points in the State. The total number of farmers attending these courses was 672. Over 3000 bulletins and circulars relating to agriculture were placed directly in the hands of Missouri teachers through the Department of Rural Education. Approximately two thousand teachers were addressed on the subject of reorganizing the course of study for rural schools making agriculture the central subject. Through special trains and special lectures more than 31,000 rural school patrons were reached during the year. A soil and agricultural survey of four Missouri counties was completed during 1911 and three during 1912. The work is carried on in co-operation with the United States Department of Agriculture.

Bulletin No. 112, Corn Silage for Fattening Two-year-old Steers, by H. O. Allison. 18 pp., 6 ill.—Records the results of a feeding trial with five lots of two-year-old cattle. The purpose of this experiment was to secure data concerning the relative value of clover hay and corn silage, to compare silage with shock-corn, to ascertain the importance of feeding a dry

roughage in addition to silage and to study the value of a nitrogenous concentrate when fed with corn silage. The value placed upon different feeds was as follows:

- Shelled corn, 40 cents per bushel
- Ear corn, (70 lbs. per bushel) 40 cents per bushel
- Linseed oil meal, \$33.00 per ton
- Corn silage, \$3.50 per ton
- Clover hay, \$10.00 per ton
- Corn stover, \$2.50 per ton.

Some of the conclusions are as follows:

No. 1. A ton of silage as used in this experiment was equal to one-half ton of clover hay.

No. 2. On the basis of net profit a ton of dry matter in the form of corn silage yielded 50.3 per cent greater value than a ton of dry matter in the form of shock-corn.

No. 3. The addition of clover hay to a ration in which silage was used was decidedly profitable.

No. 4. This feeding trial indicates that cattle receiving corn silage as the only roughage do not continue to do well for longer than 90 days.

No. 5. Corn silage was most valuable when used in connection with a high protein concentrate.

No. 6. The ration which produced the most economical gains, the largest gains, the best finish and the greatest profit per head was that made up of shelled corn, linseed oil meal (1 lb. to 16 lb. shelled corn), corn silage and clover hay.

Research Bulletin Number 6, the Distribution of Farm Labor, by O. R. Johnson. 36 pp., 7 ill.—This summarizes the subject of labor distribution as applied to four typical Missouri farms, comprising a total of 723 acres devoted to diversified farming with some dairying. For purposes of record, labor is divided into maintenance, crop, and other production. The data collected shows that 17% of all labor was devoted to maintenance, 28% to crop, and 55% to other production. The following table indicates the division of labor among the various farm crops:

	Man Hours	Horse Hours
Corn.....	31.60	40.20
Oats.....	10.44	16.42
Wheat.....	18.38	25.70
Clover.....	7.66	8.43
Rye.....	13.25	24.59
Timothy.....	6.50	9.65
Rape.....	2.30	6.40
Cowpeas (cultivated).....	24.80	34.30
Cowpeas (uncultivated).....	22.78	25.06

Circular No. 56, Some Factors in Wheat Production, by M. F. Miller and J. C. Hackleman. 12 pp., 5 ill.—A discussion of practical methods of wheat production based upon results obtained in co-operation with Missouri farmers and investigations on outlying fields. The circular advises July plowing for fall wheat except in the extreme southern part of the State. A depth of six or seven inches is recommended for early fall plowing and five inches for later plowing. Nitrogen and phosphorus fertilizers are advised. For most Missouri uplands, potash is rarely useful. On the limestone wheat lands of South Missouri the use of 150 pounds of steamed bone per acre is recommended. On the more worn areas a fertilizer containing three or four per cent nitrogen, eight to ten per cent available phosphoric acid and three or four per cent potash applied at the rate of 125 to 150 pounds per acre is found

profitable. For permanent results, fertilizer should be used in connection with a system of crop rotation which involves the use of clover, cowpeas and barnyard manure. Spring harrowing of wheat is not generally profitable except to harrow in clover seed. The following varieties are recommended:

Bearded Wheats—Dietz, Rudy, Mediterranean, Fulcaster, Lebanon,

Smooth Wheats—Michigan Wonder, Jones Red Wave, Hickman, Beechwood Hybrid,

Dawson's Golden Chaff, Early Ripe, Poole and Fultz.

The time of seeding wheat should be as soon as possible after the danger of the Hessian fly is past. In Central Missouri this is usually from September 15 to October 1 and in extreme North Missouri ten days earlier; in extreme South Missouri from ten to fifteen days later. From five to six pecks of seed per acre has proven the most desirable seeding. Work done at the Missouri Experiment Station indicates that there is a possibility of selecting rust resistant varieties of wheat.

Circular No. 57, Keeping Records of Dairy Cows, by C. H. Eckles. 8 pp., 6 ill.—At the Missouri Experiment Station one Jersey cow produced three times as much milk and butter per year for three years as did her half sister, both consuming about the same amount of feed. This fact taken from the records of the dairy herd supplies the text for Circular No. 57. This publication describes the method of keeping milk records and other records which are of incidental value in putting system into the dairy. The equipment needed in addition to the milk record sheets comprises a good spring balance and a milk testing outfit.

Circular No. 58, the Missouri Fertilizer Law, by F. B. Mumford. 4 pp.—A statement of the Missouri Fertilizer Law, approved March 14, 1903, with prefatory remarks by the author calling attention to the important requirements of the law. Under the provision of this statute, every manufacturer or dealer must register with the Missouri Experiment Station all brands of fertilizers offered for sale in Missouri together with a guaranteed chemical composition of the same. Every package of fertilizer sold in the State must bear a printed tag signed by the director of the Experiment Station, certifying to the fact of registration. The Experiment Station is required to collect from the open market, samples of all brands of fertilizers sold in the State, make a chemical analysis of each brand and publish annually a detailed report of such inspection and analyses of samples collected.

Circular No. 59, the Farm Adviser in Missouri, by F. B. Mumford and D. H. Doane. 14 pp.—This circular gives the acts of the Legislature authorizing counties to appropriate money to employ County Farm Advisers in co-operation with the College of Agriculture and the United States Department of Agriculture. Attention is directed to the importance of the Farm Adviser as a medium through whom the investigational work of the Experiment Station may be put into practical use on Missouri farms. The circular gives in detail directions for the local county manager to follow in securing a Farm Adviser, with suggestive blank forms for each step involved in the organization of a county under the Farm Adviser plan. A form of constitution and by-laws for township and county farm bureaus is presented.

Circular No. 60, the County Farm Adviser Plan, by D. H. Doane. 4 pp.—A condensed statement of the general plan under which Missouri counties may secure Farm Advisers. This publication does not give detailed forms but merely outlines the general scheme and is written to fill the need of a concise statement of the County Farm Adviser project.

Circular No. 61. Docking and Castrating Lambs by H. Hackedorn. 4 pp., 2 ill.—A circular describing methods of docking and castrating lambs as practiced successfully at the Missouri Experiment Station. At this station no difference in weight was noticeable at the end of one month as between entire lambs and those which had been docked and castrated. A dull hatchet,

jack-knife or the hot docking pinchers are recommended for docking. The latter method is especially advised for lambs six weeks old or older.

Circular No. 62, the Chinch-Bug and its Control, by Leonard Haseman. 4 pp.—A brief review of the history of the chinch-bug in Missouri, a description of its life cycle and a discussion of means of combat. Farmers are advised to place little faith in the chinch-bug disease since this disease is always present and under suitable weather conditions will develop without artificial infection. Early winter burning of weeds, trash, stubble, straw and other places in which chinch-bugs winter over, is recommended as the best method of control. In order to prevent the migration of chinch-bugs from infested areas, dust barriers are advised as most simple and effective. A desirable barrier is made by plowing a deep ditch throwing the dirt both ways and dragging a log back and forth in the ditch, during the hot part of the day, so as to keep a layer of dust in the bottom. During wet weather when a dust barrier can not be maintained, one of thick road oil or of tar is advised. The line must be kept fresh by adding more oil from time to time. It may be necessary at first to apply the oil twice a day. The line of oil need not be more than one inch wide. Post holes every rod or so on the side of the line next to the infested field will help to trap the swarms of migrating bugs, when they can be killed by means of a little coal oil.

Circular No. 63, Inspection Service, Control of Insect Pests and Plant Diseases, by F. B. Mumford and L. Haseman. 8 pp.—This circular gives the text of the Missouri Nursery Inspection Law, the main features of which are as follows:

Sec. 1. The Missouri Agricultural Experiment Station is vested with the authority to make the necessary regulations and to carry into effect the provisions of the act.

Sec. 2. Representatives of the Experiment Station are authorized to inspect any premises and take any necessary steps for the destruction of nursery and orchard insects and diseases.

Sec. 3. On or before the first day of July of each year each nurseryman or other person within the State engaged in growing nursery stock for distribution, sale or use in the public parks shall file with the Agricultural Experiment Station an application for the inspection of such nursery stock.

Sec. 4. The Experiment Station must be notified of all shipments of nursery stock from foreign countries and such shipments must be held by the importer until duly inspected and released by the inspector.

Sec. 5. All nursery stock shipped from place to place in Missouri or shipped into Missouri from another state, county or province, must have each car, box, bale or package plainly labelled on the outside with the name of the consignor, the name of the consignee, statements of the contents and a certificate signed by the inspector showing that the contents have been inspected since the first day of the preceding July, and that the nursery stock there present appears free from any dangerous insects and diseases.

Sec. 6. Any owner of an orchard or fruit plantation, or dealer in plant products may apply to the Agricultural Experiment Station for inspection service.

EXPERIMENT STATION PROJECTS.

The following statement of definite projects of investigation in the Experiment Station will indicate the scope and extent of the work being done at this Station. The mere title of the project does not give a very clear idea of the essential character of the investigation but it is of some assistance in determining the nature of the investigational work being accomplished.

In the list of projects which is here printed no attempt at classification has been made. It should be understood however that many of these are major projects, and others are of less significance and should, perhaps, be classified separately as minor projects.

Four projects have been completed and ten new projects have been added during the year. Forty-eight projects have been continued.

Projects Completed.

1. Roughness for Breeding Ewes.
2. Preparation of Corn for Fattening Steers.
3. Cytology of Sporidia.
4. Nutrients Required for Milk Production.

New Projects.

1. Improvement Possible Through Use of Pure Bred Ram.
2. Fall Forage for Lambs.
3. A Comparison of Warm Feed and Water to Cooked and Uncooked Feed and Cold Water.
4. Relative Efficiency of Pregnant Mares for Farm Work.
5. Investigation of Nursery Pests.
6. A Study of the Methods of Prolonging the Service of Wood Fence Posts.
7. Farm Management Survey of Johnson County, Missouri.
8. Classification of Local Rusts.
9. Micro-organisms in Silage.
10. Experiments on the Relative Value of Vermifuges for Hogs.

Projects Begun Prior to July 1, 1912, Still Incomplete.

1. Age as a Factor in Animal Breeding.
2. Use of Feed Experiment.
3. Forage Crop Rotations for Pork Production.
4. Experiments in Crop Rotation.
5. Experiments with Alfalfa Varieties and Alfalfa Culture.
6. Corn Breeding and Variety Tests.
7. Factors Influencing the Development of the Maize Plant.
8. Experiments with Cowpeas and Soybeans.
9. Wheat and Oat Breeding and Variety Tests.
10. Experiments with Various Spring and Fall Sown Forage Crops.
11. Pasture Fertilization and Pasture Rejuvenation Experiments.
12. Experiments in the Associated Growth of Corn and Cowpeas.
13. Cultural and Varietal Experiments with Sweet Clover.

14. Effect of Various Crop Rotations on the Physical Character of the Soil.
15. Factors Influencing the Normal Composition of Milk.
16. Nutrients Required to Develop the Foetus.
17. Factors Influencing the Development of Dairy Heifers.
18. The Rest Period of Plants.
19. Orchard Nutrition.
20. The Cause of Stop-back on Nursery Stock and Methods of Prevention.
21. Investigation of the Life History, Development, Injury and Remedies for the Apple Leaf Hopper.
22. Distribution of Insect Pests in Missouri—Preventive Control.
23. The Effect of Storage Conditions on the Vitality of Forest Tree Seeds.
24. An Investigation of the Method of Culture and Varieties of Basket Willows for Missouri.
25. Farm Cost Accounting.
26. Seasonal Distribution of Labor on the Farm.
27. Peach Breeding for Hardy Sorts.
28. Apple Breeding for Late Blooming Habit.
29. Orchard Tillage, Sod, Clean Cultivation, Mulch, and Combined Cultivation and Cover Crops.
30. Bud Selection for Increasing Yields.
31. Spraying Fruits for Insect and Fungus Diseases.
32. Orchard Heating. (In years when spring frost occurs.)
33. Fruit Bud Development of Fruit Trees, as Influenced by Treatments.
34. Fall vs. Spring Planting of Trees.
35. Self Fertility and Self Sterility of Fruits.
36. Asparagus Selection.
37. Co-Operative Fertilizer Experiments.
38. Powdery Mildews.
39. Grain Smut Infections and Control.
40. Effect of Toxic Substances, as Toluol and CS_2 , on Soil Organisms.
41. An Experimental Study of Hog Cholera and the Factors Concerned in Immunity Against the Disease.
42. Experiments to Determine Whether Hog Cholera Infection is Conserved and Spread by Healthy Immune and Hyperimmune Swine.
43. A Study of the (a) Bacteria Causing Suppurative Conditions in Farm Animals; and, (b) the Therapeutic Value of the "bacterins" made from same.

44. Experiments on "Complement Fixation"—Hog Cholera.
45. Experiments on "Complement Fixation"—Bovine Abortion.
46. The Factors causing Variations in the Potency of Hog Cholera Immunizing Serum.
47. The Transmission of Bovine Tuberculosis.
48. Sex-linked Inheritance of Characters in Poultry.

PROGRESS IN INVESTIGATION.

The following statements describing the progress of the work in the various departments are taken from the annual reports of the chairmen of the departments. These statements have been somewhat abbreviated but, in the main, follow rather closely the original reports of the men in charge.

Agronomy Department.

Associated Growth of Corn and Cowpeas.—There was no excessive reduction of available nitrogen in the soil at any time during the growing season as a result of growing cowpeas with corn. More water was available to corn where grown with cowpeas especially during the months of July to September, inclusive. Corn grown alone is slightly taller, has more leaf surface, yields more corn and stover, and apparently matures a little earlier. As to dry matter produced per acre, the yields were as follows: corn alone, first; corn with cowpeas planted at same time, second; cowpeas alone, third.

Crop Rotation.—The season of 1913 closes the first quarter century of continuous experiments on the same field. The highest average gross return for the various systems of cropping and manuring has been secured with a rotation of corn, wheat and clover (manured), the second highest with continuous timothy (manured), and the third highest with the six year rotation of corn, oats, wheat, timothy and clover (manured). In the last named rotation timothy and clover meadow occupied three of the six years. The lowest average gross return has been with continuous corn without manure. The largest return per ton of manure has been secured on the six year rotation of corn, oats, wheat, clover and timothy (three years meadow) and the second highest on continuous timothy.

The use of a complete commercial fertilizer applied in quantities sufficient to supply the crop has given as high an average yield as barnyard manure, applied at the rate of $7\frac{1}{2}$ tons per acre annually, both when applied on a crop rotation and on straight wheat.

Alfalfa Varieties and Alfalfa Cultivation.—Alfalfa variety tests running since 1910 continue to show marked difference in yield of different varieties as well as distinct difference in the relative hardiness of the various strains. The northern grown varieties, particularly the Minnesota Grimm, are proving superior to Kansas and Nebraska varieties. The hardiness of these Northern varieties seem in part to be associated with a more branched root system which prevents "heaving."

Wheat and Oat Breeding and Variety Tests.—The wheat breeding work was quite successful and about one hundred hybrids which were set to type were harvested for seeding in September, 1913. Several excellent strains secured by selection were retained to be carried in the test. A few selected strains were propagated during the season and distributed to farmers in the fall of 1913.

The wheat variety test gave yields much better than the average. Michigan Wonder, Poole, Fulcaster, Lebanon and Early Ripe were among the best yielders.

The oat breeding work and variety tests were failures due to hot weather and the drought.

Cowpeas and Soybeans.—The cowpea appears to be better for hay production while the soybean is better for yield of seed. The beans are more easily harvested and do not crack so badly in threshing. Seeding tests indicate that both crops for seed should be put in rows and cultivated, about 30 inches being the best width at sixty to sixty-five pounds per acre. Mixtures with millet proved a failure. Both crops were injured by the mixture.

Spring and Fall Sown Forage Crops.—Forage crops sown in August, 1912, harvested May, 1913, showed rye and vetch to be a very satisfactory mixture, but that rye and crimson clover were not satisfactory, due to the fact that crimson clover could not withstand the winter. Vetch alone stands such a winter as that of 1912-13, making an excellent growth and a very fine quality of early spring pasture. Vetch comes much earlier in the spring and stands later in the fall than the crimson clover, therefore seems better adapted for winter cover crops.

Cultural Experiments and Variety Tests with Sweet Clover.—Twenty-eight rows of sweet clover, the seed for which was from as many sources, seeded the previous season were harvested in June, 1913. Variety and individual plant studies are being made as regards their cumarin content for the purpose of determining whether strains of low cumarin content may not be better forage. Cultural

tests as to methods of seeding indicate that sweet clover offers difficulty in securing a uniform stand. It has also been shown that inoculation is needed for successful growth.

Factors Influencing the Development of the Maize Plant.—Experiments have shown that the most important of the three periods in the growth of the corn plant from the standpoint of nutrition is the third period; from the standpoint of moisture, the second. Upland clay loam soil gives a larger root development than sandy bottom land soil. Boone County White shows a larger root development than Reid's Yellow Dent. The growth of parts above ground is not always proportional to the growth of parts below ground. Optimum moisture gives the largest root development; minimum moisture the least. A unit weight of root produced greater weight of top growth in the soil with a maximum moisture content than in either the optimum or minimum moisture contents. A high production of ear corn seems correlated with a dense kernel rather than a starchy kernel and with a large germ rather than a small germ.

Animal Husbandry Department.

Preparation of Corn for Fattening Steers.—Five lots each comprising six choice two-year-old steers were fed a ration of alfalfa hay, corn silage, cold pressed cotton seed cake, and corn in various forms.

Lot I received broken ear corn; Lot II received shelled corn; Lot III received crushed corn and cob; Lot IV received corn and cob meal; Lot V received corn meal.

Each lot was given practically one pound of cold pressed cottonseed cake to six pounds of corn. Each lot was given all the feed it would consume without waste. The test lasted 130 days. The pork produced was credited at eight dollars per hundred weight. This value was deducted in estimating the final cost of producing a pound of beef. The following table presents a final summary.

	COST OF GRAIN PER POUND.	SELLING PRICE PER CWT.	PROFIT PER STEER.
Lot I	\$7.14	\$8.125	\$6.18
Lot II	6.47	8.15	8.96
Lot III	7.31	8.10	6.21
Lot IV	8.41	8.40	4.79
Lot V	7.85	8.40	6.33

Use of food Experiment.—The purpose of this experiment is to compare various planes of nutrition in their influence upon breed-

ing cattle. The experiment was started with calves and at this time no progeny has been produced so that no results can be reported. From the data at hand, it appears that heifers on a high plane of nutrition reach the breeding period at an earlier age but are more uncertain breeders than those maintained on a lower plane of nutrition.

Roughness for Breeding Ewes.—The results of this investigation are as follows:

1. Corn stover proved nearly as efficient as timothy hay;
2. The use of silage instead of stover materially reduced the amount of grain required;
3. Silage, clover hay and grain proved the most economical ration; clover hay and grain was the second in economy;
4. Two pounds of corn silage appeared to be equivalent to one pound of hay in the ration where it was used.

Breeding ewes proved to be very susceptible to poisoning from old silage.

Warm Feed and Water vs. Cooked and Uncooked Feed and Cold Water.—The results of this investigation verify those which have been previously obtained here and elsewhere. Warm feed and warm water showed no advantage over cold feed and water. Unfortunately the weather was warm during practically the entire continuance of this experiment.

Improvements Through Use of Pure Bred Ram.—The results of the first year's work may be summarized as follows:

The average daily gain of lambs sired by the pure bred ram was 6.6 per cent greater than that of the lambs sired by the inferior ram. The former had gained 2.54 pounds more at three months of age than had the latter at four months. The lambs from the inferior ram required 88.78 pounds of grain per hundred pounds gain. The lambs from the pure bred ram required only 52.81 pounds.

Lambs sired by the pure bred ram sold for \$7.35 per hundred pounds, while those sired by the scrub sire brought only \$4.50 per hundred pounds.

Age as a Factor in Animal Breeding.—The investigation of age in relation to animal breeding has been in progress for four years. A sufficient number of generations have been available for studying:

- (a) The influence of early pregnancy on the mother.
- (b) The relative vigor and thrift of offspring from mature and immature parents.

The most important positive result is apparently the stunting effect on the young mother. Careful measurements indicate that early pregnancy interferes with the rate of growth and the ultimate development of the maternal parent.

Botany Department.

Grain Smut Infections and Control.—The work of the past year has conclusively shown that the loose smut of barley and wheat can be completely controlled by the hot water treatment and that when once eradicated in this way, it will not reappear except when introduced from the outside. As a result of manuring the soil abundantly, a development of about seventy per cent of smutted plants has been obtained with the loose smut of oats.

Effect of Toxic Substances on Soil Organisms.—The principal results obtained may be summarized as follows:

1. The detrimental or beneficial effect of toluol or CS_2 upon nitrate accumulation in soils depends (a) upon acting strength of the chemical in question; and (b) upon whether the soil is exposed for the chemical to evaporate.

2. Toluol, in strengths approximating .1 cc. per 100 grams soil, exerts no appreciable effect upon nitrification. If the strength exceeds this it may, and usually does, exert a detrimental or even inhibitory effect upon the process for short periods of incubation. However, if the periods of incubation are extended this harmful effect, which may last as long as one hundred and fifty days, is overcome with strengths up to and including 1 cc. per 100 grams soil, the strongest tested.

3. In strengths of less than approximately 1 cc. per 100 grams soil, CS_2 , even for short periods of incubation, does not exert an appreciable effect upon nitrate accumulation. If the strength exceeds approximately 1 cc. per 100 grams soil, CS_2 may, and usually does, exert a temporary retarding effect which, however, is soon overcome even with as strong a treatment as 5 cc. per 100 grams soil.

4. Samples of soil treated with either chemical in sufficient quantity to entirely inhibit nitrification for a period of four to twenty weeks may entirely recover from the effect with reinoculation.

5. So far as the results thus far reported from laboratory experimentation can be applied to experimental field practice, it would seem that neither toluol or CS_2 as previously used, could materially effect nitrate accumulation since practical applications rarely ever exceed approximately .1 cc. per 100 grams soil.

Classification of Local Rusts.—As a preliminary to the study of parasitic flora, local rusts have been carefully studied. About four hundred collections have been made and seventy different species have been distinguished.

Powdery Mildews.—Prior to this year the work has been confined to the three cereal mildews on barley, rye and wheat. Recently the study of powdery mildew on oats was started. It is found that this mildew will not pass over onto wheat, barley, rye, or other grasses tested. It does, however, infect the tall wild oats (*A. elatior*).

In studying the effect of light it is found that etiolated plants will not become infected even though normal green plants of the same varieties are extremely susceptible to the mildew. Just in proportion as etiolated plants, when placed in the light, become green, just in that proportion does infection occur. When plants are grown in the light but deprived of carbon dioxide, infection still seems to occur to some extent. The work this year, will clear up this point.

Department of Dairy Husbandry.

Nutrients Required for Milk Production.—It is found that, in general, if the maintenance requirements of the animal are provided for, the requirements for milk production are almost in direct proportion to the caloric value of the milk. The experiments which included eight animals for the entire year and others for shorter periods show that Haecker's feeding standard is too low and that the error is the largest with cows producing rich milk. The data also raises the question as to the accuracy of "Production Value Tables" as prepared by Armsby when applied to milk production. With eight out of ten cows the energy value of the milk produced was more than the production value of the feed if Armsby's figures are used in making the later calculations. It is also shown that with five cows for which digestion trials were made that they uniformly fell five to seven per cent below the average digestion coefficients when on full feed, while the same animals, on maintenance, were able to show a digestion coefficient equal to the average. This work also makes it clear for the first time as to the comparative economy of fat production by the Holstein and Jersey breeds. It is not due to any better use of the food or to production of less skim milk by the Jersey cow but to the fact that the Jersey produces more fat in proportion to her size and therefore uses a smaller proportion of the entire ration for maintenance. The difference in economy of production is less than is usually supposed. A feeding standard is suggested, based upon

Armsby's method and modifying his figures which are given for average milk only, to meet the requirements of cows producing milk varying in fat content from three to six and one-half per cent.

Nutrients Required to Develop the Foetus.—Results so far confirm those previously reported that the amount of feed required to develop the foetus is so small that it cannot be measured by weighing the animal and taking the weights and analyses of the feed. In other words the foetus may be developed on a maintenance ration. A cow in producing about 200 pounds of milk produces as much dry matter and of much the same composition, except in regard to the ash, which varies in certain respects, as would be required to develop the foetus.

Factors Influencing the Normal Composition of Milk.—This investigation includes a study of the effect of natural yellow pigments upon the color of milk, the influence of the plane of nutrition upon milk composition and the effect of cottonseed products upon milk and butter. Carotin, a plant product, is found to be the natural yellow color of milk and cream. It passes through the cow's body from the feed to the milk-fat. This pigment has been fully identified in the blood. It is responsible for the yellow color of body fat and gives the yellow color to milk. It was found by feeding cows rations devoid of this coloring matter that a colorless butter could be produced. Further data on the subject of feeding cottonseed products was taken during the fiscal year with a view of confirming previous results on certain points and further studying the question as to whether the oil in cottonseed meal or the other constituents are responsible for the effects resulting from its use. By feeding cottonseed oil in combination with other grains results were secured identical with those obtained in feeding cottonseed meal containing equal quantities of oil. It may, therefore, be concluded that the results from cottonseed meal feeding are due to the oil content. Previous results in regard to the greatly increased keeping quality of butter resulting from feeding cottonseed meal were further confirmed.

Factors Influencing the Development of Dairy Heifers.—Available data indicates that ordinary variations of feed have no measurable effect upon the development of the dairy functions. Apparently the tendency to produce milk is an inherited characteristic and is not subject to much, if any, modification by feeding.

A preliminary experiment was started in December, 1912, with two Jersey heifers on a ration which contained an insufficient amount of mineral matter, one animal received in addition bone meal and chalk. Up to July 1, 1913, no effects were in evidence. The plan

in this connection contemplates a sufficient study of the mineral requirements to learn if there is any danger in ordinary practice of having animals underfed in this respect.

Entomology Department.

“Stopback” and Tarnished Plant Bug.—The year’s work with the disease known as “Stopback” in young peach and pear stock in the nurseries of the state point quite conclusively to the fact that the injury is caused by the tarnished plant bug. In connection with this work, the life history, breeding and feeding habits of the tarnished plant bug have been accurately and completely worked out for the first time by this Station. No positive method of control can be recommended until further work is done.

Apple Leaf Hopper.—The pest is found to pass the winter largely if not entirely in the adult stage in this state. In working out the life history, it is found that in Missouri there are three full broods annually and at least a partial fourth brood. Heretofore it has been believed that there was but one brood annually.

Peach Tree Borer.—An attempt is being made to find a remedy more economical than the old method of cutting out borers which is thoroughly effective but slow and expensive. Various paints recommended for the purpose have been tested and have not been successful. The practice of digging a small ditch around the crown of the tree is being tested but definite conclusions have not yet been reached.

Distribution of Insect Pests in Missouri—Preventive Control.—As a preliminary step in a State-wide campaign against destructive insects, the life histories of several of the most injurious types were carefully worked out during the year. A general survey of the entire State has shown the extent of infestation and has indicated the logical points of attack.

Among the insects studied are the following:

Hickory Twig-Girdler.—Found mainly attacking the elm and the persimmon—cuts back tips of growing twigs—can be controlled by destroying all girdled twigs—not likely to prove a serious pest.

Unspotted Tentiform Leaf-miner of Apple.—Works between the layers of apple leaves destroying a large percentage of the leaf surface—cannot be controlled by spraying—may be partly prevented by plowing under or by burning fallen leaves early in the spring.

Periodical Cicada.—Survey indicates that the only serious damage in Missouri may be expected in young orchards. This injury can

be avoided by the use of whitewash spray. It is also recommended that young orchards be not planted near woods or on new ground for the first two years preceding the occurrence of a destructive swarm.

Striped Cucumber-Beetle.—The use of arsenical poisons, Bordeaux mixture, nicotine sprays, lime and soaps have all given negative results. The only remedy which has proven of any value is that of hand picking in the early morning, a remedy which is too expensive to be practical.

Chinch-bug.—In studying the distribution of the chinch-bug, it is found that in 1910-11 three counties were affected. The next year it had spread to twenty-eight counties and during 1912-13, thirty-nine counties of the state were attacked. Most of the injury was restricted to the two west tiers of counties extending from the Missouri river southward. A small group of counties, including Chariton, Livingston, Linn and Macon also were badly affected during the past year. The pest also showed itself in considerable numbers in Callaway, Audrain, Pike, Lincoln and St. Charles counties. Nothing new has been determined in the way of preventive measures. The dust barrier (and the tar or road oil barrier in wet weather) effectively stops the migration of the pest. Burning of waste places in the fall has proven a thoroughly effective measure.

San Jose Scale.—A study of the distribution of this pest shows that it is now common in thirty-eight counties south of the Missouri River and in fourteen counties north of the river. It is most abundant in the vicinities of St. Louis, Springfield, Boonville, Hannibal, Kansas City and in Southeast Missouri and the Ozark belt. From the general distribution of the pest and the rate at which new infestations are being found, it appears logical that San Jose Scale is present in practically every county of the state. The work of control has been undertaken in co-operation with progressive farmers in each of the most seriously affected districts. This work has clearly indicated that San Jose Scale can, by regular annual spraying, be held in such complete check that to all practical intents it will do no damage at all. On account of the general distribution of the pest, it is necessary, however, to spray regularly. The omission of a single year will cause heavy infestation.

Nursery Pests.—A fairly complete list of the important insects of nursery stock in Missouri has been collected. It includes the following:

San Jose scale—Most abundant about St. Louis, Kansas City and Southern Missouri.

Woolly apple aphid—Found largely south of the Missouri River.
Plant lice—Common everywhere.

Apple leaf hopper—Common everywhere, though worse in Northern Missouri.

Tarnished plant bug—Found throughout the state, though most destructive to peaches and pears in Central Missouri.

Leaf folder caterpillar—Found everywhere in state.

Bag-worm—Southwest Missouri. Common about St. Joseph and St. Louis.

Peach tree borer—Common throughout state.

Apple tree borer—Not a severe pest, though common throughout state.

Leaf miner caterpillar—Common everywhere.

Black peach aphid—Found in south part of state, though not common.

Oyster shell scale—Not common.

Scurfy scale—Not common.

Forbes or cherry scale—Quite abundant in Southern Missouri.

Catalpa sphynx caterpillar—Southwest Missouri.

Poplar leaf beetle—St. Louis, St. Joseph and Kansas City.

Farm Management Department.

Distribution of Labor.—In studying the distribution of farm labor a careful account was kept of every item of man and horse labor in connection with four typical Missouri farms. The data derived from this investigation indicated that the average day for a man is 9.9 hours; for a horse, 3.9 hours. It appears that seventeen per cent of the labor on a farm is given to maintenance and upkeep, that twenty-eight per cent is spent in the production of crops, and that fifty-five per cent is given to production labor of all kinds not including crops. The problem of the farm is to reduce the maintenance labor which is nonproductive and increase all forms of productive labor. The importance of using horses for other than field work is evident in the relatively few hours a horse works in the course of a year.

Farm Survey Work.—During June 1913, seven men were sent into four townships in Johnson County. These men made a farm to farm canvass gathering data on the following topics: Financial and labor conditions, crops and cropping methods, live stock equipment and management, tenantry systems, social conditions, and farm administration methods including cost of family living. It has not yet been possible to compile this data into a report.

Farm Cost Accounting.—This work has been conducted with seven co-operators furnishing daily reports of all farm transactions and farm operations. Twenty other co-operators have been keeping farm diaries. The data collected up to the present time is not of sufficient quantity to supply positive figures regarding the cost of production. Tentatively, however, it appears that the acre-cost of producing crops is approximately: corn, \$14.22; oats, \$13.50; wheat, \$12.70; clover, \$9.35; and timothy, \$9.30. The figures indicate that farm labor costs much less than in other states which have figures on the same subject.

Forestry Department.

A Study of the Methods of Prolonging the Service of Wood Fence Posts.—Fence posts of the following species of wood were set: White cedar, butternut, walnut, hickory, willow, cottonwood, river birch, ironwood, white oak, red oak, black oak, slippery elm, white elm, hackberry, osage orange, sassafras, sycamore, red bud, coffee bean, honey locust, black locust, sugar maple, basswood, dogwood, persimmon, black ash and catalpa.

Approximately five hundred fifty posts were secured. On account of the difficulty of securing the posts, the actual experiment, aside from the preliminary working out of details, did not start until shortly after the close of the fiscal year here reported.

Effect of Storage Conditions on the Vitality of Forest Tree Seeds.—Seeds of fifteen different species and varieties of trees were put up in several different types of packages including plain paper envelopes, sealed bottles, and wooden boxes. The various packages were then stored under different temperature conditions; the first lot was subjected to relatively great changes, a second to very small changes, and a third to the ordinary atmospheric changes. No report can be made upon this experiment until next year.

An Investigation of Methods of Culture and Varieties of Basket Willows for Missouri.—In co-operation with the Government Forest Service, approximately 3445 basket willow cuttings representing six different varieties were planted in the spring of 1912. Because of an unfavorable planting season, the crop was practically a complete failure. In the spring of 1913, 6500 willows were received from different sources. The plants resulting from this planting are being used for distribution in the state and for further investigation as to the practicability of the crop.

Department of Horticulture.

Peach Breeding for Hardy Sorts.—During the year a goodly number of seeds were secured from crosses between large fruited, purple twigged sorts of peaches, including Elberta, Champion, Carman and others, and the green twig sorts represented by Rise's Seedling and Snow. These peach seeds have been planted and the seedlings secured are growing. Several hundred similar crosses have now been started, but none of them have yet reached bearing age.

Apple Breeding for Late Blooming Habit.—Several hundred seedlings of apples of the latest blooming habit including Ingram, Rome Beauty and others have been crossed with leading commercial sorts including Jonathan, Gano, York and Grimes. These seedlings, despite the drouth, made good growth during the past season. In addition a considerable number of crosses were secured during the spring of 1913 and these seeds should give an additional increase to the collection of crosses. None of these apple trees have yet reached bearing age.

Bud Selection.—Three crops of apples have now been harvested from trees, part of which were grown from scions selected from high producing parents, and part from trees of low producing parents.

The difference in yield between trees grown from scions from high producing and low producing parents has not been large enough to be significant. There was practically as much variation in yield of fruit and in size and color of fruit between trees from the same parent as there was between trees of different parentage.

Bud selection from high producing and from low producing strawberries carried on through twelve previous years showed absolutely no gain in productiveness by selecting runners from high producing parents.

Spraying Fruits for Insect and Fungus Diseases.—Comparative tests were made of Bordeaux mixture and lime sulphur for spraying apples against the ordinary diseases which occur in spring and summer. These two fungicides proved to be about equally effective but in the case of the Bordeaux there was considerable damage from burning the fruit with the spraying material. However, where the Bordeaux was omitted at the calyx spray and lime sulphur used instead, the injury from spray burn was comparatively small. Both materials seem to be equally effective against apple scab. Arsenate of lead paste was compared with arsenite of zinc as a poison for controlling the curculio and codling moth insects. The arsenate of

lead proved to be a very dependable insecticide. The arsenite of zinc, which was used in quantities recommended by the manufactures not only failed to control the insect, but greatly injured the fruit by burning. Besides russetting the apples, it also scorched the leaves to a considerable extent.

In a commercial orchard near Columbia, Bordeaux mixture at different strengths was compared with lime-sulphur at the regular strength. All of the mixtures were very effective in controlling diseases of the apple. The stronger mixtures, particularly the 4-4-50 Bordeaux russetted the fruit to a considerable extent. Even when used at a strength of 3-3-50 as a calyx spray, a great many of the apples were slightly russetted. However, the fruit colored up so well that none of the russetting injured the sale value of the apples. Arsenate of lead paste was used as the insecticide. Insects were absolutely controlled. Only now and then was any trace of apple scab to be found. The fruit over the entire orchard was 98 per cent perfect. The sprayed orchard yielded approximately 2000 bushels of apples. All of these were of first class grade. An adjoining orchard of the same acreage, same variety, having the same treatment in every way except that it was not sprayed, yielded only about 300 bushels of very inferior fruit. The sprayed fruit sold for \$2.17 per barrel while the unsprayed fruit sold for \$1.10 per barrel. The sprayed fruit, less the cost of spraying brought \$66.80 per acre, while the unsprayed orchard sold for \$5.50 per acre a net return in favor of spraying of \$61.30 per acre.

Fruit Bud Development of Fruit Trees as Influenced by Various Treatments.—Apple trees girdled in early June, set a higher percentage of fruit buds than did untreated trees of the same varieties without essentially injuring the growth of the trees. Other things being equal, trees that bore a heavy crop the previous year did not set as large a crop as did the trees which bore a light crop the previous year. In pears and apples it has been shown that water sprouts can in one season be induced to produce fruit spurs and fruit by proper cutting back. This emphasizes the possibility of replacing lost bearing limbs by proper treatment of water sprouts which frequently start from the trees adjacent to where the missing limb was removed.

During the winter a study of apple buds was made to determine the possibility of forecasting a good bloom the next year. Of ten varieties studied, the average error in forecasting the bloom was only about two per cent, indicating the possibility of making a practical forecast several months in advance. Methods are being perfected so that the grower himself may determine in the winter time

whether his trees are likely to have a good bloom. This information will enable him to purchase orchard supplies at a time when they are cheap and will also enable him to know when not to lay in a stock of supplies.

Fall vs. Spring Planting of Trees.—This is the third year comparative measurements have been made between growth of fall planted and spring planted trees. These measurements show that during the year the fall planted trees produced thirty-three per cent more growth than spring planted trees. Comparing this result with the previous two years shows that the previous year, fall planted trees made fifty per cent more growth than spring planted, and during the first year the same set of trees lacked only one-half of one per cent of producing one hundred per cent more growth than the spring planted. It will be observed that in the same set of trees the difference in the amount of annual growth is decreasing each year as the trees develop.

Self Fertility and Self Sterility of Fruits.—This year it was necessary to confine this study to peaches alone. The results show that during the year all the leading commercial varieties of peaches grown on the Horticultural grounds proved to be self fertile. This is in line with previous years' work on peaches. The work of the year, coinciding with work on the peach, in previous years leads us to feel safe in the conclusion that the grower may safely plant even a single variety like Elberta and expect the trees to set fruit from their own pollen. Apparently the self-fertile trees set as much fruit and the fruit develops as well as where varieties are cross-fertilized. It is planned to continue this work on apples and other fruits in subsequent years.

Rest Period of Plants.—During the summer and fall of 1912, almost 200 species of seeds, representing fifty-one genera, were planted to determine whether seeds in general are capable of germinating immediately after ripening, if placed under favorable conditions, or whether they must first pass through a period of rest. The following results were secured:

The seeds of the Grass, Lily, Pink, Mallow, Legume and Composite families seem to have no rest period, while the Sedge, Rose, Cashew and Vine families have a pronounced rest period.

Seeds of woody plants have a more pronounced resting period, and are more difficult to force into growth by treatment than seeds of vegetable and other herbaceous plants

The length and intensity of the rest period varies with the different species. However all the species of a single order seem to be more or less similar in their behavior.

Etherization tends to stimulate seeds into an early growth and to increase the percentage of total germination. Seeds that have been soaked or stratified are more strongly affected by ether than dry seeds. A twelve-hour exposure to ether is the most favorable dosage for forcing seeds to germinate.

Orchard Nutrition.—None of the apple orchards showed any visible response to any of the fertilizers applied during the past year. Peaches showed a notable response to an application of nitrogen whether in the form of dried blood or nitrate of soda. In a peach orchard at Brandsville seven plots to which nitrogen was applied in the spring were the highest yielding plots in the orchard. The two check plots in the orchard had the largest individual peaches of any of the trees. Their yield, however, was markedly lower than the plots on which nitrogen was applied. The addition of phosphorus and potash showed no appreciable influence upon the yield of fruit. It is probable that the smaller size of the fruit on the nitrogen-fertilized plots was due, first, to the fact that the trees carried, during a drouth year, the burden of a much larger crop, and second, the nitrogen fertilized plots had longer wood growth and much heavier foliage during drouth. This very abundant leaf surface evaporated too much water for the trees to properly supply the fruit. In previous years with fairly normal rainfall the nitrogen fertilized trees have had the additional vigor to mature their peaches to as large size as on unfertilized trees.

Department of Zoology.

A Study of Sex-Linked Inheritance in Poultry.—In the spring of 1913 matings were made as follows:

1. Barred Plymouth Rock male and Black Minorca female.
2. Barred Plymouth Rock female and Black Minorca male.
3. White Leghorn male and Whitecrested Black Polish female.
4. White Leghorn female and Whitecrested Black Polish male.
5. Silver Spangled Hamburg male and Brown Leghorn female.
6. Silver Spangled Hamburg female and Brown Leghorn male.
7. Seabright Bantam male and Black Bantam female.
8. Seabright Bantam female and Black Bantam male.

From all of the above matings, except 7, a large number of birds were obtained in the F_1 generation.

Matings 1 and 2 gave typical sex-linked results: In 1, both the males and the females are barred, while in 2, the reciprocal cross, only the males are barred, the females being entirely black like their father.

In matings 3 and 4, no sex-linked characters have been observed.

The F_1 birds from matings 5 and 6 show a number of points of interest. The spangled pattern of the Hamburg is evidently sex-linked, but the pattern is not transmitted for the entire body as a unit. In all of the offspring of both crosses, the tail is pure black and shows no spangling whatever, but on the rest of the body the pattern is inherited as a sex-linked character. From mating 5, both cocks and hens are spangled, while from mating 6, the reciprocal cross, only the males are spangled, the females being black with some scattered brown and golden markings.

The Bantam matings are of unusual importance by reason of the fact that the Seabright male lacks the usual secondary sexual feathers of poultry, and is therefore feathered like the female. The cocks of this breed have no sickle feathers, and the long hackle and saddle feathers are also absent. The crosses in question were made in order to determine the mode of inheritance of this peculiarity. It is known, furthermore, that the Seabright cocks show a greatly reduced fertility, and it is possible that a correlation exists between this condition and the absence of secondary sexual characters. From the mating, 7, in which the Seabright cock was used, only four birds were obtained, one male and three females. The cock has the usual sickle feathers and the hackles and saddle. But in the mating, 8, in which the reciprocal cross was made, all of the cocks are hen-feathered. A complete analysis of this result will not be possible until the next generation is obtained.

COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE.

Soil Survey.—The Missouri Agricultural Experiment Station has co-operated with the United States Department of Agriculture in a number of projects. The most important co-operative project at this time is the soil survey of Missouri counties. In co-operation with the Department of Agriculture, this Station has completed a detailed soil survey of thirty-one counties in Missouri. Through the co-operation of the Bureau of Soils, we are now able to complete five counties each season. It is hoped that this co-operation may be continued until every county in Missouri has been surveyed.

Seed Testing Laboratory.—In co-operation with the Bureau of Plant Industry, the Station has been conducting a seed laboratory in which farm seeds are examined free. This service which the Station and the Department of Agriculture have been rendering to Missouri farmers has been in the highest degree valuable to those persons who have availed themselves of this opportunity.

During the past year 1337 samples of various seeds were tested. Of this number, 751 were from farmers and 586 from seedsmen. On many of these samples, a test was made both for purity and for germination. Altogether, there were 757 tests for purity, 949 for germination, fifty-three for rough examination and 134 for identification of the species. The per cent of clover and alfalfa seeds containing dodder was seventeen as against twenty-one for the year preceding.

Farm Advisers.—The College is co-operating with the Office of Farm Management in the appointment of County Farm Advisers. This extension project is rendering highly efficient service in those counties where it has been possible to locate such men.

INVESTIGATION AND CO-OPERATION ENTERPRISES CONDUCTED OUT IN THE STATE.

Soil Survey of Missouri Counties.—The detailed soil survey of Missouri counties has been continued during the past year without increase in the number of field men. The surveys of Barton, Carroll, Cass, Miller, Pike and Stoddard Counties were completed in 1912 and in the spring of 1913 surveys were started in Perry, Greene, Nodaway, and Ralls Counties. (See page 431.)

Outlying Experiment Fields.—Two new outlying experiment fields have been established in the last fiscal year. These are at Wentzville in St. Charles County, and at Union in Franklin County. This makes a total of eighteen fields conducted during the year by the Missouri Experiment Station. These fields are distributed in seventeen counties of the state. Eleven of this number are soil experiment fields; two are crop fields, two are soil and drainage fields and there is one field each for crop and soil, crop and drainage, and crop, drainage and soil investigations.

The purpose of the 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 Experiment Station to local conditions.

Hog Cholera Serum Distribution.—An appropriation made by the forty-seventh General Assembly has enabled the Experiment Station to materially increase its output of hog cholera serum. During the year 208,619 doses were distributed to the farmers of Missouri. This is an increase of thirty per cent over the previous year. This serum was sent into ninety-nine counties and to 3389 farms. The number of doses sent out practically represents the number of hogs treated. Between eighty-five and ninety per cent of the hogs treated were saved. Even with the increased facilities, it has been impossible to do much more than to treat animals in herds in which the disease had started. The application of the number of doses mentioned, therefore, means that approximately 175,000 hogs were saved by the use of this treatment. At ruling prices, this represents a cash saving to the farmers of Missouri of over a million dollars and probably a million and a half would be safely within the range of conservatism.

Co-operative Experiments with Missouri Farmers.—The Experiment Station is co-operating with farmers in practically every county of the state along twenty-five different lines. Six departments of the College are directly concerned with this work of co-operation. The following projects are included in this wide range of work:

Agronomy Department.

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. Kudzu Experiments.
9. Crimson Clover Experiments.
10. Corn Breeding Experiments.
11. Barley Variety Experiments.
12. Outlying Experiment Fields.

Dairy Department.

1. Record of Dairy Herds.
2. Co-operative Bull Experiments.
3. Testing Soybeans as Dairy Feed.

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.

Co-operation with farmers is bringing to light many interesting and important facts. The Agronomy department finds that for average Missouri conditions, the large white varieties of corn like Boone County White are the heaviest yielders; while in the yellow corn, varieties such as Reid's Yellow Dent and Leaning have given especially good returns. Among the best wheat varieties, the Fulcaster seems to stand out as the high standard yielder among the bearded varieties, and the Fultz among smooth wheats. The work in alfalfa continues to indicate that this crop is well adapted to the well drained bottoms and on the uplands; that inoculation is usually beneficial and necessary on upland soils and that lime is sometimes, though not always, beneficial. The expense of establishing a satisfactory stand of alfalfa on average to poor lands continues to be greater than the return which may be expected. The grass experiments in the Ozark region indicates that orchard grass is the most hardy on thin or rocky lands. Blue grass and timothy take its place on the better lands. Clovers are adapted to practically the entire region. The work on the outlying experiment fields shows that with hardly any exception, the greatest needs of Missouri soils are organic matter, nitrogen, and soluble phosphate. Potash and lime are necessary on some soils.

Under direction of the Department of Entomology, the chinch-bug has been thoroughly controlled in a few sections where the farmers could be induced to co-operate actively in seeking its extermination. San Jose scale has been practically stamped out of many localities and many orchards threatened with destruction have been saved.

The demonstration work in pruning and spraying has emphasized to the fruit growers in the state the importance of caring well

for their orchards. The following data secured from an orchard near Pierce City is typical. Part of the orchard was sprayed and part was left unsprayed. Of the fruit produced on the unsprayed trees, only 18 per cent was marketable while on the sprayed trees, 94 per cent was marketable fruit. The cost of spraying was \$12 per acre and the net profit per acre as a result of spraying was \$180.40.

The co-operative work in Dairy Husbandry has been confined largely to sections of the Ozarks which because of special climatic and soil adaptations are suited to the development of dairying. Community effort has been fostered and the results are becoming evident in the larger use of pure bred sires, in the more consistent keeping of dairy records, and in the conducting of official and semi-official dairy tests.

COLLEGE EXTENSION SERVICE.

Teaching and Demonstration.

1. Branch Short Courses.
2. Farmers' Meetings.
3. Special Trains.
4. Correspondence.
5. Agriculture in the Rural Schools.
6. County Farm Advisers.
7. County and State Fair Exhibits.
8. Silo Plans.
9. Dairy Extension Lecturer and Demonstrator.
10. Official Cow Testing.
11. Judging Live Stock at County and State Fairs.
12. Judging Corn at County and State Fairs.
13. Orchard Demonstrations.
14. Farmers' Short Course at Columbia.
15. Boys' Corn Growing Contest.
15. Short Course for Farm Boys.
17. Extension Teaching by Correspondence for University Credit.
(In charge of Secretary of Extension Division.)

Inspection Service.

1. Fertilizer Control.
2. Nursery Inspection.

Branch Short Courses.—Eleven Branch Short Courses were held during the winter of 1912-13 in eleven counties of the state.

These five-day courses were attended by a total of 862 persons. The people taking this work were mature farmers with the exception of a few students of agriculture who composed a part of the class at two points. Courses were held at Bowling Green, Sedalia, Kahoka, Eagleville, Maywood, Diamond, Maryville, Elsberry, Trenton, O'Fallon, and Callao.

Eighteen men from the College of Agriculture gave Branch Short Course instruction. In all cases the nature of each course was determined largely by the special needs of the community in which it was held.

Farmers' Meetings.—Through the medium of farmers' institutes and special meetings, arranged by farmers clubs, commercial clubs, granges, farm advisers and various other agencies, men from the College of Agriculture have been able to personally reach over 30,000 people in thirty-three counties of the state. This form of extension work is of great importance in paving the way for more intensive and systematic work.

Special Trains.—Three special trains were run during the winter of 1912-13, reaching twenty-five counties of the state. In connection with these special trains, men from the Experiment Station made a total of 134 addresses to over 15,000 people.

Correspondence.—During the year 65,138 letters were written by the various departments of the College of Agriculture. A small proportion of these letters related to questions of administration. The balance were written in reply to requests for information concerning farm practices, care of live stock, orchard management, etc.

Agriculture in the Rural Schools.—The Department of Rural Education has continued its work of helping the rural schools of the state in the organization of agricultural instruction. In carrying out this work, the Professor of Rural Education has made one hundred and sixty-three addresses during the year to 18,304 people. Twenty of these addresses were on consolidation of schools and on the subject of reorganization of the course of study making agriculture the central subject. Fully three thousand teachers have been reached in these addresses. Personal visits have been made to sixty-five schools. As noted elsewhere, twenty-five hundred letters have been written during the year. An investigation showed that over 30,000 pupils were studying elementary agriculture in the rural schools of Missouri. At present the work is largely text book work but a beginning has been made and practical results may be expected in the immediate future.

County Farm Advisers.—In the fall of 1912, the Missouri College of Agriculture entered into a co-operative agreement with the United States Department of Agriculture by which the College and the Department each agreed to pay one-fourth the salary of an agricultural agent in any Missouri county in which the county court would appropriate money for the balance of the salary for such a man.

The agricultural agents in this state are given the title of Farm Advisers. In order to systematize the work of the various county farm advisers, a State Leader was appointed jointly by the Department and the College. The State Leader is in direct charge of the farm adviser work.

In order to enable the state to extend this project, the Legislature at its forty-seventh session made a special appropriation of \$25,000. During the fiscal year, eight counties of the state entered into the co-operative agreement proposed and were supplied with farm advisers. These counties are Audrain, Buchanan, Dade, Jackson, Johnson, Marion, Pettis, and Cape Girardeau.

Agricultural Exhibits.—Two complete exhibits representing the work of the College of Agriculture and the results of investigations conducted by the Experiment Station were sent out on county fair circuits during the second half of August and the month of September. During this time the following eleven fairs were visited:

FAIR.	COUNTY.	ATTENDANCE.
Bowling Green,	Pike	18,000
Knox City,	Knox,	20,000
Green City,	Sullivan,	10,000
Maysville,	Dekalb,	9,000
Queen City,	Schuyler,	1,000
Columbia,	Boone,	20,583
Shelbina,	Shelby,	10,000
New Cambria,	Macon,	2,736
Palmyra,	Marion,	8,000
New London,	Ralls,	11,000
Sedalia (State Fair)	Pettis,	85,000

Both exhibits were brought together for the state fair which closed the fair season.

Silo Plans.—The development of the dairy industry in Missouri and the interest taken by cattle feeders in silage has made the silo problem a foremost consideration in this state. In order to meet the situation, the College of Agriculture has arranged to send out plans

for silo construction. These are sold at a nominal price which is just enough to cover their actual cost. During the year assistance was given in the construction of fifty silos.

Dairy Extension.—The entire time of one man is given to dairy extension work. Aside from the service rendered in connection with silo construction, this man has assisted in the organization of cow testing associations, the running of special trains, the conduct of Farmers' Institutes, and farmers meetings of all kinds, the organization of breeding centers, and every activity looking toward the development of the dairy industry.

Official Cow Testing.—The work of conducting official tests of dairy cows in various parts of the state has continued to develop with the growth of the dairy industry and the introduction of more high class and pure bred dairy cattle in the state. During the year ending June 30, 1913, the College of Agriculture officially tested forty-five cows representing eleven herds in nine counties of the state.

Judging Live Stock.—The demand for judges of live stock to assist at county fairs continues to grow. The College is not in position at present to extend its services as fast as the demands increase. During the last fair season, however, the College supplied live stock judges at fifty-three county fairs at which 385,000 people were in attendance.

Judging Corn.—At thirty-six county fairs, men from the College judged corn and small grains. The attendance at these various fairs and corn shows was 75,500.

Orchard Demonstrations.—A large proportion of the orchards in Missouri as in other states are unprofitable because of lack of proper attention. In order to demonstrate the advantage of right methods of pruning, spraying, and cultivation, the Agricultural Experiment Station conducted five demonstration orchards in three of the fruit growing regions of the state. This work had just started during the latter part of the period covered by this report. The results will, therefore, appear in the annual report for the year ending June 30, 1914.

Farmers' Short Course.—This four day course for mature farmers continues to grow in popularity. In January, 1913, 1381 people were registered for the course. These people came from ninety-two counties of Missouri and from eighteen other states. Thirty-six men gave instruction in this course.

Boys' Corn Growing Contest.—This contest is organized under a special appropriation to the College of Agriculture which is

expended by and with the advice of the Missouri Corn Growers' Association. The purpose of the contest is to interest Missouri farm boys in the problem of growing larger crops of corn by teaching them right methods of seed selection and seed testing as well as proper methods of cultivation. In the spring of 1913, over 3,000 Missouri boys enrolled in the contest which is state wide in character.

Short Course for Boys.—During the session of the Farmers' Short Course in January, 1914, a special short course for boys under sixteen years of age was held. Fifty-nine boys from six counties attended this Short Course. Johnson County led with twenty-two boys; Buchanan County was second with fifteen, while Marion County sent twelve. Adair, Pettis, and Dade Counties, sent ten boys altogether. The average total cost for each boy during his stay in Columbia was four dollars for the four days. A special instructional program for the Boys' Short Course was carried out. This program included work in judging live stock and corn, in soil studies, and orchard practice. A live stock judging contest and a corn judging contest were the two features of the course. Valuable prizes and medals were given to the winners in these contests.

Correspondence Courses.—Several courses in Agriculture are now being offered by correspondence. The administration of extension teaching in Agriculture has been placed in charge of the Secretary of the University Extension division. Agriculture taught by correspondence is credited in the Two Year Winter Course but not in the Four Year College Course.

Fertilizer Control.—The fertilizer inspection was conducted by the College of Agriculture with the same completeness which has characterized the work since its establishment. Over seven hundred samples were collected in various parts of the state and analyzed by the Agricultural Experiment Station. The report of this inspection appears in bulletin, No. 109.

Nursery Inspection.—This work has started with the promise of great good to orchard and nursery interests of the state. Although nursery inspection did not start until the spring of 1913, 125 nurseries were inspected in forty-five different counties. Of this number, twenty-three of the smaller nurseries which had not been having inspection regularly were found to be infested with San Jose Scale and required special treatment before certificates could be issued. The total amount of nursery stock inspected was nearly three thousand acres. In every state there are a great many firms

dealing in nursery stock who do not grow the stock themselves. The law requires such dealers to hold dealer's certificates. Seventy-eight of these certificates have been issued during the first year. In order to know the source of all imported stock and to make sure that it is properly certified, the Missouri law requires all outside nurserymen desiring to ship stock into Missouri to secure a state permit. One hundred twenty-one nurseries from twenty-one states have applied for these permits. In order to completely safe-guard the legitimate nursery business in the state, it is required of all agents and salesmen that they, too, secure a state permit. Three hundred seventy-seven sellers of nursery stock have complied with this provision of the law.

In order to prevent the introduction of insect pests and plant diseases from foreign countries, it has been made the duty of the state nursery inspector to inspect all foreign shipments of nursery stock. Nearly five hundred cases of stock have been inspected during the past year.

SUMMARY OF VARIOUS EXTENSION ACTIVITIES.

Branch Short Courses.

Number given	11
Number of instructors	18
Total enrollment	862
Average daily attendance	47.2

Special Trains.

Number of trains	3
Number of cars	14
Number of counties reached	25
Number of addresses made	134
Number of people addressed	15,350

Farmers' Institutes.

Number of institutes attended	40
Number of counties	33
Number of people addressed	6,130

Special Lectures.

Total number of addresses	49
Number of counties	24
Number of people addressed	4,495

Number of Letters.

Animal Husbandry	6,270
Agronomy	12,000
Poultry Husbandry	1,000

Dairy Husbandry	3,340
Entomology	1,344
Horticulture	4,097
Farm Management	2,640
Forestry	500
Botany	330
Agr. Chemistry	1,500
Vet. Science	7,277
Dean's Office	22,340
Rural Education	2,500

Total65,138

Live Stock Shows Judged.

Number of shows	53
Number of counties	42
Numbers of days judging	166
Number of people attending	384,977

Judging at Corn Shows.

Number of shows judged	36
Number of counties	31
Number of days judging	40
Number of people attending	75,500

Concrete Silos.

Plans supplied for concrete silos	50
Construction of concrete silos supervised	6

Creamery Assistance.

Creameries visited	16
Ice cream factories visited	11
City milk plants visited	2

Educational Scoring of Butter for Creameries.

Number of contests held	8
Number of creameries represented	18

Boys' Corn Growing Contest.

Number of boys enrolled	3,500
Number of counties represented	113
Actual number of samples exhibited	665

County Farm Advisers.

Number of counties organized	12
Number of farms visited	765
Number of farmers' meetings attended	252

Attendance of farmers at farmers' meetings	19,674
Personal advice given to farmers	2,749
Tons of limestone used on advice	1,000
Number of hogs vaccinated with hog cholera serum..	7,116
Value of hogs saved	\$56,920
Boys and girls organized in clubs	530
Number of farmers' clubs organized	31
Membership of these clubs	556
Soil tests made	350
Samples of seed examined	300
Bulletins written	17

Co-operation with Farmers.

Department	Number of Projects	Total Number Co-operators	Number of Counties Co-operating
Agronomy	8	133	74
Entomology	2	332	84
Dairy	3	11	11
Farm Management	6	1870	76
Forestry	1	2	2
Horticulture	3	10	9

Free Seed Testing.

Number of tests:

Germination	949
Purity	755
Identification	134
Rough examination	53

Total number of samples:

From farmers	751
From seedsmen	586

Short Course for Boys.

Length of Course	4 days
Number of boys attending	59
Number of counties represented	6
Number of instructors	12

Agriculture in the Rural Schools.

Number of addresses	163
Number of people addressed	18,304
Number of teachers addressed	3,000
Number of schools visited	65

FINANCIAL STATEMENT.

The Missouri Agricultural Experiment Station, in account with
the United States Appropriation.

1912-13	Dr.	Cr.
To receipt from Treasurer of the United States as per appropriation for the year ending June 30, 1913, under the acts of Congress approved March 2, 1887, and March 16, 1906	\$30,000.00	
By Salaries		\$15,407.71
By Labor		4,521.97
Publications		60.91
Postage and Stationery		500.18
Heat, Light and Water		11.50
Chemical Supplies		2,233.10
Seed, Plants and Sundry Supplies		902.99
Fertilizer		72.20
Feeding Stuffs		4,283.11
Tools, Implements and Machinery		350.36
Furniture and Fixtures		27.30
Scientific Apparatus		588.96
Live Stock		758.74
Traveling Expenses		236.77
Contingent Expenses		20.00
Building and Repairs		24.20
	\$30,000.00	\$30,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Missouri Agricultural Experiment Station for the fiscal year ending June 30, 1913; 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.