

**KANSAS AGRICULTURAL
EXPERIMENT STATION**

Kansas State Agricultural College

DIRECTORS' REPORT

1914-'15



MANHATTAN, KAN.

KANSAS

AGRICULTURAL EXPERIMENT STATION KANSAS STATE AGRICULTURAL COLLEGE.

DIRECTOR'S REPORT, 1914-1915.

MANHATTAN, KANSAS.

KANSAS STATE AGRICULTURAL EXPERIMENT STATION.

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C. W. McCampbell, Horse Feeding.
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J. G. Jackley, Poultry Disease Investigations.
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J. P. Poole, Seed Control and Plant Breeding.
L. E. Melchers, Plant Pathology.
E. P. Harling, Seed Analyst.

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J. H. Merrill, Fruit Insect Investigations.
J. W. McColloch, Staple Crop Insect Investigations.
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M. F. Ahearn, Vegetables and Forcing Crops.
D. E. Lewis, Diseases of Fruits and Vegetables.
F. S. Merrill, Cultural Methods and Fertilizer Investigations.

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FORT HAYS.

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* A. L. Hallsted, Dry-land Agriculture.
* F. A. Kiene, Cereal Crops.
* R. E. Getty, Forage Crops.

GARDEN CITY.

M. C. Sewell, Superintendent.
* J. G. Lill, Dry-land Agriculture.
* G. S. Knapp, Irrigation.

CHEMISTRY.

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C. O. Swanson, General Investigations.
R. C. Wiley, Feeding Stuffs and Fertilizers.
A. G. Hogan, Animal Nutrition.
E. L. Tague, Protein Investigations.
W. L. Latshaw, Soil Analysis.

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J. B. Fitch, Dairy Production.
W. E. Tomson, Dairy Manufactures.
G. A. Gilbert, Dairy Manufactures.
G. S. Hine, State Dairy Commissioner.
H. M. Jones, Deputy State Dairy Commissioner.
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ECONOMICS.

E. D. Baker, Agricultural Economics

FORESTRY.

C. A. Scott, State Forester, in Charge.

MILLING INDUSTRY.

L. A. Fitz, in Charge.
Leila Dunton, Wheat and Flour Investigations.
L. L. Leeper, Miller.
A. E. Langworthy, Feed Control.
O. C. Miller, Feed Control.
L. G. Hepworth, Feed Control.

POULTRY HUSBANDRY.

W. A. Lippincott, in Charge.
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L. W. Goss, Histology.
T. P. Haslam, Pathology.
R. V. Christian, Hog Cholera Serum Manufacture.
Q. M. Franklin, Veterinary Medicine.
C. W. Hobbs, Field Veterinarian.
O. E. Strodman, Hog Cholera Investigations.

ZOOLOGY.

R. K. Nabours, in Charge.
J. E. Ackert, Parasitology.
H. B. Yocum, Injurious Mammals.

COLBY.

S. P. Clark, Superintendent.
* J. B. Kuska, Dry-land Agriculture.

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* F. J. Turner, Superintendent.

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C. E. Cassel, Superintendent.

* In cooperation with the United States Department of Agriculture.

Kansas Agricultural Experiment Station.

OFFICE OF THE DIRECTOR,

June 30, 1915.

To His Excellency, Arthur Capper, Governor of Kansas:

I have the honor to present herewith the report of the Kansas Agricultural Experiment Station for the fiscal year ended June 30, 1915. It includes a brief statement of the work completed or in progress, and the principal changes which have occurred since the issuance of the last report.

W. M. JARDINE, *Director.*



FIG I. The lambs used in the 1914-1915 feeding experiment.

THE DIRECTOR'S REPORT.

The emphasis recently placed upon the dissemination of agricultural knowledge as a result of the enactment of the Smith-Lever bill has required experiment stations in general to institute investigations on a larger and more fundamental scale than ever before. The increase in the number of county agents, the enthusiastic reception of agricultural courses in the high schools, and the growing demands made by farmers in general upon the Experiment Station, has required a means of providing more advanced and reliable information for agricultural workers than has hitherto been available. The service of the Experiment Station has been requested more frequently during the past twelve months than during any similar previous period.

Modern rural problems are numerous and difficult. It is the function of the Experiment Station to solve them, if possible, since the station is the only institution in the state equipped to conduct exact agricultural investigations. However, unless it is strongly supported and keeps abreast of the times, rural information for Kansas will be of a more or less superficial character. The limitations of agricultural knowledge become more and more apparent as the farmers become better informed and as the conditions under which they operate become more exacting. It is of paramount importance that a proper balance be maintained between agricultural research and agricultural extension, if the greatest good to the state is to be attained. The need for well-trained station workers is felt more keenly now than ever before in the history of the station. Never was there greater necessity for specially designed apparatus, equipment and facilities to aid investigators. The greatest demand of the station to-day is for additional well-trained men, but closely correlated is the necessity for more equipment—land upon which to develop livestock; apparatus that will permit control of varied conditions of atmosphere, soil and climate by the investigator; and an increased number of well-equipped laboratories.

It is impossible for an investigator to study and solve difficult problems if his time is too heavily engaged with teaching, carrying on a large correspondence, preparing material for popular bulletins, judging at county fairs, doing institute work, and conducting a general agricultural propaganda. Yet this is the condition under which a great many of the best station workers are now laboring. To do work of a fundamental character, such a man must have time to think, to study, and to keep in touch with the literature and developments in his line.

In spite of this condition several significant steps have been taken toward real contributions to agriculture during the year covered by this report (1914-1915). Among them may be mentioned the following:

(1) The veterinary department has developed a blackleg serum through the use of which outbreaks of blackleg may be entirely checked. This serum has been tried on over 5000 animals with results 100 percent effective.

(2) Opportunities for careful and fundamental work have resulted from the addition to the station equipment of an air conditioner, later described in this report. This apparatus provides means of controlling temperature and humidity conditions and increases immensely the possibilities for doing exact work in inheritance and development. The life history of little-known insect pests may now be readily worked out; and the confirmation or contradiction of field conclusions in regard to certain soil and crop conditions can be accomplished. The addition of this machinery makes possible the prosecution of certain classes of fundamental scientific work which have not previously been commonly pursued by the agricultural experiment stations.

(3) The investigation of sex type as related to function in cattle is of immense significance to livestock breeding. It has been common observation among both livestock breeders and livestock judges that the best beef cow seldom produces the best calves. A scientific investigation of this issue has hitherto been precluded because of expense. Due to the generous cooperation of the Department of Agriculture this work is now under way, and individuals from representative families of Shorthorns have been gathered whose sole criterion for inclusion in the experiment is breeding performance. A tried

sire, the college herd bull, Matchless Dale, is at the head of the herd at present, and the information which is to be gained through the prosecution of the project should throw light not only on the type of beef cow to select, but also on the perplexing problem of dual-purpose cattle.

(4) What promises to be the best variety of wheat ever produced by the Kansas Experiment Station is now being increased in amount, and will be ready for general distribution next season. This variety, as yet unnamed, is a selection from the Crimean variety, a Turkey strain of wheat. The average yield of this selection for the five-year period, 1911-1915, inclusive, has been 30.1 bushels, as compared with 27.4 bushels for Turkey during the same period, an increase of over 9 percent. In the extremely unfavorable season of 1912 it produced 57 percent more grain than the Turkey. In twelve variety tests conducted in cooperation with farmers in the wheat belt of central Kansas, this variety was compared with the Turkey, and the local variety used for general seeding. In 1914 the Turkey wheat in these tests gave an average yield of 25.9 bushels, the local wheat 25.5 bushels, and the improved strain, 28.7 bushels per acre. In 1915 the averages were: Turkey, 22.1 bushels, local wheat, 20.9, and the improved strain, 24.7 bushels per acre. The variety is more hardy, winterkills less, apparently has a more extensive root system when young, and ripens from three to five days earlier than the ordinary strains of wheat.

(5) The dairy husbandry department initiated an experiment in heifer development on July 1, 1914, which has both a practical and scientific bearing. Twenty-four heifer calves were divided into three lots; the first lot being fed alfalfa hay, silage, and grain; the second, alfalfa and silage; and the third, alfalfa alone. Records are kept of the total amount of each feed consumed from birth and the proportions of nutrients in each. The effect of each ration on the development, size, and milk production of the animals, and the residual effects after at least three lactation periods, will be determined. The animals are weighed and measured each month and complete records are kept of their gains, growth, and behavior. Significant differences between the lots have developed within the year.

While these are the leading features of the station work as developed during the year, many other lines of investiga-

tions just as significant which were initiated in previous fiscal years, have progressed satisfactorily. Furthermore, many lines of routine work which make little or no showing from a publicity standpoint have been continued, all of which give a large total when the activities of the year are summated.

PERSONNEL.

Few changes have occurred in the staff during the year covered by this report. An assistant professorship in farm management has been established with W. E. Grimes, formerly superintendent of the agronomy farm, in charge of the work. Mr. Grimes' previous position was filled by A. L. Clapp.

The animal husbandry department was broadened to include a professorship in animal breeding, and E. N. Wentworth, associate editor of the *Breeders' Gazette*, and former associate professor of animal husbandry at Iowa State College, was employed to fill this position. J. D. Lewis and W. L. Blizzard resigned their positions in this department to engage in commercial undertakings, and A. M. Paterson was transferred from the Fort Hays Branch Station to take charge of sheep investigations.

Investigational work in agricultural economics was initiated during the fiscal year by E. D. Baker, special stress being laid on Kansas problems. A third member, F. E. Mixa, was added to the staff of the poultry department as assistant. J. I. Kirkpatrick resigned as assistant in hog-cholera serum manufacture, and O. E. Strodtman was employed by the state as assistant in hog-cholera eradication in Marshall county, to act in Coöperation with the federal government. C. B. Brown replaced J. G. Lill as assistant in dry farming at the Garden City Substation, in coöperation with the Department of Agriculture, Mr. Lill being transferred to Rocky Ford, Colo.

The scope of investigation in bacteriology was widened by the addition of a soil bacteriologist, P. L. Gainey, who devotes his entire time to station research. E. L. Tague was added to the staff of the chemistry department in protein investigations, and A. G. Hogan and W. L. Latshaw replaced J. W. Calvin and J. C. Summers in animal nutrition and soil analysis, respectively. P. S. Welch was relieved from station duties to devote his entire time to teaching, and W. P. Hayes was engaged to give full attention to the study of staple crop insects.

PUBLICATIONS ISSUED.

Six bulletins and twelve circulars were published and distributed during the fiscal year, July 1, 1914, to June 30, 1915. They were as follows:

Bulletin No..	Title.	Edition.	Pages.	Total pages.
185	Preparing Land for Wheat (revised)	10,000	12	120,000
202	Kansas Flours	2,500	135	337,500-
203	Orchard Spraying	25,000	39	975,000
204	Commercial Fertilizers	10,000	38	380,000
205	Growing Corn in Kansas.	40,000	40	1,600,000
206	The Relation of Moisture to Yield of Winter Wheat in Western Kansas.	25,000	32	800,000
	Totals	112,500	296	4,212,500
Circulars				
37	The Hessian Fly Situation in Kansas (revised),	25,000	4	100,000
41	Actinomycosis or "Lumpy Jaw"		3	24,000
42	Which Stallion and Why?	70,000	4	280,000
43	The Pocket Gopher.	2,500	4	10,000
44	Sweet Clover	30,000	10	300,000
45	Dairy Farming	30,000	25	750,000
46	The Spring Canker Worm Situation in Kansas.	20,000	7	140,000
47	Insects Destructive to Grain and Grain Products Stored in Bins and Granaries.	10,000	4	40,000
48	Raising Calves on Skim Milk.	30,000		
49	Pruning	5,000	13	65,000
50	Kansas Livestock Remedy Law, with List of Remedies Registered April 1, 1915.	5,000	15	75,000
51	Improving the Kansas Egg.	30,000	10	300,000
52	The Kansas Feeding-stuffs Law, Revision of 1913; Amended 1915.	3,500	10	35,000
	Totals	269,000	120	2,449,000

SUMMARIES OF BULLETINS.

185. *Preparing Land for Wheat. (Revised.)* (L. E. Call.) This bulletin discusses the preparation of the seedbed for wheat, including the cost of preparation, the yield, and the value of grain and straw. Eleven different methods of preparing the seedbed were used for wheat grown continuously, and five methods for wheat grown in rotation. The value of early plowing and rotation systems was emphasized.

202. *Kansas Flours: Chemical, Baking and Storage Tests.* (C. O. Swanson, J. T. Willard, and L. A. Fitz.) This bulletin of 135 pages describes extensive baking experiments on commercial flours, as well as on the flours from the different mill streams. The effects of storage on flour is treated, and the apparatus and methods used in the investigation are fully described. The results can not be summarized briefly.

203. *Orchard Spraying.* (D. E. Lewis.) A comparison of the relative values of standard fungicides and insecticides with directions for making them is given in this bulletin. Spraying machinery and accessories are briefly explained, and a spraying calendar for the most important fruits is given.

204. *Commercial Fertilizers: I. Analyses of Inspection Samples of Fertilizers; II. Value and Use.* (J. T. Willard and R. C. Wiley.) The results of the analyses of inspection samples of fertilizers, with explanations of technical terms are given in this publication. It furthermore includes a financial statement of the receipts and expenditures under the provisions of the fertilizer law from January 1, 1913, to June 30, 1914.

An extended article upon the manufacture, composition and use of fertilizers, with practical reference to Kansas climate, conditions, and soils is included.

205. *Growing Corn in Kansas.* (C. C. Cunningham.) The areas of Kansas adapted to corn growing are pointed out in this bulletin. The necessity of a rotation, the importance of home-grown seed, the comparative value of listing and surface planting, the time and rate of planting, and the methods of cultivation and harvesting are emphasized. A brief discussion on the effect of injurious insects and the method of combating them is included.

206. *The Relation of Moisture to Yield of Winter Wheat in Western Kansas.* This brochure contains a review of the work with wheat in the dry-land investigations at the Fort Hays Branch Station. The relative value of early-plowed, late fall-plowed, summer-fallowed, and subsoiled ground for conservation of moisture and yield of wheat, and the place for the fallow in a rotation are presented.

SUMMARIES OF CIRCULARS.

37. *The Hessian Fly Situation in Kansas.* (Revised.) (Geo. A. Dean and J. W. McColloch.) The Hessian fly situation in Kansas for 1915 is discussed in this circular.

41. *Actinomycosis or Lumpy Jaw.* (R. R. Dykstra.) This circular discusses briefly the causes and symptoms of lumpy jaw in cattle. It instructs the owner of animals how this disease may be prevented, and how it may be cured if it has obtained a foothold on the premises. The methods of treatment outlined are thorough and practical so that they may be readily adopted by the average farmer.

42. *Which Stallion and Why?* (C. W. McCampbell.) This circular presents the importance of a purebred stallion from the mare owner's viewpoint and gives a county list of the stallions licensed by the Kansas State Livestock Registry Board from July 1, 1913, to October 1, 1914. A list is available for each county in the state. The stallions are classified as purebred, grade, or scrub, and the license number and owner's name and address are given.

43. *The Pocket Gopher.* (H. B. Yocum.) Information is given in regard to the habits and distribution of the pocket gopher in Kansas. The principal crops damaged by gophers in this state are alfalfa, grass meadows, trees, and root crops. Poisoning and trapping are the methods of control recommended and are described in detail.

44. *Sweet Clover.* (C. C. Cunningham.) The wide adaptation of sweet clover and its value for pasture, hay, and soil improvement are considered in this publication. Directions are given concerning the preparation of the seedbed, the time of seeding, inoculation, and the method of saving seed.

45. *Dairy Farming.* (O. E. Reed.) This circular contains general information on dairying, dairy breeds, the selection, feeding, care and management of the dairy herd, and directions for making the Babcock test.

46. *The Spring Canker-worm Situation in Kansas.* (Geo. A. Dean.)

This seven-page pamphlet gives warning of an outbreak of canker-worms. The life history and habits of the insect are discussed and practical methods of control are described in detail.

47. *Insects Destructive to Grain and Grain Products.* (Geo. A. Dean.) This circular calls attention to the seriousness of damage done by the grain-infesting insects that were unusually abundant in 1915, and describes in detail practical methods of control.

48. *Raising Calves on Skim Milk.* (O. E. Reed.) General information is given concerning the value of skim milk as a calf feed. Directions for feeding calves, and the causes of calf scours with remedies are presented.

49. *Pruning.* (F. S. Merrill.) This is a brief outline of pruning methods for apples, peaches, grapes, and bush fruits. It includes advice regarding tools to use, the season to prune, wound treatments, and fruiting habits for the various fruit trees.

50. *Kansas Livestock Remedy Law with List of Remedies Registered April 1, 1915.* (L. A. Fitz.) In addition to a list of the livestock remedies registered April 1, 1915, this circular contains certain statements regarding the law and certain information regarding common ingredients used in the remedies.

51. *Improving the Kansas Egg.* (Wm. A. Lippincott.) Simple and effective methods of preserving the quality of the new-laid egg are given, accompanied by reasons for selling eggs on a graded basis. The adoption of the graded basis in handling eggs commercially is fundamental to improvement in Kansas.

PAPERS APPEARING IN SCIENTIFIC JOURNALS.

In addition to the official publications listed above, the staff members have prepared numerous papers along the various lines of applied science which make up the research activities of the station. These papers have been presented at meetings of the respective scientific associations, or have appeared in the leading scientific periodicals. A partial list of these papers is given herewith:

"Notes on Apparent Relation between Aphids and Fire Blight (*Bacillus amylovorus*)." J. H. Merrill, *Journal of Economic Entomology*, vol. 8, pp. 402, 403.

"On Some Genera of the Pimpline Ichneumonidæ." J. H. Merrill, *Transactions of the American Entomological Society*, vol. 41, pp. 109-154.

"A Cricket Predaceous on the Termite." James W. McColloch, *Journal of Economic Entomology*, vol. 8, p. 308.

"Recent Results in the Use of Dust Sprays for Controlling the Corn Ear-Worm." James W. McColloch, *Journal of Economic Entomology*, vol. 8, pp. 211-214.

"Further data on the Life Economy of the Chinch-bug Egg Parasite." James W. McColloch and H. Yuasa, *The Journal of Economic Entomology*, vol. 8, pp. 248-261.

- "Habits of the Larva of *Bellura melanopyga* Grote (Lepidoptera)." P. S. Welch, *Biological Bulletin*, vol. 27, pp. 97-114.
- "A New *Henlea* (Enchytræidæ) from Northern Michigan." P. S. Welch, *Transactions of the American Microscopical Society*, vol. 33, pp. 155-164.
- "Entomological Abstracts." P. S. Welch, *Transactions of the American Microscopical Society*, vol. 33, pp. 205-208, vol. 34, pp. 49-50, 190-195.
- "The Lepidoptera of the Douglas Lake Region, Northern Michigan." P. S. Welch, *Entomological News*, vol. 26, pp. 115-119.
- "Root-knot or Eelworm Attacks New Hosts." L. E. Melchers, *Ohio Naturalist*, vol. 15, pp. 551-555.
- "A Method of Obtaining an Abundance of Large Uredinia from Artificial Cultures." L. E. Melchers, *Phytopathology*, vol. 5, pp. 236-237.
- "Prepotency." E. N. Wentworth, *Journal of Heredity*, vol. 6, pp. 17-20.
- "Sex-linked Factors in the Inheritance of Rudimentary Mammæ in Swine." E. N. Wentworth, *Bulletin of Iowa Academy of Science*, 1914, pp. 265-268.
- "The Cabbage Curculio (*rapæ* Gyll) Injuring Radishes." Geo. A. Dean, *Journal of Economic Entomology*, vol. 8, p. 429.
- "Radishes Seriously Injured by Flea Beetles." Geo. A. Dean, *Journal of Economic Entomology, Current Notes*, vol. 8, p. 429.
- "Further Data on Poisoned Bran Mash Flavored with Fruit Juice as a Means of Controlling Some Insects." Geo. A. Dean, *The Journal of Economic Entomology*, vol. 8, pp. 219-223.
- "A New Air-conditioning Apparatus." Geo. A. Dean and R. K. Nighbours, *The Journal of Economic Entomology*, vol. 8, pp. 107-111.
- "The Effect of Different Methods of Preparing a Seedbed for Winter Wheat upon Yield, Soil Moisture and Nitrates." L. E. Call, *Journal of the American Society of Agronomy*, vol. 6, pp. 249-259.
- "The Loss of Nitrogen and Organic Matter in Cultivated Kansas Soils and the Effect of This Loss on the Crop-producing Power of the Soil." C. O. Swanson, *Journal of industrial and Engineering Chemistry*, vol. 7, pp. 529-238.
- "Studies in Carbohydrate Metabolism." Frank P. Underhill and Albert G. Hogan.
- VIII. "The Influence of Hydrazine on the Utilization of Dextrose." *The Journal of Biological Chemistry*, vol. 20, pp. 203-210.
- IX. "The Influence of Hydrazine on the Glyoxalase Activity of the Liver." *The Journal of Biological Chemistry*, vol. 20, pp. 211-216.
- "The Parenteral Utilization of Disaccharide Sugars." Albert G. Hogan, *The Journal of Biological Chemistry*, vol. 18, No. 3, pp. 485-496.
- "The Vacuum Method of Drawing Anti-hog-cholera Serum." Thos. P. Haslam, A. E. Hagan and R. V. Christian, *The Journal of Infectious Diseases*, vol. 16, pp. 487-492.
- "The Standardization of Anti-hog-cholera Serum." T. P. Haslam and O. M. Franklin, *The Journal of Infectious Diseases*, vol. 15, pp. 257-267.

"Causes of the Deficiency in the Meat Supply and the Probable Remedies." W. A. Cochel, *Proceedings of the American Society of Animal Production*, 1914 Report, pp. 4-7.

"Experiments on Cysticerci of *Taenia pisiformis* Bloch and of *Taenia seriali* Gervais." Jas. E. Ackert, *Journal of Parasitology*, vol. 1, p. 151.

Experimental Work.

It is impossible to report the various lines of research work in detail. A brief summary indicating the progress which has been made in the more important lines of investigation is presented herewith, grouped according to the funds from which these projects receive their principal financial support.

HATCH FUND.

Soil Fertility. The soil fertility project was continued as reported in 1913. The season of 1914 was very favorable for the production of wheat and cowpeas, only fair for alfalfa, and very poor for corn. Yet the season's results verified those of the previous year in that commercial fertilizers did not increase the value of the crops produced sufficiently to pay for their additional cost. In every case the use of barnyard manure increased the value of the crop sufficiently to produce a profitable return after deducting the cost of the manure. The use of 380 pounds of raw rock phosphate in connection with 2 1/2 tons of manure increased the yield of alfalfa more than 15 percent over an adjoining plot which received manure alone (2 1/2 tons). The use of lime (1000 pounds) in connection with manure (2 1/2 tons) gave practically no increase in the crop of alfalfa.

Seedbed Preparation for Wheat. Due to the dry summer of 1913 there was very little accumulation of soluble plant food before fall, and the wheat showed very little difference in yield as a result of different methods of seedbed preparation. The highest yield, 27.69 bushels, was produced by the plot double disked in July and plowed deep in August. The lowest yield, 22.38 bushels, was produced on the plot disked at seeding time. These results are in accord with those secured in previous years.

Crop Experiments. In the investigations in small grain improvement, tests were made with over 940 varieties and head selections, of which 65 were in 1/40-acre plots, 124 in .002-acre plots, 137 in .001-acre plots and 30 in .0005-acre plots.

There were 1900 plots in all, varying in size from head rows to 1/40 acre. In addition there were 34 plots used for a rate and date of seeding test with winter wheat, 60 for a test to determine the best method of preparing the land and the best time and rate of seeding oats, and 27 plots to determine the practicability of seeding oats, barley, and wheat in furrows to prevent winterkilling.

Since the soil and climate of Kansas vary widely in different parts of the state, it is not reasonable to expect a single variety of small grain to be best for all sections of the state. Accordingly, a few of the most promising varieties have been included in cooperative tests with farmers in different sections of the state. The strain of wheat which gave best results at Manhattan, yield, quality, and early maturity being considered, was grown in fifteen localities throughout the state. The average yield in comparison with Turkey and the principal local variety was 2.36 and 3.75 bushels, respectively, in favor of the improved strain developed at this station. The highest yield of wheat was secured from seeding 6 to 8 pecks to the acre on September 30. Later seedings showed marked decreases in yield. The two most promising varieties of oats have been increased to procure seed for distribution next year.

In the station's forage crop improvement investigations the main lines of work of the preceding year have been paralleled closely. Following are some of the results secured: Sweet sorghums seeded May 15 at the rate of 18 pounds per acre produced 11.67 tons more silage and 4.57 tons more dry stover than kafir planted on the same date at the rate of 28 pounds per acre. Cowpeas are not adapted for growth in Sudan grass for hay, because the first hay crop is removed in fifty days and at that time the cowpeas have not had time to make sufficient growth to be worth harvesting. It has been found advisable to save the first crop of Sudan grass hay for seed, if a seed crop is desired, as chinch-bug injury is greater later in the season. Sudan grass is a much heavier-yielding crop for coarse hay than kafir, millet, or the legumes, and is superior to sweet sorghum because of its finer stems and greater proportion of leaves. Sudan grass planted in 7-inch to 10-inch drills produced three cuttings, which yielded 4½ tons, 3 tons, and ¾ tons, respectively, or a total of 8¼ tons of field-cured hay per acre. Kafir in adjoining plots yielded 6.7 tons, millet 4 tons and cowpeas 4 tons of field-cured hay per acre.

Poultry Disease. Fifty autopsies were made on diseased birds sent in from various parts of the state for diagnosis. The principal diseases encountered were roup, white diarrhea, cholera, and contagious epithelioma. Typical cases of roup developed in healthy fowls inoculated with suspension of organisms from thick, furry croupous membranes from the throat of a naturally infected bird. Isolated cultures of roup-producing organisms failed to produce eye lesions in any of the 100 birds inoculated. This study is being continued, to learn, if possible, the relation between "roup" of the diphtheritic and eye type and the so-called "sorehead." To date the evidence seems to indicate that avian diphtheria and sorehead are different manifestations of the same infection.

Cereal Disease Resistance. New and improved methods in culture technique were developed and put into use in the wheat, corn and sorghum smut investigations under way. Spraying of rust spores to cause infection in the field was replaced by a transference of infected plants from the greenhouse, causing centers of infection by which field epidemics may be produced at will among the varieties which are being tested for resistance. This method was devised at this station to meet the climatic conditions of this state. It was discovered that a certain variety of emmer was not attacked by rust, while another variety became slightly infected. Wheat hybrids of the F_1 and F_2 generations of 1913, 1914 and 1915 seed are being tested for their resistance to rust. Rust (*Puccinia graminis tritici*) showed a range of infection varying from 20 to 85 percent in winter wheats and 0 to 35 percent in spring varieties. Notes on 119 Kansas winter wheats showed 5 to 90 percent infection with leaf rust (*Puccinia rubigo-vera, tritici*). Histological studies are under way in an effort to determine the cause of immunity to smut in milo and susceptibility to it in the other sorghums. Studies are being conducted on the life habits of the smut on maize, and on varietal resistance due to environmental conditions or to specific characteristics in the host.

Hessian Fly Investigations. Considerable data were gathered which extend markedly the knowledge of the life history of the Hessian fly. Six broods were reared in succession in the insectary. The life cycle of these flies averaged about thirty days, although the drouth of the summer delayed emergence

until the last of September. Flaxseeds collected July 4, 1913, gave forth adults as late as October, 1914, or over fifteen months after collection. In Hessian-fly infested areas, wheat planted after the fly-free date gave an average yield of 25 to 30 bushels more grain per acre than wheat planted before that date.

Corn-ear Worm Investigations. It was demonstrated that corn-ear worm injury could be greatly reduced by thorough dusting of the silks with a 63-percent arsenate of lead mixture. The cost, however, is prohibitive except where corn is grown for roasting ears, show purposes, or seed.

Chinch-bug Investigations. A thorough study of the life history of the chinch bug has been made and a vast amount of data collected on all points relating to it. Practical and efficient measures of control have been developed and given a thorough trial under field conditions. Since the life history and methods of control have been thoroughly worked out under Kansas conditions the project has been closed.

Fruit Insect Investigations. As a result of work carried on by the Experiment Station in coöperation with fruit growers of the state, orchards which had previously been conducted at a loss are now producing large profits. Spraying in June with arsenate of lead at the rate of 3 pounds to 50 gallons of water has resulted in very good control of the apple-leaf skeletonizer. Observations made during the past three years indicate the apple aphid to be a common carrier and means of distributing apple blight (*Bacillus amylovorous*). Interesting data have been collected relating to San José scale control through the introduction of insects parasitic on the scale.

Grasshopper Investigations. Poisoned bran mash for the destruction of grasshoppers has been tested under new conditions with good results. Several interesting and apparently very important parasitic enemies of the grasshopper have been discovered.

ADAMS FUND.

The Physiological Effect Upon Work Horses of Alfalfa Hay Cut at Different Stages of Growth. Work on this project was begun in the summer of 1914. The alfalfa used is cut at four stages of growth, in the bud, at one-tenth bloom, in full bloom, and when seeds begin to form. The departments of agronomy, chemistry and animal husbandry are coöperating to determine

(1) the effect upon stand and yield when alfalfa is harvested at these different stages of growth; (2) the variation in the amount of total nutrients and fertility elements in the hay cut at different stages of growth; and (3) the physiological effect upon horses fed the different alfalfa hays. In 1914 the largest yield was obtained from the alfalfa cut at the time of bud formation, and each successive stage gave a smaller yield. No effect on the stand was noticed this first year. The alfalfa cut in the bud stage had the largest percentage of ash and crude protein and the smallest percentage of crude fiber and nitrogen-free extract; the first two decreased in each successive stage, and the last two increased. In 1914 the alfalfa cut in the bud stage not only gave the largest total yield of all nutrients per acre, but per ton this alfalfa contained the greatest amount of the most valuable constituent, protein. The bud stage had the largest percentage of the fertility elements, nitrogen, phosphorus, and potassium, and all these decreased in the successive stages. It was also found that the alfalfa hay cured in the sun had a larger percent of pure protein than that cured in the shade. In feeding these different alfalfa hays to horses no material difference in physiological effect was noticed.

Nutrition Investigations. The fifth series of experiments to determine the deficiencies of corn as a ration for young pigs was completed. It is hoped that another year's work will bring to a conclusion the studies in the use of food with both beef cattle and hogs.

Alfalfa-breeding Experiments. At the beginning of this fiscal year the alfalfa breeding project was relocated on a new tract of land to escape bindweed, which had infested the former field. Sixty-three additional strains or varieties were added to those already under test in the attempt to develop a hardy, drouth-resistant alfalfa.

Corn Mold Investigations. This work has been continued as outlined in the last report. In an effort to determine the toxic fraction, seven fractions have been isolated, purified and tested on guinea pigs, with negative results. The study of the distribution of the nitrogen-containing substances as obtained by the use of various solvents and the various methods of precipitation of alkaloids, proteins and toxalbumins has been

nearly completed. Studies in the minute histology of the softened areas and further tests with isolated fractions are in progress. A few *post mortems* have been held in the field. Corn was procured from two of these places and is being fed to horses under observation.

Chinch-bug Egg Parasite Investigations. The life histories of approximately 4500 individual parasites were worked out during the year and a vast amount of data collected. Special methods of technique were developed by which it was possible

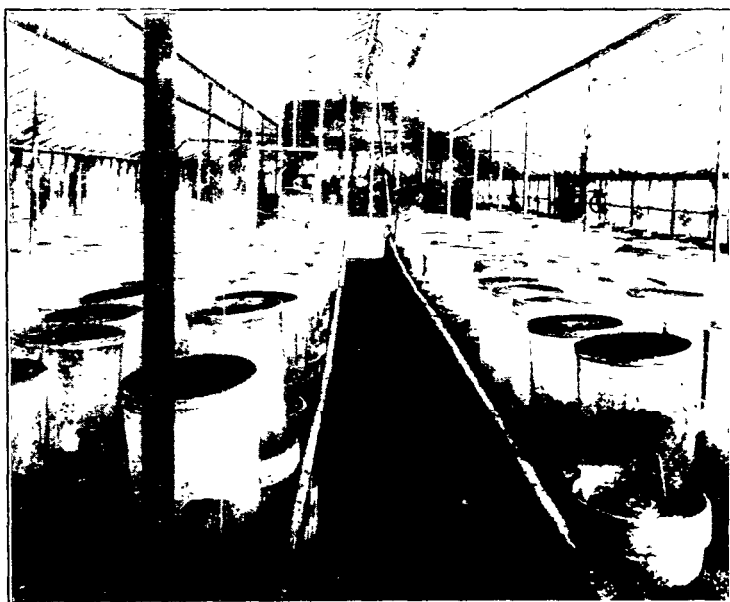


FIG. II. Insectary for inheritance investigations in Orthoptera.

to study the stages of the parasite within the host egg. Nine broods were reared during the summer. It has been determined that low temperatures prolong adult life of the chinch-bug egg parasite from five to as high as seventy-eight days and the life cycle from sixteen to forty-two days. Temperatures of 42° F. to 55° F. retard larval development.

Climate and Injurious Insect Investigations. The installation of the air-conditioning apparatus has been completed, and studies with completely analyzed forms are in progress under various controlled conditions of temperature and moisture, to determine the influence of temperature and moisture on germinal and somatic modification.



FIG. III. The Shorthorn cows used in the investigations in sex type as related to function.

Breeding Investigations. The air-conditioning apparatus has made possible the production of five instead of four generations of pedigreed *Paratettix bolivar* per year. Several new types have been analyzed and two new unit characters found.

Parasitological Investigations. The findings of other investigators, which show that the fowl nematode *Heterakis perspicillum*, may be transmitted by the dung earthworm *Helodrilus parvis*, have been confirmed by this station. Experiments indicate that this transmission is due to association rather than parasitism. It has been discovered that cottontails and jackrabbits infested with tapeworm cysts may be fed to fowls without danger of transmitting the tapeworms.

Sex Type as Related to Functional Development and Performance. This experiment has just been inaugurated and will be financed coöperatively by the United States Department of Agriculture and the State Experiment Station. The object of the experiment is to determine the relation of beef and dairy type in the parent to breeding performance and the transmission of beef characteristics. Twenty cows from the leading Shorthorn herds of the country have been purchased for use in this experiment, being selected on a basis of breeding performance.



FIG IV. Matchless Dale, the Shorthorn bull used in the investigations in sex type as related to function.

STATE FUND.

Inheritance Investigation in Swine. A six-year project in the investigation of heredity in swine was instituted by the animal husbandry department. The animals used are Duroc-Jersey sows and a Berkshire boar, and records on the transmission of the following characters are being taken: (1) The dished face; (2) the number and pattern of nipples; (3) fertility; (4) meat type as related to sex; and (5) size and growth. Incidentally it is planned to study the cumulative effect of ancestry in relation to the transmission of characters as measured by color, weight, and size of bone.

Silage for Beef Cattle Investigation. The silage feeding tests begun in 1912 and reported upon last year are still in progress. Silages made from corn, kafir, and sorghum are being compared and the relative value of ground corn, ground kafir, and hominy feed as a grain ration, in connection with cottonseed meal and sorghum silage, is being studied. The following conclusions have been drawn: The full feeding of cattle should be limited to those farms on which a surplus of corn or kafir is grown, the cattle being used as a means of marketing the farm products. Stockers should be used for the same purpose where an abundance of roughage but little grain is produced. The best crop to grow for silage is the one which will produce the largest tonnage to the acre. This, of course, varies with the soil and climate.

Experiments in Dairy Cattle Feeding. It has been observed that cattle apparently obtain nothing of the value of the grain of kafir or the sorghums when present in silage. An investigation was initiated, therefore, to determine the comparative value of silage made from (1) kafir heads and butts; (2) kafir butts only, the grain from the same being ground and fed to the animals separately; and (3) kafir butts alone, no grain being fed. Similar work is under way to determine the value of silage made from corn with and without the grain. One test has been completed and a second test is being prosecuted. Some progress of a preliminary nature has been made in the study of the production of silage from green alfalfa. Alfalfa cut at four different stages, namely, (1) Bud formation; (2) one-tenth bloom; (3) full bloom; and (4) seed formation, was successfully preserved in the laboratory. The bud stage gave the poorest silage. There was no material difference between

the other stages. All made good silage except where there was too much water present. Fig. V shows the method of handling the alfalfa. The presence of corn chop and molasses favors the production of good silage, but does not seem to be absolutely essential, provided the silage can be very tightly packed and no air admitted later—two conditions hard to realize under field conditions. It has been demonstrated that the principal agents of fermentation are microorganisms and not the enzymes of tissue cells as has been advocated by previous investigators. A great deal of information has been collected relating to the microbial flora of silage produced from various crops and the relative importance of the various organisms found.

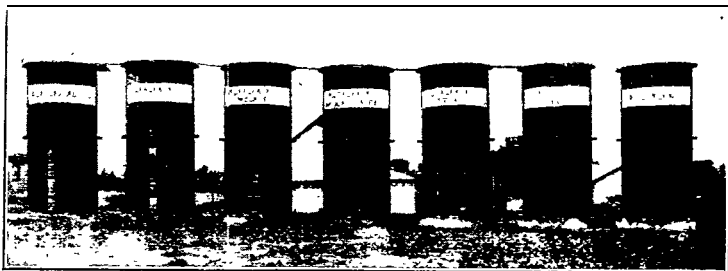


FIG. V. Alfalfa silage experiment.

It has been determined that there is no appreciable difference between the quality of silage as affected by temperature in silos constructed of various materials, such as metal, concrete and wood. Investigations concerning the weight of silage show that figures commonly used in estimating the contents of silos give too great a capacity.

Physiological Investigations with Drouth-resistant Plants. Work in the development of drouth-resistant strains of corn has been continued. There are now thirty-two third-generation strains that have segregated from Hybrid 58, which thus far has proved to be the most drouth-resistant of all tested corn. Additional crosses have been made with corn brought from South America by the Department of Agriculture and reported to be drouth-resistant. In a test at the Garden City Branch Station to determine the weight of water required to make a pound of dry matter, Hybrid 58 proved more efficient than Sherrod's White Dent or Pride of Saline, both of which

are standard western white dent corns, and one of which (Sherrod's) forms part of the ancestry of the cross.

In investigations at Garden City to ascertain some of the fundamental differences in the water relations of plants, the water requirement has been determined for dwarf milo, standard kafir, and several varieties of corn, and has been found to be 319, 305 and 364, respectively, for these three plants. Field studies of the root systems of these plants have shown them to be practically the same in extent and in the number of primary roots, but the number of secondary roots per unit of length has been found to be twice as great for the sorghums as for corn. The ratio of the weight of leaves and stems to the weight of root system was found to be 9.6 for milo, 10.9 for kafir, and 9.6 for corn. The leaf area has also been determined for these plants at four stages of their growth. Some progress has been made in the study of relative transpiration and in the daily variation of the dry matter and moisture content of the leaves.

Milling Industry Investigations. During the year complete milling and baking tests, with chemical analyses of wheat flour and feed, have been completed for eighty-one samples of wheat from the 1913 crop. Similar tests are in progress with seventy-five samples from the 1914 crop.

Investigation on Staple Crop Insects of Southern Kansas. In the spring of 1914 a project to determine the life history, economy and control of staple-crop insects in the southern counties of Kansas was instituted. Special attention was given to the kafir and maize bill-bug. This work is demonstrational as well as investigational, and is conducted in coöperation with the county demonstration agents of the district. The life history of the maize bill-bug was worked out in the laboratory and in the field. From the data at hand it appears that the bill-bug can readily be controlled by rotation of crops. A large amount of data was also obtained with reference to the life economy of the kafir ant in the field.

Fruit Bud Formation. A study is in progress to determine variations in the production of fruit buds on trees propagated from parent stock of tested productiveness and quality and trees from scions with several generations of vegetative propagation intervening between their growth and fruiting trees.

Small Fruits and Garden Crops. About 1200 plants of vegetables and fruits are growing in the trial garden plot. A great deal of information as to hardiness and adaptability of varieties, comparative yields, effect of commercial fertilizers upon growth and yield, and effect of spraying for the control of insects, is being accumulated. Methods of trellising tomatoes have been developed which will give material assistance to the intensive tomato grower.

Potato Investigations. The past year's work with potatoes emphasizes the value of the rotations recommended by the station in previous years. A cultivated crop intervening between alfalfa and potatoes seems to be best for the Kaw valley. Corn has proved to be one of the most desirable crops to use in rotation with alfalfa and potatoes, also with melons and sweet potatoes on sandy soil.

The Improvement and Conservation of Farm Poultry. October 1 will bring to a close the second year's work in the improvement of farm poultry through the use of standard-bred males from high egg-producing strains in grading up mongrel flocks. The first year's egg record of the first cross-generation will be complete October 1. The second cross-generation of offspring is over two months old at the close of the fiscal year, June 30. It will be impossible to draw definite conclusions concerning the results of this work for at least two more years, but the progress of the project to date is very gratifying.

Changes in Composition of Soils by Cropping and Treatment. The object of this experiment has been to study the income and outgo of elements essential in plant nutrition which are likely to be deficient in cultivated soils. Last year 26 samples were taken from the soil-fertility plots and analyzed. This spring 116 samples were taken from the soil-fertility plots and 40 samples from the seedbed-preparation plots. These samples are being analyzed for carbon and nitrogen.

Injurious Mammal Investigations. The principal work of the year has been the preparation and distribution of poison and directions for its use in the destruction and control of the prairie dog, gopher and other injurious mammals.

Blackleg Investigations. A blackleg serum produced at moderate cost has given 100 percent protection in infected herds. It was used on over one thousand animals and stopped

losses due to both natural infection and vaccination with pill vaccine. A germ-free blackleg vaccine, formerly a by-product of the regular vaccine, has given absolute protection on all animals against a fatal dose of blackleg infection. This will be a most practical vaccine for the protection of purebred animals. During the year 79,090 doses of single blackleg vaccine and 64,940 doses of double blackleg vaccine were prepared and distributed by the station. This vaccine was standardized and conformed with the government requirements.

Methods of Marketing Wheat. By means of personal visits made to the principal terminal wheat markets in the state, and through questionnaires sent to farmers, grain dealers, and flour millers, the question of marketing wheat was studied from the viewpoint of the farmer, grain dealer, and flour miller, in an effort to determine how the farmer may secure a better price and make a larger profit on his wheat. It has been concluded that the farmer could doubtless secure a greater profit from his wheat operations if he would (1) produce a better product, without at the same time increasing the cost prohibitively; (2) lengthen the marketing period, or (3) secure full competitive market price at the local market. Storage methods on the farm and farm credit are the two factors which regulate the lengthening of the marketing period.

Sheep-feeding Experiment. A sixty-day feeding experiment to determine methods of utilizing forage and other roughage abundant on the average Kansas farm was undertaken in October, 1914. A double-deck load of western range lambs (313 in number) averaging 54 pounds each, was purchased on the Kansas City market at a cost of \$7.30 per cwt. laid down at Manhattan. Ten days after purchase these lambs were divided into six lots, and an experiment begun to determine the comparative value (1) of corn and kafir as grain, (2) of alfalfa and cowpea hay as roughage, (3) of sorghum as silage or hay, and (4) of ground versus unground kafir. The lambs were fed so as to make a maximum use of the roughage. Cottonseed meal was fed equally in all lots. The table on the following page gives the results of this experiment.

LAMB-FEEDING EXPERIMENT.
October 30, 1914, to December 20, 1914.

RACTIONS.	Lot 1. Shelled corn. C. S. meal. Alfalfa hay. Silage.	Lot 2. Shelled corn. C. S. meal. Cowpea hay. Silage.	Lot 3. Shelled corn. C. S. meal. Alfalfa hay. Sorghum hay.	Lot 4. Shelled corn. C. S. meal. Alfalfa hay.	Lot 5. Kafir. C. S. meal. Alfalfa hay. Silage.	Lot 6. Ground kafir. C. S. meal. Alfalfa hay. Silage.
No. lambs in lot.....	50	50	50	50	50	50
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Average initial weight.....	56.7	55.9	56.6	56.7	55.4	57.5
Average final weight.....	80.9	77.3	80.4	80.4	76.6	79.1
Average total gain; 60 days.....	24.2	21.4	23.8	23.7	21.2	21.6
Average daily gain.....	.4	.35	.39	.39	.35	.36
Average daily ration:						
Grain.....	.89	.90	.9	.9	.9	.9
Cottonseed meal.....	.19	.19	.19	.19	.19	.19
Alfalfa hay.....	1.35	-----	1.36	1.78	1.36	1.36
Other hay.....	-----	1.53	.43	-----	-----	-----
Sweet sorghum silage.....	1.09	1.09	-----	-----	1.09	1.09
Feed for 100 lbs. gain:						
Grain.....	222.13	252.90	227.25	228.01	254.4	250
Cottonseed meal.....	46.86	53.45	48.01	48.17	53.75	52.8
Alfalfa hay.....	335.58	-----	344.77	450.96	335.01	378.36
Other hay.....	-----	431.57	110.53	-----	-----	-----
Sweet sorghum silage.....	271.11	307.06	-----	-----	398.76	303.43
Cost of 100 lbs. gain.....	\$5.60	\$6.19	\$5.52	\$5.73	\$6.03	\$6.18
Cost of total feed.....	1.35	1.32	1.31	1.35	1.28	1.33
Initial cwt. value.....	7.30	7.30	7.30	7.30	7.30	7.30
Final cwt. value.....	8.05	8.05	8.00	7.90	7.90	8.05
Av. initial value of lamb.....	4.14	4.03	4.13	4.14	4.01	4.20
Average final value of lamb.....	6.51	6.22	6.43	6.35	6.05	6.37
Average profit on lamb.....	1.02	.82	.99	.86	.73	.84

Price of grain per cwt.: Shelled corn, \$1.25; kafir, \$1.10; ground kafir, \$1.20; cottonseed meal, \$1.30.

Price of roughage per ton: Alfalfa hay, \$10; cowpea hay, \$8; sorghum hay, \$6; sweet sorghum silage, \$4.

Price of lambs per cwt.: The initial value is 60 cents per cwt. higher than the market cost to cover expense of shipping lambs to the feed lot; the final value is 60 cents lower than market price to cover expense of shipping them to market.

The combination of shelled corn, cottonseed meal and silage resulted in the most rapid gains, the lowest cost of production, and the greatest profit. Cowpea hay can be substituted for alfalfa in those sections of the state where it is advisable to grow it. The lambs which received alfalfa hay without silage did not give us satisfactory returns in any way as those where silage was made a part of the ration. There was no advantage gained by grinding kafir.

Sheep raising has proved to be an extremely profitable industry in those sections of the state adapted to the growing of grass and other roughage. Sheep require more fencing and more care and better housing facilities than do cattle under similar conditions. Where sheep are handled as one of the main sources of income it is necessary that the unit be large enough to utilize labor economically. A small flock on the farm can usually be maintained with comparatively little expense for feeds and with labor that would otherwise be considered of little or no value.

OTHER WORK.

Besides the regular work of investigation, during the year the Experiment Station staff accomplished control and demonstration work as outlined below.

CONTROL WORK.

Pure Seed Control. The farmers and seed dealers of the state have continued to show their appreciation of the work being done through the seed-testing laboratory of the institution. During the year 1314 samples of seed were received, each one of which was tested in duplicate and reported upon for purity and germination.

Fertilizer Control. Ninety-one samples of fertilizers were analyzed during the year in connection with the enforcement of the fertilizer law. Inspection Circular No. 1 of the station reports the results of this work.

State Dairy Commission. Reports received indicated a 20 percent shortage in butter and ice cream manufactured from Kansas cream for the fiscal year. Practically every creamery showed an increased production over any previous year when the last six months of the fiscal year only are considered. The greatest shortage occurred during the months of September, October and November. Poor native pastures and an almost total lack of wheat pasture were probably responsible for the butter shortage, while the light consumption of ice cream was due to the exceedingly cool spring and early summer. During the year 55 examinations for cream-station operator permits were held in the state, 13 in Manhattan and 42 at various other points. In all, temporary examinations were given to 824 applicants and final examinations to 1206 applicants. One hundred sixty-nine dairy farms and one cheese factory were inspected and scored. Including some necessary duplicate visits, 1281 towns were visited. One hundred eighteen cream stations were closed by the commission pending improved sanitary conditions. Two permits were permanently canceled and two prosecutions instigated, both being won by the state.

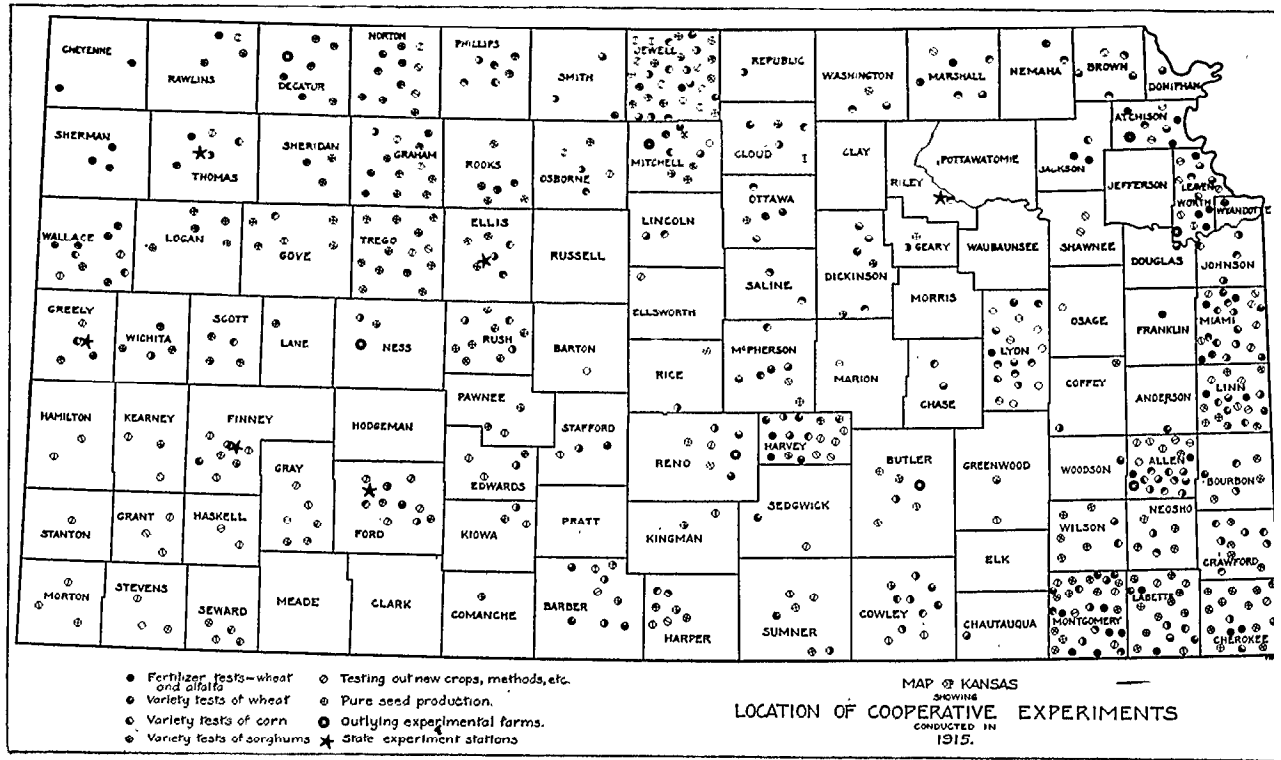
Practically one month's time was given to farmers' institute work and the attending of association meetings outside of the state where papers on cream grading were delivered. Five circulars and announcements were prepared and distributed. During the year the department coöperated with the food and

health departments of five cities. New work was taken up by the department, the object of which was (1) to unify and advance the grading work by adoption of grading cards, (2) to increase accuracy in sampling and testing through requiring operators to hold samples after testing, and (3) to eliminate all possible losses in the dairy industry. One important step has been to enforce rigidly the non-can-loaning law. At a conservative estimate, the enforcement of this law for this past year has saved to the dairymen of the state \$20,000.

The outlook for the dairy industry is exceedingly bright in Kansas. Never was there so great a demand for good cows. This, combined with the abundance of ideal dairy feeds, should make a decided increase in dairy products during this and the following years.

Livestock Feed and Remedy Control. Under the livestock remedy law and the feeding-stuffs law, 514 towns were visited by inspectors during the fiscal year 1914-1915. A total of 2403 inspections were made of places where either livestock remedies or feeds were manufactured or offered for sale. Twelve hundred thirty-five samples were collected and analyzed. Two prosecutions were made under the feeding-stuffs law and one under the livestock-remedy law. The work of this department is supported by registration fees and the sale of revenue stamps.

State Livestock Registry Board. During the year covered by this report the State Livestock Registry Board issued 5464 stallion licenses, classified as follows: purebred, 3052 (55.8 percent); grade, 1289 (23.6 percent); scrub, 1123 (20.6 percent). There were 3 fewer purebreds and 112 fewer grades and scrubs licensed in 1915 than in 1914. There were 40 percent more grades and scrubs than purebred licenses issued during 1910, while during 1915, 21 percent more purebred than grade and scrub licenses were issued. A great benefit that has come from the operation of the stallion license law has been the almost complete elimination of the dishonest stallion peddler. Records of the registry board for 1910 show 301 grade and scrub stallions that had been sold to unsuspecting purchasers as purebreds at prices ranging from \$600 to \$4200 each. Only ten instances have been reported where such sales were attempted in 1915, and in each case the purchaser was protected in his purchase by the stallion license law.



- Fertilizer tests—wheat and alfalfa
- Variety tests of wheat
- Variety tests of corn
- Variety tests of sorghums
- Testing out new crops, methods, etc.
- Pure seed production.
- Outlying experimental farms.
- ★ State experiment stations

FIG. VI. The extent of the cooperative experimental work in Kansas.

COÖPERATIVE EXPERIMENTS AND SEED DISTRIBUTION.

Soil and climatic conditions vary greatly in Kansas. For this reason it is necessary to conduct investigations on the varying soil types in all parts of the state in order to obtain information regarding the fertility and tillage requirements of the various soil types and crop adaptations throughout the state. This work has been in progress since 1911.

In 1915 the agronomy department cooperated with farmers in 99 counties in conducting the following experiments: 152 variety tests of corn; 72 variety tests of grain and forage sorghums; 56 variety tests of wheat; 6 date of seeding tests of wheat; 40 fertilizer tests with wheat, oats, corn, and alfalfa; 8 outlying experimental farms, which included fertility and rotation projects; 91 miscellaneous tests in crop production; and 137 tests in which improved varieties of crops were grown for the production of seed for increase planting. Fig. VI shows the extent of the coöperative improvement work carried on with farmers in the state in 1915. One of the outstanding benefits resulting from this work is the importance of home-grown varieties of corn over introduced varieties. An average of forty tests, extending over a period of seven years, shows a difference in yield of 6.47 bushels to the acre in favor of home-grown seed. A thousand bushels of improved high-yielding seed wheat from the Manhattan station have been sold and distributed to the farmers this year. In addition to this, over 100,000 bushels of seed grain of the various crops have been listed and sent to inquirers for seed for planting.

DEMONSTRATIONS.

Dairy. The institution maintains a herd of more than fifty cows in milk, in which the four principal dairy breeds, Jersey, Guernsey, Ayrshire, and Holstein-Friesian, are represented. The herd is used for class work in judging and for feeding and breeding investigations. During the past five years the average production of the entire herd has been increased from 260 pounds to 498 pounds of butter in a year. One Holstein cow has produced 19,600 pounds of milk and 837 pounds of butter; a Jersey has produced 14,600 pounds of milk and 765 pounds of butter; an Ayrshire has produced 14,700 pounds of milk and 683 pounds of butter; a Guernsey has produced 9990 pounds of milk and 613 pounds of butter in a year. A creamery

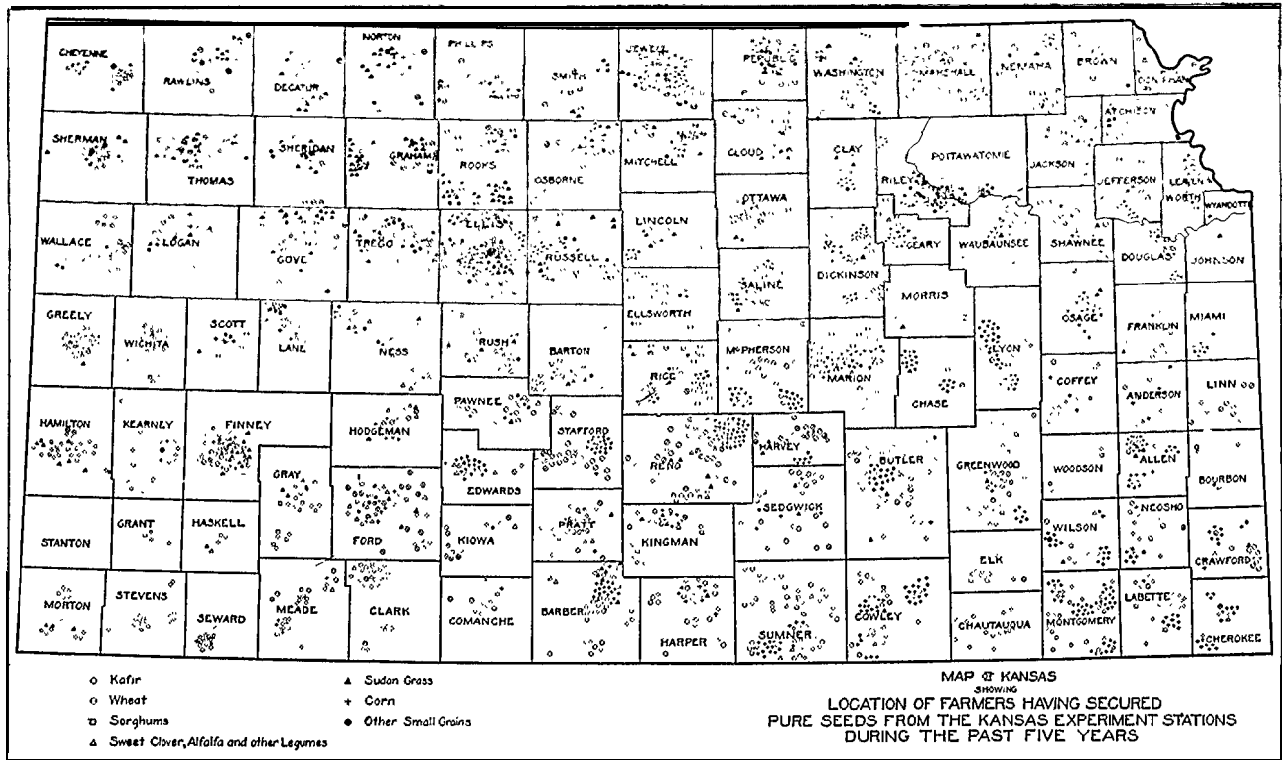


FIG. VII. Pure seed distribution in Kansas by the Experiment Station.
 Saccharine sorghums, 1064 bu.; nonsaccharine sorghums, 2599 bu.; Sudan grass, 36 bu.; winter wheat, 3027 bu.; oats, 468 bu.; corn, 744 bu.; alfalfa, 17 bu. Total, 7955 bu.

is maintained which makes two thousand pounds of butter a month and is used as a medium for marketing the products of the dairy herd. The creamery is also used for giving instruction and conducting investigational work along commercial dairy lines.

The Dickinson County Cow Testing Association, organized by the dairy department in 1913, is now in its third year, and has proved of immense value in helping the dairymen of this county. It has attracted the attention of the entire state, with the result that more such associations will undoubtedly be formed. The dairy department is also answering a great number of calls to conduct advanced registry tests of purebred dairy stock in the state. This is an indication of the growth and demand for better dairy cattle.

Entomology. The station entomologist has continued his work as a member of the State Entomological Commission. The funds (\$2500) available for his use during the year were expended in the control of San José scale. The Experiment Station, the extension division of the college, and the Santa Fe Railway Company operated a special train for five days in June, 1915, just prior to harvest for the purpose of disseminating information regarding Hessian fly injury and control. This train, known as the "Hessian fly special," operated over the Santa Fe lines in southern Kansas, the hotbed of Hessian fly infestation. This was the first exclusively entomological train ever run. Sixty-two stops were made during the five days. Seven thousand persons met the train and received instruction regarding control methods, which was given by means of lectures and a vast amount of exhibition material in the nature of specimen cases and charts. Station circulars and other published matter on the Hessian fly and on seedbed preparation for wheat were distributed.

Horticulture: The past year's horticultural demonstration work carried on by the station was similar to that covered by the 1913 report. An increasing amount of time is required each year for aid in the planning and improvement of grounds of schoolhouses, courthouses, and other public buildings. Communities which are developing park areas, and private individuals starting new orchards or attempting to secure better results from established ones, have also sought advice and assistance from the department. Aid given communities in

securing a better grade of seed potatoes has resulted in an appreciable decrease in loss by disease.

Veterinary. During the year 2,920,300 cc. of anti-hog-cholera serum were sent out from the station's laboratories. The hog-cholera eradication work in Silver Lake township was continued during the year with very gratifying results. The number of farms visited was increased considerably, and during the year approximately 6000 hogs were vaccinated, with a loss of about 1 percent in well herds. There were only two or three slight outbreaks of cholera in the district during the year. The farmers are well pleased with the work that has been accomplished and are very anxious to continue the project.

Complying with the request of farmers and business men of Marshall county, the Bureau of Animal Industry of the Department of Agriculture, coöperating with the Kansas Experiment Station and the State Livestock Sanitary Commission, organized the county through educational meetings and demonstrations. In less than two years this county, which produced 101,207 hogs in 1915, has been practically freed from hog cholera. The annual loss from this disease in the three preceding years was 6 percent in 1912, 10 percent in 1913, and 5 percent in 1914.

MISCELLANEOUS MEANS OF DISSEMINATING AGRICULTURAL INFORMATION.

Forty thousand copies of station bulletins and circulars were mailed during the year in response to miscellaneous requests received. This was in addition to the publications supplied to the twenty thousand persons whose names appear on the regular mailing lists. Thirty-eight thousand letters were written by members of the station staff, giving advice and information on every conceivable phase of agriculture in reply to inquiries received from farmers. Between seven and eight hundred days of the time of the staff members were occupied in field work in compliance with requests for speakers at various farmers' institutes, association meetings, and livestock conventions, as well as for judges at fairs, and for personal assistance in landscape gardening, farm management, and similar activities.

Branch Stations of the Kansas Agricultural Experiment Station.

The five branch stations discussed in the 1913 report have continued in operation. No radical changes in the plan of their work have been made during the year. The Department of Agriculture has continued to coöperate in conducting investigations in dry-land agriculture at the Fort Hays, Garden City and Colby stations; irrigation investigations at Garden City, and cereal and forage crop investigations at Fort Hays.



FIG. VIII. Sudan grass planted in rows for seed production, Fort Hays Branch Station.

FORT HAYS BRANCH EXPERIMENT STATION.

The work in progress at this station may be classed as follows: (1) Commercial farming; (2) dry-land agricultural investigations; (3) cereal crop investigations; (4) forage crop investigations; (5) forest nursery; (6) demonstration dairy farm; (7) public park and forestry; (8) livestock breeding and feeding; and (9) tenant farm management.

Cattle. Approximately 400 head of high-grade Hereford, Shorthorn, Aberdeen-Angus and Galloway cows are maintained at this station. Their primary function is to furnish a

market for the by-products of grain farming, such as wheat straw, kafir butts, corn stover and the low-grade and damaged alfalfa that is produced. A portion of these cattle are used for experimental work. During the winter of 1914-1915, 100 yearling heifers were wintered in four different lots to determine the comparative value of Sudan hay, kafir stover, damaged alfalfa, and sorghum butts. All of these feeds proved to be satisfactory roughages when fed in connection with a limited amount of linseed meal as a source of protein. These animals had access to wheat straw at all times. The data secured in this test are presented in tabular form.

FORAGE-TEST WITH LONG YEARLING HEIFERS.

120-day period—December 17 to April 15.

	Lot 3, 25 heifers.	Lot 4, 25 heifers.	Lot 5, 25 heifers.	Lot 6, 25 heifers.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Birth weight	15,520	16,265	16,525	16,390
Close weight	17,530	18,330	18,500	18,410
Gain per lot	2,010	2,065	1,975	2,020
Gain per head	80.4	82.6	79	80.8
Average gain per day per head .....	.67	.688	.658	.673
Total feed consumed:	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Silage	30,000	30,000	30,000	30,000
Sudan hay	22,620	38,660	.....	10,930
Kafir stover .....	.....	.....	24,520	.....
Alfalfa .....	.....	.....	.....	19,780
Cane stover .....	.....	.....	.....	.....
Straw	7,920	11,330	9,310	7,800
Linseed meal	3,090	3,000	3,000	3,000
Total value feed consumed	\$149.73	\$152.02	\$167.00	\$150.15
Labor cost per lot	21.16	21.16	21.16	21.16
Cost per lot—120-day period	170.89	173.18	188.25	171.31
Cost per head—120-day period	6.84	6.93	7.53	6.85
Cost per head per day .....	.057	.0577	.0628	.057
Feed values:				
Silage	\$3.00 per ton.			
Alfalfa	6.00 per ton.			
Kafir stover	3.00 per ton.			
Sudan hay	5.00 per ton.			
		Feed values:		
		Straw	\$0.50 per ton.	
		Linseed meal	1.54 per cwt.	
		Cane stover	3.00 per ton.	

The sixty-four mature beef cows in the experiment to determine economical methods of wintering breeding stock are still under test. (Tabular report of first year's work is made in 1913 Report.) These animals were wintered on kafir silage, kafir butts, wheat straw, and alfalfa hay, supplemented with linseed and cottonseed cake in 1914-1915. Information on the effect of cottonseed cake on abortions was desired. They furnished a market for \$367.36 worth of feed which would otherwise have had no commercial value. The average cost for wintering these animals was \$8.36 per head. The cows

were wintered on the open range at a cost of \$8.84 for feed and labor as compared with \$8.23 for similar cattle which had access to an open shed and dry lot.

WINTERING BEEF CATTLE.
120-day period—December 16 to April 14.

	Dry Lot 7. 25 cows.	Dry Lot 8. 25 cows.	Range fed, 14 cows.
Initial weight.....	<i>Pounds.</i> 26,865	<i>Pounds.</i> 26,860	<i>Pounds.</i> 17,300
Closing weight.....	28,310	26,000	16,840
Difference in weight.....	1,445*	860†	460
No. calves born per lot.....	10	15	6
Weight of calves.....	1,600	1,500	750
Total feed consumed:	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Silage, \$3 per ton.....	44,070	45,900	24,580
Kafr fodder, \$3 per ton.....	11,495	12,865	7,375
Wheat straw, \$9.50 per ton.....	14,330	13,730	5,230
Alfalfa, \$6 per ton.....	17,165	17,110	12,270
Linseed meal, \$1.54 per cwt.....	2,983		1,649
Cotton cake, \$1.39 per cwt.....		2,979	
Total value of feed.....	\$184 36	\$184 31	\$111 43
Total amount feed per animal:	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Silage.....	1,762	1,836	1,756
Kafr fodder.....	460	515	327
Wheat straw.....	573	549	374
Alfalfa.....	687	684	576
Linseed meal.....	119		118
Cotton cake.....		119	
Total value of feed per animal.....	\$7.374	\$7 37	\$7 96
Labor value per animal, 120 days.....	.864	.864	.88
Cost per animal (labor and feed),.....	\$ 8 238	\$ 8 234	\$ 8 84
Number of cows aborting.....	1		2

*Gain, +loss.

NOTE.—Five cows had not calved in Lot 7. In Lot 8 there were four more to calve, one cow in Lot 8 had twins. In the range lot two more were to calve.

Sixty high-grade Hereford heifer calves were placed in the experimental lots in the fall of 1913. They were divided into two groups as nearly equal in every respect as possible. One of these lots was fed in order to produce maximum growth, the other maintained in ordinary range condition. At the close of the second year's feeding it was found that there was a difference of fifty-three pounds in the average weight of the heifers that had been range-wintered as compared with those that had been wintered under more nearly ideal conditions. The average cost of getting this additional growth was \$6.97 per head. As this is a fundamental problem in the development of a breeding herd, it is possible that the excessive cost of developing cattle may be justified in the kind of calves they will produce.

GRAIN SORGHUMS FOR PORK PRODUCTION

November 21 to February 2.

RATION.	Lot 1. Ground kafir, 65% Shorts, 30% Tankage, 5%.	Lot 2. Ground feterita, 65% Shorts, 30% Tankage, 5%.	Lot 3. Ground milo, 65% Shorts, 30% Tankage, 5%.	Lot 4. Ground kaoliang, 65% Shorts, 30% Tankage, 5%.	Lot 5. Ground corn, 65% Shorts, 30% Tankage, 5%.	Lot 6. Whole kafir, with shorts and Tankage as in Lot 1.	Lot 7. Kafir head-, with shorts and Tankage as in Lot 1.	Lot 8. Ground kafir, 50% Shorts, 50%.
Average initial weight	Pounds. 140	Pounds. 139	Pounds. 139	Pounds. 140	Pounds. 140	Pounds. 141 8	Pounds. 144	Pounds. 152 5
Average final weight	211	210	245	237	248	230	239	245
Average total gain	104	101	106	97	108	85 2	95	92 5
Average daily gain	1.4	1.36	1.43	1.31	1.46	1.15	1.28	1.25
Total feed consumed per pig:								
Grain	360.7	360.7	360.7	360.7	360.7	416.5	458.5	277.5
Shorts	166.5	166.5	166.5	166.5	166.5	167.9	168.6	277.5
Tankage	27.7	27.7	27.7	27.7	27.7	27.0	28.1	.....
Feed per 100 lbs. gain:								
Grain	346.8	357.1	340.3	371.0	334	488.8	482.6	300
Shorts	160.1	161.8	157	171.6	154.1	197	177.4	300
Tankage	26.6	27.4	26.1	28.6	25.6	32.7	29.5	.....
Cost of 100 lbs. feed	\$1.18	\$1.18	\$1.18	\$1.18	\$1.38	\$1.10	\$0.89	\$1.10
Cost of 100 lbs. gain	6.29	6.48	6.18	6.75	7.13	7.94	6.13	6.60

NOTE.—After the first 45 days, the hogs in lot 4 received a mixture of cane seed containing not more than 5 percent of grain sorghums. All lots had access to alfalfa hay. Prices of feed per cwt.: Tankage, \$2.70; shorts, \$1.10; ground corn, \$1.42; ground kafir, \$1.10; ground feterita, \$1.10; ground milo, \$1.10; ground kaoliang, \$1.10; whole kafir, \$1.10; kafir heads, 70 cents.

Director's Report, 1914-1915.

Hogs. The Fort Hays Branch Station maintains thirty head of high-grade Duroc-Jersey brood sows which produce two litters annually. From this herd from 320 to 375 hogs are marketed each year. These hogs consume the damaged wheat and surplus grain sorghums on the station farm. Feeding tests were conducted at the Fort Hays station from November 21, 1914, to February 2, 1915, to compare the value of the grain sorghums with corn for fattening hogs. The results indicate that corn is slightly superior to any of the grain sorghums, its use resulting in more rapid gains and a higher finish. There was very little difference between the value of kafir, feterita, and milo. Kaoliang did not prove to be very palatable. The feeding of whole threshed kafir resulted in a great waste of feed, while the feeding of kafir in the head proved to be advisable where facilities for grinding it are not present on the farm. The table on the preceding page gives the complete results of this test.

Sheep. The station's flock of sheep has been increased 25 percent and now numbers from 150 to 200 head. These animals are handled under western farm conditions and are fed upon the by-products of the wheat farm.

Dairy. During 1913 a dairy barn and silos were built at this station, and that fall eighteen head of grade Holstein-Friesian cattle were purchased for the farm. A purebred bull of this breed from the Agricultural College heads this herd. An average production of 300 pounds of butter per cow was made the first year the dairy was in operation. Any surplus stock is readily sold in the immediate vicinity. The herd is a demonstration of good dairy management, and also shows the value for milk production of feeds common to western Kansas.

Crop Experiments. Three lines of experimental work with crops are in progress at the Fort Hays station—cereal crops, forage crops, and dry-land agriculture. This year 352 varieties and strains of small-grain crops, 231 varieties and strains of forage crops, and 61 tillage rotation or soil-fertility experiments are under test.

Distribution of Field Seeds and Forest Trees. Nine hundred bushels of improved seed grain were grown and distributed from the station during the fiscal year. Six hundred fifty thousand trees of varieties suitable for planting in western



FIG. IX. Alfalfa planted in rows, Fort Hays Branch Station.

Kansas, and grown in the station's forest nursery, were available for sale and distribution this past spring. Over half a million trees have been distributed since the establishment of this nursery.

GARDEN CITY BRANCH EXPERIMENT STATION.

Climatic Conditions. The growing season of 1914 was a favorable one at the Garden City station. Although the precipitation for the year, January to January, was but 9.7 inches, its distribution and character were such that the various crops matured. Several inches of rain had fallen in the fall of 1913, thus some moisture was stored in the subsoil. The normal rainfall at this station for the six years prior to 1914 was 17.07 inches, and for the eighteen years prior 20.02 inches. There was not so much severe wind during the spring and summer of 1914 as in previous years, but on several occasions the wind velocity averaged more than forty miles per hour for the day, as measured by an eight-foot anemometer. The evaporation, measured from a free water surface, was one inch below the average for the previous six years, being 52.69 inches for the period from April 1 to September 30, inclusive. The maximum temperature recorded was 103° F., which is less than the usual maximum. During the crop season the relative humidity for

the twelve hours, six a. m. to six p.m., was 29 percent, and for the full twenty-four hours was 60 percent.

Irrigation Investigations. Ninety-three plot experiments were conducted, comparing different methods of soil preparation for the four staple crops, wheat, oats, corn, and the sorghums. Twenty-one rotation experiments, comprising 75 plots, in progress the previous year, were continued, and irrigation investigations covering 100 plots were inaugurated and carried through the season. The irrigation investigation plots are comprised of three series, one being devoted to forage crops, one to cereal crops, and the third to miscellaneous crops, such as sugar beets, potatoes and millet. It is the plan of the experiment to irrigate all plots uniformly during the winter season. During the growing season duplicate plots receive no seasonal irrigation. Of those plots which receive seasonal irrigation, one set receives irrigation when the moisture has decreased to 16 percent, another set when the moisture has decreased to 12 percent, and the third set when the moisture has decreased to 8 percent. For the season of 1915 the plan is to irrigate when the soil moisture has been reduced to 20 percent, 16 percent and 12 percent, respectively, on the three duplicate plots of each crop receiving seasonal irrigation, while in each series duplicate plots of each crop will be grown that receive winter irrigation only. The irrigation data for the season proved that in no case did the moisture content drop to 8 percent, hence the third series of plots received no irrigation. Maximum yields were obtained where seasonal irrigation was applied and the moisture maintained at 16 percent. Yields from the plots irrigated at 12 percent were intermediate between the 16 and 8 percent plots. The amount of water applied besides the winter irrigation varied from 3 inches on plots maintained above 12 percent moisture, to 7 inches on plots maintained above 16 percent moisture. The object of the irrigation experiments is to determine the minimum amount of water necessary to produce the maximum crop and the most profitable times to apply water, also to gain information on which to base more detailed experiments.

Dry-land Crop Investigations. A summary of the dry-land work to date indicates that winter and spring wheat, oats, barley and corn are unprofitable crops even when raised in rotation and under the best systems of culture. Sorghums, either

fur forage or grain, have been profitable. Summer fallowing has not proved profitable for the crop following, when an average of the six years' work of the station is taken into consideration. However, it may be that summer fallowing once in three or four years will prove profitable, even though alternating summer fallow is not profitable. The nature of the rainfall has much to do with the tillage methods employed. In order that water may be absorbed readily, the surface of the ground must be kept in a rough and moderately cloddy condition. Summer rainfall of less than an inch evaporates so rapidly that it does very little good to growing crops unless followed immediately by more rain. Records of the station show that with good methods of tillage it is possible to store approximately 25 percent of the rainfall occurring during the tillage period—harvest to spring seeding. Moisture determinations show very little difference in the amount of moisture stored by spring or fall plowing. Summer tillage stores 15 percent of the rainfall occurring from the period of harvest to seeding date. A practical sorghum rotation that will maintain in the soil a proper supply of humus and available nitrogen must be worked out for this section of the state.

Studies in the Drouth-resistance of Plants. Research work is now under way to determine the water requirements and the depth of feeding of the roots of kafir, milo, Freed's sorghum, sumac, Sudan grass, corn and the millet crops planted at three different rates of seeding. It will take several years to gather reliable figures on this work. The results should aid in determining the field water requirements of different crops, the depth of root penetration, and the value of winter irrigation. They should also help to determine the advisability of fallowing for the purpose of storing water in the soil for the succeeding crops.

The botany department of the Experiment Station at Manhattan is carrying on research investigations on the water requirements and root systems of corn and the various sorghum crops. The purpose of this study is to determine why sorghum crops are physiologically drouth-resistant, and thus to form a basis for the development of dry-land crops. A résumé of this work is included under the report of the state fund, page 22.

Demonstration Work. Demonstration plots of twenty-five varieties of sorghums were grown. Of the forage sorghums, red amber, Freed sorghum, Minnesota amber, and an early-maturing strain of orange sorghum, ranked best. Of the grain sorghums, dwarf milo is probably best, feterita ranking second. Of the kafirs grown for both grain and forage, white-hulled white kafir, because of its larger growth, is no doubt the most profitable from the farmers' standpoint though dwarf kafir from the grain standpoint alone is a little surer and yields as good a quality of grain.

Cost of Pumping. The pump in the irrigation well was remodeled from a two-stage to a four-stage pump, which increased its efficiency considerably. During the entire year (if the cost of pumping is based on the actual fuel, oil and repairs used) the cost per acre foot was:

Fuel	\$1.95
Oil .....	.40
Engine repairs .....	.58
Pump repairs	2.63
	\$5.56

The item of pump repairs is a great deal higher than it should be. However, the larger part of this, expense was incurred in the remodeling of the pump from a two-stage to a four-stage pump.

Improvements. No improvements of note were made on the station, with the exception of planting approximately 800 forest trees and the purchase of two metal grain bins having a total capacity of 1000 bushels.

COLBY BRANCH EXPERIMENT STATION.

The work of the Colby Branch Experiment Station was only well started during the last fiscal year. The farm buildings, on the station when it was purchased, have all been remodeled or rebuilt this year, so that they are now suitable for experiment station work. A building formerly used as a granary has been moved to a more desirable location and rebuilt for office and laboratory use. The barn has been remodeled so that it is used both as a horse barn and a dairy barn. A metal-lath cement-plastered silo of 85 tons capacity and a concrete water tank of 110 barrels capacity have been built. Prac-

tically the entire farm has been refenced. Fields have been plotted and different rotations outlined. The irrigation plant has been completed and an engine house built. The wells have been tested to a capacity of 200 gallons per minute, with an ordinary working capacity of about 120 gallons. The irrigation plant will be used to irrigate five acres of orchard, a small field of alfalfa, and to carry on a limited amount of experimental work.

Under a coöperative agreement with the Department of Agriculture, tillage methods and crop rotations are under test on 22 acres of ground. These tests include more than twenty rotations, comprising 160 plots.

During the year eleven different varieties of sorghums were tested, and ten different varieties of corn. The sorghums yielded as follows:

	Bushels grain.	Pounds forage.
Dwarf kafir	26	6,600
Dwarf milo	28	9,200
Feterita	30	11,000
Freed sorghum (estimated).	28	8,800
Sumac sorghum		12,800
Honey sorghum		15,200

Field tests indicated red amber sorghum to be the most satisfactory all-round variety. The yields of corn were as follows:

	Bushels.
Native Bloody Butcher	20
Nebraska Calico	18
Minnesota No. 13	21
Freed's White Dent	21
Ness County White	9
Kansas Sunflower	3
Sherrrod's White Dent	19
Reid's Yellow Dent	5
Pride of Saline	9
Local strain of Iowa Silvermine.	18

The home-grown varieties of corn yielded much better than the varieties which are adapted to eastern Kansas.

About 700 forest trees were planted at the station during the year.

TRIBUNE BRANCH EXPERIMENT STATION.

Satisfactory results were secured in the tillage, rotation and variety testing work, which indicated that the same work in the previous years was reliable and approached an average of results that could be expected from a longer series of years.

A severe local hailstorm destroyed a wheat crop on the station which gave promise of yielding approximately 23 bushels per acre. During the calendar year of 1914 the total precipitation was 16.65 inches, and the following yields of sorghums were secured :

	Bushels of grain.
Freed sorghum	34.4
Dwarf milo	35.7
Standard milo	32.3
White milo	28.27
Feterita	33.66
Dwarf kafir	25.00

Methods which approach summer fallow and allow the storage of considerable moisture in the soil without having the drawbacks of summer fallow—that is, without the loss of one year's crop and without creating favorable conditions for the drifting of soil—are much needed throughout western Kansas and similar territory. As a partial summer fallow, or a method approaching summer fallow, for the past two years the Tribune Station has planted corn in alternate rows, or in rows 84 inches apart instead of the regular width of 42 inches. The entire ground is listed and cultivated the same as though corn were planted in every row. Eight different varieties were planted in 1914, and in every case the wide spacing made more corn to the acre than the regular spacing. The yields were as follows:

	Ordinary spacing, 42 inches.	Double spacing, 84 inches.
Tribune No. 13 (local variety).....	17.46	21.50
T. B. Moore (local variety).....	12.60	13.55
Nebraska Calico	14.00	14.13
Freed's White Dent	11.93	12.45
Pride of Saline	6.88	8.75
Kansas Sunflower	2.18	6.06
Reid's Yellow Dent	3.34	5.72
Ness County White	13.33	14.13

From this test it will be noted that home-grown and western-grown varieties are much better than eastern or central Kansas corn, such as Pride of Saline, Kansas Sunflower, and Reid's Yellow Dent. In this particular the results confirm those at the Colby Branch Station.

During the year a superintendent's cottage was built at the station, at a cost of approximately \$1800.

About 500 forest trees were planted during the year.

DODGE CITY BRANCH EXPERIMENT STATION.

The Dodge City Branch Experiment Station has been handled more as a demonstration farm than as an experiment station. Variety tests of sorghums and corn have been grown, and by newspaper articles and through local farmers' institutes farmers have been invited to inspect these varieties in the field. A high-grade Ayrshire dairy herd is being developed. Purebred Duroc-Jersey hogs are raised, their principal feeds being skim milk and grain grown on the farm. An attempt is being made to operate the station as a practical upland farm for that section of the state. By means of livestock grown at the station the inventory has been increased considerably. During the year \$1283.59 worth of products grown on the farm were sold. The bulk of these products were from the dairy farm, from hogs, and from grains sold for seed purposes. No building improvements were made during the year, except that a water-pressure system was installed in the house.

Seven hundred forest trees were planted at the station during the year.

FINANCIAL STATEMENT.

	Federal appropriations.	State appropriations.	Totals.
Manhattan station	\$30,000.00	\$30,851.10	\$60,851.10
Branch stations		45,467.64	45,467.64
Cooperative experiments		7,925.53	7,925.53
Branch station farm products			22,324.74
			\$136,569 01
Salaries	\$13,975.01	\$21,247.62	\$35,222 63
Labor	8,610 38	35,130 22	43,740 60
Publications	9 70	176 33	186 03
Postage and stationery	142 19	977 94	1,120 13
Fuel, light and express	76 84	1,346 75	1,423 59
Heat, light, water, power	216 00	1,354 09	1,570 09
Chemical, laboratory supplies	832 53	889 74	1,722 27
Seed, plants, sundry supplies	1,003 78	6,140 69	7,144 47
Fertilizers		27 62	27 62
Feeding stuffs	1,595 36	6,324 45	7,919 81
Library	189 16	81 62	270 78
Tool, machinery, appliances	679 04	4,336 76	5,015 80
Scientific apparatus, specimens	1,032 61	411 84	1,504 45
Livestock	600 67	10,099 05	10,699 72
Traveling expenses	366 61	3,435 20	3,801 81
Contingent expenses	36 50	54 76	91 26
Buildings and land	277 47	6,205 95	6,483 42
Furniture and fixtures	295 15	1,237 87	1,533 02
Site fund		1 75	1 75
Balance		7,088 68	7,088 68
Totals	\$30,000 00	\$106,569 01	\$136,569 01

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, 1915; that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been \$30,000, and the corresponding disbursements \$30,000, for all of which proper vouchers are on file and have been by us examined and found correct.

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

E. T. HACKNEY.

E. W. HOCH.

CORA G. LEWIS.

A New Air-conditioning Apparatus.

By GEO. A. DEAN and R.K. NABOURS.

Within the last ten years the influence of moisture and temperature on animal life has received considerable attention. The value and absolute necessity of accumulating data relative to this important phase of entomological and zoological work are self-evident. The difficulty has been to secure an air-conditioning apparatus that would maintain a desired humidity and temperature within a reasonable degree of variation. Different machines and incubators have been devised for this purpose, but as far as the knowledge of the writer extends, they have all proved more or less unsatisfactory.

For several years the departments of entomology and zoology have been building and experimenting with various types of moisture and temperature control apparatus with little success. At the suggestion of Dean Potter, of the engineering division of the college, it was decided to take the matter up with some air-conditioning specialists. After conferring with several companies, a contract was let to the Carrier Air Conditioning Company, Buffalo, N. Y., to construct and install a machine that would automatically condition the air before it entered the breeding chamber, and that would force it into the breeding chamber continuously at a rate causing a complete displacement of the air every minute or oftener.

This machine has been installed for over a year, and it is here proposed merely to present an account of the general arrangement of the apparatus, the principle of operation, some records of the moisture and temperature conditions maintained in the breeding chamber, and some of the experiments for which the machine is used.

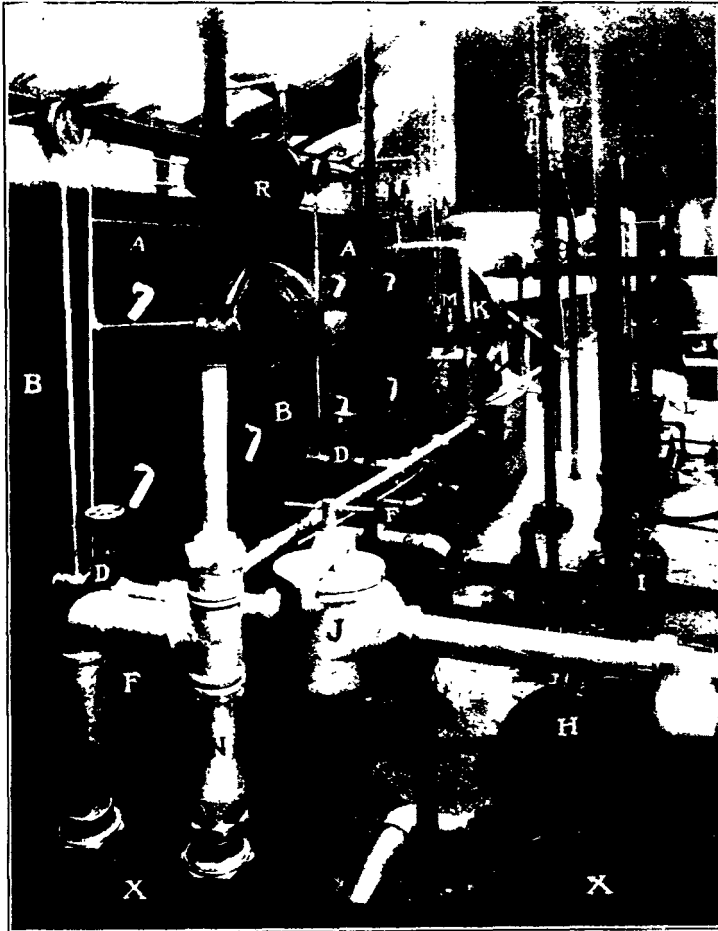


FIG. X. The humidifier and automatic controlling machinery. A, spray chamber; B, nozzle standpipe; C, nozzle standpipe over the eliminators; D, valve for nozzle standpipe; E, water-tight inspection door; F, settling tank; G, overflow pipe; H, double-suction centrifugal pump; I, spiro steam turbine with direct connected suction pump; J, pot strainer; K, suction fan; L, spiro steam turbine; M, graduated thermostat; N, ejector water heater; O, direct-acting diaphragm valve; Q, compressed-air storage tank; R, reverse-acting diaphragm valve; S, safety relay; T, tempering or heating chamber; X, air duct leading from breeding chamber to spraying chamber; Z, automatic lubricator.

The spray chamber shown at A (Fig. X) is nine feet long, and is provided with nozzle standpipes (B) arranged in two groups or banks, placed about three feet apart, with the last bank three feet from the eliminator plates. The eliminators are flooded by an independent set of nozzles shown at C across the top. These nozzles distribute the water over the washing

surface uniformly. Valves shown at *D*, outside of the spray chamber, are provided on each bank of nozzles and also on the flooding nozzles over the washing surface, and thus either or both banks of nozzles can be closed to regulate the humidity. With both banks of nozzles closed, no appreciable increase in the humidity of the air is produced. With one bank in operation (and the water recirculated without being heated) the humidity of the air will be increased about 60 percent. With both banks of nozzles in operation the humidity is increased about 80 percent. If the water is heated the air leaves the conditioner saturated. The banks of sprays can be opened or closed and the temperature of the water also varied as required.

Two water-tight inspection doors shown at *E* (Fig. X) are provided to allow easy access to the spray chamber. Beneath the entire washer and eliminator is a settling tank (*F*) 16 inches in height. A strong frame, built of angle iron, incloses the settling tank, to which it is firmly united, making a very rigid and substantial base to support the balance of the washer. The tank is provided with an automatic float valve, which controls the water supply and maintains a constant water level; with an overflow valve (*G*), which connects with the sewer to prevent flooding; and with a drain valve arranged under the bottom which connects with the sewer, so that all the water may be drawn off for cleaning.

The settling tank is divided into two compartments by a wire-cloth strainer, through which the mater passes before entering the suction pump (*H*).

Connected to the passage just beyond the eliminator chamber is the air-suction fan, shown at *K* (Fig. X), propelled by a steam turbine (*L*). This fan draws the air through the spray chamber of the air washer and humidifier, where it comes in contact with the atomized spray of water. The evaporation of a portion of the spray water humidifies the air, and the amount thus evaporated depends upon the relative temperature of the water. Leaving the spray chamber, the air next passes over the washing surfaces of the eliminators and then over the stem of a graduated thermostat, shown at *M*, placed in the passage just beyond the eliminators, so that it is exposed to the air leaving the washer. The expansion or contraction of the thermostat is caused entirely by the temperature, and the resulting variation regulates the temperature of the circulating

air. A water heater of the ejector type, shown at *N*, is placed in the suction line to the pump. The heater operates like a barometric condenser, so that the temperature of the spray water is modified by varying the amount of steam furnished to the ejector.

The diaphragm steam valve, shown at *O* (Fig. X), is placed in the steam line which supplies the water heater. The valve is operated by compressed air from the graduated thermostat.

The air compressor, shown at *P* (Fig. XI), furnishes compressed air to the storage tank (*Q*, Fig. X) at about fifteen pounds pressure. The compressor is driven by the same steam turbine (*L*) that drives the air-suction fan (*K*).

The reverse-acting diaphragm valve shown at *R* (Fig. X), is normally closed, but is opened by compressed air from the tank passing through the safety valve *S*.

This method of control is extremely sensitive, as any variation in the temperature of the air passing over the stem of the graduated thermostat produces a change in the air pressure on the diaphragm steam valve, causing the valve to partially open or close, thereby producing a new water temperature. In a very few seconds this water is sprayed into the air, affecting its temperature, giving to it more or less heat in accordance with the requirements of the thermostat. This air in about one second passes over the thermostat stem, imparting to it the change in temperature.

The air then passes to the tempering or heating chamber (*T*, Fig. X), to be heated sufficiently to maintain the required temperature and moisture. The heating chamber consists of six double-section steam radiators of the vento type, each having a radiating surface of sixteen square feet. The radiators are so constructed and so arranged as to distribute and heat the air uniformly before it flows into the breeding chamber. Any or all of the six radiators may be used in accordance with the requirements of the air. The steam entering the radiators is automatically controlled by the graduated thermostat placed in the breeding chamber. The entering air is evenly distributed in the chamber and flows over the stem of the thermostat. The expansion or contraction of the thermostat is caused entirely by this temperature, and the resulting variation regulates the temperature and consequently the humidity. The diaphragm steam valve, placed in the steam line that supplies the

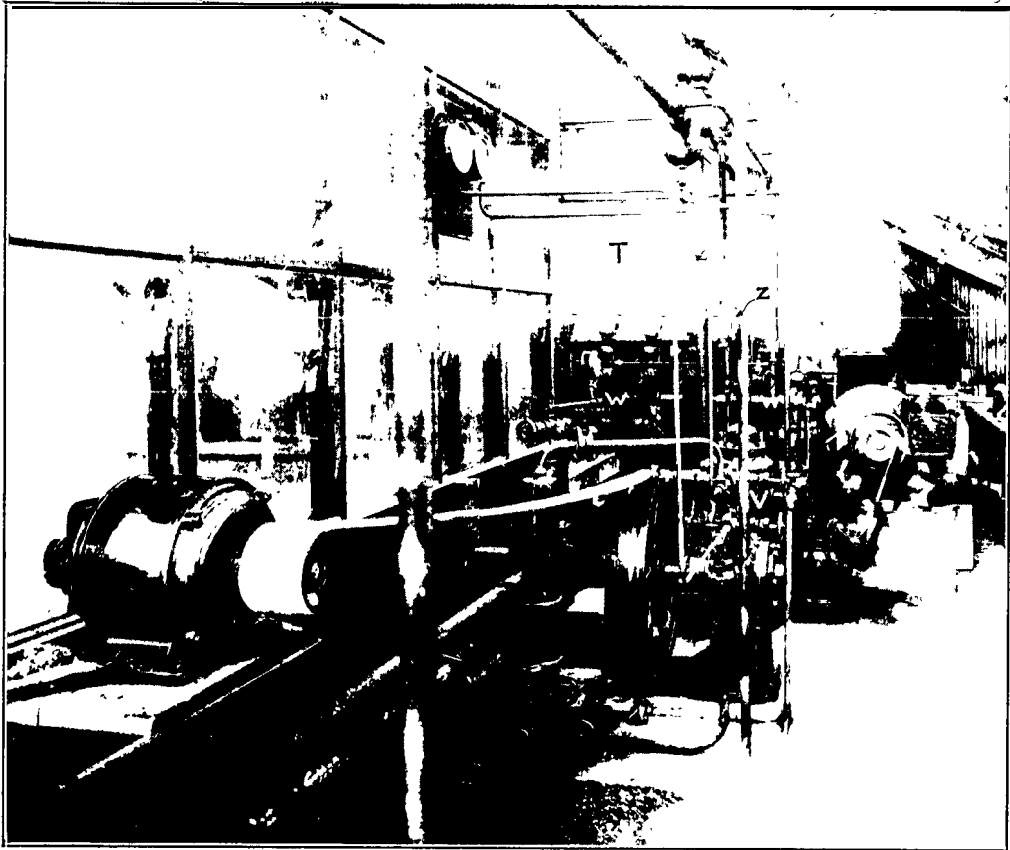


FIG. XI. Refrigerating machinery, heating chamber, and controlling machinery. *K*, suction fan; *P*, air compressor; *T*, tempering or heating chamber; *V*, ammonia compressor; *W*, steam line; *Z*, automatic lubricator.

steam for the radiators, is operated by compressed air from the graduated thermostat in the breeding chamber. The thermostat produces a change in the air pressure on the diaphragm steam valve, causing the valve to partially open or close, thereby controlling the temperature of the heating chamber.



FIG. XII. Breeding chamber.

The breeding chambers (Fig. XII) consist of two double glass-walled rooms, one 6 feet wide, 8 feet long and 7 feet high, with a small entering vestibule, and the other 8 feet wide, 12 feet long and 7 feet high, with a larger entering vestibule. A complete change or displacement of the air in the breeding chambers is produced every minute, the air flowing out at the

bottom of the chambers and entering the spraying chamber by means of a large air duct, shown at *X*. The outside air may also be brought in by means of a large air duct which comes in from the outside and enters the same chamber as the air duct coming from the breeding chambers. The control of the moisture and temperature of one chamber is independent of that of the other.

A refrigerating machine (Fig. XI) of a ton capacity is installed as a part of the air-conditioning apparatus. By means of this machine it will be possible to lower the temperature nearly to freezing point, and with brine to a point below freezing. This accessory is necessary in order that even a moderately cool temperature may be kept during the very hot days of summer.

In the entomological investigations, results have already been obtained that clearly indicate the need of definite knowledge concerning the relation of temperature to insect development. In the life-history studies of the Hessian fly some valuable results have been secured and some interesting and important habits observed. The fly, with an optimum temperature, will pass through its entire life cycle in from twenty-three to twenty-four days. One generation will follow another, and thus it is clearly indicated that with climatic conditions such as are often experienced in Kansas it is possible to have from one to five broods of the fly in a single season. During the last eight years the field studies of the Hessian fly have indicated that several times there were more than the two broods of the fly.

The most interesting discovery, and one of economic importance, is in relation to the movements of the Hessian fly larva. It may move rapidly up a perpendicular leaf with perfect ease; for instance, at a rate of two inches per hour, which is approximately two-thirds as rapid as its downward movement. The presence of moisture on the leaf in the form of dew or drops of water is not necessary, because the larva may secrete and supply moisture itself.

It is planned to carry on careful life-history studies of several of the staple-crop insects, such as the chinch bug, corn-ear worm, green bug, maize bill-bug, and some of the root-feeding forms. In these studies one of the principal objects will be to secure data relative to the effect of temperature and moisture

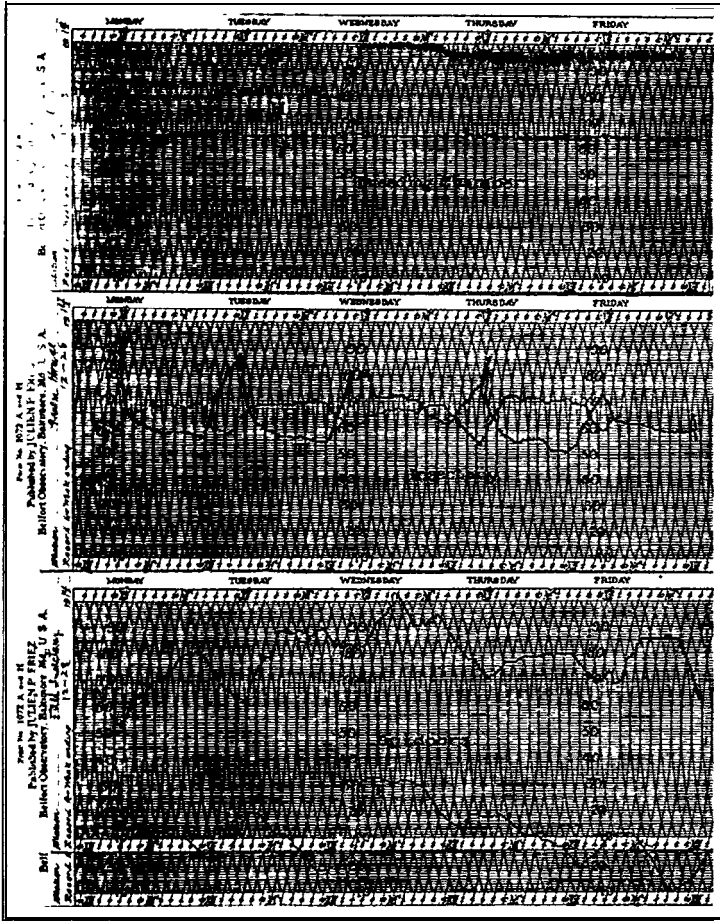


FIG. XIII. Charts showing the moisture and temperature control in the breeding chamber from December 21 to nine o'clock, December 26, 1914, compared with the humidity and temperature in the insectary and outdoors. T, temperature; H, humidity.

NOTE.—The temperature during the night of December 25 was ten degrees below zero. This air was brought directly into the spray chamber, and in less than three seconds was passed into the breeding chamber at a temperature indicated by the chart.

upon hibernation, and to determine, as far as possible, how far hibernation is controlled by the influence of heredity.

In the zoological investigations results of promise have already been attained. Some phases of the work in inheritance in Orthoptera have been improved, an entire additional generation a year being possible. This apparatus is especially suited, on account of the wide controlled range in temperature

and moisture, for testing the influence of the environment of the germ plasm, and some preliminary work has been carried on during the first year. Certain work in parasitology, especially the life history and experiments in digestion, can be done best, and in some phases only at all, under controlled temperature and moisture conditions. Use of the machine in these lines has already been made, and the preliminary results have been gratifying. Since the beginning of the successful operation of the apparatus several lines of usefulness in a wide range of zoölogical investigations have become apparent.