

# AGRICULTURAL EXPERIMENT STATION

KANSAS STATE AGRICULTURAL COLLEGE  
MANHATTAN, KANSAS

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## **DIRECTOR'S REPORT** **1919-'20**



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## DIRECTOR'S REPORT

1919-20





# KANSAS AGRICULTURAL EXPERIMENT STATION

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**LETTER OF TRANSMITTAL**

OFFICE OF THE DIRECTOR  
June 30, 1920

*To His Excellency, Henry J. Allen, Governor of Kansas:*

Pursuant to the Act of Congress approved March 2, 1887, establishing Agricultural Experiment Stations, I transmit herewith the report of the Agricultural Experiment Station of the Kansas State Agricultural College for the fiscal year ending June 30, 1920. It includes a brief account of the work completed or in progress, a complete list of the scientific contributions of the station staff to December 31, 1920, a list of the station publications issued during the fiscal year under review, a statement of receipts and expenditures, and the principal changes in personnel which have occurred since the issuance of the last report.

F. D. FARRELL, *Director*

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## DIRECTOR'S REPORT

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### INTRODUCTION

During the fiscal year 1919-20, the principal work of the Kansas Agricultural Experiment Station comprised 64 primary projects of investigation. Many of them were subdivided into two or more secondary projects. These investigations included inquiries into certain of the economic features of agriculture; studies in soil conservation; problems directly connected with the maintenance of the plant industries and animal industries of the state; and a small number of miscellaneous agricultural problems.

The following report makes brief mention of each of the more important features of the work in progress during the year, gives a summary statement of the receipts and expenditures, and includes a list of the principal publications of the station from the time of its establishment to December 31, 1920.

### COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE

Several of the important lines of investigational work are carried on by the Agricultural Experiment Station in cooperation with the United States Department of Agriculture. This cooperative work during the fiscal year 1919-20 included the work of cereal improvement and the investigation of cereal diseases in cooperation with the Office of Cereal Investigations; the investigation of sex type as related to functional development and performance in Shorthorn cows, in cooperation with the Division of Animal Husbandry of the Bureau of Animal Industry; cereal production experiments at the Fort Hays Branch Station, in cooperation with the Office of Cereal Investigations; dry-land agriculture investigations at the Fort Hays, Colby, and Garden City Branch Stations, in conjunction with the Office of Dry-land Agriculture; and forage crop investigations at the Fort Hays Branch Station, in cooperation with the Office of Forage Crop Investigations.

## SCOPE OF THE STATION WORK IN 1919-20

A list of the investigational projects which were active during the fiscal year is given below, together with a list of the service and regulatory activities of the experiment station during the same period.

ACTIVE PROJECTS				
No.	NAME	Departments	Funds	Discussed on page
6, 8, 9, 13, 92, 100, 101, 115, and 116	Insect Pests .....	Entomology .....	Hatch and State....	22
17	Systematic Investigations of Soil Fertility....	Agronomy .....	Hatch .....	12
18	Tillage Investigations .....	Agronomy .....	Hatch .....	12
25, 26, and 27	Horticultural Experiments .....	Horticulture .....	State .....	20
34	The Use of Silage in Feeding Dairy Cattle....	Dairy Husbandry .....	State .....	30
34	The Use of Cane Seed as a Feed for Dairy Cows,	Dairy Husbandry .....	State .....	31
38	Swine Nutrition Studies .....	Animal Husbandry and Chemistry,	Adams .....	27
60	The Milling Qualities of Wheat.....	Milling Industry .....	State .....	17
60	The Chemical Qualities of Certain Food Products,	Chemistry .....	State .....	18
67	The Improvement of Crop Plants by Breeding..	Agronomy .....	Hatch .....	17
72	Inheritance in Orthoptera.....	Zoology .....	Adams .....	39
74	Studies of the Physiology of Crop Plants.....	Botany .....	State .....	15
76	Cereal and Forage Crop Diseases .....	Botany .....	State .....	21
77	Breeding and Feeding Farm Poultry.....	Poultry Husbandry .....	State .....	33
78	The Use of Silage in Beef Production.....	Animal Husbandry .....	State .....	25
79 and 119	Animal Parasites .....	Zoology .....	Adams and State ...	23
82	Growth Tests of Forest Trees .....	Horticulture .....	State .....	20
84	Injurious Mammals .....	Zoology .....	State .....	24
85	Investigations of Poultry Diseases.....	Bacteriology .....	State .....	38
90	The Time to Cut Alfalfa for Hay.....	Agronomy and Chemistry .....	Adams .....	16
90	The Feeding Value of Alfalfa Hay Cut at Differ- ent Stages .....	Animal Husbandry and Chemistry,	Adams and State ...	26
93	Inheritance in Guinea Pigs.....	Animal Husbandry .....	State .....	39
95	Farm Organization Studies.....	Agricultural Economics .....	State .....	9

Historical Document  
Kansas Agricultural Experiment Station

AGRICULTURAL EXPERIMENT STATION.

No.	NAME	Departments	Funds	Discussed on page
96	Pasture Investigations .....	Agronomy .....	State .....	18
97	Breeding Shorthorn Cattle .....	Animal Husbandry .....	Adams and State ..	25
99	The Development of Dairy Heifers.....	Dairy Husbandry .....	State .....	29
102	Miscellaneous Diseases .....	Veterinary Medicine .....	State .....	38
103	Soil Chemistry Investigations.....	Chemistry .....	Fees .....	13
110	Rations for Growing and Fattening Pigs.....	Animal Husbandry .....	State .....	27
111	Feeding Western Lambs .....	Animal Husbandry .....	State .....	26
113	Chemical Nutrients in Forage Crops .....	Chemistry .....	State .....	17
120	Bacteriological Studies on Vegetables.....	Bacteriology .....	State .....	40
125	Factors that Influence the Composition of Body Fats .....	Chemistry .....	Adams .....	27
126	The Wintering of Bees.....	Entomology .....	State .....	36
127	The Effects of Feed Deficiencies Upon the Vi- tality of Chicks .....	Chemistry and Poultry Husbandry, ..	Adams .....	34
128	The Fixation of Nitrogen in Soils.....	Bacteriology .....	Adams .....	13
129	Field Crop Varieties and Cultural Methods.....	Agronomy .....	Hatch .....	15
130	Fruit and Vegetable Diseases.....	Botany .....	State .....	22
131	Relation Between Adequacy of Diet and Im- munity to Roup .....	Poultry Husbandry, Chemistry, and Bacteriology .....	State .....	38
132	Investigations of Tenancy, Agricultural Credit, and Other Land Problems .....	Agricultural Economics .....	State .....	9
133	Sudan Grass Pasture for Dairy Cows.....	Dairy Husbandry and Agronomy, ..	State .....	30
134	The Marketing of Milk in Typical Kansas Towns, ..	Agricultural Economics .....	State .....	10
135	Investigation of Animal Abortion .....	Veterinary Medicine .....	State .....	39
137	Plant Survey .....	Botany .....	State .....	14
138	Protein Synthesis by Microorganisms.....	Bacteriology .....	State .....	41
139	The Relation of the Vitamines in the Feed Con- sumed to Those in the Milk Produced by a Dairy Cow .....	Dairy Husbandry and Chemistry, ..	State .....	31
140	The Development of Dairy Heifers.....	Dairy Husbandry .....	State .....	29
	Cooperative Experiments with Farmers.....	Agronomy .....	State .....	19
	Hog Cholera and Blackleg Investigations.....	Veterinary Medicine .....	Receipts .....	37



No.

NAME	Departments	Funds	Discussed on page
The Distribution of Blackleg and Cholera Pre-ventives .....	Veterinary Medicine .....	Receipts .....	37
Seed Testing .....	Agronomy .....	State .....	20
Fort Hays Branch Experiment Station.....		State .....	42
Garden City Branch Experiment Station.....		State .....	45
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**SERVICE AND REGULATORY WORK**

Fertilizer Inspection .....	Chemistry .....	Fees .....	13
Feedingstuffs and Livestock Remedy Inspection, .....	Milling Industry .....	Fees .....	35
Dairy Inspection .....	State Dairy Commissioner.....	State .....	32
Inspection and Licensing of Stallions.....	State Livestock Registry Board ..	Fees .....	23
Official Testing of Dairy Cows.....	Dairy Husbandry .....	Fees .....	33
Improvement of State Institutional Dairy Herds, .....	Dairy Husbandry .....	State .....	31

## STUDIES IN THE ECONOMICS OF AGRICULTURE

As mentioned in the Director's Report for 1918-19, the Kansas Agricultural Experiment Station is expanding its investigations in the economics of the agriculture of the state as rapidly as the necessary funds are made available. During the fiscal year ending June 30, 1920, the work was prosecuted along three major lines, each of which is briefly discussed below.

**Farm Organization Studies.**—It is becoming increasingly evident that agricultural progress in this state will require many modifications in the organization of the individual farm. These modifications cannot be made intelligently in the absence of reliable detailed information as to the economic relationships among the various farm enterprises. In order to secure this information, the Agricultural Experiment Station has started two investigational units, known as statistical routes. One of these units is located in Jackson County, where the agriculture is fairly well diversified, and the other is located in McPherson County, where the wheat industry is dominant. Each unit consists of about 25 farms, well distributed throughout the county, on which complete cost accounts are kept. A specialist in agricultural economics is detailed to each unit, and he visits each farm twice a week for the purpose of assisting the farmer in keeping his accounts and of making the necessary measurements of fields and of products. As this work was not begun until about the middle of the fiscal year, no full year's records of results are available. It is proposed to continue the work on each unit for a period of at least five years so as to minimize the effects of seasonal variations of both natural and economic conditions. In this way it is expected that definite and reliable information regarding the various farm enterprises will be secured so as to facilitate the making of any necessary modifications in the farm organization. [Project 95; Department of Agricultural Economics; state funds.]

**Investigations of Tenancy, Agricultural Credit, and Other Land Problems.**—This investigation was begun during the preceding fiscal year and the results of the first year were summarized in the Director's Report for 1918-19. During the fiscal year ending June 30, 1920, very little work was done because of the absence of the head of the Department of Agri-

cultural Economics, who had been directing this work. In the later months of the year a questionnaire was sent to all farmers who replied to the questionnaire sent out during the preceding year. A total of 698 replies to the second questionnaire were received, but these have not yet been summarized. [Project 132; Department of Agricultural Economics; state funds.]

**The Marketing of Milk in Typical Kansas Towns.**—There has been a good deal of agitation during recent years regarding the marketing of milk, and much dissatisfaction has been expressed by both producers and consumers. In order to secure some reliable information on the question, the Agricultural Experiment Station during the fiscal year ending June 30, 1920, conducted an investigation into the marketing of milk in six representative towns of Kansas. The towns included were Topeka, Wichita, Salina, Emporia, Dodge City, and Concordia. The following are some of the conclusions reached as a result of the investigation:

1. One of the most needed improvements in the marketing of milk in Kansas is a good grading system and adequate inspection service to enforce it. Topeka and Wichita have departments of milk inspection but none of the other four cities studied had any such service.

2. The question of surplus milk is not of such importance in Kansas as in sections where dairy farming is followed to a greater extent, as there is little milk produced at any season of the year over the amount necessary to supply the demand. A distinct shortage exists at many times during the year, but the periods of surplus and shortage are not uniform with all the distributors, which helps to equalize these two factors.

3. The city trade and large centralizer creameries furnish the principal markets for Kansas milk, although ice cream factories and condenseries offer some of the producers other avenues for the disposal of their product.

4. There are two general types of marketing—direct and indirect. A much larger proportion of the milk supply of the cities of Kansas is furnished by the direct method than is the case in larger cities in the North and East, because of difference in conditions. There are several different types of distributors coming under each of these two general heads. Practically all of the milk sold is bottled, the change from

dipping milk in the streets probably having been made first in this state in Topeka, in 1896. A large part of the milk is sold in bottles to the grocery stores, from which it is retailed over the counters or delivered to the consumers. This method is especially common in Kansas, and because of its increasing importance a questionnaire was sent to grocery stores in each of the six cities. The answers indicated, among other things, that the grocerymen as a whole did not wish to handle milk, and that this practice was only another evidence of the costly demand for service on the part of the consumer.

5. Inequalities in the market have been the main cause of organization among the producers. There are various types of cooperative associations among the milk producers, but they have made comparatively little headway in Kansas. One of the main benefits of cooperative action should be the increase in individual efficiency. Cooperation among the dairy-men will progress faster when indirect marketing supplants to a greater extent the pint system of producer-distributors.

6. The study of the costs of marketing and marketing efficiency should be considered under two headings: Individual costs and efficiency, and costs and efficiency of the system as a whole. The costs of marketing vary considerably with the types of distributors and with individuals, the producer-distributors having the lowest cost per quart. Various factors affect individual costs and efficiency-labor, delivery expense, and amount of business being among the principal ones. For the system as a whole, duplication of service is the greatest defect. Various plans, eleven in all, have been proposed as meeting the needs for a change in method. These plans all have their strong and weak points, but all have a tendency toward the indirect method of milk marketing. The question of direct versus indirect marketing resolves itself into the choice between cheap methods with consequent lowering of quality and costlier methods with higher quality. The indirect method probably is more efficient when the work done is considered. The common feeling against the "middleman" should not be allowed to interfere with the most efficient operation of the marketing processes.

7. Finally, it may be said that the problems of marketing milk have to do with questions of efficiency in the minute details of the business rather than those arising from the faulty

distribution of the income from the sale of the product. It is true that the system of marketing milk is not, as a whole, what it should be, but the difficulty in the system lies principally in the seemingly unimportant details.

The detailed results of the investigation are being assembled for publication as a station bulletin. [Project 134; Department of Agricultural Economics; state funds.]

#### CONSERVATION OF THE SOIL

A declining soil fertility constitutes one of the most important agricultural problems in Kansas. A large proportion of the agriculture of the state in the past has been essentially exploitative. As a result, much of the land is less productive now than it was 50 years ago. This condition presents the problem of determining a practicable method of utilizing the soil and at the same time maintaining or increasing its fertility. There are given below brief descriptions of the more important features of the work which is being done by the Agricultural Experiment Station on this problem.

**Systematic Investigations of Soil Fertility.**—These Investigations include the comparison of various cropping systems with and without the application of manure, green-manuring crops, and commercial fertilizers. The experiments are centered at the main station at Manhattan, where a portion of the Agronomy Farm is set aside for this purpose. They include comparisons of various crop sequences; the application of various quantities of different kinds of commercial fertilizers, and of barnyard manure; and the use of green-manuring crops and of lime. The character of the work is such that it requires a long series of years to secure conclusive results. A rather extensive summary of the results secured up to 1919 was published in the Director's Report for 1918-19. From now on summaries of the results of certain features of the work will be published from time to time and distributed among the farmers of the state. [Project 17; Department of Agronomy; Hatch funds.]

**Tillage Investigations.**—In addition to the fundamental problems of soil fertility, satisfactory utilization of the soil requires an understanding of the tillage requirements of different soil types and of different crops. The tillage investi-

gations in progress at Manhattan during the fiscal year ending June 30, 1920, included a test of several methods of preparing a seedbed for wheat; studies of the effects of the soil mulch; studies of nitrification as associated with various methods of tillage; and an investigation of the effect of the sorghum crops upon the tilth of the soil. This work is to be continued for an indefinite number of years and summaries of the results of certain features of it will be published from time to time. The most recent publication bearing on the work is Kansas bulletin 219, "Growing Wheat in Kansas." [Project 18; Department of Agronomy; Hatch funds.]

**The Fixation of Nitrogen in Soils.**—For several years the experiment station has been conducting an investigation into the behavior of certain nitrogen fixing bacteria of the soil, special attention being paid to the organism known as Azotobacter. The behavior of this organism was studied during the fiscal year under review, with particular reference to its relation to the lime content of the soil and to soil acidity. [Project 128; Department of Bacteriology; Adams funds.]

**Soil Chemistry Investigations.**—For a number of years the Department of Chemistry has been making a survey of certain soils in the state to determine the effect of alfalfa production on the fertility elements of the soil. This study has included the ordinary plant foods and also sulphur. The work is now practically completed. Among other things, it has been ascertained that the cultivated soils in the eastern part of the state have lost on the average about one-fifth of their original sulphur content, and the sulphur content of the soil is approximately equal to its phosphorus content. Particular attention was paid during the year under review to the relation of the calcium content of certain soils to the soil reaction as determined by the electrometric titration method, and a paper summarizing the results of the investigation has been published.<sup>1</sup> [Project 103; Department of Chemistry; fertilizer fees.]

**Fertilizer Inspection.**—An important part of the work of the Agricultural Experiment Station in relation to soil fertility is that relating to the inspection of commercial fertilizers

<sup>1</sup> Swanson, C. O., Latshaw, W. L., and Tague, E. L. Relation of the calcium content of some Kansas soils to the soil reaction as determined by the electrometric titration. Jour. Agr. Research. 20:855.868. March 1, 1921.

offered for sale in the state. During the year 1919, a total of 16,937 tons of commercial fertilizer was sold in Kansas. Samples, representing 31 different brands of commercial fertilizer, were secured and analyzed during the spring of the year under review, and samples representing 46 brands were obtained and analyzed during the fall of the year. In addition to the routine fertilizer inspection work, a study was made during the year of the relation between the price charged for the different fertilizers and their plant food content. The results of this study were included in the report on commercial fertilizers for the year.<sup>2</sup> [Department of Chemistry; fertilizer fees.]

#### INVESTIGATIONS IN THE PLANT INDUSTRIES

Something of the importance of the plant industries in the state is indicated by the fact that the gross value of the products of these industries in 1919 was more than 564 million dollars. About half of this value was represented by the wheat crop alone. Other important plant industries besides wheat are the corn, oats, alfalfa, and sorghum industries. The Agricultural Experiment Station is working on numerous problems<sup>2</sup> relating to these industries with reference both to production and utilization or marketing. Some of the work which the station did in connection with the plant industries during the fiscal year ending June 30, 1920, is indicated below.

**Plant Survey.**—It is to be regretted that no comprehensive survey of the plant life of Kansas has ever been made. The state has an exceptionally rich flora, including many native plants of great economic importance, but the distribution of these plants is very imperfectly understood. The Agricultural Experiment Station has recently begun a survey which in time is expected to make possible the publication of a comprehensive report on the flora of the state. A beginning was made during the fiscal year under review. Approximately 500 new plants were labeled and incorporated with the college herbarium. Special attention was paid to the classification of poisonous plants. This classification is particularly useful to college students in Veterinary Medicine and to veterinary practitioners of the state. The station is planning to develop herbaria along certain definite lines, such as farm weeds, pasture weeds,

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<sup>2</sup> Swanson, C. O., Latshaw, W. L., and Throckmorton, R. I. Report on commercial fertilizers in 1919. Kan Agr. Expt. Sta. Insp. Cir. 12:1-43. 1920.

roadside weeds, poisonous plants, pasture plants, and forage plants. [Project 137; Department of Botany; state funds.]

**Studies of the Physiology of Crop Plants.**—For several years the Agricultural Experiment Station has been carrying on fundamental investigations in the physiology of certain plants of the state, particularly corn and the sorghums. These were continued during the past year. The work has included the water requirement of certain varieties of these crops; a study of the processes of fertilization of the flowers of corn; and a study of the metabolism of corn and sorghum plants, both during the day and during the night. These latter studies have included the development of dry matter, water, total nitrogen, amino nitrogen, total sugar, dextrose, cane sugar, and starch. [Project 74; Department of Botany; state funds.]

**Field Crop Varieties and Cultural Methods.**—The work of the station in the testing of varieties of wheat, oats, and corn was continued during the year under review. In the wheat variety tests, the ninth year of a comparison of Kanred, a new variety developed by this station, and Turkey and Kharkof, the two varieties most commonly grown in the state, was completed. The average yields in bushels per acre of these three varieties for the nine-year period ending with 1919, are as follows:

Variety	Bushels per acre
Kanred .....	27.3
Turkey .....	23.2
Kharkof .....	23.3

In the tests of varieties of oats, the superiority of Kanota, a variety which is being tested extensively by the station; was again demonstrated. In 1919 this variety yielded 54.3 bushels per acre as compared with 33.2 bushels for Red Texas, and 50.2 bushels for Iowa No. 103.

The test of the furrow method of seeding wheat which was discussed in some detail in the Director's Report for 1918-19 was continued. This test was conducted at the main station and the branch stations at Colby and Hays. The furrow method gave a slightly lower yield at Manhattan in 1919; a distinctly higher yield at Colby; and at Hays an average increase of 3.6 bushels per acre over the ordinary method of seeding. An average of all available data up to the end of the season of 1919 shows that at Manhattan in a ten-year test, the furrow



method has produced 0.6 bushels per acre more than the ordinary method; that at Colby in a two-year test the furrow method has produced 4.5 bushels per acre more than the ordinary method; and that at Hays the yield secured by the furrow method has exceeded that resulting from the ordinary method by 2.5 bushels per acre in a two-year test. It is interesting to note in this connection that where the furrows extend north and south the yields usually are somewhat higher than where the furrows extend east and west.

For the past five years a test of four different methods of cultivating corn has been conducted at the Manhattan station. This test includes ordinary cultivation; ordinary cultivation supplemented with an occasional cultivation with a one-horse cultivator; ordinary cultivation supplemented with the one-horse cultivator every 10 days during the growing season; and no cultivation at all, but having the weeds removed with a sharp hoe without disturbing the soil to any material depth. As an average of the five years ending with 1919, there has been no significant difference in the yields secured by different methods of cultivation. The results indicate that the principal object of cultivation of corn is to control the growth of weeds. [Project 129; Department of Agronomy; Hatch funds.]

**The Time to Cut Alfalfa for Hay.**—Each year since 1914 an experiment has been conducted at the Manhattan station to determine the best of four stages of growth at which to cut alfalfa for hay. The average yields secured during the six-year period ending with 1919 are as follows:

Stage of cutting	Average yield in tons per acre
When the buds appear . . . . .	3.43
When one-tenth of the plants are in bloom. . . . .	4.03
When plants are in full bloom . . . . .	4.08
When the seed has been formed . . . . .	3.69

In connection with this test studies are being made of the effects of cutting at different times upon the yield and cost of production of hay; upon the stand of alfalfa plants; upon the incursion of grass and weeds; and upon the chemical content of the hay and its feeding value. Complete analyses were made during the fiscal year under review of samples of hay harvested in each of the four stages of growth. [Project 90; Departments of Agronomy and Chemistry; Adams funds.]

**The Improvement of Crop Plants by Breeding.**—Extensive experiments were carried on in the breeding of wheat, oats, rye, barley, flax, corn, and sorghums. The principal work was done in connection with wheat, oats, and sorghums. In the case of wheat particular attention was paid to winter resistance, earliness, rust resistance, and yield. In the case of oats special attention was paid to earliness and yield. The primary object of the sorghum breeding work is to secure accurate and detailed information on the inheritance of characters in the sorghums. Information on this point is now almost entirely lacking. The results of these studies are supplying a basis for later work in sorghum improvement, and may well be expected to produce improved types through the artificial recombination of characters. [Project 67; Department of Agronomy; Hatch funds.]

**The Milling Qualities of Wheat.**—During the fiscal year ending June 30, 1920, 84 samples of wheat, produced in varietal and cultural tests at the Agronomy Farm in 1918, were subjected to milling, baking, and chemical tests. This work included milling and baking determinations on different varieties of wheat, and on certain varieties of wheat produced by different methods. This work is an important part of the wheat production investigations of the Agricultural Experiment Station, as the final proof of the value of a wheat variety or of a method of wheat production must take account of the milling and baking quality. [Project 60; Department of Milling Industry; state funds.]

**Chemical Nutrients in Forage Crops.**—During the year the Chemistry Department made a large number of determinations of nutrients in different forage crops and of certain forage crops cut at various stages of growth. Special attention was paid in this connection to Sudan grass and sweet clover, and to the chemical effects of different methods of curing alfalfa for hay. A special study was begun on hydrocyanic acid in Sudan grass. Large amounts of this poison were found in Sudan grass which was being pastured by dairy cows. Excellent progress was made in the perfecting of satisfactory analytical methods for determining the presence of hydrocyanic acid. [Project 113; Department of Chemistry; state funds.]

**The Chemical Qualities of Certain Food Products.**—The Department of Chemistry is conducting an investigation which is concerned primarily with the intermediate processes by which certain agricultural products, especially wheat, are transformed into human foods. This investigation involves a study of changes taking place in the preparation of wheat for the milling process and also in the making of flour and the baking of bread. The investigation involves a study of the proteins of wheat and milk; a study of the enzymes of wheat and flour and their action during the baking process; investigations looking toward more uniform methods of determining the baking qualities of flour; and a study of various conditions for the storage of wheat and flour. During the year under review special attention was paid to the influence of electrolytes on gluten formation in flour. Two papers, based on these investigations, were published.<sup>1</sup> [Project 60; Department of Chemistry; state funds.]

**Pasture Investigations.**—One of the most important problems in the agriculture of Kansas is that relating to the conservation and utilization of the native pastures of the state. Not less than 15 million acres of land in the state is native pasture. The future of the livestock industries of the state depends very largely upon the efficiency with which these native pastures are utilized and the degree to which they are conserved. The pasture investigations of the Agricultural Experiment Station are centered on a 1,400-acre pasture in Pottawatomie County belonging to Mr. Dan Casement. In addition to the work on that area, considerable work is being done at the Manhattan station and elsewhere with both native pastures and tame grasses. During the year under review the pasture work included a continuation of the deferred grazing system at the Casement pasture; a study of the effects of burning pasture vegetation in the spring of the year; a determination of the carrying capacity of native pastures under different methods of grazing; a determination of the effects of different methods of grazing upon weed growth; and the beginning of an experiment to test the preference that live-

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<sup>1</sup> Tague of E. L. A study of the determination of amino acids by means of the hydrogen electrode *Jour. Amer. Chem. Soc.* 42:173-184. 1920.

Tague, E. L. The changes taking place in the tempering of wheat. *Jour. Agr. Research.* 20:271-275. 1920

stock on native pasture may have for different kinds of stock salt. [Project 96; Department of Agronomy; state funds.]

**Cooperative Experiments with Farmers.**—Because of variations in soil and climatic conditions, it is desirable to extend the crop production studies made at the regular experiment stations to all parts of the state before the results of these studies are considered conclusive and directly applicable in farm practice. This state-wide testing of methods and of various crops and crop varieties, which the experiments at the regular stations have shown to be desirable, is accomplished through the conduct of cooperative experiments with practical farmers. This cooperative experimental work was begun in 1911. During the year 1919 the work was under way in 74 counties of the state and included 395 experiments. The following table indicates the scope of the work:

Nature of tests	Number of tests
Corn varieties . . . . .	148
Sorghum varieties . . . . .	118
Wheat varieties . . . . .	56
Fertilizers for wheat . . . . .	29
Fertilizers for alfalfa . . . . .	10
Oat varieties . . . . .	6
Miscellaneous . . . . .	26
Total . . . . .	395

Throughout the hard-wheat-growing section, Kanred for the fifth consecutive season outyielded Turkey and Kharkof by an average of about four bushels per acre. Its ability to withstand rust attacks gave the variety a decided advantage over the others during the season of 1919, when rust was unusually prevalent in the wheat-growing sections. Kanota oats was included for the first time in the cooperative tests. The six tests of this variety were conducted in Atchison, Franklin, Cherokee, Jewell, Dickinson, and Sedgwick Counties. In each test the Kanota variety was compared with local Red Texas. The average yield for the year of Kanota in these tests was 45.2 bushes per acre, while the average yield of local Red Texas was 29.9 bushels per acre. In the fertilizer tests conducted in eastern Kansas, the application of bone meal at the rate of 150 pounds per acre increased the yield of wheat an average of 6.7 bushels per acre. The application of potash and blood meal had very little effect on the yield of wheat. In the tests conducted in central Kansas the yields of wheat showed practically no increase following the application of

commercial fertilizers. The results secured in the alfalfa fertilizer tests again indicated that manure or acid phosphate can be used to good advantage in the eastern third of the state. [Department of Agronomy; state funds.]

**Seed Testing.**—The improvement of the seed supply is one of the important problems to be dealt with in Kansas agriculture. One of the things to be done in this connection is the testing of seeds to determine their purity and their viability. During the past year the seed laboratory, which is a part of the Department of Agronomy, tested a total of 2,629 samples of seed for citizens of the state. Of these samples, 2,549 were tested for germination, and 239 for purity. The seeds of which most of the samples consisted included vegetables, 431 samples; wheat, 416 samples; alfalfa, 287 samples; sorgos, 224 samples; kafirs, 138 samples; corn, 204 samples; and flowers, 110 samples. The average germination of certain of the samples tested included alfalfa, 64.2 percent; sorgos, 68.3 percent; kafirs, 85.8 percent; Sudan grass, 64.1 percent; wheat, 98.4 percent; corn, 86.7 percent. Some of the figures with reference to average purity are: Alfalfa, 95 percent; red clover, 94 percent; white clover, 76 percent; orchard grass, 72 percent; and blue grass, 88 percent. [Department of Agronomy; state funds.]

**Horticultural Experiments.**—The experiments of the Department of Horticulture include varietal tests of various vegetable crops; a source-of-seed test with potatoes; a varietal test of asparagus; an experiment to determine the effect of various cultural methods upon the formation of fruit buds in orchard trees; and experiments with several varieties and various cultural and fertilizer methods for potatoes. A part of this work is carried on at the Manhattan station and a part is conducted on commercial vegetable farms in various parts of the state. [Projects 25, 26, and 27; Department of Horticulture; state funds.]

**Growth Tests of Forest Trees.**—In The fall of 1896, a planting was made of forest trees at the Manhattan station in cooperation with the United States Forest Service, primarily for the purpose of testing the hardiness and growth of a number of tree species. In December, 1919, the planting was thinned, and the average height and diameter of the trees in each species was determined. The following table shows the

results of the determination made upon trees which had been growing in the planting for 23 years:

Species	Average height	Average diameter in inches
<i>Quercus rubra</i> (Red Oak) . . . . .	33	3.7
<i>Quercus macrocarpa</i> (Bur Oak) . . . . .	35	4.3
<i>Celtis occidentalis</i> (Hackberry) . . . . .	35	6.0
<i>Fraxinus lanceolata</i> (Green Ash) . . . . .	36	5.0
<i>Gleditsia triacanthos</i> (Locust) . . . . .	40	6.0
<i>Juglans nigra</i> (Walnut) . . . . .	35	5.0
<i>Catalpa speciosa</i> (Catalpa) . . . . .	36	4.5
<i>Acer negundo</i> (Box Elder) . . . . .	31	7.2

This information indicates something of what may be expected of the species concerned when closely planted under conditions similar to those at Manhattan. The trees are being allowed to continue their growth so that additional determinations can be made in the future. [Project 82; Department of Horticulture; state funds.]

#### DISEASES OF PLANTS

The work of the station during the fiscal year with reference to plant diseases was conducted along two general lines: Cereal and forage crop diseases, arid fruit and vegetable diseases.

**Cereal and Forage Crop Diseases.**—The work in connection with cereal diseases was concerned chiefly with wheat rust, cereal smuts, and corn root rot. The principal feature of the wheat rust work was that relating to the development of rust-resistant strains of wheat and to the study of various biological forms of the black stem rust organism. Smut investigations were carried on chiefly with oat and sorghum varieties, the work consisting mainly of determining varietal resistance to smut and of tests of various seed treatments for the prevention of smut. The work on corn smut and root rot was concerned chiefly with the testing of fungicidal treatments and of selected ears of commercial white corn, apparently resistant to corn smut and root rot, as seed. Some marked differences were discovered in the degrees of resistance of the corn plants produced from seed from these selected ears.

In addition to the regular experimental work indicated above, the survey of cereal and forage crop diseases in the state was continued. This disclosed the fact that both black stem rust and orange rust of wheat were more severe in 1919 than they had been for a number of years. The black chaff disease

of wheat caused injury in many fields in 1919. Its existence was shown to be closely related to the quantity of rainfall and the degree of humidity between the time the wheat heads and the time of harvest. Wheat scab was reported in a few counties in 1919 for the first time. It was again prevalent in the early part of 1920. Various root rots of wheat caused by certain species of imperfect fungi appeared in the season of 1920. The *Septoria* leaf spot was more prevalent in 1920 than ever before. [Project 76; Department of Botany; state funds.]

**Fruit and Vegetable Diseases.**—The work with fruit and vegetable diseases had to do chiefly with diseases of tomatoes, apples, strawberries, and potatoes. Bordeaux spraying experiments for the control of early blight and tip burn of potatoes were continued and promising results were secured. Good progress was made in the development of wilt-resistant tomatoes and in the investigation of strawberry decay, which was found to be associated with the presence of certain species of *Rhizopus*. [Project 130; Department of Botany; state funds.]

#### INJURIOUS INSECTS AND OTHER PESTS

The control of insects and other pests is one of the important requirements for success in the agriculture of Kansas. A large number of destructive insects and injurious mammals occur in the state, and unless they are checked they do very great damage to crops. During the year the Department of Entomology continued its work on nine projects and the Department of Zoology conducted investigations on three major projects having to do with animal parasites and injurious mammals.

**Insect Pests.**—The work on insects by the Department of Entomology included the following:

1. Studies of the life history of *Aphis prunifoliae* and methods of controlling this pest.
2. A continuation of the study of the life history, period of emergence, and methods of control of the Hessian fly, and in cooperation with the Department of Agronomy continued testing of fly-resistant wheat varieties.
3. The conduct of a varietal resistance test and a time-of-planting test with corn in relation to the corn earworm, and the conduct of an investigation of the methods of oviposition by this insect. (This experiment was conducted to determine the relation of oviposition to different varieties of corn and to

different dates of planting. The results showed that fewer eggs are laid on corn planted on May 1 and fewer on medium early varieties, or those varieties which have a short silking period. It was also found, in a study of the factors which attract the moths of the corn earworm to the corn plant, that the presence of maizenic acid in corn silk plays an important part. The addition of this acid to ordinary cotton twine was shown to make the twine attractive to the moths.)

4. Laboratory and field tests of various powdered sulphur compounds as insecticides for orchard trees. (The results of these tests were, in general, unfavorable to the use of this material.)

5. Studies of the kafir ant and other insects attacking the sorghums.

6. Studies of insects attacking the roots of staple crops, including May beetles, *Lachnosterna*, *Scarabæidæ*, wireworms, and false wireworms.

7. Investigations on termites.

8. Studies of insects injurious to alfalfa, including the clover leaf weevil, clover root curculio, clover seed chalcid, alfalfa caterpillar, and other insects.

9. Investigations of shade tree insects, with particular attention to the canker worm.

[Projects 6,8,9, 13,92, 100, 101, 115, and 116; Department of Entomology; Hatch and state funds.]

Animal Parasites.—The Department of Zoology continued its work on the life histories of chicken tapeworms and the transmission of the fowl nematode. It was shown in the life history studies of the chicken tapeworm that the common house fly is the means of transmitting another tapeworm, *Davainea tetragona*, from one fowl to another. This fact is a contribution to the knowledge of chicken tapeworms in general. It was published for the first time in 1919. Studies on the fowl nematode were continued for the purpose of determining the economic importance of this parasite, the principal facts of its life history, and, if possible, methods of control. It was shown to have a decidedly depressing effect on the growth of young chicks. Certain facts were discovered regarding the life histories of these parasites, including the place of oviposition and the size and rate of growth of the organism. Preliminary tests of methods of control indicated



that the nematode eggs in the fowl feces are very resistant to desiccation and to freezing. [Projects 79 and 119; Department of Zoology; Adams and state funds.]

**Injurious Mammals.**—During the year the investigational work on injurious mammals was confined to pocket gophers, moles, and ground squirrels. A general study of the pocket gopher received attention and considerable data were collected concerning this animal's breeding habits, the damage it does to crops, its parasites, and its general life activities. Much valuable information was obtained regarding the feeding habits of moles kept in captivity. It was learned that these animals are not exclusively insectivorous as was heretofore believed, but that they will eat certain grains, especially corn after the grains have been softened by the absorption of water. In nature moles are heavily parasitized by mites, ticks, lice, and fleas.

The zoological poison laboratory was operated throughout the year and distributed 16,168 quarts of poisoned oats for use in combating injurious mammals. [Project 84; Department of Zoology; state funds.]

INVESTIGATIONS IN THE ANIMAL INDUSTRIES

In 1919 the numbers of different kinds of farm animals in Kansas were approximately as follows:

Horses . . . . .	1,000,000
Mules . . . . .	250,000
Milk cows . . . . .	700,000
Others cattle . . . . .	2,220,000
Sheep . . . . .	268,000
Swine . . . . .	1,300,000
Total . . . . .	5,738,000

The total value of the 5,738,000 farm animals in the state in that year was approximately \$339,000,000. The value of the animals slaughtered or sold for slaughter and of the poultry products sold during the year amounted to approximately \$150,000,000. All the common animal industries are important in the state, but the beef, dairy, and swine industries predominate. The dairy industry has expanded materially during recent years. The conduct of the animal industries involves a number of problems which are yet to be solved with reference to the breeding, feeding, management, and marketing of farm animals. Some of the important work done by

the experiment station in connection with these problems is mentioned in the following pages.

**Breeding Shorthorn Cattle.**—Since 1915 the Agricultural Experiment Station has been conducting an experiment to determine the relation of sex type to functional development and performance in Shorthorn cattle. The primary purpose of this experiment is to secure information relative to the following questions: Is the milking tendency in beef cattle transmitted mainly by the dam through the male line of descent? To what extent does the milk-giving function of the dam influence the beef character of the progeny? Is it possible to retain the typical beef form in the male animals and at the same time increase the milking tendency in the females? Is the present standard of selecting beef cows conducive to the production of the best beef type in the breed? In connection with the experiment, records of milk production are kept on each of the cows used. Up to the end of the fiscal year under review, milk records for one year or more have been secured on 18 cows. These records ranged from 10,203 pounds of milk produced in one year by Cream Toast 87609, to 2,138 pounds of milk produced by Archduchess 15th, 217426. As the experiment progresses the cows originally included are being replaced by their daughters whenever the latter are of the desirable beef type and also heavy milkers. Up to the end of the fiscal year under review eight daughters of the original cows have been officially entered in the experiment. [Project 97; Department of Animal Husbandry; Adams and state funds.]

**The Use of Silage in Beef Production.**—One of the conspicuous features of the agriculture of Kansas during recent years has been the increasing popularity of silage as a part of the ration for beef cattle. Effective use of silage is proving to be one of the best methods of reducing the cost of beef production. During the past fiscal year the Agricultural Experiment Station conducted a series of experiments for the purpose of discovering practicable methods of making a maximum utilization of silage in beef cattle feeding. The experiments involved the utilization of silage by aged steers and yearling steers, also by calves for the production of baby beef. Another phase of the work was to determine whether cattle, wintered on silage, will gain as much weight on pasture the following

summer as will cattle wintered on dry roughage. The results of these experiments have been published as station circular 86, "Cattle Feeding Investigations, 1919 -20." [Project 78; Department of Animal Husbandry; state funds.]

**The Feeding Value of Alfalfa Hay Cut at Different Stages.**— In a previous section of this report (page 16) reference was made to an experiment being conducted by the Agronomy Department to determine the best of four stages of growth at which to cut alfalfa for hay. The Animal Husbandry Department during the past fiscal year conducted a feeding trial with the alfalfa hay produced by cutting at the four different stages. This experiment involved four lots of five high-grade Hereford calves each. These lots were fed the four kinds of alfalfa hay for a period of 90 days ending March 16, 1920. In this experiment the rate of gain by the calves and the feed efficiency of the hay declined as the time of cutting was deferred. The range in gains was from 0.46 pound per day by the calves receiving hay made by cutting when the seed had formed, to 1.07 pounds per day by the calves which received hay cut at the bud stage. The feed efficiency ranged from 959 pounds of hay for 100 pounds of gain in the case of calves receiving bud-stage hay, to 2,247 pounds for 100 pounds of gain in the case of the calves receiving seed-stage hay.

A digestion trial of the four kinds of alfalfa hay used in this experiment was made by the Chemistry Department as a part of the investigation. The coefficients of digestibility ranged as follows:

Dry matter, 56.53 for seed-stage to 63.75 for one-tenth bloom stage

Ash, 56.99 for seed-stage to 64.38 for bud-stage

Crude protein, 66.88 for seed-stage to 78.82 for bud-stage

True protein, 60.70 for seed-stage to 72.63 for bud-stage

Crude fiber, 32.15 for bud-stage to 47.20 for seed-stage

Nitrogen free extract, 52.80 for bud-stage to 68.41 for one-tenth bloom stage

Ether extract, 27.45 for one-tenth bloom stage to 39.15 for bud-stage

[Project 90; Departments of Animal Husbandry and Chemistry; Adams and state funds.]

**Feeding Western Lambs.**—During the year the Animal Husbandry Department conducted feeding trials with 12 lots of western lambs, including a total of 445 head. These trials included tests of the following: Handfeeding versus self-feeding; silage versus no silage; alfalfa versus straw as a rough-

age; protein supplement versus no protein supplement; corn gluten feed versus linseed meal as a protein supplement; shelled corn versus ground corn; shelled corn versus whole barley; and a test of a stock tonic. The results of the experiment have been published as station circular 88, "Lamb Feeding Investigations, 1919 -20." [Project 11; Department of Animal Husbandry; state funds.]

**Rations for Growing and Fattening Pigs.**—A Total of 20 lots of pigs were used in testing various rations either for growing or for fattening. These tests included a comparison of corn and barley for growing pigs on alfalfa pasture; a comparison of wheat and rye for fattening pigs in dry lot; the test of various protein supplements for fattening hogs; and a comparison of kafir, milo, and feterita with corn as a feed for fattening hogs. The results of these experiments have been published as station circular 89, "Swine Feeding Investigations, 191-20." [Project 110; Department of Animal Husbandry; state funds.]

**Swine Nutrition Studies.**—During the fiscal year ending June 30, 1919, a three-year experiment was begun to determine the effects of continued feeding of four specific rations upon three generations of swine. The following rations were fed to four lots of pigs: Corn and tankage; corn, tankage, and ground alfalfa; kafir and tankage; kafir, tankage, and ground alfalfa. This experiment was continued during the fiscal year ending June 30, 1920.

The work of the experiment with reference to swine was paralleled by the Chemistry Department through the use of rats as the experimental animals. The results secured with rats were in harmony with those secured with the first generation of swine, and indicated in general that both corn and tankage, and kafir and tankage are inadequate, and that the addition of alfalfa to the ration of kafir and tankage, makes the diet adequate for both growth and reproduction. This experiment is still in progress. [Project 38; Departments of Animal Husbandry and Chemistry; Adams funds.]

**Factors that Influence the Composition of Body Fats.**—One of the problems confronting the animal husbandman in the finishing of animals for either marketing or show purposes is the production of firm tissues. One of the factors contributing

to the flabbiness of animal tissues is the low melting point of certain fats caused by the presence of either unsaturated or short-chained fatty acids. The Chemistry Department is conducting an experiment to determine, if possible, what factors influence the composition of these body fats. The results so far secured indicate that none of the short-chained fatty acids of the feed are deposited in the body fat, while the unsaturated fatty acids contained in feed are so deposited. The results also indicate that the body fat produced by a high-protein diet differs from that produced by a low-protein diet. [Project 125; Department of Chemistry; Adams funds.]

**Inspection and Licensing of Stallions.**—One of the important services rendered by the experiment station to the livestock industry of the state is that relating to the inspection and licensing of stallions. Stallions standing for public service in the state are licensed by the State Livestock Registry Board.<sup>1</sup> During the fiscal year ending June 30, 1920, a total of 3,543 licenses were issued. Of this number, 2,600 were for purebred stallions; 561 for grade stallions; and 382 for scrubs. Great progress has been made during the past 10 years in connection with the reduction of the number of grade and scrub stallions used in the state, as is indicated by a comparison of the license figures for 1910 and 1920, respectively. In 1910, only 40.8 percent of the stallions licensed were purebred. In 1920, the purebreds amounted to 73.4 percent of the total number of stallions licensed. In 1920, 2,484 of the purebred licenses issued were for purebred draft stallions and 116 for purebred light-weight stallions. Corresponding figures for 1910 are 1,892 draft stallions and 707 light stallions. In 1920, the Percheron breed led with a total of 1,996 stallions. It was followed by French draft with 218; the Belgian with 158; the Standardbred with 78; and the Shire with 48. Other breeds of which a smaller number of stallions were licensed include Clydesdale, Morgan, American Saddle, German Coach, Shetland, Thoroughbred, French Coach, Cleveland Bay, Hackney, and Suffolk. The stallion license law has given mare owners a means of knowing the exact breeding of the stallions they patronize and has practically eliminated misrepresentations regarding blood lines. Previous to the passage of the stallion

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<sup>1</sup> An ex-officio board consisting of the Dean of Division of Agriculture, Head of Department of Animal Husbandry, and Dean of Division of Veterinary Medicine.

license law, hundreds of grade and scrubs with fraudulent pedigrees were sold as purebreds to unsuspecting purchasers at high prices. The practical and beneficial results from the operation of the stallion license law have shown clearly the value of the law to the horse industry of the state. [State Livestock Registry Board; stallion license fees.]

**The Development of Dairy Heifers.**—During the year two experiments were carried on to secure information regarding the influence of various feeds upon the development of dairy heifers. One of these experiments has been in progress since 1914. It is conducted for the purpose of securing information on the influence of three different rations upon the development, reproduction, and cost of feeding dairy heifers. The experiment involves four lots, as follows:

- Lot 1, fed alfalfa hay only.
- Lot 2, fed alfalfa hay and corn silage.
- Lot 3, fed alfalfa hay, corn silage, and grain.
- Lot 4, fed alfalfa hay, corn silage, and grain. (The animals in this lot are bred to calve at 24 months of age, or six months earlier than those in lots 1, 2, and 3.)

This experiment will be completed during the fiscal year ending June 30, 1921, when the results of the seven years' work will be summarized and prepared for publication. [Project 99; Department of Dairy Husbandry; state funds.]

A second experiment in the development of dairy heifers involves six lots of six animals each and is conducted for the purpose of determining the relative values of different protein supplements. Three of the lots receive uniformly a ration of prairie hay and corn chop. With one of the three lots this ration is supplemented with cottonseed meal; with another it is supplemented with bran and cottonseed meal; and with the third the ration is supplemented with bran and oilmeal. The three remaining lots are fed a uniform ration of alfalfa and corn chop. These lots receive the same supplements, respectively, as are indicated above for the first three lots. This experiment has not yet progressed far enough to produce definite conclusions. Before it is finished it is expected to furnish useful information regarding the effects of the different combinations of feeds upon the body development, milk production, and reproduction of the animals used. [Project 140; Department of Dairy Husbandry; state funds.]

**Sudan Grass Pasture for Dairy Cows.**—During the summer of 1919 an experiment was conducted to determine the feasibility of using Sudan grass as a pasture for dairy cows under conditions similar to those at Manhattan. Six large Holstein cows were pastured for a period of 92 days, beginning on July 10. In addition to the Sudan grass pasture, the cows were fed a mixture of 4 parts of corn, 2 parts of bran, and 1 part of oilmeal at the rate of 1 pound daily for each 4 pounds of milk produced. The area of the pasture was 5.4 acres. It supported the six cows very satisfactorily for the 92 days, as mentioned above, and in addition to this produced 7.33 tons of field-cured hay. The details of this experiment are published as station circular 80, "Sudan Grass as a Supplementary Pasture Crop for Dairy Cattle." [Project 133; Departments of Dairy Husbandry and Agronomy; state funds.]

**The Use of Silage in Feeding Dairy Cattle.**—During the fiscal year under review the following experiments were conducted with silage as a feed for dairy cattle: A comparison of silage made from the whole kafir plant with silage made from kafir stover; a comparison of silage made from the whole cane plant with silage made from cane stover; a comparison of kafir stover silage with cane stover silage; and a test of silage made from wild sunflowers. Slightly better returns were secured from the whole kafir silage than from kafir stover silage, and the same was true with reference to the whole cane silage and cane stover silage. The results secured from silage made from cane stover were slightly better than those secured through the feeding of silage made from kafir stover.

Unsatisfactory results were obtained from the feeding of silage made from wild sunflowers. This test involved five cows which were fed alfalfa hay, grain, and wild sunflower silage for a period of 20 days and then changed to alfalfa, grain, and cane silage. Great difficulty was experienced in inducing the cows to eat the silage made from wild sunflowers, and the animals lost weight and declined markedly in milk production upon this ration. The sunflowers used in making this silage may have been cut at an unfavorable stage, so that the unsatisfactory results secured in this one test should not be regarded as conclusive. The results of the test, however, do not give any justification for thinking that the wild sunflower is a satisfactory substitute for the plants ordinarily used in

Kansas for the making of silage. [Project 34; Department of Dairy Husbandry; state funds.]

**The Use of Cane Seed as a Feed for Dairy Cows.**—There is a widespread prejudice against the use of cane seed as a feed for dairy cows and a general belief that the feeding of this material depresses milk production. During the past fiscal year an experiment was conducted in which ground cane seed was fed to five dairy cows during three 30-day periods. No unfavorable effects were noted. The experiment is to be repeated before definite conclusions are announced. [Project 34; Department of Dairy Husbandry; state funds.]

**The Relation of the Vitamines in the Feed Consumed to Those in the Milk Produced by a Dairy Cow.**—A good deal of interest attaches to the question of the relationship between the vitamines in the feed consumed by dairy cows and those in the milk produced by them. In order to secure information on this subject, an experiment was started during the fiscal year, in which two grade Holstein cows were fed continuously on a practically vitamine-free ration. The ration consisted of pearl hominy, tankage, cottonseed meal, and wet beet pulp. The milk produced by these cows was tested biochemically in comparison with milk produced by cows receiving normal feeds. The preliminary results indicated that milk produced by cows fed no vitamines contained much less fat-soluble and water-soluble vitamines than the milk produced by cows receiving ordinary dairy rations. A similar difference with reference to antiscorbutic vitamines was not noted. This experiment is being continued. [Project 139; Departments of Dairy Husbandry and Chemistry; state funds.]

**Improvement of State Institutional Dairy Herds.**—By an act of the Kansas legislature, the dairy herds of the state institutions were placed under advisory supervision of the Department of Dairy Husbandry on July 1, 1917. During the past fiscal year a total of 13 institutional herds received this supervision. These institutional herds are located at the following points: Atchison, Beloit, Dodge City, Hutchinson, Lansing, Larned, Norton, Osawatomie, Parsons, Winfield, and Topeka, there being three herds at Topeka. Regular visits are made to these institutions by representatives of the Department of Dairy Husbandry, who give assistance in connection with the



selection, feeding, management, and breeding of the respective dairy herds. Local problems, especially those involving the production of clean milk, receive consideration. During the past fiscal year the 13 herds included a total of 888 cows, of which 753 were grades and 135 were purebreds. Great variation exists among these herds and within each herd with reference to the efficiency and cost of milk production. During the month of June, 1920, for example, the average milk production per cow per herd ranged from 521 pounds to 1,010 pounds, a spread of almost 100 percent. The average milk production per cow of the five highest-producing cows in each herd during that month ranged from 820 pounds in one herd to 1,369 pounds in another. The average cost of feed per gallon of milk produced during the month ranged from 3.1 cents in one herd to 8.8 cents in another. These variations are due to differences in the quality of herds, the methods of feeding, and the methods of management. One of the principal objects of the work of advisory supervision is to build up the efficiency of each herd through the improvement of feeding, breeding, and management methods, and thus to increase the production of milk and reduce its cost. [Department of Dairy Husbandry; state funds.]

**Dairy Inspection.**—A state law provides that a state dairy commissioner under the direction of the Agricultural College shall perform certain inspection activities with reference to the dairy industry of the state. Something of the activities of the dairy commissioner and his deputies during the past fiscal year is indicated by the following table:

Number of towns visited . . . . .	988
Number of cream-buying station inspections . . . . .	1,637
Number of creamery inspections . . . . .	159
Number of ice cream factory inspections . . . . .	102
Number of milk plant inspections. . . . .	42
Number of condensery inspections . . . . .	8
Number of cream-buying stations closed because of insanitary conditions . . . . .	14
Number of prosecutions won by the state . . . . .	1
Number of ice cream and cream samples collected and analyzed. . . . .	302
Number of complaints investigated. . . . .	94

During the year cream grading has been carried on both at creameries and at cream-buying stations. The creameries of the state have cooperated with the dairy commissioner in this connection and some progress has been made with reference to

cream grading. In order to show cream-buying station operators how to grade cream, the dairy commissioner has continued the practice of making cream-grading demonstrations at each point where cream buyers' examinations are held. As a part of the examination each operator is required to test and grade samples of cream. During the year there were in operation in the state about 1,500 cream-buying stations; 7 condenseries; 81 creameries; 18 centralizing plants; 1 cheese factory; and about 150 ice cream factories. [State Dairy Commissioner; state funds.]

**Official Testing of Dairy Cows.**—The steady advance of the dairy industry in the state is indicated in a measure by the constantly increasing interest in the official testing of dairy cows for the production of milk and butterfat. This work is carried on by the Department of Dairy Husbandry. The increased interest in official testing is indicated in the following table, which shows the extent of the work during each of the three fiscal years ending with the fiscal year 1919-20:

	YEAR		
	1917-18	1918-19	1919-20
<i>Two-day Tests</i>			
Number of tests . . . . .	1,798	2,010	2,815
Number of breeders having cows tested . .	34	51	86
<i>Seven-day Tests</i>			
Number of tests . . . . .	146	394	425
Number of breeders having cows tested . .	34	50	74

Not only has the number of official records increased, but there has been an increased tendency to keep records over longer periods than was the case in previous years. On June 30, 1920, a total of 3,242 cows in 236 herds were being tested for milk and butterfat production in 12 cow-testing associations in the state. The advanced registry testing and the work of cow-testing associations are two factors which are aiding materially in the development of the dairy industry of the state. [Department of Dairy Husbandry; fees from official testing.]

**Breeding and Feeding Farm Poultry.**—Station bulletin 223 "Improving Mongrel Farm Flocks Through Selected Standard-bred Cockerels," published under date of January, 1920, reports the results secured up to that time in one important branch of this work. Additional data upon the best breeding age for chickens have been gathered. The fact that the sale of hatching eggs has been discontinued by the Department of

Poultry Husbandry made available a much larger number of eggs for hatching and of chicks for recording. The work of selecting for high egg production within the standard breeds most common in Kansas was continued, and the demand for pedigreed stock from high-producing families exceeded the supply. The work of grading up mongrel farm flocks through the use of selected standardbred cockerels is being continued with very satisfactory results. The studies of inheritance of Andalusian blue have progressed satisfactorily, more than 3,000 chickens having been examined and described during the year.

The feeding tests conducted during the year included a comparison of common grains as the sole source of food for day-old chicks. In this comparison it was found that wheat gave slightly better results in connection with weight than corn, kafir, or oats. In the vitamine feeding tests with day-old chicks, cabbage gave fairly good results; less satisfactory results were secured from the feeding of carrots; and the feeding of tomatoes failed to prevent leg weakness. The experiment to determine the desirability or undesirability of using commercial chick feeds which include weed seeds was continued. In addition to the fact that a large number of weed seeds are refused by the chicks, it was found that a large percent of these seeds would germinate, and thus constitute a menace to the farms upon which they are fed to chicks. [Project 77; Department of Poultry Husbandry; state funds.]

**The Effects of Feed Deficiencies Upon the Vitality of Chicks.**—As a general rule where eggs are hatched on a fairly large scale, not more than 50 or 60 percent of them produce vigorous chicks. While much of the difficulty is due to unfavorable incubating conditions, such as temperature, moisture, and oxygen supply, no doubt the improper nutrition of the embryo due to a deficiency of some substance in the egg which is essential to the proper development of the embryo plays an important part in this low percent of vigorous chicks. To investigate the effect of the feeds fed on the deficiencies of these essential substances in the egg, six pens, each containing one male and five female Single Comb White Leghorns, housed and handled under as nearly identical conditions as possible, were fed different rations of known composition as follows:

- Pen I. A supposedly adequate diet.
- Pen II. A diet low in protein.
- Pen III. A diet low in fat-soluble vitamins.
- Pen IV. A diet low in water-soluble vitamins.
- Pen V. A diet containing 25 percent Canadian field peas.
- Pen VI. A diet containing alfalfa.

In Pens I and VI there was a decided gain in weight, and in Pen III a slight gain. In Pens II, IV, and V there was a loss in weight. Pens I and VI laid the most eggs, and as was true in the case of the low-protein pen the previous year, Pen II laid very few eggs and the birds were poor in weight. The mortality was high in the case of Pens III, IV, and V, and numerous replacements were necessary. While this work has not been completed, the results show clearly that the vitamine content of eggs is dependent on the vitamine content of the feed. This may account for the fact that an egg from a hen receiving a restricted diet does not hatch well. [Project 127; Departments of Poultry Husbandry and Chemistry; Adams funds.]

**Feedingstuffs and Livestock Remedy Inspection.** —One of the duties imposed by law upon the experiment station is the inspection of commercial feedingstuffs and livestock remedies. This work is carried on by the Feed Control Office, a part of the Department of Milling Industry. Its primary purpose is to see to it that each commercial feed or livestock remedy offered for sale in the state is properly labeled as to content and weight, so that the consumer may know what he is buying and that the manufacturer or dealer may know definitely what he is selling. A numerical summary of the work of the Feed Control Office during the fiscal year ending June 30, 1920, is given below.

Inspector's visits to firms and individuals . . . . .	1,681
Inspector's visits to towns . . . . .	540
Registrations of feedingstuffs . . . . .	2,409
Firms or individuals registering feeds . . . . .	875
Official samples of feed analyzed . . . . .	749
Samples found not up to guaranty in one or more particulars. . . . .	393
Samples deficient in protein . . . . .	86
Samples deficient in fat . . . . .	59
Samples excessive in fiber . . . . .	208
Citations issued . . . . .	31
Prosecutions filed for violation of feedingstuffs law . . . . .	25
Convictions obtained . . . . .	25
Known number of refunds paid . . . . .	35
Known amount of refunds paid . . . . .	\$2,793.14
Commercial samples of feed analyzed . . . . .	218
Office samples of feed analyzed . . . . .	47

Livestock remedies registered . . . . .	81
Total livestock remedy registrations on file . . . . .	548
Prosecutions under livestock remedy law . . . . .	3
Convictions. . . . .	2
Cases held in abeyance. . . . .	1
Official samples of livestock remedies analyzed . . . . .	5
New firms registering livestock remedies . . . . .	6
Total number of firms with livestock remedies registered. . . . .	186
Federal samples analyzed. . . . .	106
Found in compliance with law and dropped . . . . .	62
Found in violation of law and prosecution recommended . . . . .	44
Interstate shipments found deficient in protein . . . . .	15
Interstate shipments found short in weight . . . . .	14
Interstate shipments found unlabeled . . . . .	17
Interstate shipments found to be adulterated . . . . .	1
Interstate shipments on which seizure was made . . . . .	4

[Department of Milling Industry; feedingstuffs fees.]

**The Wintering of Bees.**—Because of the importance of the bee industry in certain parts of the state, a good deal of interest attaches to the problems relating to the wintering of bees. Since the fall of 1917 the experiment station has been studying these problems. Six different methods of wintering bees are being tried. They involve the use of single-story hives, both packed and unpacked; two-story hives, both packed and unpacked ; protection from the wind; and exposure to the wind. The total weight of each colony is determined periodically and the number of bees present in each is determined at the beginning and again at the close of the winter season. Some of the indications so far noted are that packed hives have more bees in the spring than unpacked hives; that 40 to 50 pounds of honey are necessary for stores for a well-packed colony to pass the winter; and that a so-called open winter is more likely to be unfavorable for bees than what is ordinarily regarded as a severe winter. [Project 126; Department of Entomology; state funds.]

#### DISEASES OF FARM ANIMALS

During the twelve months ending March 1, 1920, the following losses of livestock, as a result of disease, occurred in Kansas, according to the reports of the State Board of Agriculture:

Horses and mules . . . . .	27,494
Milk cows . . . . .	14,811
Other cattle . . . . .	52,733
Sheep . . . . .	15,996
Swine . . . . .	63,207
Total . . . . .	174,241

Many of these losses undoubtedly occurred from diseases which are preventable through the application of knowledge already available, but many of them resulted from diseases which are not well understood. Each year the Agricultural Experiment Station carries on investigations for the purpose of increasing the knowledge of these diseases.

**Investigation of Animal Abortion.**—Under the authority of a special act of the 1919 session of the Kansas legislature an investigation was started during the past fiscal year on animal abortion disease. This disease is one of the most important in the state. The investigation has been started along three principal lines: (1) An effort to determine the efficacy of the agglutination and complement fixation tests for the presence of abortion. (This work is carried on in the college herds.) (2) An attempt to induce immunity to the disease. (This work is being conducted with a special herd of abortion cattle and is being paralleled in the laboratory through the use of guinea pigs.) (3) Further studies of the organism which is believed to cause abortion. These three lines of the investigation are now making satisfactory progress. It is likely that it will require several years to secure results which can be successfully applied. [Project 135; Department of Veterinary Medicine; state funds.]

**Hog Cholera and Blackleg Investigations.**—While satisfactory preventives of hog cholera and blackleg are now available, there still remain numerous problems to be investigated with reference to the production and use of these preventives. During the year investigational work was conducted along the following lines: The attempted production of artificial virus for use in hyperimmunizing hogs for the production of anti-hog-cholera serum; cultural and biological tests on various strains of *Bacillus chauvæi* in the production of blackleg filtrate; differential cultural tests for *Bacillus chauvæi* and allied spore-bearing anaerobes; further work on the development of a potency test for blackleg filtrate and blackleg ag-gressin; and an investigation of the immunity and susceptibility of guinea pigs to blackleg. [Department of Veterinary Medicine; vaccine funds.]

**The Distribution of Blackleg and Cholera Preventives.**—The Agricultural Experiment Station maintains a plant for the

production of anti-hog-cholera serum and virus, and for the production of blackleg vaccines. During the year there were distributed from this plant a total of 1,158,650 c. c. of anti-hog-cholera serum; 34,915 c. c. of hog cholera virus; 13,231 doses of blackleg aggressin; 34,989 doses of blackleg filtrate; 11,961 doses of blackleg single-powder vaccine; 3,595 doses of blackleg double-powder vaccine; and 28,530 c. c. of blackleg serum. The manufacture and distribution of these biologics by the station serves to standardize the quality and the prices of these materials and also to maintain a continuing demonstration of their efficacy in the prevention of the two diseases concerned. [Department of Veterinary Medicine; vaccine funds.]

**Investigations of Poultry Diseases.**—During the last year the work on the subject of poultry diseases included the examination of 160 fowls sent in for diagnosis. The diagnoses disclosed the following diseases and pests: Roup, fowl typhoid, cholera, white diarrhea, tuberculosis, scaly leg, gangrene of feet, lice, and intestinal worms. A pure culture bacterial vaccine was developed for the treatment of roup and fowl typhoid. This vaccine was tested in 12 commercial flocks of poultry, including a total of 1,225 birds, of which only four, or about 0.3 of 1 percent, acquired the disease after treatment, as compared with a total of 117, of 9.5 percent which acquired the disease before treatment was applied in the flocks. It is expected that this preventive vaccine will be ready for distribution among the poultrymen of the state at an early date. [Project 85; Department of Bacteriology; state funds.]

**Relation Between Adequacy of Diet and Immunity to Roup.**—The investigation to determine the relation between adequacy of diet and immunity to roup was continued. During the past year it involved six pens of nine young chickens each. The results so far secured seem to indicate that the feeding of a diet lacking vitamins is likely to lower the vitality of chickens, and consequently reduce immunity to roup. [Project 131; Departments of Poultry Husbandry, Chemistry, and Bacteriology; state funds.]

**Miscellaneous Diseases.**—During the year the Department of Veterinary Medicine was called upon to investigate a number of disease outbreaks including the following: Hemmor-

rhagic septicemia in sheep; red dysentery and rabies in cattle; and reports of the so-called "plague" in horses. Three alleged outbreaks of "horse plague" were investigated, in each of which it was possible to isolate a small gram positive diplococcus from the heart blood and pericardial and spinal fluids of animals which had died of the disease. It was also possible to isolate an organism resembling *Baccillus paratyphosus* from the blood and pericardial fluid. Experiments are still under way to determine the relationship of these organisms to the disease. [Project 102; Department of Veterinary Medicine; state funds.]

#### MISCELLANEOUS INVESTIGATIONS

Under this heading four investigational projects of rather general interest will be discussed briefly. The first two relate to studies of the laws of inheritance; the third to some bacterial investigations with vegetables; and the fourth to an investigation of protein synthesis by microorganisms.

**Inheritance in Orthoptera.**—For several years the Department of Zoology has been investigating certain laws of inheritance, using grasshoppers as the experimental animals. During the past year studies were continued on the inheritance of 15 allelomorphous characters, including a mutation, and on two other independent characters of the grouse locust, *Paratettix texanus*. In the species, *Tettigidea parvipennis pennata*, five multiple allelomorphs and one independent character have been thoroughly tested. Further studies on parthenogenesis and linkage in the genus *Apotettix* were made. Varied matings have resulted in several new linkages in this group. As many as four different characters have been linked into a single individual so as to breed true. These linkages occur on a definite percentage basis and can be predicted as certainly as Mendelian segregation. Applications of this principle may possibly be adaptable to the production of double-purpose breeds, and thus be of great economic benefit. The results of these studies during the past year were based on 632 crosses, which produced over 10,000 recordable individuals. [Project 72; Department of Zoology; Adams funds.]

**Inheritance in Guinea Pigs.**—In the inheritance project of the Animal Husbandry Department the following questions were investigated, guinea pigs being used chiefly as the experimental animals: Color inheritance; inheritance of size;



inheritance of defects; inbreeding; and the physiology of reproduction. These studies have included investigations of the cause of aberrant ratios and linkage relations. Added proof has been secured that the factors for albinism and black are completely linked. In that part of the investigation having to do with inheritance of defects, a number of animals were born during the year but they furnished no positive evidence that the defects studied are inherited. These defects include congenital blindness, absence of toes, and certain other characters. In the study of inbreeding in guinea pigs two new inbred generations were produced, none of which showed any decrease in vigor, fecundity, or size. In connection with a study of reproduction the data on prenatal growth, sex ratios, litter size, gestation periods, etc., have been almost completely summarized. [Project 93; Department of Animal Husbandry; state funds.]

**Bacteriological Studies on Vegetables.**—This work has been continued during the past year and confined to a study of bacteria isolated from spoiled canned asparagus. The organisms isolated were grouped according to the method of treatment. It was found that *Bacillus subtilis* predominated to some extent in jars to which a small amount of salt and a larger amount of acid had been added, while *B. mesentericus* predominated in larger amounts of salt and smaller amounts of acid. The influence of blanching upon the distribution of various types of bacteria was also studied. Blanching was found to have the most influence in the case of *B. subtilis*, *B. mesentericus*, and *B. botulinus*. The other organisms were present in such small numbers that it was difficult to draw conclusions from their distribution as influenced by blanching. An attempt was made to study the influence of various amounts of air upon growth and thermal death points of the aerobes most commonly present in canned foods. The conclusions drawn from this study include the following with reference to aerobes:

1. That merely sealing the container almost completely inhibits the growth of these organisms.
2. That the amounts of salt and acid used in the experiments cause practically no decrease in the number of spores up to 37 days at 37° C. in sealed containers containing various amounts of air.

3. That increasing the amount of salt has practically no influence upon the thermal death point.

4. That decreasing the amount of air has no influence upon the thermal death point.

5. That increasing the amount of acid has a very marked influence upon the thermal death point. Increasing the amount of acid to one-tenth of 1 percent reduces the thermal death point nearly 50 percent. [Project 120; Department of Bacteriology; state funds.]

**Protein Synthesis by Microorganisms.**—In this study attention was directed chiefly to the ability of *Azotobacter* to synthesize atmospheric nitrogen into protein. It was observed that, contrary to the usually accepted view, *Azotobacter*, under optimum growth conditions, is a fairly rapid-growing organism. Rapid cell development, and consequently rapid azofication, can be produced by vigorous aeration of the culture. By this method, vigorous growth and prompt azofication can be produced within two to four days when the organism is cultivated in large quantities of liquid. The azofying ability of 12 pure cultures, using dextrose as the source of energy, was determined. Preliminary nutrition experiments are now in progress, including the determination of the coefficient of digestibility and the vitamin content of the *Azotobacter* cell. It appears that the investigation will result in the devising of a means of growing *Azotobacter* rapidly in bulk. Emphasis has been placed upon the nitrogen-fixing ability of various cultures used, since the higher the fixation, the greater the protein content of the cells will be. The nutritive value of the *Azotobacter* cells produced is now being determined by the Department of Chemistry. [Project 138; Department of Bacteriology; state funds.]

#### BRANCH EXPERIMENT STATIONS

In addition to the main experiment station at Manhattan, branch stations are maintained at Hays, Garden City, Colby, and Tribune. These branch stations are maintained for the purpose of supplementing the investigational work conducted at the main station, especially with reference to testing, under western Kansas conditions, the results secured at Manhattan, and to the investigation of agricultural problems which are peculiar to the four western Kansas districts in which the

branch stations are located. Some of the more important features of the work of these branch stations are mentioned in the following pages.

**Fort Hays Branch Experiment Station.**—The Fort Hays Branch Experiment Station consists of 3,600 acres of land equipped for investigational work with both crops and livestock. The principal general lines of work in progress include investigations in dry-land agriculture; cereal and forage crop investigations; the management of a herd of range cattle with special attention to winter maintenance; the management of a dairy herd; the production of sheep; and the operation of the State Forest Nursery.

The nursery is maintained for the purpose of conducting experiments with various species of trees and shrubs in order to determine which are desirable for the conditions prevailing in western Kansas. During the past fiscal year more than 40,000 trees and shrubs were distributed throughout the western part of the state, and about 80,000 seedlings and cuttings were added to the nursery to be grown for trial and future distribution.

The cereal investigations include experiments in the production of winter and spring wheat, barley, and oats. During the year under review the work was conducted on 408 plots, varying in size from one-fiftieth to one-twentieth of an acre. During the past four years the average yield of Kanred wheat in varietal tests has been 23.9 bushels per acre as compared with 22.1 bushels for Kharkof and 19.1 bushels for Turkey. Five years of experimental work in rate and date of seeding winter wheat have indicated that October 1 is the optimum date, where the seedbed has been well prepared. But little difference occurred in the yields secured by seeding at the rates of 3 to 4 pecks per acre, except when the seeding was done later than October 15. In such cases the four-peck rate gave the best yields. Extensive breeding and selection work has been projected with grain sorghums, one of the leading experiments being a study of a large number of plants of the F<sub>3</sub> generation of a cross between Red Amber and feterita. In addition to this, 374 selections of Dawn kafir, feterita, mile, and miscellaneous groups of sorghums are under observation. Earliness and drouth resistance, together with high yield, are the principal objects sought in this connection. Excellent progress has been

made with Dawn kafir and with a cross between Pink kafir and Freed sorgo.

Investigations with forage crops at the Fort Hays station during the past fiscal year were conducted on 342 field plots ranging in size from one-twentieth to one-tenth of an acre each. In addition to this, tests were made of 720 head-to-row plantings of sorghums. A new series of spacing tests was begun with Pink kafir to determine the relative merits, for both forage and grain, of seeding in rows 40 inches apart, 80 inches apart, and of alternating 40-inch and 80-inch rows. Sudan grass has been grown at the Fort Hays station since 1913 and has proved to be a very valuable annual hay and pasture crop. The hay is particularly valuable for work horses. Experiments conducted at Hays since 1913 with alfalfa on upland have failed to produce any satisfactory method of growing alfalfa in that part of the state on upland soils. These experiments have included both the ordinary method of seeding and seeding in rows ranging in width from 6 to 42 inches. The results secured on all of the forage crops at the Fort Hays station from 1913 to 1919, inclusive, have been published as a station bulletin.<sup>1</sup>

One of the recent additions to the forage crop work has to do with the eradication of bindweed. This weed has become a serious pest in several counties in west central Kansas. The eradication experiment, begun in 1919, involves 31 one-tenth acre plots. The methods of eradication under test include varying intensity of fallow; the use of sorghum and Sudan grass as smother crops, both under continuous culture and in rotation with fallow; and the application of common salt at the rates of 8, 12, 17, 20, 24, and 28 tons per acre. It will require several years yet to complete this investigation.

The dry-land agriculture work, begun in 1906, was continued during the past year along the same lines as during the year previous. The work covers experiments in seedbed preparation for winter wheat, kafir, mile, cane, barley, oats, and spring wheat; the growth of the common crops of the region in various rotations and under various methods of soil treatment; experiments to determine the best method of handling land during a period of fallow; and tests of the value of straw, barnyard manure, and green manure as fertilizers for in-

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1. Getty, R. E. Forage crops in western Kansas. Kan. Agr. Expt. Sta. Bul. 225:1-54. Figs. 10. 1921.

creasing soil productivity. During the past year experiments were started to try out various commercial fertilizers in wheat production and to determine the value of barnyard manure and certain commercial fertilizers in the production of alfalfa.

The livestock work of the station includes experiments in breeding, feeding, and wintering stock under western Kansas conditions. In the winter of 1919-20 experiments were carried on with 18 lots of cattle, a total of 330 head. In these experiments the following problems were studied: The comparative feeding value of an acre of kafir with the heads on and with the heads off, both as silage and as dry feed; the value of cane silage as compared with cane fodder for wintering cows; the relative value of alfalfa hay and linseed cake as a protein supplement for wintering mature cows; the comparative value of the small lot and the large pasture for wintering calves; and the effect of methods of feeding and age of breeding upon the development of the beef cow and her offspring.

A large portion of the 3,600 acres of land at the Fort Hays station is used in applying on a commercial scale those production methods which are found by experiment on a small scale to be the most practical. The crops produced in this way are used in feeding station livestock, as sources of seed of better-yielding crops for distribution to farmers, and for the general market. A major portion of the roughage and much of the grain produced is used in experimental work with livestock. For these purposes about 400 acres are devoted to alfalfa; 600 acres to wheat; 100 acres to corn; 100 acres to barley and oats; 50 acres to Sudan grass for seed and forage; and 400 acres to forage and grain sorghums. The station has seven silos, a grain elevator, and a seed barn for use in the storage of crops produced. This large scale work serves as a check on the experimental results and as a source of revenue for the partial support of the experimental work.

By correspondence and lectures the station supplies information regarding agricultural practices to a large number of farmers in western Kansas. The chief activities in this direction have been in tree planting for parks and homesteads, the control of insects and plant diseases, and the application of desirable cropping methods. The work of the station is brought to the attention of the farmers through correspondence, newspaper articles, and the Round Up Day, Sorghum Day, and Wheat Day held at the station each year.

**Garden City Branch Experiment Station.**—The Garden City Branch Experiment Station, which is located in Finney County, works along two general lines: (1) Investigation of various methods of crop production under dry-land conditions; and (2) the conduct of experiments in irrigation agriculture. The dry-land work includes varietal tests of sorghums, corn, and small grains, together with experiments to determine the best rotation and tillage methods to use in the dry-land agriculture of the region.. So far the Dwarf Yellow milo has proved to be the most reliable grain sorghum variety for the region, while Dwarf Blackhull kafir and the sweet sorgos have proved to be the best sorghum varieties for the production of silage.

The irrigation investigational work was modified during the year. The rate-of-watering experiment with milo, kafir, sumac, Sudan, and small grains was completed, and a series of crop rotation experiments was begun. The rate-of-watering tests which were conducted for a period of six years have indicated, among other things, that irrigation water can be used most profitably in that region on such crops as milo, kafir, and the sorgos, and that small grain crops in ordinary years will make less efficient use of large quantities of irrigation water than the sorghum crops just mentioned. Detailed results of these experiments are being prepared for publication.

**Colby Branch Experiment Station.**—This station, which is located in Thomas County in the northwestern part of the state, is concerned chiefly with the peculiar agricultural problems of that region. During the past year the experiments included a comprehensive series of crop rotation and tillage tests; production tests with Sudan grass, Red Amber cane, alfalfa, barley, and corn; tests of the furrow method of seeding winter wheat; and the maintenance of a dairy herd. In the varietal test with corn, Sherrod White Dent, with a yield of 48.8 bushels per acre, was the highest yielder among 11 varieties. The highest yield of stover among 12 varieties of forage sorghums tested was 22,550 pounds per acre, produced by Sumac sorgo. Kanred again was the highest yielding variety in winter wheat, its yield being 28.4 bushels per acre. Six varieties of barley were tested, the highest yielder being the Coast variety, which produced 26.15 bushels per acre.

The work with the dairy herd was continued as in the previous year and the results confirmed the conclusions formerly reached, that a small dairy herd may profitably be included in the farming system of the northwestern part of the state. The gross receipts from the sale of milk from 12 cows during the year exceeded \$2,500. Careful records of the milk production of each of the cows in the herd are kept for use in informing the farmers of that region regarding practicable methods of maintaining a dairy herd.

**Tribune Branch Experiment Station.**—The work of the Tribune station was conducted on substantially the same lines as during the previous year. This work includes the production of varieties of various crops to test their adaptability to southwestern Kansas conditions; varietal tests with wheat, oats, barley, sorghum, and beans; width-of-row tests with milo and corn; and a comparison of the furrow-drill and the common-drill methods of seeding small grains. The results so far secured at this station indicate that a great deal can be done in improving the agriculture of that region by paying more attention to the production of feeds for use in winter. Such crops as Dwarf mile, Dwarf kafir, and Freed sorgo are particularly promising, and fairly satisfactory results have been secured with millet and Sudan grass.

PUBLICATIONS OF THE STAFF  
OF THE  
KANSAS AGRICULTURAL EXPERIMENT STATION  
*To Dec. 31, 1920*

For several years it has been the practice of the Director of the Agricultural Experiment Station to include in his annual report a list of the station publications issued during the year under review, and also a list of papers contributed by members of the station staff and published in scientific journals during the year. This systematic method of reporting the published contributions of the station has not been followed regularly, however; neither has there been any compilation of such lists of publications. It has seemed desirable, therefore, to compile an up-to-date list which shall include not only the formal publications issued by the station since the beginning of its work in the Kansas State Agricultural College, but also all contributions of the station staff made to other scientific publications during the same period. In this list the publications are grouped by departments.

In preparing the list it has been necessary to take arbitrary action with reference to the departmental numbers of certain publications in the interest of the list as a whole. For this reason the departmental serial numbers indicated in the following table do not in all instances agree with the serial numbers given in publications themselves. It is believed, however, that this will not detract from the usefulness of the list, which not only has important historical value, but should be useful to investigators and librarians.



## LIST OF PUBLICATIONS BY DEPARTMENTS

TITLE	AUTHOR	PUBLICATION
<b>Department of Agricultural Economics</b>		
The Marketing of Kansas Butter.....	Theodore Macklin .....	Kan. Bul. 216
Farm Leases in Kansas.....	W. E. Grimes .....	Kan. Bul. 221
Cooperation Applied to Marketing by Kansas Farmers.....	Theodore Macklin .....	Kan. Bul. 224
<b>Department of Agronomy</b>		
Cultivated Grasses and Clovers in Kansas: Fourteen Years' Experience at the College Farm.....	E. M. Shelton .....	Kan. Bul. 2
Experiments with Wheat.....	E. M. Shelton .....	Kan. Bul. 4
Waste of Manure in Summering It in the Yard.....	E. M. Shelton, H. M. Cottrell, William Shelton .....	First Ann. Rpt., pp. 10-14
Experiments in the Corn Field.....	E. M. Shelton, H. M. Cottrell, William Shelton .....	First Ann. Rpt., pp. 14-54
Forage Crops .....	E. M. Shelton, H. M. Cottrell, William Shelton .....	First Ann. Rpt., pp. 63-69
The Relation of Rainfall to the Corn Crop.....	E. M. Shelton, H. M. Cottrell, William Shelton .....	First Ann. Rpt., pp. 99-116
Experiments with Wheat.....	E. M. Shelton .....	Kan. Bull. 7
Experiments with Corn.....	E. M. Shelton, H. M. Cottrell, William Shelton .....	Second Ann. Rpt., pp. 6-29
Forage Crops .....	E. M. Shelton, H. M. Cottrell, William Shelton .....	Second Ann. Rpt., pp. 42-52
Experiments with Wheat.....	C. C. Georgeson .....	Kan. Bul. 11
Experiments with Oats.....	C. C. Georgeson .....	Kan. Bul. 13
Experiments with Forage Plants.....	C. C. Georgeson .....	Kan. Bul. 18
Experiments with Wheat.....	C. C. Georgeson .....	Kan. Bul. 20
Experiments with Oats.....	C. C. Georgeson .....	Kan. Bul. 29
Experiments with Corn.....	C. C. Georgeson .....	Kan. Bul. 30

16	1891	Test of Some Japanese Beans.....	C. C. Georgeson .....	Kan. Bul. 32, pp. 233-238
17	1892	Experiments with Wheat.....	C. C. Georgeson .....	Kan. Bul. 33
18	1893	Experiments with Wheat.....	C. C. Georgeson .....	Kan. Bul. 40
19	1893	Experiments with Oats.....	C. C. Georgeson .....	Kan. Bul. 42
20	1893	Experiments with Corn.....	C. C. Georgeson .....	Kan. Bul. 45
21	1894	Experiments with Wheat.....	C. C. Georgeson .....	Kan. Bul. 47, pp. 11-16
22	1894	Some Forage Plants. Renovating a Prairie Pasture.....	C. C. Georgeson .....	Kan. Bul. 48, pp. 40-43
23	1895	Experiments with Oats.....	C. C. Georgeson .....	Kan. Bul. 54
24	1895	Part I, Experiments with Corn. Part II, Experiments with Kafir Corn.....	C. C. Georgeson .....	Kan. Bul. 56
25	1896	Experiments with Wheat.....	C. C. Georgeson .....	Kan. Bul. 59
26	1896	Experiments with Oats.....	C. C. Georgeson .....	Kan. Bul. 63
27	1897	Experiments with Corn.....	C. C. Georgeson .....	Kan. Bul. 64
28	1897	Experiments with Wheat.....	C. C. Georgeson .....	Kan. Bul. 71
29	1897	Experiments with Oats.....	C. C. Georgeson .....	Kan. Bul. 74
30	1897	Investigations of the Root Development of some Forage Plants.....	C. C. Georgeson and J. E. Payne .....	Kan. Bul. 75
31	1898	Wheat Experiments .....		Kan. Press Bul. 1
32	1898	Fall Preparation for Alfalfa Seeding.....		Kan. Press Bul. 10
33	1898	Possibilities in Corn Improvement.....		Kan. Press Bul. 20
34	1899	A New Crop for Kansas Farmers.....		Kan. Press Bul. 24
35	1899	Get Ready for the Drouth.....		Kan. Press Bul. 34
36	1899	Investigations of the Growth of Alfalfa in Kansas.....	Geo. L. Clothier .....	Kan. Bul. 85
37	1899	Soybeans .....		Kan. Press Bul. 46
38	1899	Alfalfa in Eastern Kansas.....	H. M. Cottrell .....	Kan. Press Bul. 51
39	1899	Kafir-Corn .....		Kan. Press Bul. 54
40	1900	Alfalfa in Eastern Kansas.....	H. M. Cottrell .....	Kan. Bul. 90
41	1900	Gophers and Crab-grass versus Alfalfa.....	J. G. Haney .....	Kan. Press Bul. 60
42	1900	Tame Grasses for Kansas.....	H. M. Cottrell .....	Kan. Press Bul. 62
43	1900	Bromus Inermis .....	H. M. Cottrell .....	Kan. Press Bul. 63
44	1900	A New Drought-Resisting Crop—Soybeans.....	H. M. Cottrell .....	Kan. Bul. 92
45	1900	Kafir-corn <sup>1</sup> .....	H. M. Cottrell <i>et al.</i> .....	Kan. Bul. 93
46	1900	Soil Inoculation for Soybeans.....	H. M. Cottrell .....	Kan. Bul. 96
47	1901	Soybeans in Kansas in 1900.....	H. M. Cottrell .....	Kan. Press Bul. 81
48	1901	Disking Alfalfa .....	H. M. Cottrell .....	Kan. Press Bul. 82

<sup>1</sup> See No. 17, Department of Animal Husbandry.

SERIAL NO.	DATE OF ISSUE	TITLE	AUTHOR	PUBLICATION
49	1901	Test of Soybeans by Kansas Farmers in 1900.....	H. M. Cottrell .....	Kan. Press Bul. 84
50	1901	Roots for Kansas Farmers.....	H. M. Cottrell .....	Kan. Press Bul. 85
51	1901	Soybeans in Kansas in 1900.....	H. M. Cottrell .....	Kan. Bul. 100
52	1901	When to Cut Alfalfa.....	H. M. Cottrell .....	Kan. Press Bul. 87
53	1901	Cowpeas as a Second Crop.....	H. M. Cottrell .....	Kan. Press Bul. 92
54	1901	Fall Seeding of Alfalfa.....	H. M. Cottrell .....	Kan. Press Bul. 99
55	1901	Fall Seeding of Alfalfa.....	H. M. Cottrell .....	Kan. Bul. 104
56	1902	Spontaneous Combustion of Alfalfa.....	H. M. Cottrell .....	Kan. Bul. 109
57	1902	Growing Alfalfa in Kansas.....	H. M. Cottrell .....	Kan. Bul. 114
58	1903	Better Bred Grain and Corn for Kansas.....	A. M. Ten Eyck .....	Kan. Press Bul. 120
59	1903	Late Crops .....	A. M. Ten Eyck .....	Kan. Press Bul. 124
60	1903	Meadow Fescue .....	A. M. Ten Eyck .....	Kan. Press Bul. 125
61	1903	Bromus Inermis .....	V. M. Shoesmith .....	Kan. Press Bul. 129
62	1904	Renewing Washed and Sanded Lands.....	A. M. Ten Eyck .....	Kan. Bul. 121, pp. 133-138
63	1904	Crop Experiments in 1903.....	A. M. Ten Eyck and V. M. Shoesmith .....	Kan. Bul. 123
64	1904	The Roots of Plants.....	A. M. Ten Eyck and V. M. Shoesmith .....	Kan. Bul. 127
65	1905	Testing Seed Corn for Vitality.....	V. M. Shoesmith .....	Kan. Press Bul. 138
66	1905	Experiments at Fort Hays Branch Station, 1902-1904.....	J. G. Haney .....	Kan. Bul. 128
67	1905	Testing Winter Wheat Varieties for Western Kansas.....	O. H. Elling .....	Kan. Press Bul. 146
68	1906	The Alfalfa Seed Crop and Seeding Alfalfa.....	A. M. Ten Eyck .....	Kan. Bul. 134
69	1906	The Study of Corn.....	V. M. Shoesmith .....	Kan. Bul. 139
70	1907	Small Grain Crops.....	A. M. Ten Eyck .....	Kan. Bul. 144
71	1907	Indian Corn .....	A. M. Ten Eyck .....	Kan. Bul. 147
72	1907	Alberta Seed Wheat.....	A. M. Ten Eyck.....	Kan. Press Bul. 157
73	1908	A Great Need for Saving Soil Moisture This Spring.....	L. E. Call .....	Kan. Press Bul. 160
74	1908	Late Crops .....	A. M. Ten Eyck.....	Kan. Press Bul. 162
75	1908	Alfalfa .....	A. M. Ten Eyck <i>et al.</i> ...	Kan. Bul. 155
76	1908	Russian Seed Wheat.....	C. W. Burkett .....	Kan. Press Bul. 164
77	1909	Distribution of Improved Seed Wheat.....	A. M. Ten Eyck.....	Kan. Press Bul. 172
78	1909	Distribution of Improved Seed Corn and Improved Seed of Other Standard Crops by the Kansas Experiment Station.....	A. M. Ten Eyck.....	Kan. Press Bul. 175

79	1909	Preparing Land for Winter Wheat.....	A. M. Ten Eyck and L. E. Call .....	Kan. Cir. 2
80	1909	Improved Seed Wheat.....	A. M. Ten Eyck and L. E. Call .....	Kan. Cir. 3
81	1910	Variety Tests .....	A. M. Ten Eyck and L. E. Call .....	Kan. Cir. 6
82	1910	Injury to Wheat and Other Crops by Freezing and Heaving of the Soil .....	A. M. Ten Eyck.....	Kan. Press Bul. 183
83	1910	Spring Grains .....	A. M. Ten Eyck and L. E. Call .....	Kan. Bul. 166
84	1910	Investigation of the Vitality of Kansas Seed Corn.....	A. M. Ten Eyck and L. E. Call .....	Kan. Cir. 8
85	1910	Management of Chinch Bug Infested Lands <sup>1</sup> .....	A. M. Ten Eyck and T. J. Headlee .....	Kan. Press Bul. 185
86	1910	The Relation of Size, Weight, and Density of Kernel to Germination of Wheat .....	J. G. Lill .....	Kan. Cir. 11
87	1910	Cowpeas .....	A. M. Ten Eyck and L. E. Call .....	Kan. Bul. 160
88	1911	Grasses .....	A. M. Ten Eyck.....	Kan. Bul. 175
89	1911	How to Grow Wheat in Kansas.....	W. M. Jardine .....	Kan. Bul. 176
90	1911	Exceptional Wheat Yields as a Result of Scientific Soil Treatment..	.....	Kan. Press Bul. 186
91	1912	The Condition of Kansas Seed Corn.....	E. G. Schafer .....	Kan. Cir. 22
92	1912	The Sorghum Crop in Kansas.....	A. H. Leidigh .....	Kan. Cir. 25
93	1913	Preparing Land for Wheat.....	L. E. Call .....	Kan. Bul. 185
94	1913	Corn .....	A. M. Ten Eyck .....	Kan. Bul. 193
95	1913	Sweet Clover .....	C. C. Cunningham .....	Kan. Cir. 34
96	1914	Alfalfa in Kansas .....	W. M. Jardine and L. E. Call .....	Kan. Bul. 197
97	1914	Kafir in Field and Feedlot.....	G. K. Helder .....	Kan. Bul. 198
98	1914	Soil Survey of Shawnee County <sup>2</sup> .....	L. E. Call, R. I. Throckmorton, C. O. Swanson .....	Kan. Bul. 200
99	1914	Seed Corn for Kansas.....	L. E. Call .....	Kan. Cir. 31
100	1914	Management of Soil to Prevent Blowing.....	W. M. Jardine .....	Jour. Am. Soc. Agron., 5:213-217
101	1914	The New Method of Growing Corn.....	C. C. Cunningham .....	Jour. Am. Soc. Agron., 6:84 88
102	1914	Preparation of Exhibits for Fairs and Contests.....	G. E. Thompson .....	Kan. Cir. 36
103	1915	Sweet Clover .....	C. C. Cunningham .....	Kan. Cir. 44

<sup>1</sup> See No. 157, Department of Entomology.

<sup>2</sup> See No. 53, Department of Chemistry.

DEPARTMENT OF AGRONOMY—*Concluded*

SERIAL NO.	DATE OF ISSUE	TITLE	AUTHOR	PUBLICATION
104	1915	The Effect of Different Methods of Preparing a Seedbed for Winter Wheat upon Yield, Soil, Moisture, and Nitrates.....	L. E. Call .....	Jour. Am. Soc. Agron., 6:249-259
105	1915	Growing Corn in Kansas.....	C. C. Cunningham .....	Kan. Bul. 205
106	1915	The Relation of Moisture to Yield of Winter Wheat in Western Kansas .....	L. E. Call and A. L. Hallsted .....	Kan. Bul. 206
107	1915	Soil Survey of Cherokee County <sup>1</sup> .....	L. E. Call, R. I. Throckmorton, C. O. Swanson .....	Kan. Bul. 207
108	1915	Soil Survey of Reno County <sup>2</sup> .....	L. E. Call, R. I. Throckmorton, C. O. Swanson .....	Kan. Bul. 208
109	1915	The Use of Dynamite in the Improvement of Heavy Clay Soils.....	L. E. Call and R. I. Throckmorton .....	Kan. Bul. 209
110	1916	Soil Survey of Jewell County <sup>3</sup> .....	L. E. Call and R. I. Throckmorton .....	Kan. Bul. 211
111	1916	The Effect of Rate and Date of Sowing on Yield of Winter Wheat... ..	W. M. Jardine .....	Jour. Am. Soc. Agron., 8:163-166
112	1916	Seeding Winter Grains in Furrows to Prevent Winterkilling .....	S. C. Salmon .....	Jour. Am. Soc. Agron., 8:176-188
113	1916	The Relation of Ear Characters of Corn to Yield.....	C. C. Cunningham .....	Jour. Am. Soc. Agron., 8:188-196
114	1916	Sudan Grass in Kansas.....	G. E. Thompson .....	Kan. Bul. 212
115	1916	The Time to Seed Wheat in Kansas.....	L. E. Call, S. C. Salmon, C. C. Cunningham .....	Kan. Bul. 213
116	1917	The Relation of Winter Temperatures to the Distribution of Winter and Spring Grains in the United States.....	S. C. Salmon .....	Jour. Am. Soc. Agron., 9:21-24
117	1917	The Soil Mulch .....	L. E. Call and M. C. Sewell .....	Jour. Am. Soc. Agron., 9:49-61
118	1917	A New Wheat for Kansas.....	W. M. Jardine .....	Jour. Am. Soc. Agron., 9:257-266
119	1917	Why Cereals Winterkill .....	S. C. Salmon .....	Jour. Am. Soc. Agron., 9:353-380
120	1918	Growing Sorghum in Kansas .....	C. C. Cunningham and Ralph Kenney .....	Kan. Bul. 218
121	1918	The Relation of the Density of the Cell Sap to Winter Hardiness... ..	S. C. Salmon and F. L. Fleming .....	Jour. Agr. Res., 13:497-506

<sup>1</sup> See No. 59, Department of Chemistry.

<sup>2</sup> See No. 61, Department of Chemistry.

<sup>3</sup> See No. 62, Department of Chemistry.

122	1918	A Preliminary Note on Soil Moisture and Temperature Factors in the Winterkilling of Grain Crops.....	S. C. Salmon .....	Science, 47:173-174
123	1918	A Preliminary Report on the Relation of Kinds and Varieties of Grain to Hessian Fly Injury <sup>1</sup> .....	J. W. McColloch and S. C. Salmon .....	Jour. Agr. Res., 12:519-527
124	1918	The Relation of Weed Growth to Nitric Nitrogen Accumulation in the Soil .....	L. E. Call and M. C. Sewell .....	Jour. Am. Soc. Agron., 10:35-44
125	1918	Growing Wheat in Kansas.....	L. E. Call and S. C. Salmon .....	Kan. Bul. 219
126	1918	Soil Fertility .....	L. E. Call and R. I. Throckmorton ..	Kan. Bul. 220
127	1919	Some Factors in the Winterkilling of Grain Crops.....	S. C. Salmon .....	Trans. Kan. Acad. Sci., 28:129
128	1919	Losses of Organic Matter in Making Brown and Black Alfalfa <sup>2</sup> ....	L. E. Call, C. O. Swanson, S. C. Salmon .....	Jour. Agr. Res., 18:299-304
129	1919	Tillage, A Review of Literature.....	M. C. Sewell .....	Jour. Am. Soc. Agron., 11:269-290
130	1919	Winter Irrigation for Western Kansas.....	George S. Knapp .....	Kan. Cir. 72
131	1919	Growing Alfalfa in Western Kansas.....	C. R. Weeks .....	Kan. Cir. 73
132	1919	Establishing Kanred Wheat in Kansas.....	S. C. Salmon .....	Kan. Cir. 74
133	1920	Sudan Grass as a Supplementary Pasture for Dairy Cattle <sup>3</sup> .....	L. E. Call and J. B. Fitch .....	Kan. Cir. 80
134	1920	The Use of Commercial Fertilizers in Kansas.....	L. E. Call and R. I. Throckmorton ..	Kan. Insp. Cir. 12, pp. 39-43

**Department of Animal Husbandry**

1	1889	Experiments in Pig Feeding.....	E. M. Shelton and H. M. Cottrell .....	Kan. Bul. 9
2	1889	Pigs from Mature and Immature Parents.....	E. M. Shelton, H. M. Cottrell, William Shelton .....	Second Ann. Rpt., pp. 79-89
3	1892	Experiments in Feeding Steers.....	C. C. Georgeson .....	Kan. Bul. 34
4	1893	Experiments in Feeding Steers, II.....	C. C. Georgeson, F. C. Burtis, D. H. Otis .....	Kan. Bul. 39
5	1894	Experiments in Feeding Steers, III.....	F. C. Burtis and D. H. Otis .....	Kan. Bul. 47, pp. 17-31

<sup>1</sup> See No. 242, Department of Entomology.  
<sup>2</sup> See No. 86, Department of Chemistry.  
<sup>3</sup> See No. 88, Department of Dairy Husbandry.

## DEPARTMENT OF ANIMAL HUSBANDRY—Continued

SERIAL NO.	DATE OF ISSUE	TITLE	AUTHOR	PUBLICATION
6	1895	Steer feeding Experiments, IV: A Comparison Between Purebred Shorthorns and Scrubs.....	C. C. Georgeson, F. C. Burtis, D. H. Otis .....	Kan. Bul. 51
7	1895	Pig feeding Experiments with Corn, Wheat, Kafir-corn, and Cotton-seed .....	C. C. Georgeson, F. C. Burtis, D. H. Otis .....	Kan. Bul. 53
8	1896	Steer feeding Experiments, V.....	C. C. Georgeson, F. C. Burtis, D. H. Otis .....	Kan. Bul. 60
9	1896	Kafir corn, Corn, and Soybean Meal for Pigs. Kafir-corn and Corn-meal for Cattle.....	C. C. Georgeson, F. C. Burtis, D. H. Otis .....	Kan. Bul. 61
10	1897	Steer-feeding Experiments, VI.....	C. C. Georgeson, F. C. Burtis, D. H. Otis .....	Kan. Bul. 67
11	1897	Data on the Growth of Young Stock.....	C. C. Georgeson .....	Kan. Bul. 72
12	1898	Kafir-corn for Fattening Pigs.....	.....	Kan. Press Bul. 7
13	1898	The Balanced Ration.....	.....	Kan. Press Bul. 12
14	1898	Alfalfa Hay for Fattening Hogs.....	.....	Kan. Press Bul. 25
15	1899	Kafir-corn, Alfalfa Hay, and Soybeans for Pork.....	.....	Kan. Press Bul. 37
16	1899	Fattening Steers Without Hogs.....	.....	Kan. Press Bul. 72
17	1900	Kafir-corn <sup>1</sup> .....	H. M. Cottrell, D. H. Otis, J. G. Haney.....	Kan. Bul. 93
18	1900	Fattening Hogs with Drought-Resisting Crops.....	H. M. Cottrell, D. H. Otis, J. G. Haney.....	Kan. Bul. 95
19	1901	Shelled Corn Compared with Corn Chop for Young Calves.....	D. H. Otis .....	Kan. Press Bul. 89
20	1901	Dried Blood as a Tonic for Young Calves.....	D. H. Otis .....	Kan. Press Bul. 90
21	1901	Baby Beef .....	H. M. Cottrell .....	Kan. Press Bul. 93
22	1901	What Shall We Feed?.....	H. M. Cottrell .....	Kan. Press Bul. 98
23	1902	Quality in Beef.....	H. M. Cottrell and V. M. Shoemith .....	Kan. Bul. 111

<sup>1</sup> See No. 45, Department of Agronomy.

24	1902	Fattening Steers Without Hogs to Follow.....	H. M. Cottrell and J. G. Haney .....	Kan. Bul. 112
25	1902	Baby Beef .....	H. M. Cottrell, J. G. Haney, O. H. Elling .....	Kan. Bul. 113
26	1903	Flesh and Fat in Beef.....	D. H. Otis .....	Kan. Bul. 118
27	1903	Pasture for Hogs.....	D. H. Otis .....	Kan. Press Bul. 122
28	1903	Corn Ensilage for Steers.....	D. H. Otis .....	Kan. Press Bul. 126
29	1904	Experiments in Feeding Steers and in Breeding and Feeding Pigs..	D. H. Otis .....	Kan. Bul. 124
30	1904	Baby Beef .....	J. G. Haney and O. H. Elling .....	Kan. Press Bul. 134
31	1905	Steer-feeding Experiments, VII (1903-04).....	Oscar Erf, R. J. Kinzer, G. C. Wheeler .....	Kan. Bul. 130
32	1905	Swine Feeding Test with Sorghum Seed Meal, Kafir-corn Meal, Soy- bean Meal, and Cornmeal.....	Oscar Erf and R. J. Kinzer .....	Kan. Press Bul. 141
33	1906	Western Feeds for Beef Production.....	J. G. Haney, O. H. Elling, G. K. Helder .....	Kan. Bul. 132
34	1906	Swine Feeding Tests.....	R. J. Kinzer and G. C. Wheeler .....	Kan. Press Bul. 149
35	1906	Baby Beef Production with Western Feeds.....	O. H. Elling .....	Kan. Press Bul. 151
36	1910	Kansas State Livestock Registry Board Report No. 1.....	C. W. McCampbell .....	Kan. Indus., Oct. 1 (Vol. 37, No. 40)
37	1911	Kansas State Livestock Registry Board Report No. 2.....	C. W. McCampbell .....	Kan. Bul. 179
38	1912	Kansas State Livestock Registry Board Report No. 3.....	C. W. McCampbell .....	Kan. Bul. 183
39	1912 ✓	Feeding Work Horses.....	C. W. McCampbell .....	Kan. Bul. 186
40	1912	The Stallion Law and the Farmer.....	C. W. McCampbell .....	Kan. Cir. 23
41	1913	Hog Feeding .....	G. C. Wheeler and T. R. H. Wright .....	Kan. Bul. 192
42	1913	Kansas State Livestock Registry Board Report No. 4.....	C. W. McCampbell .....	Kan. Bul. 194
43	1914	Which Stallion and Why?.....	C. W. McCampbell .....	Kan. Cir. 42
44	1914	Prepotency .....	E. N. Wentworth .....	Jour. Heredity, 6:17-20
45	1914	Sex-linked Factors in the Inheritance of Rudimentary Mammæ in Swine .....	E. N. Wentworth .....	Proc. Iowa Acad. Sci. for 1914, 21:265-268
46	1915	Causes of the Deficiency in the Meat Supply and the Probable Remedies .....	W. A. Cochel .....	Proc. Amer. Soc. Anim. Prod., 1914, pp. 4-6
47	1915	Kansas State Livestock Registry Board Report No. 5.....	C. W. McCampbell .....	Kan. Insp. Bul. 1.







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48	1915	Inheritance of Fertility in Swine.....	E. N. Wentworth and C. E. Aubel .....	Jour. Agr. Res., 5:1145-1160
49	1915	A Sex-limited Color in Ayrshire Cattle.....	E. N. Wentworth .....	Jour. Agr. Res., 6:141-147
50	1915	Sex in Livestock Breeding.....	E. N. Wentworth .....	Jour. Heredity, 7:29-32
51	1915	Rudimentary Mammas in Swine a Sex-Limited Character.....	E. N. Wentworth .....	Science, n. s., 43:648
52	1916	Growing Draft Colts.....	C. W. McCampbell .....	Kan. Cir. 57
53	1916	Some Important Essentials in Profitable Horse Production.....	C. W. McCampbell .....	Kan. Insp. Cir. 2
54	1917	Feeding Work Horses.....	C. W. McCampbell .....	Kan. Cir. 62
55	1917	Kansas State Livestock Registry Board Report No. 7.....	C. W. McCampbell .....	Kan. Insp. Cir. 6
56	1918	Kansas State Livestock Registry Board Report No. 8.....	C. W. McCampbell .....	Kan. Insp. Cir. 8
57	1919	Home Preparation of Pork.....	A. M. Paterson .....	Kan. Cir. 76
58	1919	Cattle Feeding Investigations, 1918-19.....	C. W. McCampbell, F. W. Bell, H. B. Winchester .....	Kan. Cir. 77
59	1919	Swine Feeding Investigations, 1918-19.....	C. W. McCampbell, E. F. Ferrin, H. B. Winchester .....	Kan. Cir. 78
60	1919	Lamb Feeding Investigations, 1919.....	A. M. Paterson .....	Kan. Cir. 79
61	1919	Kansas State Livestock Registry Board Report No. 9.....	F. W. Bell .....	Kan. Insp. Cir. 11
62	1920	Kansas State Livestock Registry Board Report No. 10.....	F. W. Bell .....	Kan. Insp. Cir. 13
<b>Department of Bacteriology</b>				
1	1903	Bacteria of the Soil.....	N. S. Mayo and A. T. Kinsley .....	Kan. Bul. 117
2	1908	Studies on Hog Cholera and Preventive Treatment.....	Walter E. King .....	Kan. Bul. 157
3	1909	The Influence of Depth of Cultivation Upon Soil Bacteria and Their Activities .....	Walter E. King and Charles J. T. Doryland..	Kan. Bul. 161
4	1910	Studies on Hog Cholera and Preventive Treatment.....	Walter E. King and Robert H. Wilson .....	Kan. Bul. 171
5	1910	Bacteria and the Dairy.....	L. D. Bushnell .....	Kan. St. Dairy Com. Bul. No. 1, pp. 25-30
6	1911	Bacteriological Studies on Eggs.....	Otto Maurer .....	Kan. Bul. 180
7	1913	The Use of Milk Cultures of B. Bulgaricus in the Prevention and Treatment of Bacillary White Diarrhea of Young Chicks.....	L. D. Bushnell and Otto Maurer .....	Amer. Vet. Rev., 44:194-207

8	1914	Some Factors Influencing the Bacterial Content and Keeping Quality of Eggs .....	L. D. Bushnell and Otto Maurer .....	Kan. Bul. 201
9	1916	The Importance of Bacterium Bulgaricus Group in Ensilage. . . . .	O. W. Hunter and L. D. Bushnell .....	Science, n. s., 43:318-320
10	1916	Some Important Fermentations in Silage.....	O. W. Hunter and L. D. Bushnell .....	Kan. Tech. Bul. 2
11	1916	The Effect of Time and Depth of Cultivating a Wheat Seedbed Upon Bacterial Activity in the Soil.....	P. L. Gainey .....	Soil Science, 2:193-204
12	1917	Microorganisms and Heat Production in Silage Fermentation.....	O. W. Hunter .....	Jour. Agr. Res., 10:75-83
13	1917	Effect of Paraffin on the Accumulation of Ammonia and Nitrates in the Soil .....	P. L. Gainey .....	Jour. Agr. Res., 10:355-364
14	1917	Some Factors Affecting Nitrate-Nitrogen Accumulation in Soil.....	P. L. Gainey and L. F. Metzler .....	Jour. Agr. Res., 11:43-64
15	1917	The Influence of the Ration Upon the Intestinal Flora of Swine....	L. D. Bushnell and J. J. Frey .....	Kan. Tech. Bul. 3
16	1917	A Study of the Etiology of Roup in Birds.....	J. G. Jackley .....	Kan. Tech. Bul. 4
17	1917	The Significance of Nitrification as a Factor in Soil Fertility.....	P. L. Gainey .....	Soil Science, 3:399-416
18	1917	The Examination of Canned Salmon for Bacteria and Tin <sup>1</sup> .....	L. D. Bushnell and C. A. A. Utt .....	Jour. Indus. and Engr. Chem., 9:678-680
19	1917	The Colon-Aerogenes Group from Silage.....	O. W. Hunter .....	Jour. Bact., 2:635-639
20	1917	A Lactose Fermenting Yeast Producing Foamy Cream.....	O. W. Hunter .....	Jour. Bact., 3:293-300
21	1918	The Influence of Cold Shock in the Sterilization of Canned Foods...	L. D. Bushnell .....	Jour. Indus. and Engr. Chem., 10:431-442
22	1918	Soil Reaction and the Growth of Azotobacter.....	P. L. Gainey .....	Jour. Agr. Res., 14:265-271
23	1918	The Influence of the Separator Upon Distribution of Bacteria in Milk and Cream .....	L. D. Bushnell and O. W. Hunter .....	Trans. Kan. Acad. Sci., pp. 61-69
24	1918	The Microbial Flora of Graded Cream.....	L. D. Bushnell and O. W. Hunter .....	Trans. Kan. Acad. Sci., pp. 69-78
25	1918	Bacteriological Studies on Alfalfa Silage.....	O. W. Hunter .....	Jour. Agr. Res., 15:571-592
26	1918	Bacteriological Examination for Meningococcus Carriers.....	L. D. Bushnell .....	Jour. Med. Res., 33:1-10
27	1918	A Further Study of the Etiology of Roup in Poultry.....	J. G. Jackley .....	Jour. Amer. Vet. Med. Assn., 52:853-858
28	1918	Poultry Diseases .....	L. D. Bushnell and J. G. Jackley .....	Kan. Cir. 70
29	1918	Effect of Carbon Disulphide and Toluol Upon Nitrogen-Fixing and Nitrifying Organisms .....	P. L. Gainey .....	Jour. Agr. Res., 15:601-614

<sup>1</sup> See No. 77, Department of Chemistry.

DEPARTMENT OF BACTERIOLOGY—*Concluded*

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30	1918	Soil Reaction and the Presence of Azotobacter.....	P. L. Ganey .....	Science, n. s., 48:139-140
31	1919	The Colon-Aerogenes Group of Milk.....	O. W. Hunter .....	Dairy Science, 2:108-129
32	1919	Parallel Formation of Carbon Dioxide, Ammonia, and Nitrate in Soil,	P. L. Ganey .....	Soil Science, 7:293-311
33	1919	The Canning of Asparagus.....	Alice Skinner and Grace Glasgow	Jour. Home Econ., 2:154-157
34	1920	Bacteriological Studies of Methods of Preparing a Seedbed for Wheat .....	P. L. Ganey .....	Kan. Tech. Bul. 8

**Department of Botany**

1	1888	Sorghum Blight .....	W. A. Kellerman and W. T. Swingle .....	First Ann. Rept., pp. 281-302
2	1888	Preliminary Report on Sorghum Blight.....	W. A. Kellerman .....	Kan. Bul. 5
3	1888	Branch Knot of the Hackberry.....	W. A. Kellerman and W. T. Swingle .....	First Ann. Rpt., pp. 302-315
4	1888	Experiments in Cross Fertilization of Corn.....	W. A. Kellerman and W. T. Swingle .....	First Ann. Rpt., pp. 316-337
5	1888	Germination of Weed Seeds.....	W. A. Kellerman and W. T. Swingle .....	First Ann. Rept., pp. 337-343
6	1888	Fungous Parasites of Weeds.....	W. A. Kellerman and W. T. Swingle .....	First Ann. Rept., pp. 344-346
7	1889	Report on Loose Smuts of Cereals. ....	W. A. Kellerman and W. T. Swingle .....	Second Ann. Rept., pp. 213-288
8	1889	Experiments in Crossing Varieties of Corn.....	W. A. Kellerman and W. T. Swingle .....	Second Ann. Rept., pp. 288-334
9	1889	Crossed Corn the Second Year.....	W. A. Kellerman and W. T. Swingle .....	Second Ann. Rept., pp. 334-346
10	1889	Bibliography of Cross-Fertilization of Varieties of Corn.....	W. A. Kellerman and W. T. Swingle .....	Second Ann. Rept., pp. 346-353
11	1889	Preliminary Study of the Receptivity of Corn Silk.....	W. A. Kellerman and W. T. Swingle .....	Second Ann. Rept., pp. 353-355
12	1889	Preliminary Report on Smut in Oats.....	W. A. Kellerman and W. T. Swingle .....	Kan. Bul. 8
13	1890	Fungicides for Stinking Smut of Wheat.....	W. A. Kellerman and W. T. Swingle .....	Kan. Bul. 12
14	1890	Oat Smut: Additional Experiments and Observations.....	W. A. Kellerman and W. T. Swingle .....	Kan. Bul. 15

Crossed Varieties of Corn, Second and Third Years.....	W. A. Kellerman and W. T. Swingle .....	Kan. Bul. 17
Fungicides for Stinking Smut of Wheat (Second Report).....	W. A. Kellerman .....	Kan. Bul. 21
Smut of Oats, 1891.....	W. A. Kellerman .....	Kan. Bul. 22
Smuts of Sorghum and Corn.....	W. A. Kellerman .....	Kan. Bul. 23
Crossed Varieties of Corn .....	W. A. Kellerman and C. H. Thompson .....	Kan. Bul. 27
The Botanical Library of a Station Botanist.....	A. S. Hitchcock .....	Science, n. s., 20:241-242
The Missouri Botanical Garden.....	A. S. Hitchcock .....	Kan. Indus., May 7 (Vol. 17, No. 36)
Notes of Some Kansas Weeds.....	A. S. Hitchcock .....	Kan. Indus., Oct. 22 (Vol. 18, No. 9)
Some Depauperate Grasses .....	A. S. Hitchcock .....	Bot. Gaz., 17:194
Preliminary Report on Rusts of Grain.....	A. S. Hitchcock .....	Kan. Bul. 38
Effect of Fungicides on the Germination of Corn.....	A. S. Hitchcock and M. A. Carleton .....	Kan. Bul. 41
Another Hybrid Oak .....	A. S. Hitchcock .....	Bot. Gaz., 18:110-111
The Distribution of the Genus Vitis in Kansas.....	A. S. Hitchcock .....	Trans. Kan. Acad. Sci., 13:79-80
Key to Kansas Trees in Their Winter Condition.....	A. S. Hitchcock .....	Eighth Bien. Rpt. St. Bd. Agr., pp. 181-187
The Opening of the Buds of Some Woody Plants.....	A. S. Hitchcock .....	Trans. Acad. St. Louis, 6:133-141
Plants of the Bahamas, Jamaica, and Grand Cayman.....	A. S. Hitchcock .....	Rpt. Mo. Bot. Gard., 4:47-179
The Relations of the Composite Flora of Kansas.....	A. S. Hitchcock .....	Trans. Kan. Acad. Sci., 13:89-91
The Undergraduate Course of Study for a Scientific Specialist....	A. S. Hitchcock .....	Kan. Indus., Dec. 16 (Vol. 19, No. 15)
Variation in Spores of Corn Smut.....	A. S. Hitchcock .....	Science, n. s., 22:52
The Woody Plants of Manhattan in Their Winter Condition.....	A. S. Hitchcock .....	Dept. Pamph., pp. 1-20
Preliminary Report on Rusts of Grain.....	A. S. Hitchcock .....	Kan. Bul. 46
Distribution of Kansas Grasses.....	A. S. Hitchcock .....	Kan. Indus., May 26 (Vol. 19, No. 37)
Eragrostis eragrostis (L.) Beauv.....	A. S. Hitchcock .....	Erythea, 2:37-39
A Hybrid Baptisia.....	A. S. Hitchcock .....	Bot. Gaz., 19:42
A Key to the Genera of Manhattan Plants, Based on Fruit Characters .....	A. S. Hitchcock .....	Dept. Pamph., pp. 1-35
A Key to the Spring Flora of Manhattan.....	A. S. Hitchcock .....	Dept. Pamph., pp. 1-35
Notes on Florida .....	A. S. Hitchcock .....	Kan. Indus., Oct. 13 (Vol. 20, No. 7)
Directions for Collecting Botanical Specimens.....	A. S. Hitchcock .....	Kan. Indus., April 6 (Vol. 20, No. 30)

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43	1895	Kansas Weeds, I: Seedlings.....	A. S. Hitchcock and J. B. S. Norton.....	Kan. Bul. 50
44	1895	Kansas Weeds, II: Preliminary Circular on Distribution.....	A. S. Hitchcock and J. B. S. Norton.....	Kan. Bul. 52.
45	1895	Note on Buffalo Grass.....	A. S. Hitchcock.....	Bot. Gaz., 20:464
46	1896	Flora of Southwestern Kansas. Report on a Collection of Plants Made by C. H. Thompson in 1893.....	A. S. Hitchcock.....	Contrib. U. S. Nat. Herb., 3:537-557
47	1896	The Grasses of Kansas.....	A. S. Hitchcock.....	Trans. Kan. Acad. Sci., 14:135-147
48	1896	Kansas Weeds, III: Descriptive List.....	A. S. Hitchcock and J. B. S. Norton.....	Kan. Bul. 57
49	1896	The Great World's Farm (Review).....	A. S. Hitchcock.....	Kan. Indus., Nov. 30 (Vol. 22, No. 14)
50	1896	Corn Smut.....	A. S. Hitchcock and J. B. S. Norton.....	Kan. Bul. 62
51	1896	Kansas Weeds, IV: Fruits and Seeds.....	A. S. Hitchcock and G. L. Clothier.....	Kan. Bul. 66
52	1897	The Botanical Department.....	A. S. Hitchcock.....	Kan. Indus., May 24 (Vol. 22, No. 37)
53	1897	Ecological Plant Geography (Review).....	A. S. Hitchcock.....	Amer. Nat., 31:435-440
54	1898	Kansas Weeds, V: Vegetative Propagation.....	A. S. Hitchcock and G. L. Clothier.....	Kan. Bul. 76
55	1898	Kansas Weeds, VI: Distribution and Other Notes.....	A. S. Hitchcock and G. L. Clothier.....	Kan. Bul. 80
56	1898	Reminiscences of Jamaica.....	A. S. Hitchcock.....	Kan. Indus., Jan. (Vol. 24, No. 1)
57	1898	Camping in Florida.....	A. S. Hitchcock.....	Kan. Indus., Nov. (Vol. 24, No. 9)
58	1898	Ecological Plant Geography of Kansas.....	A. S. Hitchcock.....	Trans. Acad. St. Louis, 8:55-69
59	1898	List of Cryptogams Collected in the Bahamas, Jamaica, and Grand Cayman.....	A. S. Hitchcock.....	Rpt. Mo. Bot. Gard., 9:111-120
60	1898	Onogrææ of Kansas.....	A. S. Hitchcock.....	Monde des Plantes, 7:141-151
61	1898	Some Reasons Why Fruit Does Not Set.....	.....	Kan. Press Bul. 8
62	1898	Seed Breeding.....	.....	Kan. Press Bul. 13
63	1898	Notes on Weeds.....	.....	Kan. Press Bul. 18
64	1899	Grazing Grasses of Western Kansas.....	.....	Kan. Press Bul. 22
65	1899	Potato Scab.....	.....	Kan. Press Bul. 81



66	1899	Native Agricultural Grasses of Kansas.....	A. S. Hitchcock and G. L. Clothier .....	Kan. Bul. 87
67	1899	How Plants Live .....	A. S. Hitchcock .....	Kan. Indus., Oct. 24 (Vol. 26, No. 5)
68	1899	Selection of Seed Wheat.....	.....	Kan. Press Bul. 43
69	1899	Awless Brome-grass .....	.....	Kan. Press Bul. 47
70	1899	List of Plants in My Florida Herbarium.....	A. S. Hitchcock .....	Trans. Kan. Acad. Sci., 16:108-157
71	1899	Notes on Corn Smut.....	A. S. Hitchcock .....	Bot. Gaz., 27:429-430
72	1899	Studies on Subterranean Organs.....	A. S. Hitchcock .....	Trans. Acad. St. Louis, 9:1-8
73	1899	Some Nitrogenous Forage Plants.....	A. S. Hitchcock .....	Kan. Press Bul. 52
74	1900	Plant Breeding by Bud Selection.....	A. S. Hitchcock .....	Kan. Press Bul. 55
75	1900	Questions about Forage Plants.....	.....	Kan. Press Bul. 58
76	1900	How to Test the Vitality of Garden Seeds.....	A. S. Hitchcock .....	Kan. Press Bul. 59
77	1900	Prevention of Grain Smuts.....	A. S. Hitchcock .....	Kan. Press Bul. 64
78	1900	How Plants Live.....	A. S. Hitchcock .....	Kan. Indus. (Vol. 26, pp. 201- 204; 302-305)
79	1900	Studies on Subterranean Organs.....	A. S. Hitchcock .....	Trans. Acad. St. Louis, 10:131-142
80	1900	Collecting Sets of Plants for Exchange.....	A. S. Hitchcock .....	Plant World, 3:148-151
81	1900	The Cultivated Catalpas.....	A. S. Hitchcock .....	Kan. Press Bul. 67
82	1900	The More Important Native Kansas Grasses.....	A. S. Hitchcock .....	Twelfth Bien. Rept. Kan. St. Bd. Agr., pp. 523-538
83	1900	The Cultivated Millets .....	A. S. Hitchcock .....	Kan. Press Bul. 69
84	1900	Botanical Notes on Wheat and Spelt.....	A. S. Hitchcock .....	Kan. Press Bul. 70
85	1900	Some Familiar Economic Plants.....	A. S. Hitchcock .....	Kan. Indus., Oct. 16 (Vol. 27, No. 3)
86	1900	Cultivated Blue-grasses .....	A. S. Hitchcock .....	Kan. Press Bul. 73
87	1900	The Races of Corn.....	A. S. Hitchcock .....	Kan. Press Bul. 75
88	1901	Johnson Grass .....	A. S. Hitchcock .....	Kan. Press Bul. 78
89	1901	Clovers .....	A. S. Hitchcock .....	Kan. Press Bul. 83
90	1901	Forage Plants for Kansas.....	A. S. Hitchcock and J. M. Westgate .....	Kan. Bul. 102
91	1901	Some Familiar Economic Plants.....	A. S. Hitchcock .....	Kan. Indus., Jan. 29, Apr. 9, Apr. 30, May 7 (Vol. 27, pp. 205-208; 324-328; 361-363; 373-377)
92	1901	Bermuda Grass .....	A. S. Hitchcock .....	U. S. Dept. Agr. Cir., Div. Agrostr., 31:1-6
93	1901	A Brief Outline of Ecology.....	A. S. Hitchcock .....	Trans. Kan. Acad. Sci., 17:28-34

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94	1901	List of Plants in My Florida Herbarium, Part II.	A. S. Hitchcock	Trans. Kan. Acad. Sci., 17:79-105
95	1902	Pasture Weeds—Their Prevention and Eradication.	H. F. Roberts	Kan. Press Bul. 113
96	1903	The Hardy Catalpa <sup>1</sup>	H. F. Roberts, Albert Dickens, G. O. Greene	Kan. Bul. 108 Kan. Bul. 121, pp. 139-141
97	1904	Sand-binding Grasses	H. F. Roberts	Kan. Bul. 108
98	1906	Alfalfa Seed: Its Adulterants, Substitutes, and Impurities and Their Detection	H. F. Roberts and G. F. Freeman	Kan. Bul. 133
99	1906	Commercial Seeds of Brome-grass and of English and Kentucky Blue Grasses, Adulterants and Substitutes and Their Detection,	H. F. Roberts and G. F. Freeman	Kan. Bul. 141
100	1907	Prevention of Sorghum and Kafir-corn Smut.	H. F. Roberts	Kan. Press Bul. 155
101	1907	Prevention of Sorghum and Kafir-corn Smut.	H. F. Roberts and G. F. Freeman	Kan. Bul. 149
102	1907	How Plants Feed and Grow.	G. F. Freeman and J. T. Willard	Agr. Ed., K. S. A. C., Vol. 1, No. 2
104	1907	Alfalfa Breeding: Materials and Methods.	H. F. Roberts and G. F. Freeman	Kan. Bul. 151
104	1908	Deterioration of Red Texas Oats in Kansas.	H. F. Roberts and G. F. Freeman	Kan. Bul. 153
105	1908	The Yellow Berry Problem in Kansas Hard Winter Wheats.	H. F. Roberts and G. F. Freeman	Kan. Bul. 156
106	1908	A Method for the Quantitative Determination of Transpiration in Plants	G. F. Freeman	Bot. Gaz., 46:118-129
107	1908	What is Plant Breeding?	G. F. Freeman	Kan. Agr. Review III, Nos. 5 and 6
108	1908	Methods of Alfalfa Breeding	G. F. Freeman	Ann. Rept. Amer. Breeders' Assoc., 5:148-166
109	1909	Importation of Seed Wheat.	H. F. Roberts	Kan. Press Bul. 171
110	1909	Plant Breeding	G. F. Freeman	Agr. Ed., K. S. A. C., Vol. 1, No. 2
111	1909	Some Wheat Problems	G. F. Freeman, A. M. Ten Eyck, T. J. Headlee	Agr. Ed., K. S. A. C., Vol. 1, No. 7
112	1910	A Quantitative Method for the Determination of Hardness in Wheat,	H. F. Roberts	Kan. Bul. 167
113	1910	Breeding for Type of Kernel in Wheat.	H. F. Roberts	Kan. Bul. 170
114	1910	A Physiological Study of the Germination of Helianthus Annuus I,	E. C. Miller	Ann. Bot., 24:693-726

<sup>1</sup> See No. 28, Department of Horticulture.



115	1910	Treatment of Seed Wheat for Smut.....	H. F. Roberts and Paul W. Graff .....	Kan. Cir. 12
116	1911	The Origin of the Chloroplasts in the Cotyledons of <i>Helianthus Annuus</i> .....	E. C. Miller .....	Bot. Gaz., 51:378-384
117	1911	A Method of Corn Pollination.....	H. F. Roberts .....	Amer. Breeders' Mag., 2:54
118	1912	Wood Rots of the Hardy Catalpa .....	N. B. Stevens .....	Phytopathology, 2:114-119
119	1912	Polystictus Versicolor as a Wound Parasite of Catalpa.....	N. B. Stevens .....	Mycologia, 4:263-270
120	1912	Educational Advertising .....	N. B. Stevens .....	School Rev., 20:577-582
121	1912	The Effect of External Conditions Upon the After-Ripening of Seeds of <i>Cratægus Mollet</i> .....	W. E. Davis and R. C. Rose .....	Bot. Gaz., 54:49-62
122	1912	A Physiological Study of the Germination of <i>Helianthus Annuus</i> II. The Oily Reserve .....	E. C. Miller .....	Ann. Bot., 26:889-901
123	1912	Variation and Correlation in Wheat.....	H. F. Roberts .....	Ann. Rpt. Amer. Breeders' Assoc., 7:80-109
124	1912	First Generation Hybrids of American X Chinese Corn.....	H. F. Roberts .....	Ann. Rpt. Amer. Breeders' Assoc., 8:367-384
125	1912	Xeralexia .....	H. F. Roberts .....	Science, n. s., 39:307-308
126	1913	Biology in the High Schools.....	H. F. Roberts .....	School Sci. and Math., 13:146-153
127	1913	Brown Rot Canker of the Peach.....	R. A. Jehle .....	Phytopathology, 3:105-110
128	1913	The Mosaic Disease of Tomato and Related Plants.....	L. E. Melchers .....	Ohio Nat., 13:149-173
129	1914	The Plaster Cast Apple Specimen.....	L. E. Melchers .....	Phytopathology, 4:113-114
130	1914	A Preliminary Report on Raspberry Curl or Yellows.....	L. E. Melchers .....	Ohio Nat., 14:281-288
131	1914	<i>Heterodera radicleola</i> Attacking the Canada Thistle.....	L. E. Melchers .....	Science, n. s., 40:241
132	1914	The Unfitting of the Public Schools.....	H. F. Roberts .....	School Sci. and Math., 14:447-459
133	1914	How Plants are Built; Roots; Stems and Leaves; Flowers and Fruits; How Plants Multiply; How Plants and Animals are Improved; Weeds .....	H. F. Roberts .....	Agriculture for the Kansas Com- mon Schools, Chaps. I-V, XIII and XIV
134	1914	Plant Diseases .....	L. E. Melchers .....	Agriculture for the Kansas Com- mon Schools, Chap. XXIX
135	1914	Delayed Germination in Seed of <i>Alisma Plantago</i> .....	William Crocker and W. E. Davis .....	Bot. Gaz., 58:285-321
136	1915	Better Plants and Animals; How Plants Feed and Grow.....	H. F. Roberts .....	The Essentials of Agriculture, Chaps. II and III (H. J. Waters, Ginn & Co.)
137	1915	Root-Knot or Eelworm Attacks New Hosts.....	L. E. Melchers .....	Ohio Nat., 15:551-555
138	1915	A Method of Obtaining an Abundance of Large Uredinia from Artificial Cultures .....	L. E. Melchers .....	Phytopathology, 5:236-237



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139	1915	A New Alfalfa Leaf Spot in America . . . . .	L. E. Melchers . . . . .	Science, n. s., 42:536-537
140	1915	The Grouping and Terminology of Plant Diseases . . . . .	L. E. Melchers . . . . .	Phytopathology, 5:297-302
141	1915	Kill Smut Spores Now . . . . .	L. E. Melchers . . . . .	Kan. Indus., Mar. 13 (Vol. 41, No. 22)
142	1916	Plant Diseases Affecting Alfalfa . . . . .	L. E. Melchers . . . . .	Quar. Rpt. Kan. St. Bd. Agr., Vol. XXXV, No. 138, pp. 339-352
143	1916	Smuts of Grain and Forage Crops in Kansas . . . . .	L. E. Melchers . . . . .	Kan. Bul. 210
144	1916	Plant Disease Exhibit Cases . . . . .	L. E. Melchers . . . . .	Ohio Jour. Sci., 16:105-109
145	1916	The Root Systems of Agricultural Plants . . . . .	E. C. Miller . . . . .	Jour. Amer. Soc. Agron., 8:129-154
146	1916	Comparative Study of the Root Systems and Leaf Areas of Corn and the Sorghums . . . . .	E. C. Miller . . . . .	Jour. Agr. Res., 6:311-331
147	1916	Relative Water Requirement of Corn and the Sorghums . . . . .	E. C. Miller . . . . .	Jour. Agr. Res., 6:473-484
148	1917	Resistance of Seed Coats of Abutilon Theophrasti to Intake of Water, Daily Variation of Water and Dry Matter in the Leaves of Corn and the Sorghums . . . . .	W. E. Davis . . . . .	Bot. Gaz., 65:166-167
149	1917		E. C. Miller . . . . .	Jour. Agr. Res., 10:11-45 Proc. Nat. Acad. Sci., 3:427-431
150	1917	The Black Spot of the Fruit of Sweet Peppers . . . . .	L. E. Melchers and E. E. Dale . . . . .	Phytopathology, 7:63 (Abstract)
151	1917	Ecological Observations on <i>Ustilago Zeae</i> (Corn Smut) . . . . .	A. A. Potter and L. E. Melchers . . . . .	Phytopathology, 7:73 (Abstract)
152	1917	Leaf Rust of Winter Wheat Causes Damage in Kansas ( <i>Puccinia triticiana</i> Erikss) . . . . .	L. E. Melchers . . . . .	Phytopathology, 7:224
153	1917	Chance to Save Million. (Treatment of Sorghum Seed Will Prevent Heavy Loss) . . . . .	L. E. Melchers . . . . .	Kan. Indus., Apr. 18 (Vol. 43, No. 27)
154	1918	<i>Botrytis</i> sp. Causing Severe Injury to Flowers and Foliage of <i>Pelargonium Hortorum</i> . . . . .	L. E. Melchers . . . . .	Phytopathology, 8:76 (Abstract)
155	1918	Three Varieties of Hard Winter Wheat Resistant to Stem Rust . . . . .	L. E. Melchers and J. H. Parker . . . . .	Phytopathology, 8:79 (Abstract)
156	1918	Potato Seed Diseases and Their Treatment . . . . .	L. E. Melchers . . . . .	Kan. Cir. 63
157	1918	Physoderma ( <i>Zeae maydis</i> ) in Kansas . . . . .	L. E. Melchers . . . . .	Trans. Kan. Acad. Sci., 29:131-132
158	1918	Plant Disease Report for Kansas . . . . .	L. E. Melchers . . . . .	Trans. Kan. Acad. Sci., 29:132-138
159	1918	Insects and Plant Diseases Attacking Garden Crops <sup>1</sup> . . . . .	J. H. Merrill and L. E. Melchers . . . . .	Kan. Cir. 65

<sup>1</sup> See No. 244, Department of Entomology.

160	1918	Another Strain of <i>Puccinia graminis</i> .....	L. E. Melchers and J. H. Parker .....	Kan. Cir. 68
161	1918	The Water Relations of Corn and the Sorghums.....	E. C. Miller .....	Trans. Kan. Acad. Sci., 29:138-172
162	1918	Comparative Transpiration of Corn and the Sorghums.....	E. C. Miller .....	Jour. Agr. Res., 13:579-604
163	1919	Development of the Pistillate Spikelet and Fertilization in Zea Mays L. ....	E. C. Miller .....	Jour. Agr. Res., 18:255-265
164	1919	A Method of Steam Sterilization of Soil for Controlling Nematodes,	L. E. Melchers .....	Phytopathology, 9:294-296
165	1919	Farm Seeds and Weeds.....	H. F. Roberts .....	Twenty-First Bien. Rpt. Kan. St. Bd. Agr., pp. 284-303
166	1919	An Early Paper on Maize Crosses.....	H. F. Roberts .....	Amer. Nat., 53:97-108
167	1919	Founders of the Art of Breeding (Series).....	H. F. Roberts .....	Jour. Heredity, 10:99-106; 147- 152; 222-239; 257-270
168	1919	The Contribution of Carl Friedrich Von Gartner to the History of Plant Hybridization .....	H. F. Roberts .....	Amer. Nat., 53:431-445
169	1919	A Darwinian Statement of the Mendelian Theory.....	H. F. Roberts .....	Nature, 103:463-464
170	1919	A Demonstration of the Coefficient of Correlation for Elementary Students of Plant Breeding .....	H. F. Roberts .....	School Sci. and Math., 19:619-628
171	1919	A Practical Method for Demonstrating the Error of Mean Square..	H. F. Roberts .....	School Sci. and Math., 19:677-692
172	1919	Yellow Berry in Hard Winter Wheat.....	H. F. Roberts .....	Jour. Agr. Res., 18:155-169
173	1919	Quantitative Character Measurements in Color Crosses.....	H. F. Roberts .....	Science, n. s., 49:516
174	1919	The Case of the American School.....	H. F. Roberts .....	School and Soc., 9:369-373
175	1919	Practical Education and the Higher Culture.....	H. F. Roberts .....	School and Soc., 10:191-194
176	1919	Agricultural Botany in Secondary Education.....	H. F. Roberts .....	Science, n. s., 50:549-559
177	1920	The Resistance Shown by Three Hard Winter Wheats, Kanred (P762), P1066, and P1068 to Plant Diseases.....	L. E. Melchers.....	Phytopathology, 10:52 (Abstract)
178	1920	The Resistance of Kanred (P762), P1066, and P1068, Three Hard Winter Wheats, to Leaf Rust.....	L. E. Melchers and J. H. Parker .....	Phytopathology, 10:52 (Abstract)
179	1920	Three Winter Wheat Varieties Resistant to Leaf Rust in Kansas...	L. E. Melchers and J. H. Parker .....	Phytopathology, 10:164-171
180	1920	Principal Noxious Weeds of Kansas.....	H. F. Roberts.....	Kan. Cir. 84
181	1920	Ecologic and Physiologic Notes on Corn Smut, <i>Ustilago Zeae</i> .....	L. E. Melchers.....	Phytopathology, 11:32 (Abstract)
182	1920	Meteorological Data, Douglas Lake, Michigan, 1912-1918.....	F. C. Gates, Ruth E. Hurd .....	Mich. Acad. Sci. Twenty-First Ann. Rpt., pp. 373-378
183	1920	Rhizopus sp. Associated with a Decay of Unripe Strawberries in the Field .....	L. E. Melchers.....	Phytopathology, 11:44 (Abstract)

**Department of Chemistry**

SERIAL NO.	DATE OF ISSUE	TITLE	AUTHOR	PUBLICATION
1	1888	Some Comparisons of Varieties of Sorghum.....	J. T. Willard .....	Kan. Bul. 5, pp. 51-55
2	1888	Shrinkage of Hay in the Mow.....	G. H. Failyer and J. T. Willard.....	First Ann. Rpt., pp. 117-121
3	1888	A Comparison of Varieties of Sorghum.....	G. H. Failyer and J. T. Willard.....	First Ann. Rpt., pp. 122-138
4	1888	The Keeping Qualities of Sorghum.....	G. H. Failyer and J. T. Willard.....	First Ann. Rpt., pp. 139-141
5	1888	Attempts to Improve Sorghum by Seed Selection.....	G. H. Failyer and J. T. Willard.....	First Ann. Rpt., pp. 141-147
6	1888	Fertilizers on Sorghum.....	G. H. Failyer and J. T. Willard.....	First Ann. Rpt., pp. 147-148
7	1888	A New Method of Milk Analysis for the Use of Dairymen.....	G. H. Failyer and J. T. Willard.....	First Ann. Rpt., pp. 149-164
8	1889	Work Upon Sorghum .....	G. H. Failyer and J. T. Willard.....	Second Ann. Rpt., pp. 90-108
9	1889	Analyses of Feedingstuffs .....	G. H. Failyer and J. T. Willard.....	Second Ann. Rpt., pp. 108-120
10	1889	Composition of Corn at Different Stages of Growth.....	G. H. Failyer and J. T. Willard.....	Second Ann. Rpt., pp. 120-123
11	1889	Ammonia and Nitric Acid in Atmospheric Waters.....	G. H. Failyer and J. T. Willard.....	Second Ann. Rpt., pp. 123-132
12	1890	Experiments with Sorghum and Sugar Beets.....	G. H. Failyer and J. T. Willard.....	Kan. Bul. 16
13	1891	Sorghum for Sugar.....	G. H. Failyer and J. T. Willard.....	Kan. Bul. 25
14	1891	Sugar Beets .....	G. H. Failyer and J. T. Willard.....	Kan. Bul. 31
15	1891	Composition of Some Feedingstuffs; Composition of Certain Plants at Different Stages of Growth.....	G. H. Failyer and J. T. Willard.....	Kan. Bul. 32, pp. 225-232
16	1892	Experiments with Sorghum and Sugar Beets.....	G. H. Failyer and J. T. Willard.....	Kan. Bul. 36
17	1893	Experiments with Sorghum and Sugar Beets.....	G. H. Failyer and J. T. Willard.....	Kan. Bul. 43
18	1897	Soil Moisture .....	G. H. Failyer and J. T. Willard.....	Kan. Bul. 68
19	1898	Soil Moisture and Soil Stirring.....	.....	Kan. Press Bul. 4

20	1898	Kansas Sugar Beets for 1898.....		Kan. Press Bul. 15
21	1898	Sugar Beets .....	J. T. Willard .....	Kan. Bul. 78
22	1899	Sugar Beets .....	J. T. Willard and R. W. Clothier .....	Kan. Bul. 83
23	1899	Sugar Beet Experiments for 1899.....		Kan. Press Bul. 27
24	1899	Soil Moisture .....	J. T. Willard and R. W. Clothier .....	Kan. Bul. 89
25	1899	What is a Digestion Experiment?.....		Kan. Press Bul. 38
26	1899	A Digestion Experiment with Alfalfa Hay.....		Kan. Press Bul. 41
27	1899	Early Plowing and Moisture Conservation.....		Kan. Press Bul. 45
28	1900	Sugar Beets .....	J. T. Willard and R. W. Clothier .....	Kan. Bul. 94
29	1900	Experiments with Sugar Beets in 1899 and 1900.....	J. T. Willard .....	Kan. Press Bul. 53
30	1900	Digestion Experiments with Kafir-corn Stover and Kafir-corn Meal, .....	R. W. Clothier .....	Kan. Press Bul. 56
31	1900	Sugar Beets in Kansas.....	J. T. Willard .....	Kan. Press Bul. 76
32	1901	Digestion Experiments with Kansas Feeds (Sugar Beets, 1891-1900) .....	J. T. Willard and R. W. Clothier .....	Kan. Bul. 103
33	1901	A Digestion Experiment with Buffalo Grass Hay.....	J. T. Willard .....	Kan. Press Bul. 79
34	1901	Feeding Wheat .....	J. T. Willard .....	Kan. Press Bul. 96
35	1902	Analyses of Corn with Reference to Its Improvement.....	J. T. Willard, R. W. Clothier, F. C. Weber .....	Kan. Bul. 107
36	1902	The Exact Calculation of Balanced Rations.....	J. T. Willard .....	Kan. Bul. 115
37	1902	Corn Improvement .....	J. T. Willard .....	Kan. Press Bul. 110
38	1907	Kansas Law Regulating the Sale of Commercial Fertilizers.....	C. W. Burkett and J. T. Willard .....	Kan. Bul. 148
39	1909	The Analyses of Registered Feedingstuffs.....	J. T. Willard et al.....	Kan. Bul. 158
40	1909	Analyses of Eggs .....	J. T. Willard and R. H. Shaw .....	Kan. Bul. 159
41	1910	Fertilizers and Their Use.....	J. T. Willard, C. O. Swanson, R. C. Wiley .....	Kan. Bul. 169
42	1911	Milling Tests of Wheat and Baking Tests of Flour <sup>1</sup> .....	J. T. Willard and C. O. Swanson .....	Kan. Bul. 177
43	1911	Effect of Common Mill Fumigants on the Baking Qualities of Flour <sup>2</sup> , .....	G. A. Dean and C. O. Swanson .....	Kan. Bul. 178

<sup>1</sup> See No. 10, Department of Milling Industry.

<sup>2</sup> See No. 167, Department of Entomology and No. 11, Department of Milling Industry.

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SERIAL NO.	DATE OF ISSUE	TITLE	AUTHOR	PUBLICATION
44	1912	Acidity of Wheat Flour, Its Relation to Phosphorus and Other Constituents .....	C O. Swanson .....	Jour. Indus. and Engr. Chem., 4:17
45	1913	Analyses of Registered Fertilizers .....	J. T. Willard, C. O. Swanson, R. C. Wiley .....	Kan. Bul. 187
46	1913	The Influence of Certain Substances Upon the Baking Quality of Flour .....	J. T. Willard and C. O. Swanson .....	Kan. Bul. 190
47	1913	The Influence of Germination on the Milling Qualities of Wheat...	C. O. Swanson .....	Operative Miller, 18:98-100; 165-167; 225-227; 293-294; 365-368
48	1913	Chemical Composition of Wheat Compared with Resultant Flours...	C. O. Swanson .....	American Miller, 41:218-219
49	1913	Acidity in Silage: Method of Determination .....	C. O. Swanson, J. W. Calvin, E. H. Hungerford .....	Jour. Amer. Chem. Soc., 35:476-483
50	1913	Wheat Conditioning .....	C. O. Swanson .....	American Miller, 41:467-469
51	1913	Preliminary Study on the Conditions Which Affect the Amylolytic Enzymes of Wheat Flour .....	C. O. Swanson and J. W. Calvin .....	Jour. Amer. Chem. Soc., 35:1635-1640
52	1914	Chemical Analyses of Some Kansas Soils .....	C. O. Swanson .....	Kan. Bul. 199
53	1914	Soil Survey of Shawnee County <sup>1</sup> .....	L. E. Call, C. O. Swanson, et al. ...	Kan. Bul. 200
54	1914	The Parental Utilization of Disaccharide Sugars .....	A. G. Hogan .....	Jour. Biol. Chem., 18:485-495
55	1915	Kansas Flours: Chemical Baking, and Storage Tests <sup>2</sup> .....	C. O. Swanson, J. T. Willard, L. A. Fitz .....	Kan. Bul. 202 Kan. Bul. 204
56	1915	Commercial Fertilizers .....	C. O. Swanson .....	Kan. Bul. 204
57	1915	The Loss of Nitrogen and Organic Matter in Kansas Soils and the Effect of This Loss on the Crop-Producing Power of the Soil....	C. O. Swanson .....	Jour. Indus. and Engr. Chem., 7:529-538
58	1915	Studies in Carbohydrate Metabolism .....	Frank Underhill and A. G. Hogan .....	Jour. Biol. Chem., 20:203-215

<sup>1</sup> See No. 98, Department of Agronomy.<sup>2</sup> See No. 15, Department of Milling Industry.

59	1915	Soil Survey of Cherokee County <sup>1</sup> .....	L. E. Call, C. O. Swanson, et al... Kan. Bul. 207
60	1915	Analyses of Inspection Samples of Fertilizers.....	J. T. Willard and R. C. Wiley ..... Kan. Insp. Cir. 1
61	1915	Soil Survey of Reno County <sup>2</sup> .....	L. E. Call, C. O. Swanson, et al... Kan. Bul. 208
62	1916	Soil Survey of Jewell County <sup>3</sup> .....	L. E. Call, C. O. Swanson, et al... Kan. Bul. 211
63	1916	Milling and Baking Qualities of Wheat and Flour as Influenced by Methods of Handling, Storing, Heat, Moisture, and Germination, <sup>4</sup>	C. O. Swanson, L. A. Fitz, Leila Dunton ..... Kan. Tech. Bul. 1
64	1916	A Study of Certain Conditions which Affect the Activity of the Proteolytic Enzymes in Wheat Flour.....	C. O. Swanson and E. L. Tague ..... Jour. Amer. Chem. Soc., 38:1098-1109
65	1916	Sodium Sulphate as a Substitute for Potassium Sulphate in the Gunning Modification for Determining Nitrogen.....	W. L. Latshaw ..... Jour. Indus. and Engr. Chem., 8:586-587
66	1916	Chemical Composition of Alfalfa as Affected by Stage of Maturity, Mechanical Losses, and Conditions of Drying.....	C. O. Swanson and W. L. Latshaw ..... Jour. Indus. and Engr. Chem., 8:726-733
67	1916	Some Comparisons of Methods for Determining Nitrogen in Soils...	W. L. Latshaw ..... Jour. Indus. and Engr. Chem., 8:1127
68	1916	Analyses of Inspection Samples of Fertilizers, 1915-16.....	J. T. Willard and R. C. Wiley ..... Kan. Insp. Cir. 3
69	1916	Analyses of Inspection Samples of Fertilizers, Fall, 1916.....	J. T. Willard and R. C. Wiley ..... Kan. Insp. Cir. 4
70	1917	The Nutritive Properties of Corn.....	A. G. Hogan ..... Jour. Biol. Chem., 27:193-208
71	1917	Corn as a Source of Protein and Ash for Growing Animals.....	A. G. Hogan ..... Jour. Biol. Chem., 29:485-493
72	1917	Effect of High Temperatures on the Nutritive Value of Feeds.....	A. G. Hogan ..... Jour. Biol. Chem., 30:115-123
73	1917	Sulphur Content of Some Typical Kansas Soils and the Loss of Sulphur Due to Cultivation.....	C. O. Swanson and R. W. Miller ..... Soil Science, 3:139-148

<sup>1</sup> See No. 107, Department of Agronomy.  
<sup>2</sup> See No. 108, Department of Agronomy.  
<sup>3</sup> See No. 110, Department of Agronomy.  
<sup>4</sup> See No. 18, Department of Milling Industry.

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74	1917	Nitrogen in Amino Forms as Determined by the Formal Titration in Relation to Some Other Factors Measuring Quality in Wheat Flour .....	C. O. Swanson and E. L. Tague .....	Jour. Amer. Chem. Soc., 39:482-491
75	1917	Chemical Studies in Making Silage.....	C. O. Swanson and E. L. Tague .....	Jour. Agr. Res., 10:275-292
76	1917	The Effect of Prolonged Growing of Alfalfa Upon Nitrogen Content of the Soil.....	C. O. Swanson .....	Jour. Amer. Soc. Agron., 9:305-314
77	1917	The Examination of Canned Salmon for Bacteria and Tin <sup>1</sup> .....	L. D. Bushnell and C. A. A. Utt.....	Jour. Indus. and Engr. Chem., 9:678-680
78	1918	Nutritive Properties of Kafirin.....	A. G. Hogan .....	Jour. Biol. Chem., 33:151-159
79	1918	Some Nutritive Properties of Corn.....	J. S. Hughes .....	Kan. Tech. Bul. 5
80	1918	Analyses of Inspection Samples of Fertilizers, 1917.....	J. T. Willard, C. O. Swanson, R. C. Wiley .....	Kan. Insp. Cir. 7
81	1918	Some Constituents of the American Grapefruit.....	H. F. Zoller .....	Jour. Indus. and Engr. Chem., 10:364-373
82	1918	Studies in the Chemistry of Sweet Clover Silage in Comparison with Alfalfa Silage.....	C. O. Swanson and E. L. Tague .....	Jour. Agr. Res., 15:113-132
83	1919	Fertilizer Control in 1918.....	C. O. Swanson, W. L. Latshaw, L. T. Anderegg .....	Kan. Insp. Cir. 10
84	1919	A Study in the Determination of Acidity and Titrable Nitrogen in Wheat Using the Hydrogen Electrode.....	C. O. Swanson and E. L. Tague .....	Jour. Agr. Res., 16:1-13
85	1919	An Electro Magnetic Hypothesis of the Kinetics of Heterogeneous Equilibrium, the Structure of Liquids and Cohesion.....	W. D. Harkins and H. H. King .....	Jour. Amer. Chem. Soc., 41:970-992
86	1919	Losses of Organic Matter in Making Brown and Black Alfalfa <sup>2</sup> ....	C. O. Swanson, L. E. Call, S. C. Salmon .....	Jour. Agr. Res., 18:299-304

<sup>1</sup> See No. 18, Department of Bacteriology.

<sup>2</sup> See No. 128, Department of Agronomy.

87	1919	The Effect of Alfalfa on the Fertility Elements of the Soil in Comparison with Grain Crops.....	C. O. Swanson and W. L. Latshaw .....	Soil Science, 8:1-39
88	1920	A Study of the Determination of Amino Acids by Means of the Hydrogen Electrode .....	E. L. Tague .....	Jour. Amer. Chem. Soc., 42:173-184
89	1920	Changes Taking Place in the Tempering of Wheat.....	E. L. Tague .....	Jour. Agr. Res., 20:271-275
90	1920	Fertilizer Control in 1919.....	C. O. Swanson and W. L. Latshaw .....	Kan. Insp. Cir. 12, pp. 1-38

**Department of Dairy Husbandry**

1	1888	The Milk and Butter Product as Influenced by the Grain Ration When Fed with Ample Pasturage.....	E. M. Shelton, H. M. Cottrell, William Shelton .....	First Ann. Rpt., pp. 69-95
2	1888	The Pressure of Contained Ensilage Upon the Walls of the Silo....	E. M. Shelton, H. M. Cottrell, William Shelton .....	First Ann. Rpt., pp. 95-99
3	1889	Silos and Silage .....	E. M. Shelton .....	Kan. Bul. 6
4	1894	Six Years' Experience with Silage.....	C. C. Georgeson .....	Kan. Bul. 48, pp. 33-40
5	1898	Feed and Care of the Dairy Cow.....	H. M. Cottrell, F. C. Burtis, D. H. Otis .....	Kan. Bul. 81
6	1898	Keeping Milk in Hot Weather.....	.....	Kan. Press Bul. 2
7	1899	Milking Scrub Cows.....	.....	Kan. Press Bul. 29
8	1899	Skim milk Calves .....	.....	Kan. Press Bul. 39
9	1899	Keeping Milk in Summer.....	H. M. Cottrell .....	Kan. Bul. 88
10	1900	Skim milk Calves .....	H. M. Cottrell .....	Kan. Bul. 97
11	1900	Experience in Soiling and Pasturing Cows, 1899.....	D. H. Otis .....	Kan. Press Bul. 71
12	1901	Kafir-corn versus Good Butter.....	D. H. Otis .....	Kan. Press Bul. 86
13	1901	Condimental Stock Food for Dairy Cows.....	D. H. Otis .....	Kan. Press Bul. 88
14	1901	Three Ways of Feeding Milk to Calves.....	D. H. Otis .....	Kan. Press Bul. 94
15	1901	Skim milk Calves in the Feedlot.....	H. M. Cottrell .....	Kan. Press Bul. 95
16	1901	Sorghum Pasture for Dairy Cows.....	D. H. Otis .....	Kan. Press Bul. 100
17	1901	Maintenance Ration for Cattle.....	D. H. Otis .....	Kan. Press Bul. 102
18	1901	Profit in Maintaining the Milk Flow.....	D. H. Otis .....	Kan. Press Bul. 106
19	1902	Whole Kafir-corn Compared with Ground Kafir-corn for Young Calves .....	D. H. Otis .....	Kan. Press Bul. 114
20	1903	A Test of Hand Separators.....	E. H. Webster.....	Kan. Press Bul. 123
21	1904	Experiments with Dairy Cows.....	D. H. Otis .....	Kan. Bul. 125



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22	1904	Experiments with Handfed Calves.....	D. H. Otis .....	Kan. Bul. 126
23	1905	Care of Dairy Utensils.....	Oscar Erf and Charles W. Melick ....	Kan. Bul. 131
24	1906	Grading Cream .....	Oscar Erf .....	Kan. Bul. 135
25	1906	Variations in the Test of Separator Cream.....	Charles W. Melick ....	Kan. Bul. 137
26	1906	Effect of Bacteria in Wash Water of Butter.....	Charles W. Melick ....	Kan. Bul. 138
27	1906	Milking Machines .....	Oscar Erf .....	Kan. Bul. 140
28	1907	Disposal of Dairy and Farm Sewage and Water Supply.....	Oscar Erf .....	Kan. Bul. 143
29	1914	Sorghum Crops for Silage.....	O. E. Reed and J. B. Fitch .....	Kan. Cir. 28
30	1914	Dickinson County Cow-Testing Association.....	O. E. Reed .....	Kan. Cir. 35
31	1915	Dairy Farming .....	O. E. Reed .....	Kan. Cir. 45
32	1915	Raising Calves on Skimmilk.....	O. E. Reed .....	Kan. Cir. 48
33	1915	Filling Silos .....	J. B. Fitch .....	Kan. Cir. 53
34	1917	Alfalfa Silage .....	O. E. Reed and J. B. Fitch .....	Kan. Bul. 217
35	1919	Sorghum Crops for Silage.....	J. B. Fitch .....	Ext. Lft., X Form 70
36	1919	Sweet Clover Pasture .....	J. B. Fitch .....	Ext. Lft., X Form 74
37	1919	Capacity of Silos and Weights of Silage.....	C. H. Eckles, O. E. Reed, J. B. Fitch .....	Kan. Bul. 222
38	1920	Sudan Grass as a Supplementary Pasture Crop for Dairy Cattle <sup>1</sup> ...	L. E. Call and J. B. Fitch .....	Kan. Cir. 80
39	1920	Suggestions Regarding Dairying in Northwestern Kansas.....	J. B. Fitch and J. J. Bayles .....	Kan. Cir. 81
40	1920	Rules for Testing Dairy Cows for Advanced Registration.....	J. B. Fitch and F. W. Atkeson .....	Kan. Cir. 82
<b>State Dairy Commissioner</b>				
1	1910	How to Test, Care For, and Handle Dairy Products.....	D. M. Wilson and M. R. Alleman .....	St. Dairy Com. Bul. No. 1, pp. 3-24
2	1912	The Permit System of Cream Buying.....	D. S. Burch and W. F. Droge .....	St. Dairy Com. Bul. 2 Kan. Bul. 181

<sup>1</sup> See No. 133, Department of Agronomy.

3	1912	Better Butter for Kansas.....	D. S. Burch .....	Kan. Cir. 21
4	1912	Better Butter for Kansas.....	D. S. Burch .....	Kan. Cir. 24
5	1913	The Permit System of Cream Buying.....	George S. Hine and W. F. Droge .....	St. Dairy Com. Bul. No. 3 Kan. Bul. 184
6	1914	Cream Grading in Kansas.....	George S. Hine .....	Kan. Cir. 39
7	1916	Cream Production and Grading in Kansas.....	George S. Hine .....	Kan. Cir. 56
8	1919	The Permit System of Cream Buying.....	H. M. Jones, J. B. Fitch, L. D. Bushnell .....	Kan. Insp. Cir. 9 (St. Dairy Com. Bul. No. 4)

**Department of Entomology**

1	1875	The Grasshopper .....	J. S. Whitman .....	Kan. Indus., Apr. 24 (Vol. 1, No. 1)
2	1875	The Grasshopper .....	J. S. Whitman .....	Kan. Indus., May 1 (Vol. 1, No. 2)
3	1875	Tent Caterpillar .....	J. S. Whitman .....	Kan. Indus., May 15 (Vol. 1, No. 4)
4	1875	Colorado Potato Bug .....	J. S. Whitman .....	Kan. Indus., May 29 (Vol. 1, No. 6)
5	1877	The Farmers and the Grasshopper.....	E. M. Shelton .....	Kan. Indus., Mar. 3 (Vol. 2, No. 46)
6	1877	Grasshopper Prospects in Kansas.....	C. R. Riley .....	Kan. Indus., May 19 (Vol. 3, No. 5)
7	1877	The "Hopper" .....	A. N. Godfrey .....	Kan. Indus., June 16 (Vol. 3, No. 9)
8	1877	The Grasshoppers .....	E. M. Shelton .....	Kan. Indus., June 16 (Vol. 3, No. 9)
9	1877	A List of Kansas Coleoptera.....	E. A. Popenoe .....	Trans. Kan. Acad. Sci., 5:21-40
10	1878	Addition to the Catalogue of Kansas Coleoptera.....	E. A. Popenoe .....	Trans. Kan. Acad. Sci., 6:77-86
11	1879	Natural Agencies in the Control of Noxious Insects.....	E. A. Popenoe .....	Kan. Indus., Oct. 18 (Vol. 5, No. 27)
12	1880	Entomological Jottings .....	E. A. Popenoe .....	Kan. Indus., Feb. 14 (Vol. 5, No. 44)
13	1880	Entomological Jottings .....	E. A. Popenoe .....	Kan. Indus., Mar. 6 (Vol. 5, No. 47)
14	1880	The Entomologist Abroad .....	E. A. Popenoe .....	Kan. Indus., Mar. 6 (Vol. 5, No. 47)
15	1880	The Cotton Worm .....	E. A. Popenoe .....	Kan. Indus., Mar. 6 (Vol. 5, No. 47)

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16	1880	A New Insect Foe.....	E. A. Popenoe .....	Kan. Indus., May 29 (Vol. 5, No. 59)
17	1880	Destroying Insects by Fungoid Diseases.....	E. A. Popenoe .....	Kan. Indus., Oct. 2 (Vol. 6, No. 7)
18	1880	The Web Worm .....	E. A. Popenoe .....	Second Quar. Rpt. Kan. St. Bd. Agr., pp. 99-103
19	1881	Entomological Inquiries Answered .....	E. A. Popenoe .....	Kan. Indus., Mar. 19 (Vol. 6, No. 31)
20	1881	Entomological Inquiries Answered .....	E. A. Popenoe .....	Kan. Indus., May 7 (Vol. 6, No. 38)
21	1881	The Introduction of Injurious Insects.....	E. A. Popenoe .....	Kan. Indus., May 21 (Vol. 6, No. 40)
22	1881	A Sketch of the Beetle Fauna of Kansas.....	E. A. Popenoe .....	Second Bien. Rpt. Kan. St. Bd. Agr., pp. 476-486
23	1882	An Interesting Moth (Abstract).....	G. E. Hopper .....	Kan. Indus, Feb. 11 (Vol. 7, No. 25)
24	1882	The Chinch Bug .....	E. A. Popenoe .....	Kan. Indus., May 6 (Vol. 7, No. 37) Kan. Indus, May 13 (Vol. 7, No. 38)
25	1882	The Chinch Bug and the Season.....	E. A. Popenoe .....	Second Quar. Rpt. Kan. St. Bd. Agr.
26	1883	Mosquitoes and Ague.....	W. A. Kellerman .....	Kan. Indus., Sept. 8 (Vol. 9, No. 4)
27	1883	Notice of Professor Litner's Report as Entomologist of New York..	E. A. Popenoe .....	Kan. Indus., Dec. 22 (Vol. 9, No. 19)
28	1883	Report of Entomologist.....	E. A. Popenoe .....	Third Bien. Rpt. Kan. St. Bd. Agr., pp. 610-617
29	1884	An Account of an Insect Injurious to the Red Cedar.....	E. A. Popenoe .....	Rpt. Kan. St. Hort. Soc., 14:51-52
30	1884	Three Insecticides of General Value.....	E. A. Popenoe .....	Rpt. Kan. St. Hort. Soc., 14:105-108
31	1884	Some Useful Insecticides.....	E. A. Popenoe .....	Kan. Indus., Feb. 9 (Vol. 9, No. 26)
32	1884	The English Sparrow at Home.....	E. A. Popenoe .....	Kan. Indus., May 31 (Vol. 9, No. 42)
33	1884	The Hessian Fly .....	E. A. Popenoe .....	Kan. Indus., Dec. 13 (Vol. 10, No. 17)
34	1885	Contributions to a Knowledge of the Hemiptera-Fauna of Kansas..	E. A. Popenoe .....	Trans. Kan. Acad. Sci., 9:62-64



35	1885	List of Unionidae Collected in Kansas Rivers, with Localities.....	E. A. Popenoe .....	Trans. Kan. Acad. Sci., 9:78-79
36	1885	Notes Upon a Cedar Bark Beetle.....	E. A. Popenoe .....	Kan. Indus., Mar. 7 (Vol. 10, No. 29)
37	1885	Report for the Department of Horticulture and Entomology, 1884-85 .....	E. A. Popenoe .....	Kan. Indus., Nov. 21 (Vol. 11, No. 14)
38	1886	A Handbook of the Butterflies of the Eastern United States.....	E. A. Popenoe .....	Kan. Indus., Feb. 20 (Vol. 11, No. 27)
39	1886	Notes on Two Important Injurious Insects.....	E. A. Popenoe .....	Rpt. Kan. St. Hort. Soc., 16:193-197
40	1886	The Wheat Straw Worm ( <i>Isosoma tritici</i> Riley).....	Warren Knaus .....	Kan. Indus., Apr. 3 (Vol. 11, No. 33)
41	1886	Report of the Department of Horticulture and Entomology, 1885-86,	E. A. Popenoe .....	Kan. Indus., Dec. 25 (Vol. 12, No. 19)
42	1887	Notes on the Oviposition of the Buffalo Treehopper.....	C. L. Marlatt .....	Trans. Kan. Acad. Sci., 10:84-85
43	1887	A New Saw-fly Upon Red Cedar.....	E. A. Popenoe .....	Kan. Indus., Feb. 19 (Vol. 12, No. 27)
44	1887	Note on the Mode of Egg-Laying in the Buffalo Treehopper.....	E. A. Popenoe .....	Kan. Indus., Feb. 19 (Vol. 12, No. 27)
45	1887	Concerning Tree Planting and the Flat-headed Borer.....	E. A. Popenoe .....	Kan. Indus., Apr. 2 (Vol. 12, No. 33)
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48	1887	The Flat-headed Borer in Young Orchards.....	E. A. Popenoe .....	Kan. Indus., Nov. 19 (Vol. 13, No. 14)
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50	1888	Notes on <i>Amphicerus bicaudatus</i> .....	E. A. Popenoe .....	Kan. Indus., Jan. 14 (Vol. 13, No. 21)
51	1888	Notes on the Sycamore Leaf-beetle ( <i>Chlarnys plicata</i> ).....	C. L. Marlatt .....	Kan. Indus., Mar. 3 (Vol. 13, No. 28)
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53	1888	Observations on Two Insect Pests.....	E. A. Popenoe .....	Kan. Bul. 3
54	1888	Some Insects Depredating Forest Trees.....	E. A. Popenoe .....	Rpt. Kan. St. Hort. Soc., 17:359-364
55	1888	Spraying the Apple Orchard.....	E. A. Popenoe, C. L. Marlatt, S. C. Mason .....	First Ann. Rpt., pp. 165-193



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56	1888	Observations Upon Injurious Insects.....	E. A. Popenoe and C. L. Marlatt .....	First Ann. Rpt., pp. 194-225
57	1889	Notes on the Early Stages of Three Moths.....	C. L. Marlatt .....	Trans. Kan. Acad. Sci., 11:110-114
58	1889	Two New Entomological Handbooks.....	E. A. Popenoe .....	Kan. Indus., Jan. 26 (Vol. 14, No. 20)
59	1889	The Box Elder Bug ( <i>Leptocoris trivittatus</i> ).....	E. A. Popenoe .....	Kan. Indus., Mar. 9 (Vol. 14, No. 26)
60	1889	New Codling Moth and Peach-borer Enemies.....	E. A. Popenoe .....	Insect Life, 2:83
61	1889	Experience in Spraying Apple Trees.....	E. A. Popenoe .....	Kan. Indus., Apr. 20 (Vol. 14, No. 32)
62	1889	Entomological Notes .....	E. A. Popenoe .....	Kan. Indus., June 8 (Vol. 14, No. 39)
63	1889	Notes on the Oviposition of a Wood Borer.....	E. A. Popenoe .....	Kan. Indus., Nov. 2 (Vol. 15, No. 10)
64	1889	Scale Insects and Their Destruction.....	E. A. Popenoe .....	Kan. Indus., Nov. 2 (Vol. 15, No. 10)
65	1889	Some Insects Injurious to the Bean.....	E. A. Popenoe, S. C. Mason, F. A. Marlatt .....	Second Ann. Rpt., pp. 206-212
66	1890	The Germination of Weeviled Peas.....	E. A. Popenoe and F. A. Marlatt .....	Kan. Bul. 19
67	1890	Note on the Bean Weevil.....	E. A. Popenoe .....	Kan. Indus., Feb 8 (Vol. 15, No. 23)
68	1890	More About the Bean Weevil.....	E. A. Popenoe .....	Kan. Indus., Apr. 5 (Vol. 15, No. 31)
69	1890	A Spinning Mite on the Red Cedar.....	E. A. Popenoe .....	Kan. Indus., May 24 (Vol. 15, No. 38)
70	1890	Arsenical Poisons for the Plum Curculia.....	E. A. Popenoe .....	Kan. Indus., Dec. 20 (Vol. 16, No. 14)
71	1890	The White Tree-Cricket a Friend.....	E. A. Popenoe .....	Kan. Indus., Dec. 20 (Vol. 16, No. 14)
72	1890	Notes on the Oviposition of a Wood Borer.....	E. A. Popenoe .....	Trans. Kan. Acad. Sci., 12:15-16
73	1891	Notes on the Recent Outbreak of <i>Dissosteira longipennis</i> .....	E. A. Popenoe .....	Insect Life, 4:41-42 Twenty-Second Ann. Rpt. Ent. Soc. Ontario, p. 63
74	1891	A Cheap and Effective Spraying Apparatus.....	E. A. Popenoe .....	Kan. Indus., Mar. 7 (Vol. 16, No. 24)
75	1891	The Germination of Weeviled Peas.....	E. A. Popenoe .....	Kan. Indus., May 2 (Vol. 16, No. 24)

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76	1892	Pear Blight and Spraying.....	E. A. Popenoe .....	Kan. Indus., Apr. 23 (Vol. 17, No. 3.)
77	1892	The Cow-horn Fly .....	E. A. Popenoe .....	Kan. Indus., Oct. 8 (Vol. 18, No. 7)
78	1892	The Apple-Twig Borer .....	E. A. Popenoe .....	Kan. Indus., Dec. 17 (Vol. 18, No. 17)
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82	1895	The Scale Insects in Kansas.....	E. A. Popenoe .....	Kan. Indus., Feb. 2 (Vol. 20, No. 21)
83	1895	A Manual for the Study of Insects.....	E. A. Popenoe .....	Kan. Indus., May 25 (Vol. 20, No. 37)
84	1895	A Noted Entomologist .....	E. A. Popenoe .....	Kan. Indus., Nov. 2 (Vol. 21, No. 9)
85	1896	The Cottonwood Borer .....	E. A. Popenoe .....	Kan. Indus., Feb. 29 (Vol. 21, No. 25)
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92	1898	Some Insects Injurious to the Orchard.....	E. E. Faville and P. J. Parrott .....	Kan. Bul. 77
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96	1898	The Potato-Stalk Weevil .....	.....	Kan. Press Bul. 19



TITLE	AUTHOR	PUBLICATION
Contributions to a Knowledge of the Coccidæ . . . . .	T. D. A. Cockerell and P. J. Parrott . . . . .	Kan. Indus., Mar., Apr., May (Vol. 25, pp. 159-165; 227-237; 276 284)
The Potato-Stalk Weevil . . . . .	E. E. Faville and P. J. Parrott . . . . .	Kan. Bul. 83
The Elm-twig Girdler ( <i>Oncideres cingulatus</i> Say) . . . . .	P. J. Parrott . . . . .	Trans. Kan. Acad. Sci., 16:200-202
Some Insects of the Year . . . . .	E. A. Popenoe . . . . .	Trans. Kan. St. Hort. Soc. for 1898, pp. 40-46
Entomological Report . . . . .	P. J. Parrott . . . . .	Trans. Kan. St. Hort. Soc., 24:48-53
The Spring Canker-worm . . . . .	P. J. Parrott . . . . .	Kan. Press Bul. 23
To Rid the House of Fles . . . . .	P. J. Parrott . . . . .	Kan. Press Bul. 42
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Causes of Failure in Spraying . . . . .	E. A. Popenoe . . . . .	Kan. Press Bul. 66
Fruit Tree Bark Beetle . . . . .	P. J. Parrott . . . . .	Trans. Kan. St. Hort. Soc., 25:78-81
Spraying . . . . .	P. J. Parrott . . . . .	Trans. Kan. St. Hort. Soc., 25:94-98
Horn fly Remedies . . . . .	P. J. Parrott . . . . .	Kan. Indus., Apr. 3 (Vol. 26, No. 27, pp. 375-376)
The Kissing-bug . . . . .	P. J. Parrott . . . . .	Kan. Indus., Oct. 2 (Vol. 27, No. 1, pp. 1-4)
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Grain Weevils . . . . .	E. A. Popenoe . . . . .	Kan. Press Bul. 103
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Report of the Official Entomologist . . . . .	E. A. Popenoe . . . . .	Trans. Kan. St. Hort. Soc., 27:94-100

1902	Some Insect Enemies of Wheat in Kansas.....	E. A. Popenoe .....	Quar. Rpt. Kan. St. Bd. Agr., March, pp. 110-116
1903	Insect Enemies of the Evergreens.....	E. A. Popenoe .....	Kan. Indus., Feb 10 (Vol. 29, No. 17, pp. 263-273)
1903	Crown Gall in Kansas.....	E. A. Popenoe .....	Trans. Kan. St. Hort. Soc., 27:134-137
1903	Preventive Work Against the Hessian Fly.....	E. A. Popenoe .....	Kan. Press Bul. 128
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1905	Some Insects of the Garden.....	E. A. Popenoe .....	Trans. Kan. St. Hort. Soc., 28:214-223
1905	The Garden Web-worm .....	E. A. Popenoe .....	Kan. Press Bul. 144
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1906	Some Points in Nursery Inspection.....	E. A. Popenoe .....	Kan. Indus., Jan. 29 (Vol. 32, No. 13, pp. 275-279)
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1907	Entomology in Kansas State Agricultural College.....	E. A. Popenoe .....	Kan. Indus., June 15 (Vol. 33, No. 33, pp. 526-528)
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1908	The Hessian Fly .....	T. J. Headlee .....	Kan. Indus., June 6 (Vol. 34, No. 35, pp. 547-549)
1908	The Chinch Bug .....	T. J. Headlee .....	Kan. Indus., June 6 (Vol. 34, No. 35, pp. 551-554)
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140	1908	Work of the Department of Entomology and Zoology.....	T. J. Headlee .....	Kan. Indus., Oct. 31 (Vol. 35, No. 4, pp 51-54)
141	1908	Information in Regard to Remedial Measures Against Scale Insects,	T. J. Headlee .....	Kan. St. Ent. Com. Cir 2
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143	1908	Greater Wheat Straw-worm .....	T. J. Headlee .....	Kan. Press Bul. 165
144	1908	Insects Destructive to Grain in Bin and Granary.....	G. A. Dean .....	Kan. Press Bul. 167
145	1909	Report of the State Entomologist for 1907 and 1908.....	T. J. Headlee .....	First Bien Rpt. of Kan. St. Ent. Com
146	1909	A Study of Insects.....	T. J. Headlee .....	Agr. Ed., K. S. A. C., Vol. 1, No. 3
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148	1909	Coccidæ of Kansas .....	G. A. Dean .....	Trans. Kan. Acad. Sci., 22:265-275
149	1909	The Bag Worm.....	T. J. Headlee .....	Trans. Kan. St. Hort. Soc., 33:33-34
150	1909	Report of the Official Entomologist.....	T. J. Headlee .....	Trans. Kan. St. Hort. Soc., 33:148-155
151	1909	The Brown-Tail Moth .....	T. J. Headlee .....	Kan. Indus., Feb. 27 (Vol. 35, No. 18, pp. 275-279)
152	1909	Circular of Information in Regard to San Jose Scale.....	G. A. Dean .....	Kan. St. Ent. Com. Cir. 3
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154	1909	Hessian Fly and Greater Wheat Straw-worm.....	T. J. Headlee .....	Kan. Press Bul. 179
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161	1910	Notes on the Corn Earworm.....	T. J. Headlee .....	Jour. Econ. Ent., 3:149-157
162	1910	Report of the Official Entomologist.....	T. J. Headlee .....	Trans. Kan. St. Hort. Soc., 31:52-64
163	1911	Report of the State Entomologist for 1909 and 1910.....	T. J. Headlee .....	Second Bien. Rpt. Kan. St. Ent. Com., pp. 13-31

<sup>1</sup> See No. 85, Department of Agronomy.

164	1911	Burn the Chinch Bug in Winter Quarters.....	T. J. Headlee .....	Kan. Cir. 19
165	1911	A Brief Report on the Work Now Being Prosecuted by Some Economic Entomologists in the State Universities, Agricultural Colleges, and Experiment Stations of the United States.....	T. J. Headlee .....	Jour. Econ. Ent., 4:35-46
166	1911	Report of the Official Entomologist.....	T. J. Headlee .....	Trans. Kan. St. Hort. Soc., 31:160-169
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168	1911	Heat as a Means of Controlling Mill Insects.....	G. A. Dean .....	Jour. Econ. Ent., 4:142-158
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171	1912	The Time When Wheat Should be Sown to Escape the Fall Brood of Hessian Fly .....	T. J. Headlee .....	Jour. Econ. Ent., 5:98-105
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178	1913	What Doniphan County Has Done With Apples.....	J. H. Merrill .....	Trans. Kan. St. Hort. Soc., 32:169-172
179	1913	Report of the Official Entomologist.....	G. A. Dean .....	Trans. Kan. St. Hort. Soc., 32:180-184
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185	1914	Grasshopper Control Work in Western Kansas.....	G. A. Dean .....	Jour. Econ. Ent., 7:67-73
186	1914	A Parasite of the Chinch Bug Egg.....	J. W. McColloch .....	Jour. Econ. Ent., 7:219-227

<sup>1</sup> See No. 43, Department of Chemistry and No. 11, Department of Milling Industry.

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191	1914	A New <i>Henlea (Euchytraidea)</i> from Northern Michigan.....	P. S. Welch .....	Trans. Amer. Micros. Soc., 33:155-163
192	1915	Report of the State Entomologist for 1913 and 1914.....	G. A. Dean .....	Fourth Bien. Rpt. Kan. St. Ent. Com., pp. 7-11
193	1915	Controlling the Hessian Fly, the Garden Webworm, and the Army Worm .....	G. A. Dean .....	Nineteenth Bien. Rpt. Kan. St. Bd. Agr., pp. 689-694
194	1915	The Spring Canker Worm Situation in Kansas.....	G. A. Dean .....	Kan. Cir. 46
195	1915	Insects Destructive to Grain and Grain Products Stored in Bins and Granaries .....	G. A. Dean .....	Kan. Cir. 47
196	1915	Insects on the Farm .....	G. A. Dean .....	Essentials of Agriculture, pp. 300-312
197	1915	Report of the Official Entomologist.....	G. A. Dean .....	Trans. Kan. St. Hort. Soc., 33:25-37
198	1915	A New Air Conditioning Apparatus <sup>1</sup> .....	G. A. Dean and R. K. Nabours .....	Jour. Econ. Ent., 8:107-111
199	1915	Recent Results in the Use of Dust Sprays for Controlling the Corn Earworm .....	J. W. McColloch .....	Jour. Econ. Ent., 8:211-214
200	1915	Further Data on Poisoned Bran Mash Flavored with Fruit Juice as a Means of Controlling Some Insects.....	G. A. Dean .....	Jour. Econ. Ent., 8:219-223
201	1915	Further Data on the Life Economy of the Chinch Bug Egg Parasite,	J. W. McColloch .....	Jour. Econ. Ent., 8:248-260
202	1915	A Cricket Predaceous on the Termite.....	J. W. McColloch .....	Jour. Econ. Ent., 8:308
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204	1915	Radishes Seriously Injured by Flea Beetles.....	G. A. Dean .....	Jour. Econ. Ent., 8:429
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207	1915	The Hessian Fly Situation.....	G. A. Dean and J. W. McColloch .....	Kan. Cir. 37 (Revised)

<sup>1</sup> See No. 30, Department of Zoology.

208	1915	The Lepidoptera of the Douglas Lake Region, Northern Michigan,	P. S. Welch	Ent. News, 26:115-119
209	1915	A New Parasite of the Chinch Bug Egg (Hym.)	J. W. McColloch and H. Yuasa	Ent. News, 26:147-149
210	1915	Entomological Notes	P. S. Welch	Trans. Amer. Micros. Soc., 34:49-50; 190-195; 279-283
211	1916	Insects Injurious to Alfalfa	G. A. Dean	Ext. Bul. 5
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214	1916	A Study of the Life History of the Maize Billbug	W. P. Hayes	Jour. Econ. Ent., 9:120-128
215	1916	The Hessian Fly Train	G. A. Dean	Jour. Econ. Ent., 9:139-141
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219	1916	Results of Ten Years of Experimental Wheat Sowing to Escape the Hessian Fly	G. A. Dean	Jour. Econ. Ent., 10:146-159
220	1916	Wind as a Factor in the Dispersion of the Hessian Fly	J. W. McColloch	Jour. Econ. Ent., 10:162-168
221	1916	A Method for the Study of Underground Insects	J. W. McColloch	Jour. Econ. Ent., 10:183-187
222	1916	Studies on the Life History of <i>Ligyryus gibbosus</i> DeG. (Coleoptera),	W. P. Hayes	Jour. Econ. Ent., 10:253-261
223	1916	Some Important Work of the Year Relating to Horticulture	G. A. Dean	Trans. Kan. St. Hort. Soc., 34:192-200
224	1916	Relation Between Aphid Infestation and Blight Infection	J. H. Merrill	Amer. Bee Jour., 16:202
225	1916	Two New Nematodes Parasitic on Insects	J. H. Merrill and A. L. Ford	Jour. Agr. Res., 6:115-127
226	1916	The San José Scale	L. M. Peairs and J. H. Merrill	Kan. Bul. 214
227	1916	Methods of Controlling Grasshoppers	F. B. Milliken	Kan. Bul. 215
228	1916	Entomological Notes	P. S. Welch	Trans. Amer. Micros. Soc., 35:65-78; 141-148; 257-268
229	1916	Snowfield and Glacier Oligochæta from Mt. Rainier, Washington	P. S. Welch	Trans. Amer. Micros. Soc., 35:85-124
230	1916	Notes on Oligochæta	P. S. Welch	Trans. Amer. Micros. Soc., 35:148-150
231	1916	Contribution to the Biology of Certain Aquatic Lepidoptera	P. S. Welch	Ann. Ent. Soc. Amer., 9:159-190
232	1916	Further Studies on <i>Hydromyza confluens</i> Loew, (Diptera)	P. S. Welch	Ann. Ent. Soc. Amer., 10:35-45
233	1917	Report of the State Entomologist for 1915 and 1916	G. A. Dean	Fifth Bien. Rpt. Kan. St. Ent. Com., pp. 5-9

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234	1917	Studies on the Life History of Two Kansas Scarabæidæ (Coleoptera),	W. P. Hayes	Jour. Econ. Ent., 11:136-144
235	1917	Notes on False Wireworms with Especial Reference to <i>Eleodes tricosata</i> Say	J. W. McColloch	Jour. Econ. Ent., 11:212-224
236	1917	Migration of the Hessian Fly Larvæ	J. W. McColloch and H. Yuasa	Jour. Anim. Behavior, 7:307-323
237	1917	Alaskan Glacier Worms ( <i>Oligochæta</i> )	P. S. Welch	Bionomical Leaflets McGill University, Montreal Leaflet, 2:5-8
238	1917	Enchytræidæ ( <i>Oligochæta</i> ) from the Rocky Mountain Region	P. S. Welch	Trans. Amer. Micros. Soc., 36:67-81
239	1917	Entomological Notes	P. S. Welch	Trans. Amer. Micros. Soc., 36:97-100; 274-280
240	1917	The Enchytræidæ ( <i>Oligochæta</i> ) of the Woods Hole Region, Mass.	P. S. Welch	Trans. Amer. Micros. Soc., 36:119-138
241	1917	Some Entomological Work for the Year of 1917 Relating to Horticulture	G. A. Dean	Trans. Kan. St. Hort. Soc., 35:201-208
242	1918	A Preliminary Report on the Relation of Kinds and Varieties of Grain to Hessian Fly Injury <sup>1</sup>	J. W. McColloch and S. C. Salmon	Jour. Agr. Res., 12:519-527
243	1918	The Toad as an Enemy of the Chinch Bug	J. W. McColloch	Jour. Econ. Ent., 12:124
244	1918	Insects and Plant Diseases Attacking Garden Crops <sup>2</sup>	J. H. Merrill and L. E. Melchers	Kan. Cir. 65
245	1918	Spraying Fruit Trees	J. H. Merrill	Kan. Cir. 66
246	1918	Treatment of Brood Diseases of Bees	J. H. Merrill	Kan. St. Ent. Com. Cir. 5
247	1918	Observations on Reproduction in Certain Parthenogenetic and Bisexual Nematodes in Artificial Media	P. S. Welch and L. P. Wehrle	Trans. Amer. Micros. Soc., 37:141-176
248	1918	An Extra Molt in the Nymphal Stages of the Chinch Bug	H. Yuasa	Ent. News., 29:233-234
249	1918	Part II. The Enchytræidæ (The <i>Oligochæta</i> Collected by the Canadian-Arctic Expedition of 1913-1916, by Frank Smith and Paul S. Welch)	P. S. Welch	Report of Canadian-Arctic Expedition, 1913-18, Vol. 9, Part 8
250	1919	Report of the State Entomologist for years 1916-17 and 1917-18	G. A. Dean	Sixth Bien. Rpt. Kan. St. Ent. Com., pp. 5-11
251	1919	Report of State Apiarist	J. H. Merrill	Sixth Bien. Rpt. Kan. St. Ent. Com., pp. 20-42

<sup>1</sup> See No. 123, Department of Agronomy.

<sup>2</sup> See No. 159, Department of Botany.



252	1919	Control of Mill-Infesting Insects.....	G. A. Dean .....	Dixie Miller, 52:36-38
253	1919	Beekeeping on the Farm.....	J. H. Merrill .....	Twenty-first Bien. Rpt. Kan. St. Bd. Agr., pp. 309-314
254	1919	Insects in Stored Grain.....	G. A. Dean .....	Twenty-first Bien. Rpt. Kan. St. Agr., pp. 314-321
255	1919	The Control of the Codling Moth in the Arkansas Valley Fruit Belt,	G. A. Dean and W. R. Martin .....	Trans. Kan. St. Hort. Soc., 35:89-102
256	1919	Apiculture in Boys' and Girls' Club Work.....	L. V. Rhine .....	Trans. Kan. St. Hort. Soc., 35:114-116
257	1919	The Life Cycle of <i>Lachnosterna lanceolata</i> Say.....	W. P. Hayes .....	Jour. Econ. Ent., 12:109-117
258	1919	<i>Bleodes opaca</i> Say, an Important Enemy of Wheat in the Great Plains Area .....	J. W. McColloch .....	Jour. Econ. Ent., 12:183-194
259	1919	Grasshopper Control in Kansas.....	G. A. Dean, A. L. Ford, E. G. Kelly .....	Jour. Econ. Ent., 12:213-217
270	1919	The Value of Winter Protection for Bees.....	J. H. Merrill .....	Amer. Bee Jour., Oct.
271	1919	Spring Management of Bees.....	J. H. Merrill .....	Kan. St. Ent. Com. Cir. 6
272	1919	The Life History of the Honey Bee.....	M. C. Tanquary .....	Sixth Bien. Rpt. Kan. St. Ent. Com., pp. 37-42
273	1920	Some Insect Enemies of Shade Trees and Ornamentals.....	G. A. Dean .....	Trans. Kan. St. Hort. Soc., 35:151-171
274	1920	Outline of Project Work in Extension Entomology.....	E. G. Kelly .....	Jour. Econ. Ent., 13:137-140
275	1920	Organization for Grasshopper Control.....	G. A. Dean and E. G. Kelly .....	Jour. Econ. Ent., 13:237-241
276	1920	The Maize Billbug .....	W. P. Hayes .....	Kan. Tech. Bul. 6
277	1920	<i>Solenopsis Molesta</i> Say (Hym.): A Biological Study.....	W. P. Hayes .....	Kan. Tech. Bul. 7
278	1920	The Process of Hatching in <i>Corydalis cornuta</i> Linn.....	Roger C. Smith.....	Ann. Ent. Soc. Amer., 13:70-74
279	1920	Some Observations on the Genitalia of <i>Lachnosterna</i> .....	W. P. Hayes and J. W. McColloch .....	Ann. Ent. Soc. Amer., 13:75-84
280	1920	A Study of the Oviposition of the Corn Earworm with Relation to Certain Phases of the Life Economy and Measures of Control..	J. W. McColloch .....	Jour. Econ. Ent., 13:242-255
281	1920	Life History of Some Kansas <i>Lachnosterna</i> .....	W. P. Hayes .....	Jour. Econ. Ent., 13:303-318
282	1920	The Importance of Winter Stores.....	J. H. Merrill .....	Amer. Bee Jour., Vol. 60, No. 10, p. 344
283	1920	Preliminary Notes on the Value of Winter Protection for Bees....	J. H. Merrill .....	Jour. Amer. Assoc., Econ. Ent., 13:99-111
284	1920	Note on <i>Udeopysylla nigra</i> .....	Roger C. Smith .....	Jour. Econ. Ent., 13:491
285	1920	The European Corn Borer.....	G. A. Dean .....	Rpt. Kan. St. Bd. Agr., Vol. 39, No. 153, pp. 145-152

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1888	Garden Trials of Vegetables.....	E. A. Popenoe, C. L. Marlatt, S. C. Mason	First Ann. Rpt, pp. 226-280
1889	Garden Tests of Vegetables.....	E. A. Popenoe, S. C. Mason, F. A. Marlatt	Second Ann. Rpt., pp. 133-206
1890	Notes on Conifers for Kansas Planters.....	E. A. Popenoe, S. C. Mason, F. A. Marlatt	Kan. Bul. 10
1890	Winter Protection of Peach Trees and Notes on Grapes.....	E. A. Popenoe, S. C. Mason, F. A. Marlatt	Kan. Bul. 14
1890	Garden Notes .....	S. C. Mason	Kan. Bul. 18, pp. 196-202
1891	A Comparison of Varieties of the Strawberry.....	E. A. Popenoe and S. C. Mason	Kan. Bul. 26
1891	The Experimental Vineyard .....	E. A. Popenoe and S. C. Mason	Kan. Bul. 28
1892	Experiments in Potato Culture.....	E. A. Popenoe and S. C. Mason	Kan. Bul. 37
1893	Further Study of Native Grapes.....	E. A. Popenoe and S. C. Mason	Kan. Bul. 44
1895	Small Fruits by Irrigation.....	S. C. Mason and F. C. Sears	Kan. Bul. 55
1897	Grafting the Apple .....	S. C. Mason and Isaac Jones	Kan. Bul. 65
1897	Vegetable Growing .....	S. C. Mason and W. L. Hall	Kan. Bul. 70
1897	Miscellaneous Fruit Notes .....	S. C. Mason and W. L. Hall	Kan. Bul. 73
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1898	Celery .....		Kan. Press Bul. 11
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1899	Winter Protection of Peach Buds.....		Kan. Press Bul. 21
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1899	Orchard Cultivation .....		Kan. Press Bul. 40
1899	The Profitable Strawberry Bed.....		Kan. Press Bul. 44

22	1900	Salsify, or Oyster Plant.....	A. Dickens .....	Kan. Press Bul. 61
23	1900	Some Interesting Climbers for the Veranda.....	E. A. Popenoe .....	Kan. Press Bul. 74
24	1900	Honeysuckles at the Kansas Station.....	E. A. Popenoe .....	Kan. Press Bul. 77
25	1901	Notes on Plums .....	A. Dickens .....	Kan. Press Bul. 80
26	1901	Notes from the Plum Orchard.....	E. A. Popenoe and A. Dickens .....	Kan. Bul. 101
27	1902	The Experimental Apple Orchard.....	A. Dickens and G. O. Greene .....	Kan. Bul. 106
28	1902	The Hardy 'Catalpa' <sup>1</sup> .....	H. F. Roberts, A. Dickens, G. O. Greene .....	Kan. Bul. 108
29	1902	Onion Notes .....	G. O. Greene .....	Kan. Press Bul. 111
30	1902	Grapes .....	A. Dickens and G. O. Greene .....	Kan. Bul. 110
31	1904	Tests of Forest Trees.....	A. Dickens and G. O. Greene .....	Kan. Bul. 120
32	1904	Trees for the Sanded Areas.....	A. Dickens .....	Kan. Bul. 121, pp. 142-144
33	1905	Summer Pruning .....	A. Dickens .....	Kan. Press Bul. 142
34	1905	Preparing Fruits for Exhibition.....	A. Dickens .....	Kan. Press Bul. 143
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37	1907	Spraying .....	A. Dickens and R. E. Eastman .....	Kan. Bul. 145
38	1910	Kansas State Forestry Work.....	A. Dickens .....	Kan. Press Bul. 182
39	1910	Provisions of the State Forest Law.....	C. A. Scott .....	Kan. Cir. 10
40	1910	Orcharding .....	A. Dickens .....	Agr. Ed., K. S. A. C., Vol. 2, No 8
41	1910	Forest Conditions in Central and Western Kansas.....	A. Dickens .....	Kan. Bul. 165
42	1910	How to Grow Black Walnuts.....	C. A. Scott .....	Kan. Cir. 13
43	1912	The Hardy Catalpa .....	C. A. Scott .....	Kan. Cir. 20
44	1913	The Chinese Arbor Vitæ.....	C. A. Scott .....	Kan. Cir. 33
45	1913	Potato Culture .....	A. Dickens .....	Kan. Bul. 194
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49	1916	Trees for Kansas .....	C. A. Scott .....	Kan. Cir. 55
50	1916	Tree Planting in Kansas.....	C. A. Scott .....	Ext. Bul. 11

<sup>1</sup> See No. 96, Department of Botany.



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51	1917	The Woodlot .....	C. A. Scott .....	Kan. Cir. 58
52	1918	The Home Vegetable Garden.....	M. F. Ahearn .....	Kan. Cir. 64

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1	1907	Kansas Law Regulating the Sale of Concentrated Feedingstuffs....	C. W. Burkett and J. T. Willard .....	Kan. Bul. 146
2	1908	What is Pure Bran?.....	J. T. Willard .....	Kan. Press Bul. 168
3	1908	Adulterated Corn Chop .....	J. T. Willard .....	Kan. Press Bul. 169
4	1908	Mixed Feed and the Kansas Feedingstuffs Law.....	J. T. Willard .....	Kan. Press Bul. 170
5	1909	An Explanation of the Kansas Feedingstuffs Law.....	E. H. Webster .....	Kan. Press Bul. 176
6	1909	The Inspection Tax on Feedingstuffs.....	E. H. Webster .....	Kan. Press Bul. 178
7	1910	Handling Wheat from Field to Mill.....	L. A. Fitz .....	U. S. D. A. Cir. 68
8	1911	A Wheat Primer .....	L. A. Fitz .....	Agr. Ed., K. S. A. C., Vol. 4, No. 17
9	1911	Kansas Feedingstuffs Law, Revision of 1911.....	E. H. Webster .....	Kan. Cir. 18
10	1911	Milling Tests of Wheat and Baking Tests of Flour <sup>1</sup> .....	J. T. Willard and C. O. Swanson .....	Kan. Bul. 177
11	1911	Effect of Common Mill Fumigants on the Baking Qualities of Wheat Flour <sup>2</sup> .....	G. A. Dean and C. O. Swanson .....	Kan. Bul. 178
12	1913	Kansas Feedingstuffs Law, Revision of 1913.....	W. M. Jardine .....	Kan. Cir. 30
13	1914	The Analysis and Registration of Commercial Feedstuffs.....	L. A. Fitz .....	Kan. Bul. 195
14	1914	The Kansas Feedingstuffs Law, Revision of 1913.....	L. A. Fitz .....	Kan. Cir. 38
15	1915	Kansas Flours: Chemical, Baking, and Storage Tests <sup>3</sup> .....	C. O. Swanson, J. T. Willard, L. A. Fitz .....	Kan. Bul. 202
16	1915	Kansas Livestock Remedy Law.....	L. A. Fitz and A. E. Langworthy ....	Kan. Cir. 50
17	1915	The Kansas Feedingstuffs Law, Revision of 1913; Amended 1915..	L. A. Fitz and A. E. Langworthy ....	Kan. Cir. 52
18	1916	The Milling and Baking Quality and Chemical Composition of Wheat and Flour <sup>4</sup> .....	C. O. Swanson, L. A. Fitz, Leila Dunton .....	Kan. Tech. Bul. 1

<sup>1</sup> See No. 42, Department of Chemistry.

<sup>2</sup> See No. 43, Department of Chemistry, and No. 167, Department of Entomology.

<sup>3</sup> See No. 55, Department of Chemistry.

<sup>4</sup> See No. 63, Department of Chemistry.

19	1917	Feed Registration Under the Kansas Feedingstuffs Law.....	L. A. Fitz and A. E. Langworthy ....	Kan. Insp. Cir. 5
20	1918	Safeguarding Feeders of Cottonseed Products.....	L. A. Fitz and A. E. Langworthy ....	Kan. Cir. 71

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1a	1905	Kansas Experiment Station Egg-Laying Contest.....	Oscar Erf and M. M. Hastings .....	Kan. Press Bul. 140
1b	1905	Kansas Experiment Station Egg-Laying Contest.....	Oscar Erf and M. M. Hastings .....	Kan. Press Bul. 147
1c	1907	Egg-Laying Contest .....	Oscar Erf .....	Kan. Press Bul. 156
1d	1907	The Hen's Place on the Farm.....	Oscar Erf .....	Kan. Bul. 150
2	1909	The Marketing of Eggs.....	A. G. Philips .....	Kan. Bul. 162
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5	1915	Improving the Kansas Egg.....	W. A. Lippincott .....	Kan. Cir. 51
6	1917	Chicken Management on the Farm.....	R. M. Sherwood et al....	Kan. Cir. 60
7	1917	Chicken Houses .....	R. M. Sherwood .....	Kan. Cir. 61
8	1918	The Case of the Blue Andalusian.....	W. A. Lippincott .....	Amer. Nat., 52:95-115
9	1918	Pedigreeing Poultry .....	W. A. Lippincott .....	Kan. Cir. 67
10	1918	The Factors for Yellow in Mice and Notch in Drosophila.....	W. A. Lippincott .....	Amer. Nat., 52:364-365
11	1919	The Breed in Poultry and Pure Breeding.....	W. A. Lippincott .....	Jour. Heredity, 10:71-79
12	1919	The Relation of Plumage to Ovarian Condition in a Barred Plymouth Rock Pullet .....	L. J. Cole and W. A. Lippincott .....	Biol. Bul., 36:167-183
13	1920	Improving Mongrel Farm Flocks Through Selected Standardbred Cockerels .....	W. A. Lippincott .....	Kan. Bul. 223
14	1920	Note on the "Pelvic Wing" in Poultry.....	W. A. Lippincott .....	Amer. Nat., 53:535-539
16	1920	A Hen Which Changed Color.....	W. A. Lippincott .....	Jour. Heredity, 11:342-348

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1	1891	Enzootic Cerebritis or "Staggers" of Horses.....	N. S. Mayo .....	Kan. Bul. 24
2	1892	Actinomycosis Bovis or "Lumpy Jaw" of Cattle. Some Observations Upon Loco .....	N. S. Mayo .....	Kan. Bul. 35
3	1895	Cattle Poisoning by Potassium Nitrate. Mastitis.....	N. S. Mayo .....	Kan. Bul. 49
4	1896	Cornstalk Disease of Cattle.....	N. S. Mayo .....	Kan. Bul. 58

(a) Revised in 1916.

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1901	Blackleg in Kansas.....	Paul Fischer and A. T. Kinsley .....	Kan. Bul. 105
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1901	Sore Mouth of Cattle.....	N. S. Mayo .....	Kan. Press Bul. 105
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1902	Pneumonia in Cattle.....	N. S. Mayo .....	Kan. Press Bul. 112
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**Department of Zoology**

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13	1907	Bird Life: Its Relations to the Farmer.....	T. H. Scheffer .....	Agr. Ed., K. S. A. C., (Vol. 1, No. 5, pp. 81-106)
14	1908	The Pocket Gopher .....	T. H. Scheffer .....	Kan. Bul. 152
15	1909	Treating Seed Corn to Protect It From Burrowing Animals.....	T. H. Scheffer .....	Kan. Cir. 1
16	1909	Prairie Dog Situation .....	T. H. Scheffer .....	Kan. Cir. 4
17	1910	The Economic Value of Bird Life.....	R. H. Sullivan .....	Agr. Ed., K. S. A. C., Vol. 3, No. 7
18	1910	The Common Mole .....	T. H. Scheffer .....	Kan. Bul. 168
19	1910	The Pocket Gopher .....	T. H. Scheffer .....	Kan. Bul. 172
20	1910	Protecting Trees from Rabbits.....	J. C. Cunningham .....	Kan. Cir. 17
21	1912	Evidence of Alternative Inheritance in the F <sub>2</sub> Generation from Crosses of Bos Indicus on Bos Taurus.....	R. K. Nabours .....	Amer. Nat., 46:428-436
22	1913	Possibilities for a New Breed of Cattle for the South.....	R. K. Nabours .....	Amer. Breeders Mag., 4:38-52
23	1913	A New Means of Transmitting the Fowl Nematode, <i>Heterakis perspicillum</i> .....	John W. Scott .....	Science, n. s., 38:672-673
24	1913	Experiments with Tapeworms. I. Some Factors Producing Evagination of a Cysticercus.....	John W. Scott .....	Biol. Bul., 25:304-312
25	1914	Studies of Inheritance and Evolution in Orthoptera I.....	R. K. Nabours .....	Jour. Genetics, 3:141-170
26	1915	The Pocket Gopher .....	Harry B. Yocom .....	Kan. Cir. 43
27	1915	The Prairie Dog Situation.....	R. K. Nabours .....	Kan. Cir. 54
28	1915	Experiments on Cysticerci of <i>Tænia Pisiformis</i> Bloch and of <i>Tænia Serialis</i> Gervais .....	J. E. Ackert .....	Jour. Par., 1:151-153
29	1915	Spermatogenesis in Paratettix .....	Mary T. Harman .....	Biol. Bul., 29:262-276
30	1915	A New Air Conditioning Apparatus <sup>1</sup> .....	G. A. Dean and R. K. Nabours .....	Jour. Econ. Ent., 8:107-111
31	1916	On the Effect of Selection in Paramecium.....	J. E. Ackert .....	Genetics, 1:387-405
32	1917	Studies of Inheritance and Evolution in Orthoptera II.....	R. K. Nabours .....	Jour. Genetics, 7:1-46
33	1917	Studies of Inheritance and Evolution in Orthoptera III.....	R. K. Nabours .....	Jour. Genetics, 7:47-54
34	1917	Studies of Inheritance and Evolution in Orthoptera IV.....	A. W. Bellomy .....	Jour. Genetics, 7:55-70
35	1917	Habits of the Magpie in Southeastern Washington.....	Lee R. Dice .....	The Condor, 19:121-214
36	1917	Systematic Position of Several American Tertiary Lagomorphs.....	Lee R. Dice .....	Univ. Cal. Pub., 10:179-183
37	1917	A Case of Superfetation in the Cat.....	Mary T. Harman .....	Anatomical Rec., 13:145-157

<sup>1</sup> See No. 198, Department of Entomology.



38	1917	Another Cestode from the Young Cat.....	J. E. Ackert and A. A. Grant .....	Trans. Amer. Micros. Soc., 36:93-96
39	1917	A Means of Transmitting the Fowl Nematode, <i>Heterakis papillosa</i> Bloch .....	J. E. Ackert .....	Science, n. s., 46:394
40	1917	Another Case of Gynandromorphism.....	Mary T. Harman .....	Anatomical Rec., 13:425-433
41	1918	The Birds of Walla Walla and Columbia Counties, Southeastern Washington .....	Lee R. Dice .....	The Auk, 35:40-51
42	1918	A Probable Case of Superfetation in the Cow.....	Mary T. Harman .....	Anatomical Rec., 14:335-336
43	1918	Abnormalities in the Chick Embryo.....	Mary T. Harman .....	Science, n. s., 48:476
44	1918	On the Life Cycle of the Fowl Cestode, <i>Davainea cesticillus</i> (Molin.), .....	J. E. Ackert .....	Jour. Par., 5:41-43
45	1919	The Effect of Abnormal Temperatures Upon the Developing Nervous System in the Chick Embryos.....	Florence M. Alsop .....	Anatomical Rec., 15:307-331
46	1919	The Land of Lambskins: An Expedition to Bokhara, Russian Cen- tral Asia, to Study the Karakul Sheep Industry.....	R. K. Nabours .....	Nat. Geog., 36:77-88
47	1919	Parthenogenesis and Crossing Over in the Grouse Locust <i>Apotettix</i> , .....	R. K. Nabours .....	Amer. Nat., 53:131-142
48	1919	On the Life History of <i>Davainea tetragona</i> (Molin.), a Fowl Tape- worm .....	J. E. Ackert .....	Jour. Par., 6:28-34
49	1920	Chromosome Studies in Tettigidae II: Chromosomes of <i>Paratettix</i> BB and CC and Their Hybrid BC.....	Mary T. Harman .....	Biol. Bul., 38:213-230
50	1920	Strongylosis ( <i>Ostertagia</i> ) in Cattle.....	J. E. Ackert and W. E. Muldeon .....	Jour. Amer. Vet. Med. Assoc., 58:138-146

**Director's Reports**

1	1889	First Annual Report .....	E. M. Shelton .....	.....
2	1890	Second Annual Report .....	E. M. Shelton .....	.....
3	1891	Third Annual Report .....	Station Council .....	.....
4	1892	Fourth Annual Report .....	Station Council .....	.....
5	1893	Fifth Annual Report .....	Station Council .....	.....
6	1894	Sixth Annual Report .....	Station Council .....	.....
7	1895	Seventh Annual Report .....	Station Council .....	.....
8	1896	Eighth Annual Report .....	Station Council .....	.....
9	1897	Ninth Annual Report .....	Station Council .....	.....
10	1897	Tenth Annual Report .....	Station Council .....	.....
11	1899	Eleventh Annual Report .....	Station Council .....	.....
12	1900	Twelfth Annual Report .....	Station Council .....	.....
13	1900	Thirteenth Annual Report .....	J. T. Willard .....	.....
14	1901	Fourteenth Annual Report .....	J. T. Willard .....	.....

DIRECTOR'S REPORTS—*Concluded.*

SERIAL NO.	DATE OF ISSUE	TITLE	AUTHOR	PUBLICATION
15	1902	Fifteenth Annual Report . . . . .	J. T. Willard . . . . .	. . . . .
16	1903	Sixteenth Annual Report . . . . .	J. T. Willard . . . . .	. . . . .
17	1905	Seventeenth Annual Report . . . . .	J. T. Willard . . . . .	. . . . .
18	1906	Eighteenth Annual Report . . . . .	J. T. Willard . . . . .	. . . . .
19	1907	Nineteenth Annual Report . . . . .	J. T. Willard . . . . .	. . . . .
20	1908	Twentieth Annual Report . . . . .	C. W. Burkett . . . . .	. . . . .
21	1909	Twenty-First Annual Report . . . . .	C. W. Burkett . . . . .	. . . . .
22	1915	Director's Report, 1913 . . . . .	W. M. Jardine . . . . .	. . . . .
23	1916	Director's Report, 1914 15 . . . . .	W. M. Jardine . . . . .	. . . . .
24	1917	Director's Report, 1915 16 . . . . .	W. M. Jardine . . . . .	. . . . .
25	1918	Director's Report, 1916 17 . . . . .	W. M. Jardine . . . . .	. . . . .
26	1918	Director's Report, 1917-18 . . . . .	L. E. Call . . . . .	. . . . .
27	1920	Director's Report, 1918-19 . . . . .	F. D. Farrell . . . . .	. . . . .

**Miscellaneous Publications**

1	1888	Organization, Equipment, and Aims . . . . .	E. M. Shelton . . . . .	Kan. Bul. 1
2	1899	Press Bulletins Nos. 1 to 34 . . . . .	. . . . .	Kan. Bul. 86
3	1899	The Kansas Experiment Station . . . . .	. . . . .	Kan. Press Bul. 48
4	1899	History and Present Status of the Kansas Experiment Station . . . . .	J. T. Willard . . . . .	Kan. Indus., Dec. 5 (Vol. 26, No. 11)
5	1900	Press Bulletins Nos 35 to 70 . . . . .	. . . . .	Kan. Bul. 99
6	1901	Feeding Wheat . . . . .	J. T. Willard . . . . .	Kan. Press Bul. 96
7	1903	Press Bulletins Nos. 71 to 124 . . . . .	. . . . .	Kan. Bul. 119
8	1906	Press Bulletins Nos 125 to 151 . . . . .	. . . . .	Kan. Bul. 136
9	1917	How to Prepare Ground for Wheat and Time to Sow . . . . .	W. M. Jardine . . . . .	Kansas Council of Defense Cir. 6

**STATION PUBLICATIONS, 1919-20**

Four bulletins and twelve circulars were published and distributed during the fiscal year ending June 30, 1920. They were as follows:

GENERAL BULLETINS				
No.	Title	Edition	Pages	Total pages
222	Capacity of Silos and Weights of Silage . . . . .	15,000	22	530,000
223	Improving Mongrel Farm Flocks Through Selected Standardbred Cockerels . . . . .	15,000	48	720,000
TECHNICAL BULLETINS				
6	The Maize Billbug of Elephant Bug . . . . .	5,000	27	135,000
7	<i>Solenopsis molesta</i> Say (Hym.): A Biological Study . . . . .	3,000	55	165,000
CIRCULARS				
73	Growing Alfalfa in Western Kansas . . . . .	15,000	10	150,000
74	Establishing Kanred Wheat in Kansas . . . . .	25,000	16	400,000
75	Blackleg and Its Control . . . . .	10,000	4	40,000
76	Home Preparation of Pork . . . . .	40,000	13	520,000
77	Cattle Feeding Investigations, 1918-19 . . . . .	15,000	11	165,000
78	Swine Feeding Investigations, 1918-19 . . . . .	15,000	7	105,000
79	Lamb Feeding Investigations, 1919 . . . . .	10,000	4	40,000
80	Sudan Grass as a Supplementary Pasture Crop for Dairy Cattle . . . . .	10,000	4	40,000
81	Suggestions Regarding Dairying in Northwestern Kansas . . . . .	15,000	16	240,000
82	Rules for Testing Dairy Cows for Advanced Registration . . . . .	10,000	12	120,000
INSPECTION CIRCULARS				
10	Fertilizer Control in 1918 . . . . .	3,000	9	27,000
11	State Livestock Registry Board, Report No. 9 . . . . .	5,000	127	635,000
Totals . . . . .		211,000	385	3,832,000

**INFORMATION REGARDING PUBLICATIONS ISSUED, 1919-20**

GENERAL BULLETINS

222. *Capacity of Silos and Weights of Silage*, C. H. Eckles, O. E. Reed, and J. B. Fitch. (22 pp., 2 figs.) The actual weights of the contents of 32 silos—25 filled with corn, 4 with sweet sorghum, and 3 with kafir—furnish the data for the figures given in this bulletin for use in estimating the weight of settled silage.

223. *Improving Mongrel Farm Flocks Through Selected Standardbred Cockerels*, William A. Lippincott. (48 pp., 30 figs.) This bulletin reports the results of "The Grading Experiment" of the Department of Poultry Husbandry. Mongrel pullets, typical of poor-producing farm flocks, were mated with standardbred cockerels from high-producing families. The experiment was continued for three successive generations using cockerels from the Single Comb White Leghorn, the Barred Plymouth Rock, and the White Orpington varieties. The experiment indicated that the egg production of poor-producing mongrel farm flocks may be markedly improved by such grading methods.

TECHNICAL BULLETINS

6. *The Maize Billbug or Elephant Bug*, William P. Hayes. (27 pp., 12 figs.) Corn on the bottom lands of south-central Kansas may be seriously injured by the maize billbug, *Sphenophorus maidis* Chittn. This



bulletin gives the life history of the species together with methods of control.

7. *Solenopsis Molesta* Say (Hym.): *A Biological Study*, William P. Hayes. (55 pp., 11 figs.) *Solenopsis molesta* Say, commonly known as the kafir ant, is especially injurious to sorghum seed planted in southern Kansas. This bulletin gives the life history of the species together with four methods of control.

CIRCULARS

73. *Growing Alfalfa in Western Kansas*, Charles R. Weeks. (10 pp., 4 figs.) This circular discusses methods of establishing and maintaining a stand of alfalfa on the river and creek bottoms of western Kansas.

74. *Establishing Kanred Wheat in Kansas*, S. C. Salmon. (16 pp., 8 figs.) This circular gives the history of the development of a new variety of wheat, named "Kanred," a derivation of the words *Kansas Red*. Kanred's superiority to other varieties of hard red winter wheat consists in its winter hardiness, earliness of maturity, rust-resistance, and yield. The publication includes the testimony of a number of farmers who have raised Kanred in various parts of the section of the state adapted to hard winter wheat.

75. *Blackleg and Its Control*, Leonard W. Goss. (4 pp.) This circular discusses the cause, symptoms, and curative treatment of blackleg; also its prevention by the use of either Blackleg Aggressin or Blackleg Filtrate.

76. *Home Preparation of Pork*, A. M. Paterson. (13 pp., 9 figs.) This circular gives practical instructions for butchering; also instructions for cutting up and curing pork. A number of recipe for curing pork are given and brief instructions for smoking meat.

77. *Cattle Feeding Investigations, 1918-19*, C. W. McCampbell, F. W. Bell, and H. B. Winchester. (11 pp., 1 fig.) The results of the year's cattle feeding investigations reported in this circular show: (1) That the greater the utilization of silage the greater the reduction in the cost of producing gains on two-year-old steers. That sweet sorghum silage has practically the same feeding value pound for pound as corn silage. (3) That it requires approximately 35 percent more concentrate and 20 percent more roughage to produce 100 pounds of gain on two-year-old steers than on baby beeves.

78. *Swine Feeding Investigations, 1918-19*, C. W. McCampbell, E. F. Ferrin, and H. B. Winchester. (7 pp., 1 fig.) The result of the year's swine feeding investigations reported in this circular show: (1) That the self-feeder reduces the cost of producing gains on hogs. (2) That, as a supplement to corn in fattening hogs, tankage is to be preferred to linseed oilmeal, peanut feed meal, or commercial buttermilk.

79. *Lamb Feeding Investigations, 1918-19*, A. M. Paterson. (4 pp., 1 fig.) The results of the investigations reported in this circular indicate: (1) That the addition of linseed oilmeal to a lamb-fattening ration increases the gains and reduces the cost of gain. (2) That corn gluten feed is not a satisfactory substitute for either linseed or cottonseed meal as a protein supplement for fattening lambs.

80. *Sudan Grass as a Supplementary Pasture Crop for Dairy Cattle*, L. E. Call and J. B. Fitch. (4 pp., 1 fig.) The adaptability and value of Sudan grass as a pasture crop for dairy cattle are discussed in this circular and detailed data given for an experiment at the station in which six cows were kept on Sudan grass pasture from July 10 to October 11, 1919. The value of the milk produced showed a credit of \$47.47 per acre for the Sudan grass pasture.

81. *Suggestions Regarding Dairying in Northwestern Kansas*, J. B. Fitch and J. J. Bayles. (16 pp., 6 figs.) In northwestern Kansas dairying is becoming a remunerative side line on many farms. This circular gives in considerable detail data on the small dairy herd of the Colby Branch Experiment Station from November 1, 1915, to December 1, 1918. It also discusses the value of dairying and its improvement under northwestern Kansas conditions.

82. *Rules for Testing Dairy Cows for Advanced Registration*, J. B. Fitch and F. W. Atkeson. (12 pp., 1 fig.) This circular gives the rules and regulations provided for the advanced registration of cows of the four leading dairy breeds.

#### INSPECTION CIRCULARS

10. *Fertilizer Control in 1918*, C. O. Swanson, W. L. Latshaw, and L. T. Anderegg. (9 pp.) The results of the inspection of commercial fertilizers sold in Kansas during 1918, together with the list of dealers selling them, are given in this circular.

11. *Kansas State Livestock Registry Board Report No. 9*, F. W. Bell, Secretary. (127 pp.) This publication gives the Kansas law "Relating to Registration and Licensing of Stallions;" a few introductory articles by the Secretary and others; and a list of all stallions licensed by the State Livestock Registry Board to stand for public service in Kansas during the year 1919.

#### PERSONNEL

The following changes in the personnel of the station staff have taken place during the year:

#### APPOINTMENTS

F. E. Colburn, Photographer  
Percy L. DePuy, Assistant Mammalogist  
Chas. R. Enlow, Research Assistant in Agricultural Economics  
W. W. Fetrow, Research Assistant in Agricultural Economics  
Blanche French, Research Assistant in Agricultural Economics  
Otis J. Gould, Deputy Dairy Commissioner  
W. E. Grimes, Acting Head of Department of Agricultural Economics  
R. L. Hensel, Associate Professor of Pasture Management  
E. N. Hiestand, Research Assistant in Agricultural Economics  
Clare Higgins, Research Assistant in Poultry Husbandry  
F. L. Hisaw, Mammalogist  
H. L. Ibsen, Assistant Professor of Animal Husbandry  
C. O. Johnston, Experimental Assistant, Department of Botany

**98** AGRICULTURAL EXPERIMENT STATION.

- H. L. Kent, Superintendent Fort Hays Branch Experiment Station
- A. H. Kerns, Assistant to Superintendent Fort Hays Branch Experiment Station
- Chas. H. Kitselman, Assistant in Veterinary Medicine
- H. H. Laude, In Charge Cooperative Experiments
- H. F. Lienhardt, Assistant Professor of Pathology
- G. E. Lowrey, Superintendent Tribune Branch Experiment Station
- J. R. Mingle, Creameryman
- R. D. Nichols, Research Assistant in Agricultural Economics
- Roger O. Smith, Associate Professor of Entomology
- F. L. Thomsen, Assistant Professor of Agricultural Economics
- Geo. Vander Veen, Associate in Feedingstuffs
- Chas. C. Vasey, Deputy Dairy Commissioner
- F. A. Wagner, Superintendent Garden City Branch Experiment Station
- R. H. Whitenack, Deputy State Dairy Commissioner

RESIGNATIONS

- C. C. Cunningham, In Charge Cooperative Experiments
- Percy L. DePuy, Assistant Mammalogist
- Chas. R. Enlow, Research Assistant in Agricultural Economics
- G. C. Gibbons, Assistant Superintendent Fort Hays Branch Experiment Station
- L. W. Goss, Professor of Pathology
- E. N. Hiestand, Research Assistant in Agricultural Economics
- Theodore Macklin, Professor of Agricultural Economics
- Ivar Mattson, Superintendent Tribune Branch Experiment Station
- J. R. Mingle, Creameryman
- C. W. Mullen, Assistant Professor of Farm Crops
- N. E. Olson, Assistant Professor of Dairy Husbandry
- S. J. Pearce, Deputy State Dairy Commissioner
- H. A. Pratt, Foreman College Greenhouse
- M. C. Tanquary, Associate Professor of Entomology
- Chas. C. Vasey, Deputy Dairy Commissioner
- Chas. R. Weeks, Superintendent Fort Hays Branch Experiment Station
- R. H. Whitenack, Deputy Dairy Commissioner

**FINANCIAL STATEMENT**

(The Kansas Agricultural Experiment Station in account with federal and state appropriations, 1919.20)

	Federal appropriations	State appropriations and receipts	Totals
Manhattan station . . . . .	\$30,000.00	\$62,935.78	\$92,935.78
Branch stations, appropriations . . .		38,800.00	38,800.00
Branch stations, sales . . . . .		70,582.35	70,582.35
Totals . . . . .		\$172,318.13	\$202,318.13
Salaries . . . . .	\$18,001.68	\$31,130.59	\$49,132.27
Labor . . . . .	8,862.04	55,773.35	64,635.39
Publications . . . . .	8.00	842.37	850.37
Postage and stationery . . . . .	177.75	1,273.46	1,451.21
Freight and express . . . . .	10.53	1,885.28	1,895.81
Heat, light, water, and power . . . .	22.75	3,194.46	3,217.21
Chemicals, laboratory supplies . . . .	759.58	1,234.75	1,994.33
Seeds, plants, sundry supplies . . . .	598.86	12,702.20	13,301.06
Fertilizers . . . . .	.65	49.50	50.15
Feedingstuffs . . . . .	336.49	9,343.76	9,685.25
Library . . . . .		83.10	83.10
Tools, machinery, appliances . . . . .	508.74	6,449.10	6,957.84
Furniture and fixtures . . . . .	6.77	1,130.82	1,137.59
Scientific apparatus, specimens . . . .	27.25	255.74	282.99
Livestock . . . . .	96.50	8,412.72	8,509.22
Traveling expenses . . . . .	256.41	2,700.80	2,957.21
Contingent expenses . . . . .	8.00	3,683.26	2,691.26
Buildings and land . . . . .	318.00	8,868.60	9,186.60
Balance, June 30, 1920 . . . . .		23,299.27	23,299.27
Totals . . . . .	\$30,000.00	\$172,318.13	\$202,318.13

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Kansas Agricultural Experiment Station for the fiscal year ending June 30, 1920; that we have found them 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.

WILBUR N. MASON  
H. J. PENNEY  
E. L. BARRIER