

AGRICULTURAL EXPERIMENT STATION

KANSAS STATE AGRICULTURAL COLLEGE
MANHATTAN, KANSAS



A group of students inspecting wheat plots in the soil fertility experiments at the main station

Work of the Kansas Agricultural Experiment Station During the Biennium Ending June 30, 1922

F. D. FARRELL, DIRECTOR

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AGRICULTURAL EXPERIMENT STATION

KANSAS STATE AGRICULTURAL COLLEGE
MANHATTAN, KANSAS

DIRECTOR'S REPORT

1920-1922



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LETTER OF TRANSMITTAL.

OFFICE OF THE DIRECTOR,
June 30, 1922.

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

Pursuant to the act of congress approved March 2, 1887, establishing agricultural experiment stations. I transmit herewith the report of the Agricultural Experiment Station of the Kansas State Agricultural College for the biennium ending June 30, 1922. It includes a brief account of the work completed or in progress, a list of the scientific contributions of the station staff from January 1, 1920, to December 31, 1921, a list of the station publications issued during the biennium under review, statements of receipts and expenditures for the two fiscal years, and the principal changes in personnel which have occurred since the issuance of the last report.

F. D. FARRELL, *Director.*

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THE WORK OF THE KANSAS AGRICULTURAL EXPERIMENT STATION

During the Biennium Ending June 30, 1922.

SCOPE OF PRINCIPAL ACTIVITIES.

During the biennium ending June 30, 1922, the principal work of the Kansas Agricultural Experiment Station comprised 104 primary projects of investigation. Many of these primary projects were subdivided into two or more closely related secondary projects. The total number of primary and secondary projects was 236. These investigations covered a broad field of agricultural inquiry, including production, utilization and marketing.

The station is organized into thirteen departments and four branch stations. The locations of the main station and its branches are shown in figure 1, which also shows the locations of the principal experiments conducted throughout the state in cooperation with farmers.

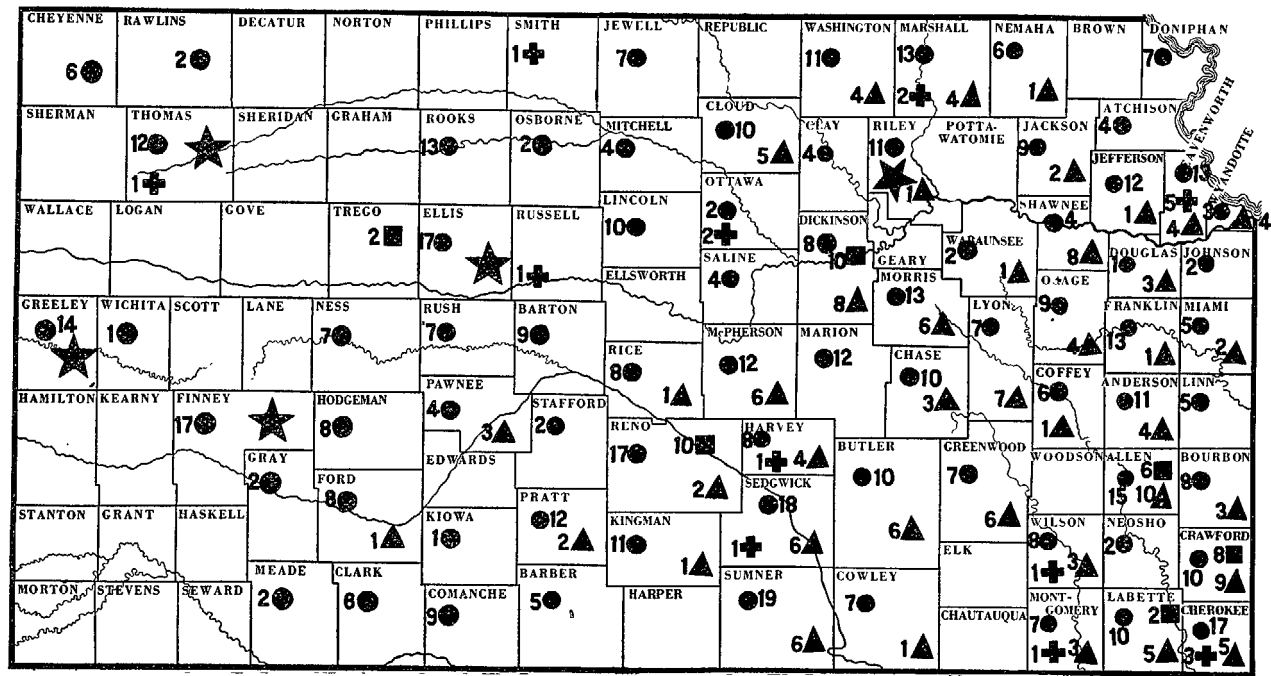
The work of the station is now so extensive and so varied that a full report of the details of all the experimental projects would be too bulky. For this reason the present report merely lists the principal projects carried on during the biennium under review and gives a brief discussion of a single project of each department and branch station. These lists and discussions are given in the following pages.

DEPARTMENT OF AGRICULTURAL ECONOMICS.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
95.	Farm Organization and Cost of Production Investigations.	State funds.*
	1. Diversified farming in Jackson county.	
	2. Specialized grain farming in McPherson counts.	
	3. Range live-stock production in Chase county.	
132.	Investigations of Tenancy, Agricultural Credit, and Other Land Problems.	State funds.
143.	The Marketing of Kansas Wheat	State funds.
144.	Economic Study of the Poultry Industry	State funds.

Wheat Marketing Studies. One of the projects of the Department of Agricultural Economics is No. 143, "The Marketing of Kansas Wheat." The first phase of the problem taken up was the factor of farm storage. A field study was made of this factor on 743 farms in 29 Kansas counties. Some of the results of this phase of the investigation are summarized below:

* Conducted in coöperation with United States Department of Agriculture, and that department supplements these funds.



● New crop and crop varietal tests ■ Crop rotation and tillage tests
 ▲ Fertilizer tests ★ Agricultural experiment stations ✚ Miscellaneous tests

FIG. 1. Map showing the location of the Kansas Agricultural Experiment Station in Riley county, the location of the Branch Experiment Stations in Ellis, Finney, Thomas and Greeley counties, and the number and distribution of experiments with soils and crops conducted in cooperation with farmers during the biennium ending June 30, 1922.

1. The monthly rate of demand for wheat by the mill and export trade of the United States for the last six crop years; the monthly rate at which the Kansas farmer has put his wheat on the market during the last six crop years; and the excess or shortage of farm marketing month by month as compared with the commercial demand month by month for the last six crop years were ascertained.

2. In general, farm storage space for wheat in Kansas is fairly adequate for a crop up to nearly 50 per cent above average.

3. Of the 743 farms reporting, 5 per cent on the average reported no storage space for wheat. Approximately 20 per cent reported some shortage of space for the 1920 crop.

4. Out of 1,140,942 bushels of wheat reported, 196,695 bushels, or 17.2 per cent, was sold direct from the threshing machine.

5. Of the wheat marketed direct from the machine, 81 per cent was hauled an average distance of 3.6 miles, 15.2 per cent an average distance of 8 miles, and 3.8 per cent an average distance of 16 miles.

6. Farmers estimated that, in general, $3\frac{3}{4}$ miles was the maximum distance wheat could be hauled economically direct from the machine where only ordinary equipment and labor forces are available.

7. Approximately 60 per cent of the wheat area of the state is further than $3\frac{3}{4}$ miles from a local elevator and therefore, outside of the radius where, as a rule, marketing can be done economically direct from the machine.

8. The status of farm storage in Kansas, together with a consideration of the ample terminal storage facilities of the country, would seem to suggest that the economic function of the local elevator in the main is that toward which it has developed in the last 25 or 30 years, namely, that of handling grain rather than warehousing it.

9. Apparently from 60 to 80 per cent of the Kansas wheat crop can be handled most economically the first one-fourth to one-half of the crop year by passing through adequate farm storage facilities.

10. In spite of its relative economy, the serious problem in farm storage of wheat is that of financing the commodity on the farm. Of 611 farmers reporting, 58 per cent reported having to borrow money in order to hold their wheat. The average loan per farmer, for wheat-storage purposes only, was \$1,030.

Work was begun June 1, 1921, on a phase of the project called "Wheat Marketing at Local Elevators and Mills." The purpose of this study is to determine the nature and size of the local elevator

market in Kansas; to determine the number, capacity, distribution and character of the ownership of the local grain elevators in the state; to determine the volume of their business, the cost of their operation, methods of operation, and their buying and selling problems; to determine their necessary buying margins, exclusive of freight, the factors that permit the profitable operation of those elevators operating on the narrowest buying margins, and to locate those sections where the number of elevators is excessive, considering the volume of grain available, and those sections where more elevator space might be supplied economically.

Out of 1,500 questionnaires mailed to elevator managers in June, 1921, returns were received from 403, as follows:

- 215 elevators, partial returns but not complete enough to determine operating costs.
- 75 independent elevators giving cost data.
- 78 cooperative elevators giving cost data.
- 35 mill and line elevators giving incomplete cost data.

A summary of costs of operation for the 75 independent elevators and for the 78 cooperative elevators has been made. The total margin necessary to meet costs (exclusive of freight, which varies with location) was practically the same for cooperative as for independent elevators. The agency employed does not in this case seem to affect the size of the margin it is necessary to take in the local elevator market in order to cover costs of doing business. This seems to indicate that the main benefit to the producer from the local cooperative elevator as now operated in this state comes not so much from the possibility of more efficient operation as from the competition it affords. Aside from this there seems to be little difference between the two local agencies from the standpoint of the consumer, where the agencies are in competition. Data for more than one year are needed, however, before definite conclusions can be drawn.

A census of the local elevators in the state has been made for the year 1920 and another for 1921. These data are recorded county by county and the location of each elevator in the state has been indicated on a map. The character of ownership is also indicated. According to the data for 1920, there are 861 independent elevators in the state, 638 cooperatives, and 181 mill-owned country elevators. The indications are that for local elevators of the average size of those in Kansas (14,000 to 15,000 bushels) a capacity turnover of five to six times a year is necessary for profitable operation. Unless, therefore, an elevator of this size can hope to secure trade, on the average, to the extent of 80,000 to 90,000 bushels of grain a year, it has little encouragement for attempting operation.

DEPARTMENT OF AGRONOMY.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
17.	Soil Fertility Investigations	State and Hatch funds.
	1. Crop rotation.	
	2. Commercial fertilizers.	
	3. Lime.	
	4. Sulphur.	
	5. Farm manure.	
	6. Green manure.	
18.	Tillage Investigations	
	1. A study of the effects of numerous methods of preparing a seed-bed for wheat on yield and quality of grain and on moisture, plant food, and humus content of the soil.	
	2. A study of the effects of crop sequence on soil tilth and productivity.	
67.	Crop Improvement Investigations	Hatch funds.*
	1. Winter wheat breeding.	
	2. Oat breeding.	
	3. Barley breeding.	
	4. Sorghum breeding.	
	5. Corn breeding.	
90.	The Effects of Cutting Alfalfa at Four Different Stages of Growth	Adams funds.
96.	Pasture Management Investigations	State funds.
	1. Rotation grazing.	
	2. Effects of burning.	
	3. Ecological studies.	
129.	Crop Production Investigations	Hatch funds.
	1. Tests of new crops.	
	2. Crop varietal tests.	
	3. The furrow method of seeding winter wheat.	
	4. Cultivation of corn.	
	5. Time and methods of seeding corn.	
	6. Time and rate of seeding winter wheat.	
—.	Conduct of the Seed Laboratory	State funds.
—.	Cooperative Experiments with Farmers	State funds.
	1. Crop varietal tests.	
	2. Fertilizer tests.	
	3. Wheat seed-bed preparation methods.	
	4. Crop rotations.	
	5. Corn irrigation tests.	
	6. Corn disease tests.	

Cooperative Experiments with Farmers. One important feature of the work of the Department of Agronomy is the series of experiments with soils and crops conducted throughout the state in cooperation with farmers. During the year 1921 a total of 299 cooperative experiments were carried on in 67 counties of the state. The general character and the distribution of these experiments are indicated in table I.

TABLE I.—Summary of cooperative experiments conducted with farmers in 1921.

<i>Kind of test.</i>	<i>Total number of tests.</i>	<i>Number of counties.</i>	<i>Number of tests successfully completed.</i>
Wheat variety	92	57	73
Fertilizers for wheat	42	27	29
Wheat seed bed	3	3	3
Oat variety	25	25	22
Fertilizers for oats	2	2	1
Corn variety	58	42	38
Fertilizers for corn	4	4	3
Sorghum variety	42	31	17
Fertilizers for alfalfa	15	13	9
Soy-bean variety	8	7	4
Crop rotation	4	4	4
Corn disease	2	2	2
Fertilizers for sugar beets	1	1	1
Corn irrigation	1	1	1
Totals	299	67	207

* Conducted in cooperation with United States Department of Agriculture, and that department supplements these funds.

The chief point of interest in the wheat variety tests was the comparison between Kanred and Blackhull. In southeastern Kansas the yields of these two varieties averaged the same, while in northeastern Kansas Kanred yielded an average of two bushels more than Blackhull. Kanred yielded about three bushels more than Kharkof and four bushels more than Turkey. These results agree closely with average results for a period of years.

Kanota oats outyielded the other varieties, producing an average of 3.5 bushels per acre more than Burt, 6 bushels more than Nebraska No. 21, and 11.5 bushels more than Red Texas.

The wheat fertility tests showed a profit from the use of fertilizers on wheat in the three tiers of counties along the east end of the state, but west of this line fertilizers did not produce an increase, on the average. Farm manure, acid phosphate and bone meal gave the best returns.

In the work with varieties of corn, Pride of Saline again ranked high in yield throughout a large part of the state. Shawnee White showed special adaptation on the better corn soils in the northeastern part of the state, and Commercial White under similar conditions in the southeastern part. Midland Yellow Dent gave very good results throughout the southeastern one-fourth of the state and is the best yellow variety tested for this section.

The proportion of successful tests was somewhat lower in the sorghum variety work than in most of the other kinds of tests. The results obtained from the successful tests were, however, more satisfactory than in preceding seasons. Sunrise kafir made a very good record as a combination grain and forage variety. For grain alone the standard Blackhull held first place in the east half of the state. Farther west, Dawn, Pink and Sunrise kafir and the milos gave better results.

The alfalfa in the fertility tests was damaged early in the season by late spring freezes and the pea aphid. Increased yields were secured from fertilizers in the eastern part of the state where there was sufficient moisture late in the season.

While only a few data were obtained on the comparative yield of varieties of soy beans, the tests showed plainly the value of this crop in eastern Kansas.

DEPARTMENT OF ANIMAL HUSBANDRY.

<i>Project No.</i>	<i>Name.</i>	<i>Source of Financial support.</i>
38	The Effects of Continued Feeding of Specific Rations on Three Generations of Swine	Adams and State funds.
78.	Silage Feeding Investigations	State funds.
	1. A study of the maximum utilization of silage in finishing baby beef.	
	2. Silage versus alfalfa hay as a winter ration for stock cattle.	
	3. The relative value of different kinds of corn silage.	
90.	The Feeding Value of Alfalfa Cut at Four Different Stages of Growth	State funds.
93.	Studies in Animal Reproduction and Inheritance	State funds.
	1. Color inheritance in guinea pigs.	
	2. Color inheritance in rats.	
	3. Size inheritance in guinea pigs.	
	4. Inheritance of defects in guinea pigs.	
	5. Inbreeding guinea pigs.	
	6. Physiology of reproduction in guinea pigs.	
	7. Size inheritance in rats.	
97.	Sex Type as Related to Functional Development and Performance in Shorthorn Cattle*	State funds.
110.	Swine Feeding Investigations	State funds.
	1. Comparison of white and yellow corn as feed for swine.	
	2. Study of the value of cane seed as a feed for swine.	
111.	Sheep Feeding Investigations	State funds.
	1. Comparison of feeding efficiency of undersized and thrifty lambs.	
	2. Comparison of white and yellow corn as a feed for wethers.	
	3. Treated versus untreated cottonseed meal for fattening lambs.	
	4. Alfalfa hay versus wheat straw for fattening lambs.	
	5. Cottonseed meal versus linseed oilmeal as supplements for fattening lambs.	
142.	A study of Pasture Values and Pasturing Methods for Horses Cattle, Sheep, and Swine	State funds.
	1. Alfalfa versus Sudan grass as pasture for brood sows.	
	2. Heavy versus light grain feeding of pigs on alfalfa pasture.	
	3. Length of feeding period for fattening hogs on alfalfa pasture.	
	4. Self-feeding versus hand-feeding of grain for pigs on alfalfa pasture.	
	— A Study of the Digestibility of Various Grains Used in Feeding Cattle	State funds.
	— Cattle Salting Studies	State funds.
	1. Salting cattle on pasture.	
	2. Salting cattle in dry lot.	

Cattle Salting Studies. The matter of supplying cattle with salt of satisfactory quality and in adequate quantity is extensively neglected by American cattlemen, and there is great diversity of opinion regarding it. Two experiments which have been conducted recently at Manhattan have thrown considerable light on this question. The outstanding results of these experiments are discussed briefly below. The first experiment mentioned was with cattle on native pasture (figure 2) and the second was with cattle in dry lot.

During the summer of 1921 forty-four head of steers were given continuous access to two kinds of salt, each in both the block and the loose form. It had been suggested by the salt trade that salt blocks made at different pressures might have different effects on the ani-

* Conducted in cooperation with United States Department of Agriculture.

mals' preference. The salt companies have been making blocks at various pressures to suit the demands of the trade, even though they apparently have preferred not to do so, as it would be cheaper, everything considered, to make a block of standard pressure that would stand shipping and handling without chipping and breaking to pieces. Moreover, the question of the kind of salt was one that the manufacturers were seriously considering. There are two kinds or grades of stock salt on the market—evaporated and the natural rock salt. Both are pressed into blocks and also sold loose. The evaporated salt is obtained by running water down in the salt mines,



FIG. 2. Some of the Hereford steers used in the salting experiments and in a three-year experiment on the effects of winter rations on summer gains.

thus making a brine, which is pumped to the surface and stored in large reservoirs and allowed to evaporate. The natural rock salt is mined much the same as coal, and is probably not as pure as the evaporated salt.

In this experiment different kinds of salt were used, as follows: 400 tons pressure evaporated; 500 tons pressure evaporated; 600 tons pressure evaporated; medium evaporated, fine ground; 400 tons pressure rock salt; 500 tons pressure rock salt; 600 tons pressure rock salt; 700 tons pressure rock salt; crushed rock salt No. 4 medium. Samples of each of these were exposed in the pasture so that the steers had continuous access to all of them.

A check group of salt samples was kept in a fenced-off inclosure for the purpose of determining the approximate amount of -weathering that took place with the salt allowed the steers, in addition to what was consumed. The steers had had access to salt for some

time before the experiment began, and the same animals were used throughout the experiment.

The experiment covered a period of 169 days—from May 16, 1921, to November 1, 1921. It should be remembered when studying the data that the calculations are only approximately correct, as no definite practical means of determining actual losses of salt from weathering were available. The consumption of the various kinds of salt, after the estimated losses from weathering are taken into consideration, is shown in the following table:

SALT CONSUMPTION AFTER WEATHERING ALLOWANCES HAVE BEEN MADE. (May 16 to November 1, 1921—169 days.)		
	<i>Pounds.</i>	<i>Pounds.</i>
Evaporated salt blocks:		
400-ton pressure	48.16	
500-ton pressure	48.19	
600-ton pressure	48.64	
Total evaporated salt blocks consumed	144.99	
Medium fine-ground evaporated salt consumed		40.47
Rock-salt blocks:		
400-ton pressure	22.70	
500-ton pressure	22.85	
600-ton pressure	22.74	
700-ton pressure	27.57	
Total rock-salt blocks consumed	95.86	
Crushed rock salt consumed		92.52
Total salt consumed (all kinds)		378.84
Total number of steers	44	
Average amount of salt consumed per animal per month	1.5	
Average amount of salt consumed per animal	8.5	

It will be observed that there was no marked difference in the steers' preference, as far as pressure was concerned. As compared to the same salt supplied loose, there was a difference of about eight pounds in favor of the block form in the case of evaporated salt. Apparently the only explanation to offer concerning this is that the loose evaporated salt when placed out for the cattle becomes lumpy and hard and a heavy crust forms on the top which is rough to the touch. The blocks remain smooth and do not have this extra coating on them. The total consumption of the evaporated block salt was about double that of rock-salt blocks, indicating a rather decided preference for the evaporated block salt. It seems that the rock-salt blocks are much more rough after licking than the evaporated-salt blocks are. On several occasions it was necessary to saw some blocks of both kinds, and the saw lost its cutting edge much quicker on the rock-salt blocks than on the evaporated-salt blocks.

The consumption of crushed rock salt was the highest of all. This salt, while having a crust form on it as did the loose evaporated salt, seemed to soften more easily when licked, and apparently when moistened thoroughly it had a different and more pleasing taste than did the evaporated salt. This was probably due to the presence of other salts than sodium chloride, which is practically the only salt

present in the evaporated article. It seems that pressure does not influence the preference of cattle, but rather that the kind of salt is the principal factor in determining preference.

The salt consumption by steers receiving, respectively, succulent and dry rations was observed during the winter of 1921-'22. This was done in order to ascertain whether, as is often stated by practical feeders, steers consume more salt if fed a succulent ration, like silage, than if fed a ration of alfalfa hay. The salt used was loose evaporated salt and was kept before the animals constantly. A check box was also kept to ascertain weathering. All salt was kept in boxes in an open shed facing south. Records were kept from December 1, 1921, to April 30, 1922—150 days, by monthly periods.

The following table shows the consumption by both lots on a monthly basis, allowance being made for weathering:

<i>Month ending—</i>	<i>Alfalfa-hay-fed steers, 20 head.</i>	<i>Corn-silage-fed steers, 19 head.</i>
December 31, 1921	47.30 pounds	230.00 pounds
January 31, 1922	68.23 pounds	201.27 pounds
February 28, 1922	75.02 pounds	216.72 pounds
March 31, 1922	59.87 pounds	166.64 pounds
April 30, 1922	61.42 pounds	71.25 pounds
Total	311.84 pounds	885.88 pounds
Average consumption per head.....	15.59 pounds	46.63 pounds

The average consumption per head was practically three times as great with corn-silage-fed steers as with the alfalfa-fed steers. There was but a moderate difference in the ash content of the two rations. Chemical analyses showed that the average ash content of the alfalfa hay was 7.63 per cent and that of the corn silage 5.65 per cent. There is a possibility that the ash of the alfalfa hay was more available than that in the silage. The salt consumption of the two lots the last month was approximately equal. It may be of interest to note in this connection that the silage fed during the last month contained 5 per cent more dry matter and the acidity was very low, which may have some bearing upon the relatively small difference in salt consumption during the last month.

DEPARTMENT OF BACTERIOLOGY.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
85.	Poultry Disease Investigations	State funds.
	1. Examination of diseased birds sent to laboratory for diagnosis.	
	2. Manufacture and testing of pure-culture bacterial vaccines for roup, chicken cholera, and fowl typhoid.	
124.	A Study of the Bacteriological Factors in the Manufacture of Ice Cream.	State funds.
128.	A Study of the Influence of the Absolute Reaction of the Soil Solution Upon the Growth and Activity of <i>Azotobacter</i> in Soils.	Adams funds.
131.	Relation Between Adequacy of Diet and Immunity to Roup in Chickens . . .	State funds.
138.	Protein Synthesis by Microorganisms	State funds.
	1. Stimulating the growth of <i>Azotobacter</i> by aeration.	
	2. The production of growth-promoting substances by <i>Azotobacter</i> .	
	3. Protein synthesis by <i>Azotobacter</i> .	

Soil Acidity and Nitrogen Fixation. In a state where the fertility of the soil is declining, as it is in Kansas, it is of great importance to secure as much knowledge as possible regarding the behavior of microorganisms which influence the nitrogen content of the soil. Project No. 128 is devoted to a study of one important group of such microorganisms—the *Azotobacter*. The study has been confined chiefly to those aspects of the problem which have to do with the absolute reaction of the soil solution. Studies of the correlation existing between the absolute reaction of the soil solution and the presence of *Azotobacter* in the soil have been concluded. These studies have covered 418 samples of soil, of which 199 were found to contain *Azotobacter*. The hydrogen-ion concentration of the soil solution was determined both by the colorimetric and the electrometric methods. Very few soils more acid than pH 6.0 contained *Azotobacter*. There were very few soils less acid than pH 6.0 that did not contain the organism. The correlation between the hydrogen-ion concentration of the soil solution and the presence or absence of *Azotobacter* in the soil was found to have the almost perfect coefficient of 0.96. Whether or not the hydrogen-ion concentration is the factor limiting the distribution of these organisms in soils, the fact is clearly established that the two are definitely associated. It has further been satisfactorily demonstrated that the same factors that will raise the hydrogen-ion concentration of the soil solution appreciably above, or lower it appreciably below 1×10^{-6} will also render the soil capable or incapable, as the case may be, of supporting an *Azotobacter* flora.

The laboratory and field plot studies of means of rendering acid soils capable of supporting an *Azotobacter* flora have been continued. Liming appears to be entirely satisfactory for this purpose. Plots that were sufficiently limed and inoculated with *Azotobacter* two to three years ago still contain a vigorous *Azotobacter* flora. *Azotobacter* disappeared from adjacent unlimed plots in a very short time. The soil in limed inoculated plots possesses a nitrogen-fixing ability of two to three times that of the unlimed uninoculated soil in adjacent plots. The influence of the hydrogen-ion concentration of laboratory culture media upon the growth and fixation of nitrogen by pure cultures has been studied. A number of cultures were isolated from different soils and grown in media of varying hydrogen-ion concentrations. This study has shown:

1. That pure cultures of *Azotobacter* will not grow in a medium with a higher acidity than pH 5.9 — 6.0.

2. That no nitrogen fixation takes place in a medium with a higher hydrogen-ion concentration than pH 6.0.

3. That no appreciable quantities of acid and basic metabolic by-products are formed by the growth of pure cultures of *Azotobacter* in laboratory media.

DEPARTMENT OF BOTANY.

Project No.	Name.	Source of financial support.
74.	The Physiology of Drouth-resistant Plants	State funds.
	1. Water requirement of maize.	
	2. Water requirement of sorghums.	
	3. Chemical changes associated with rapid vegetative growth in maize.	
	4. Chemical changes associated with rapid vegetative growth in the sorghums.	
76.	Cereal Disease Investigations	State funds.*
	1. Cereal disease survey.	
	2. Wheat-rust investigations.	
	3. Smut investigations.	
	4. Corn root-, stalk-, and ear-rot investigations.	
	5. Wheat foot-rot investigations.	
130.	Fruit and Vegetable Disease Investigations.	State funds.
	1. Potato diseases.	
	2. Tomato diseases.	
	3. Cabbage diseases.	
	4. Lettuce diseases.	
	3. Miscellaneous fruit diseases.	

Foot-rot Disease of Wheat. Because of its recent discovery in this country, special interest attaches to the wheat disease known as foot rot. Within the past two years this disease has been found in five counties in Kansas; namely, Dickinson, Jefferson, Riley, Saline and Cheyenne. It has been most severe in Dickinson county. The organisms associated with its occurrence have been *Helminthosporium* sp., *Hendersonia* sp. (*Wojnowicia graminis*), and a fungus which may prove to be *Ophiobolus cariceti*. What appeared to be the latter fungus was isolated from diseased plants from Dickinson and Riley counties in May, 1922. Should this prove to be *Ophiobolus cariceti*, it establishes the presence of the take-all disease of wheat in Kansas, although further cultural work is necessary to identify the organism definitely. *Wojnowicia* and its possible connection with *Ophiobolus* are being studied. The indications are that soil infestations are chiefly responsible for its carrying over, especially where diseased wheat stubble is plowed under. A study has been conducted at Abilene, Dickinson county, which includes a series of rotation, soil amendment and fertilizer plots, and a varietal susceptibility study. Diseased spots were numerous in the plots and general field in 1922.

The foot-rot disease behaved differently in 1922 as compared with 1921. In 1922, diseased plants attained the heading stage, but did

* Conducted in cooperation with United States Department of Agriculture, and that department supplements these finds.

not mature normal grain. Either the heads were entirely blighted and lacked grain, or the seed was badly shriveled. In 1921 diseased plants seldom formed heads. In that year the plants turned brown and dried before heads matured. Seasonal conditions probably are responsible for the differences in symptoms. In 1921 badly diseased fields gave only one-third the normal yield. Various grasses are suspected of being susceptible to these organisms, and they may be partially responsible for the spread of the disease. For this reason a study of certain grasses is being made in this connection.

DEPARTMENT OF CHEMISTRY.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
34.	Chemical Studies on Silage	State funds.
38.	The Effects of Continued Feeding of Specific Rations on Three Generations of Swine (Chemical and biochemical features).	Adams funds.
60.	Chemical Studies on Flour-milling Processes	State funds.
90.	The Effects of Cutting Alfalfa at Four Different Stages of Growth	Adams funds.
	1. Chemical analyses of hay.	
	2. Digestion trials.	
113.	Studies of Nutrients in Forage Crops	State funds.
125.	Factors Influencing the Composition of Body Fat.	Adams funds.
127.	Deficiencies of Feeds Fed Hens as Affecting the Vitality of Chicks (Chemical and biochemical features).	State and Adams funds.
131.	Relation Between Adequacy of Diet and Immunity to Roup in Chickens (Chemical and biochemical features).	State funds.
139.	The Quantitative Relation Between Vitamins in the Food Eaten and in the Milk Produced by a Lactating Mother (Chemical and biochemical features)	State funds.

Factors Influencing the Composition of Body Fat. One of the problems confronting the animal husbandmen in finishing animals for market or fitting them for show is how to produce firm tissues. One of the factors contributing to flabbiness of animal tissues is the low melting point of certain fats caused by the presence of either unsaturated or short-chain fatty acids. Project No. 125 is devoted to an attempt to determine what factors influence the composition of these body fats. The results so far secured indicate that none of the short-chain fatty acids in the food are deposited in the body fat, while the unsaturated fatty acids of the food are so deposited, thus causing the body fat to have a low melting point. The results also indicate that body fat produced by a high protein diet contains more of the unsaturated fatty acids and has a lower melting point than that produced by a low protein diet. Some of the results obtained with hens are shown in table II.

TABLE II.—Constants of body fat of hens fed various feeds.

FEEDS.	Location of tissue.	Molting point (deg. C.).	Iodine No.	Saponification No.	Reichert—Meissl No.	Refractive index at 50 C.	Specific gravity.
Coconut oil, 25 per cent.	Abdominal	36.3	44.6	214.0	0.00	1.449	0.8687
	Subcutaneous	31.2	45.3	214.9	0.38	1.450	0.8678
Linsed oil, 25 per cent.	Abdominal	Below 5	121.2	197.5	0.35	1.461	0.8735
	Subcutaneous	Below 5	124.5	197.7	0.36	1.462	0.8738
Hydrogenated cottonseed oil, 25 per cent.	Abdominal	47.8	57.6	195.5	0.00	1.452	0.8640
	Subcutaneous	46.2	61.5	196.6	0.46	1.453	0.8630
High protein.	Abdominal	34.2	67.4	197.3	0.00	1.454	0.8666
	Subcutaneous	32.2	70.2	194.7	1.80	1.454	0.8641
Low protein	Abdominal	40.8	61.7	197.1	0.53	1.453	0.8663
	Subcutaneous	40.0	64.6	195.5	1.16	1.453	0.8656

DEPARTMENT OF DAIRY HUSBANDRY.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
34.	Silage and Grain Feeding Investigations,	State funds.
	1. Comparison of corn silage made from the whole plant and that made from corn stover.	
	2. Comparison of corn grain in silage and dry corn grain.	
	3. Ground cane seed as a constituent of a grain ration for dairy cows.	
99.	Four Methods of Developing Dairy Heifers	State funds.
124.	Ice Cream Investigations	State funds.
139.	The Quantitative Relation Between Vitamins in the Food Eaten and in the Milk Produced by a Lactating Mother	State funds.
140.	A Comparison of Alfalfa Hay and Prairie Hay with Various Protein Supplements in Developing Dairy Heifers	State funds.

Four Methods of Developing Dairy Heifers. This project was started in 1914 and completed in 1921. Its purpose was to compare the four following methods of feeding and breeding in developing dairy heifers from the age of six months to the close of the second period of lactation:

<i>Lot No.</i>	<i>Ration.</i>	<i>Age at which bred to calve, months</i>
I.	Alfalfa hay alone	30
II.	Alfalfa hay and corn silage	30
III.	Alfalfa hay, corn silage, and grain	30
IV.	Alfalfa hay, corn silage and grain	24

Grade Holstein heifers were used. The feeds named above were fed exclusively throughout the period of experiment. Nineteen heifers were carried on the experiment through their first period of lactation, and seventeen completed their second period of lactation. A few of the results of the experiment are summarized below:

Alfalfa and silage made the cheapest ration in bringing a heifer to two years of age. The cost for this ration was \$60.74 per head as compared with \$62.43 for alfalfa hay alone. The cost for alfalfa hay, silage and grain was \$82.31 on one lot and \$82.90 on the other. However, the grain-fed lots were heavier, one lot averaging 1,014 pounds and the other 1,057 pounds, as compared with 766 pounds for alfalfa alone and 802 pounds for alfalfa and silage. For the first lactation period the cost of feed was least in the alfalfa and silage lot, being \$43.71 per head as compared with \$44.92 for the lot receiving alfalfa alone. The profit above feed cost was least in the alfalfa lot. In the second lactation period the lots ranked the same as in the first as to profit, but the cost of feed was slightly higher for the alfalfa and silage lot than for the lot fed alfalfa alone. The experiment involved determinations of body development, breeding behavior, and milk and butter-fat production. The results are to be reported in detail in a separate publication.

DEPARTMENT OF ENTOMOLOGY.

<i>Project No</i>	<i>Name.</i>	<i>Source of financial support.</i>
6.	Effects of Weather Conditions on Injurious Insects	Hatch funds.
8.	Investigations of Hessian Fly and Other Wheat-infesting Insects	Hatch funds.
	1. Life-history studies.	
	2. Control measures.	
	3. Varietal resistance to Hessian fly.	
	4. Studies of the green bug.	
	5. Studies of the wheat bulb worm.	
9.	Investigations of Corn-infesting Insects	Hatch funds.
	1. Effect of time of planting on corn-ear worm	
	2. Varietal resistance to corn-ear worm.	
	3. Factors which attract the corn-ear-worm moth.	
	4. Relation of morphological characters of the corn plant to the activities of the corn-ear worm.	
	5. Studies of the corn-leaf aphid.	
	6. Studies of other corn-infesting insects.	
13.	Fruit Insect Investigations	Hatch funds.
92.	Investigations of Sorghum-infesting Insects	State funds.
	1. Kafir ant.	
	2. Chinch bugs in Sudan grass	
	3. Other sorghum insects.	
100.	Insects Injurious to the Roots of Staple Crops	State funds.
	1. Biological studies of wireworms and false wireworms.	
	2. Studies of the morphology and life history of <i>Lachnosterna crassissima</i> .	
	3. Studies of other Scarabæidæ.	
101.	Termite Investigations	State funds.
115.	Insects Injurious to Alfalfa	State funds.
	1. The pea aphid.	
	2. The clover-leaf weevil.	
	3. The green clover worm.	
	4. The alfalfa caterpillar.	
	5. Other insects infesting alfalfa.	
116.	Investigations of Shade-tree Insects	State funds.
126.	Bee Investigations	State funds.
	1. Methods of wintering bees.	
	2. Studies of the relations of certain physical characters to the quantity of honey stored.	
	3. Studies of the honey plants of Kansas.	

Resistance of Wheat Varieties to Hessian Fly Injury. This important part of project No. 8 has been emphasized during the year 1921-'22. Field experiments which have been under way for several years show a number of interesting points and furnish a basis for further work. These results may be summarized as follows: (1) There is practically no discrimination by the adults in ovipositing, and eggs are deposited in about equal numbers on all varieties of wheat. (2) There is a decided difference in the subsequent infestation, and certain varieties exhibit marked resistance. (3) Such varieties as Illini Chief, Dawson Golden Chaff, Beechwood Hybrid, Currell Select and Dietz have been consistently free from injury. (4) Other varieties, as Turkey, Kharkov, Ghirka, Zimmerman and Marquis, have been very susceptible under all conditions. (5) Such varieties as Kanred, Fulcaster and Clark's Blackhull have been erratic, being apparently resistant in one test and very susceptible in another. (6) There has been a marked difference in the behavior of strains of the same variety. Fifty strains of Illini Chief

have been under observation, and two of these have been very susceptible, while the remainder have been very resistant. An extended study has been made of the morphological characters of the wheat plant which might be associated with the fly's activity. A summary of the data indicates that resistance is not associated with morphological characters. Physiological studies are now being made. Preliminary results indicate that the silica content of the plant may have a decided influence on the ability of the plant to resist Hessian fly injury.

DEPARTMENT OF HORTICULTURE.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
25.	Orchard Management Investigations	State funds.
	1. Tests of commercial fertilizers for orchard soils.	
	2. Tests of orchard green-manure crops.	
	3. Pruning methods.	
	4. Spraying methods.	
26.	Small Fruit Investigations	State funds.
27.	Experiments with Vegetables	State funds.
82.	Forest Tree Investigations	State funds.

Orchard Management Experiments. The work in orchard management during the past two years was handicapped by the complete failure of the fruit crop as a result of spring freezes. However, records were taken of the vegetative responses to various treatments which appear to be significant in some cases, indicating, especially, the value of the application of nitrogenous fertilizers for increasing the general vigor of apple trees. Assuming that a system of green manuring would probably be more economical and yield more permanent benefits, due to the addition of humus, than the continued application of commercial fertilizers, a series of orchard cover-crop plots was laid out in the station orchard and seeded during August, 1921. The commercial-fertilizer work has been continued in the station orchard and also in several orchards in Doniphan county. In the latter location two coöperators dropped out and another was added. The season's experimental spraying has been carried out satisfactorily. The main subjects of study are a comparison of the fungicidal value of dry lime sulphur and that of liquid lime sulphur, and the application of spray materials by the rod and nozzle versus the gun. The pest for which the spray applications of the second of these tests are being made is the codling moth. It appears now that the fruit failure of the past two years has so far reduced the numbers of these insects that this year's results may not have much value.

DEPARTMENT OF MILLING INDUSTRY.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support</i>
60.	Milling and Baking Investigations	State funds.
118.	Wheat Storage and Shrinkage Investigations	State funds.

The principal investigative work of the Department of Milling Industry consists of the conduct of milling and baking tests in connection with the wheat experiments of the Department of Agronomy and the testing of commercial samples of cereal products submitted for investigation.

Something of the character and extent of this work is indicated by table III and the subsequent comments:

TABLE III — Experimental wheat samples milled during the fiscal year ending June 30, 1922

<i>Kind of experiment.</i>	<i>Number of samples.</i>
Wheat seed-bed preparation	20
Soil fertility, series I	12
Soil fertility, series II	12
Soil fertility, series V	12
Soil fertility, series VIII.	12
Variety tests, Manhattan	27
Variety tests, Hays	7
Tillage experiments, series A	23
Tillage experiments, series B.	22
Tillage experiments, series C	14
Kanred-Turkey cooperative tests	70
Kanred-Turkey from cooperative tests for protein determinations only.	400
Total	631

The analytical work on 57 samples from the tillage experiments of the 1920 crop has been completed and the protein determinations have been made on the 400 small samples from the Kanred-Turkey comparisons. All milling tests have been completed and the baking tests have been made on the 70 samples of Kanred and Turkey wheat secured from the Crop Improvement Association members. Baking tests on 161 samples are yet to be made and the analytical data are yet to be summarized.

DEPARTMENT OF POULTRY HUSBANDRY.

<i>Project No.</i>	<i>Name</i>	<i>Source of financial support.</i>
77	Improvement and Conservation of Farm Poultry	State funds
	1. Improving mongrel flocks through standard-bred cockerels.	
	2. Comparison of the feeding values of milo, cane, kafir, and maize	
	3. The inheritance of sidesprigs	
	4. The inheritance of blue	
	5. Inbreeding in poultry.	
	6. The palatability of poultry feeds.	
	7. Incubation studies.	
	8. The correlation between early sexual maturity and size of egg.	
127	Deficiencies of Feeds Fed Hens as Affecting the Vitality of Chicks	Adams funds.
131	The Relation Between Adequacy of Diet and Immunity to Roup	State funds.

The Influence of Ration on Production and Hatchability of Eggs. For several years an investigation has been in progress to determine the effect of inadequate rations on the production and

hatchability of eggs. During the period of this report eight pens of hens were in the experiment. Four of the pens received the conventional grain ration used in the general college flock and considered adequate (designated as "K. S. A. C., Adq."), supplemented in some cases with a succulent feed. The other four pens received rations compounded by the Chemistry Department, some theoretically adequate and others theoretically inadequate.

Complete records have been kept of the weights of the birds, feed consumed, individual egg production, fertility and hatchability of eggs, and distribution of mortality of the fertile eggs that failed to hatch. The hens were all confined in the house during the experiment except pen XV. The hatching results for the spring season of 1922 are given in table IV.

It is difficult to determine which has the greater influence, individuality or rations. The eggs from some hens hatched well in spite of the supposed inadequacy of the rations they received, while the eggs from other hens failed to hatch when under supposedly ideal conditions. For example, in pen III three hens produced 72 of the 92 chicks; in pen IV three hens produced 43 of the 61 chicks; seven of the 11 chicks in pen VI came from one hen; and 37 of the 51 chicks in pen VII were hatched from two of the nine hens.

TABLE IV Hatching data in experiment on production and hatchability of eggs
(Spring season, March 16 to May 2, 1922)

Pen No.	RATION	Number of hens which laid eggs	Number of hens from which no eggs hatched	Number of eggs set	Per cent fertile	Number of chicks hatched.	Per cent hatched from fertile eggs.
I	K. S. A. C, Adq; no green feed; no range	9	5	177	84.7	47	31.3
II	K. S. A. C, Adq; sprouted oats, no range	8	2	166	81.9	80	58.8
XV	K. S. A. C, Adq.; sprouted oats; range in yard	7	1	186	70.9	74	56.0
III	K. S. A. C, Adq.; mangels, no range	10	1	216	90.2	92	47.1
IV	Chemistry, Adq, sprouted oats; no range	10	2	203	91.6	61	32.7
V	Chemistry, Inadq.; deficient in vitamin A; no green feed or range	3	0	55	100.0	25	45.4
VI	Chemistry, Inadq.; deficient in vitamin B; no green feed or range	9	6	57	75.4	11	25.5
VII	Chemistry, Adq; no green feed; no range	9	5	128	92.9	51	42.8

DEPARTMENT OF VETERINARY MEDICINE.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
102.	Miscellaneous Diseases of Farm Animals.	State funds.
	1. Posterior paralysis of swine	
	2. Botulism in horses.	
	3. Parasitic protozoa in swine.	
135.	Animal Abortion Investigations	State funds.
	1. Studies of <i>Bacillus abortus</i> .	
	2. Artificial production of immunity in cattle.	

Animal Abortion Investigations. The work on this project has been carried on principally in two directions: (1) A study of the behavior of the causative organism; and (2) an attempt artificially to induce immunity in cattle. The work of typing strains of *B. abortus* is still being carried on. So far there have been generated in rabbits nineteen agglutinating sera specific for nineteen strains of *B. abortus*. The titer of these sera is ascertained against the strain used in their production. They are then titered against all of the other strains in order to detect differences, if any exist. Of the nineteen strains used all but two gave identical results. These two were strains that were obtained from neighboring states, and upon careful examination were found not to be strains of *B. abortus*. Thus with seventeen strains of *B. abortus* it has not been possible to determine any difference either culturally or biologically. The work of last year in the correlation of lesions of other organisms with those of *B. abortus* has been repeated. The idea is to determine the value of the lesions of *B. abortus* in guinea pigs as to specificity for diagnostic purposes, or whether the presence of lesions is sufficient evidence, without culturing, to determine the presence of *B. abortus* in suspected material. The lesions as presented in the spleen were recorded at the time of autopsy of the guinea pigs. Bacteriological isolations were also made from the liver, spleen, kidneys, lungs and heart blood in each instance. The lesions as interpreted consisted of an enlargement of the *Malpighian* corpuscles of the spleen and were designated as follicular hyperplasia of the spleen. Pieces of these spleens were sectioned and examined microscopically to confirm the macroscopic diagnosis. Of the 80 guinea pigs' spleens examined, 50 showed follicular hyperplasia and 30 did not. From the 50 animals whose spleens showed follicular hyperplasia, *B. abortus* was isolated from 7, or 14 per cent; 28, or 56 per cent, yielded organisms belonging mainly to the colon, streptococci and staphylococci groups; 15, or 30 per cent, were sterile bacteriologically. Of the 30 animals whose spleens did not show follicular hyperplasia, 7, or 23 per cent, yielded *B. abortus*; 18, or 60 per cent, yielded organisms other than *B. abortus*, and 5,

or 16.7 per cent, were sterile bacteriologically. From the above it is concluded that the presence of lesions in spleens of guinea pigs inoculated with suspected abortion material are absolutely of no value as an index to the presence or absence of *B. abortus*. Culturing from aborted foetuses and the keeping of records of the organisms isolated are being continued.

The number of abortion organisms isolated is small as compared with the number of organisms other than *B. abortus* coming from foetuses which have been aborted and from cows with retained afterbirth. This is indicated by the work done on correlation of lesions on guinea pigs' spleens, as this material was from such sources. Out of the 80 cases there were obtained but 14 cultures of *B. abortus*, or 17.5 per cent, as against 57.5 per cent of organisms other than *B. abortus*. Twenty-five per cent of the cases were sterile bacteriologically. These results seem to suggest that *B. abortus* is not the sole incitant of abortion disease.

All of the artificially infected cattle appear to be in calf and the results of the treatments are awaited. Their drinking water and alfalfa hay are being infected twice a week with living cultures of *B. abortus*. The animals are still being bled at weekly intervals and their blood tested. This practice is to be continued throughout the experiment. Besides the value of this experiment in throwing light upon vaccination, it also offers other information; namely, whether or not infection with *B. abortus* can occur after a cow is safely in calf. There is some partial evidence that infection is possible after a cow is safely in calf and that abortion will result. Heifer No. 1743 gave negative agglutination reactions from the time of purchase up to the time of her vaccination. In July, 1920, she was bred. She was vaccinated with living organisms the following October, or three months after breeding. She aborted a 212-day foetus, February 11, 1921. It seems reasonable to assume that the only time she came in contact with infection was when she was vaccinated. *B. abortus* was isolated from the aborted foetus and from the vaginal discharge and milk of the heifer. The other animals which were vaccinated with dead organisms were not in contact with No. 1743 or with infection until after they had passed two heat periods following service. Therefore, if abortions should occur in these animals it will be evidence that infection can occur after a cow is safely in calf.

DEPARTMENT OF ZOOLOGY.

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
72.	Studies of Inheritance and Evolution in the Grouse Locust	Adams funds.
79.	Parasitological Investigations	Adams funds.
	1. Life history of chicken tapeworm.	
	2. Transmission of fowl nematode.	
	3. Relations of chickens and swine to hookworm dissemination.*	
84.	Investigations of Injurious Mammals	State funds.
	1. Food preferences of the pocket gopher.	
	2. Life history of the pocket gopher.	
	3. Life history of the mole.	
	4. Food of the mole.	
	5. Studies of the economic importance of mole and gopher damage to crops.	
104.	Influence of Weather Conditions on Inheritance and Parthenogenesis in the Grouse Locust	Adams funds.
119.	The Embryology of Parasitic Worms.	State funds.

Studies of Gophers and Moles. The extensive damage done to crops by gophers and moles in Kansas makes it desirable that these pests be studied scientifically, especially for the purpose of securing information on which to base the development of more effective control measures than are now available. Investigations of these pests have been continued during the past two years, and much additional information has been obtained concerning their breeding habits, food preferences, methods of obtaining food, damage to crops, parasites, and general life activities. The food preference of the pocket gopher has been studied extensively with the view of perfecting a satisfactory poisoned bait for their control. Known quantities of assorted foods have been offered during a successive number of days under laboratory conditions where careful checks could be made and the amounts and kinds of food preferred could be recorded. It has been found that the pocket gopher has a decided preference for alfalfa over any of the indigenous plants common to prairie grasslands. Alfalfa is also eaten in preference to such vegetables as beets, carrots, Irish potatoes and sweet potatoes.

Young pocket gophers have been born in the laboratory and their rate of growth and time of leaving the nest have been observed. Four is the average number born in a litter. At birth they weigh from 5 to 7 grams. When two weeks old they begin to take food. At the end of six weeks they are ready to leave the nest, and weigh about 130 grams. The average weight of a grown female gopher is about 175 grams. The breeding period is from the last of February to the middle of May, and from all indications they breed only once a year. Much time has been given to the study of migration of the pocket gopher and considerable data collected. A study of the natural enemies of the pocket gopher is in progress. At present the

* In cooperation with Johns Hopkins University, Baltimore.

bull snake is receiving most attention. Bull snakes have been kept in captivity an entire year and notes have been taken on period of activity, growth, molts, food, hibernation and mating. They are active from May to October and during these six months are capable of eating their own weight in pocket gophers each month.

The experimental work on the feeding habits of captive moles will soon be complete and ready for publication. Until this work was done very little information concerning the feeding habits and food preferences of moles was known, except that obtained from the study of stomach contents of dead animals. Known quantities of an assortment of foods, including grains, vegetables, meat, worms and insects were offered over a period of successive days under conditions where careful checks could be kept. It has been found that the moles are not exclusively insectivorous, as heretofore thought, but will eat certain grains, especially corn, after the latter has been softened by the absorption of water. That these experiments were carried out under conditions that approach those of nature is borne out by the fact that the animals gained weight and appeared thrifty even after being in captivity for over eleven months.

BRANCH EXPERIMENT STATIONS.

The chief justification of branch experiment stations in Kansas rests upon the existence, in different parts of the state, of differences in essential conditions. These differences involve altitude, rainfall, density of population, types of farming, size of farms, and other factors. Some of these differences are indicated in the following table, which contains certain figures for the main station at Manhattan and corresponding figures for the four branch stations:

<i>Item.</i>	<i>Manhattan.</i>	<i>Hays.</i>	<i>Garden City.</i>	<i>Colby.</i>	<i>Tribune.</i>
Altitude (feet)	1,031	2,000	2,800	3,100	3,600
Average annual rainfall (inches)	31	23	19	16	16
Maximum annual rainfall (inches)	51	35	29	32	33
Minimum annual rainfall (inches)	15	12	9	7	11
Average acreage per farm in 1920 in county where station is located	216	408	877	768	904
Average improved acreage per farm in 1920 in county where station is located	115	279	221	657	130
Average acreage per farm in 1920 of pasture and waste land	101	129	656	111	774

These differences in regional conditions make it desirable to have branch stations for the two following purposes, chiefly:

1. To provide places for testing out, under the varying regional conditions, certain discoveries made or principles developed in the progress of fundamental research work at the main station. These include new crop varieties, new methods of soil culture, new methods of using fertilizers, feeding methods, etc.

2. To make it possible to conduct experiments to find answers to problems which are peculiar to the agriculture of the region where the branch station is located; that is, to conduct original experiments which are concerned chiefly with regional rather than with state-wide problems. These include such things as irrigation experiments at Garden City; the problems of a short growing season at Tribune; problems of growing and utilizing feed crops at all four branch stations; problems of soil fertility; the use of fertilizers, etc.

FORT HAYS BRANCH STATION.

The Fort Hays Branch Experiment Station consists of 3,600 acres of land equipped for investigative work with both crops and live-stock. The principal lines of experimentation during the biennium under review are indicated in the following table:

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
1.	Operation of State Forest Nursery	State funds.
2.	Dry-land Agriculture Investigations.	State funds.*
	1. Crop-rotation experiments.	
	2. Tillage experiments.	
	3. Methods of preparing the seed-bed for wheat.	
	4. Soil-moisture investigations.	
	5. Tests of commercial fertilizers.	
	6. Green-manure tests.	
3.	Forage Crop Investigations	State funds.*
	1. Tests of varieties of forage sorghums.	
	2. Tests of varieties of alfalfa.	
	3. Tests of varieties of mallet.	
	4. Tests of varieties of beans.	
	5. Tests of varieties of peas.	
	6. Time of planting forage crops.	
	7. Methods of planting forage crops.	
	8. Rate of seeding forage crops.	
	9. Time of harvesting forage crops.	
	10. Tests of pasture crops.	
4.	Experiment in the Eradication of Bindweed.	State funds.*
5.	Cereal Investigations	State funds.*
	1. Tests of varieties of wheat.	
	2. Tests of varieties of oats.	
	3. Tests of varieties of barley.	
	4. Tests of varieties of gram sorghums.	
	5. Tests of varieties of corn.	
	6. Cereal breeding.	
	7. Seed treatment tests.	
	8. Methods of seeding cereals.	
	9. Time of seeding cereals.	
6.	Winter Feeding Experiments with Range Cattle.	State funds.
7.	Age of Breeding Range Cattle	State funds.
8.	Feeding and Pasture Experiments with Dairy Cattle.	State funds.
9.	Feeding Experiments with Sheep	State funds.
10.	Production of Pure Seed of Wheat, Sorghums, and Other Crops.	State funds.

Experiments in the Eradication of Bindweed. The small or field bindweed (*Convolvulus arvensis*) has obtained such a start on many Kansas farms, especially in the central counties, that numerous calls are received by the Experiment Station and its branches for information as to how this weed may be controlled.

* Conducted in cooperation with United States Department of Agriculture, and that department supplements these funds.

The weed is sometimes called "wild morning-glory" because its vines and flowers bear some resemblance to the ornamental annual morning-glory plant. Bindweed, however, is a most persistent perennial that spreads steadily by means of underground root-stock. Ordinary tillage merely increases its vigor and scatters the roots to new areas. Its small, black, triangular seeds are often carried from place to place by threshing machines or in seed grains. Spots of land which are badly infested with bindweed are practically worthless for small-grain production.

Several areas of bindweed became established at the Hays Branch Experiment Station more than fifteen years ago. The spreading of the infestation was prevented by farming the infested area separately from adjoining fields and by spreading salt around the edges of the area. This infested field is being used for a series of experiments in methods of eradicating bindweed. The experiments were begun in 1919, when 31 tenth-acre plots were laid out and a trial of 26 different treatments begun. The treatments may be classified as follows:

A Cultural treatments.

- 1 Sorghum grown continuously, ordinary and late dates of seeding
- 2 Sudan grass grown continuously
- 3 Sorghum, 3 years intensive fallow 1 year
- 4 Sorghum, 2 years intensive fallow 2 years
- 5 Sorghum and intensive fallow in alternate years
- 6,7,8 Wheat continuously with three methods of seedbed preparation
- 9 Wheat and intensive fallow in alternate years
- 10,11,12 Fallow continuously with three different methods of cultivation

B Chemical treatments

- 13 to 18 Common salt applied at six rates, 8 to 28 tons per acre.
- 19 to 22 Borax applied at four rates, 1 to 6 tons per acre
- 23 to 26 Arsenical spray, four rates of application.

The outstanding results which have been secured so far from cultural treatments have been obtained from the July 1 seeding of continuously grown sorghum and from the rotations of sorghum and fallow. In the spring of 1922 only a dozen or so weak bindweed plants remained on the late-seeded sorghum plot, and there has been no apparent prospect that they will survive the season. The three months intensive fallow before seeding appears to have accomplished more in eradicating bindweed than the growth of sorghum has. The sorghum is valuable, however, in that it has produced fair yields of hay and checks somewhat the growth of the weed during a part of the season sorghum and Sudan grass grown continuously and seeded at normal dates have proved ineffective in these tests. Earlier experience in the unusually wet year of 1915 had shown that in such years sorghum or Sudan grass might smother the bindweed, but the past four years' work under more nearly normal rainfall conditions have failed to produce any such

results. These crops, however, dry out the soil so thoroughly that the bindweed roots have but little moisture to draw on and the weed seems to yield to intensive fallow more readily than where fallow comes after a less exhaustive crop, such as wheat or barley. This suggests that any sorghum and fallow system which is tried for the purpose of eradicating bindweed should begin with one year of sorghum, followed by one year of intensive fallow, and that by one or more years of sorghum or intensive land treatment, if any bindweed yet remains. The average yield of sorghum hay after one year of fallow was 4.56 tons per acre for 1920 and 1921, as compared with 2.27 tons per acre for the same years on bindweed land cropped continuously to sorghum.

None of the wheat and fallow methods has given satisfactory results, and the same is true of the methods involving the continuous production of wheat. Some progress can be made against the weed during the fallow period, but under such conditions the soil is likely to be made so fine that subsequent soil blowing destroys the wheat crop. Continuous intensive fallow has eradicated bindweed in these experiments with twenty operations the first year and about half as many the second. On intensive fallow following sorghum, bindweed has been very weak, and usually only one to five per cent stand of bindweed plants have grown after the first season of fallow. If the work on fallowed land is not thorough enough to keep the weeds cut off every time they appear, the work is practically wasted.

Of the chemical treatments, salt has proved feasible as a quick means of eradicating bindweed on small spots. Because salting is expensive and ruins the soil's productiveness indefinitely, salting seems desirable only on areas that one is willing to sacrifice in order to prevent the spread of bindweed. In these experiments quantities of salt less than twenty tons per acre gave unsatisfactory results, and even as large a quantity as twenty tons per acre did not completely eradicate the bindweed plants. Aside from bindweed, nothing but Russian thistle has been able to grow to any considerable extent on salted land. Borax was tried first in 1921 and on a very small scale, on squares five by five feet, so that the results secured are merely suggestive. Borax appeared to be no more effective than common salt, ton for ton, during the first year. But in the second year, 1922, no bindweed plants appeared on the areas treated in 1921 with as much as four to six tons of borax per acre. The arsenical spray used (United States Spray Company Weed Killer)

was not tried extensively until 1922, and the results are not yet well defined. While it may be possible that the bindweed can eventually be killed with the use of an arsenical spray, the economic features of this treatment and the effect of the treatment on the soil have not yet been determined.

GARDEN CITY BRANCH STATION.

The Garden City Branch Experiment Station works along two general lines: (1) Investigations of various methods of crop production under dry-land conditions; and (2) the conduct of experiments in irrigation agriculture. The work is conducted on a tract of 320 acres of land situated about five miles from Garden City and leased for a term of ninety-nine years by the Kansas Agricultural Experimental Station. The principal lines of experimentation during the biennium under review are indicated in the following table:

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
1.	Experiments in Irrigation Agriculture.	State funds.
	1. Crop-rotation experiments.	
	2. Tests of commercial fertilizers.	
	3. Tests of pasture grasses.	
	4. Experiments with alfalfa as a pasture for hogs.	
	5. Experiments in the irrigation of alfalfa.	
	6. Winter irrigation experiments.	
	7. Relation of quantity of irrigation water to the yields of annual crops.	
	8. Operation of electric irrigation pumping plant.	
2.	Dry-land Agriculture Investigations	State funds.*
	1. Crop-rotation experiments.	
	2. Tillage experiments.	
	3. Tests of corn varieties.	
	4. Tests of oat varieties.	
	5. Tests of wheat varieties.	
	6. Tests of barley varieties.	
	7. Methods of planting milo.	

Relation of Quantity of Irrigation Water to Yield of Annual Crops. This experiment included seven crops, viz., milo, kafir, sumac, Sudan grass, wheat, oats and barley. The crops were grown in duplicate series on twentieth-acre plots. The varieties used were those most commonly grown by farmers in the Garden City area. Winter wheat was sown each year, but it failed to survive the winters of **1916-'17** and **1917-'18**, and spring wheat was grown in its place during those 2 years. Each crop was grown on four plots, designated as A, B, C and D. The different plots received different quantities of water. All plots received one winter irrigation—a fairly heavy application of water between the time of harvest and the time of seeding. In addition to the winter irrigation, the "A" plots were irrigated sufficiently during the summer to maintain the moisture content of the soil at about 20

* Conducted in cooperation with United States Department of Agriculture, and that department supplements these funds.

per cent. The moisture content of the soil in the "B" plots was maintained by irrigation at about 16 per cent, and that of the "C" plots at about 12 per cent. The "D" plots were not irrigated during the growing season. The experiment was conducted for five consecutive seasons, and the following conclusions were drawn from the results:

1. The amount of water required to keep the soil moisture content at a given per cent of saturation varies somewhat with the kind of crop grown.

2. Crops differ greatly in the amounts of water which they can profitably use and in the range of yield which can be effected by applying various quantities of water.

3. Milo shows a marked ability to increase in yield of grain as additional quantities of water are applied, and where the crop receives sufficient irrigation water it is affected less by unfavorable climatic conditions than the other crops included in this experiment. The yield of stover was not greatly influenced by increasing the quantity of irrigation water.

4. Kafir behaves the same as milo, but it is unable to respond to the application of water to the same extent as milo so far as this is measured by the yield of grain.

5. Sumac sorgo was not able to use economically large quantities of water and showed a slight falling off in yield of stover when more than about fifteen inches of water was applied.

6. Sudan grass, grown in rows for seed in this experiment, was not a profitable irrigation crop when so grown. The results indicate that Sudan grass grown in rows for seed should not be irrigated heavily.

7. The yields of wheat, oats, and barley were influenced to a greater extent by prevailing climatic conditions than by the quantities of water available, and no quantity of water used sufficed to insure good yields in years of adverse climatic conditions.

The results of this experiment have been published in detail in Bulletin 228 of Kansas Agricultural Experiment Station.

COLBY BRANCH EXPERIMENT STATION

The Colby Branch Experiment Station is located in Thomas county, in the northwestern part of the state, and is concerned chiefly with the peculiar agricultural problems of that region. The station is located upon a tract of 314 acres of land adjoining the town site of Colby. The following table indicates the principal lines of experimentation during the biennium under review:

<i>Project No.</i>	<i>Name.</i>	<i>Source of financial support.</i>
1.	Dry-land Agriculture Investigations.	State funds.*
	1. Crop-rotation experiments.	
	2. Tillage experiments.	
	3. Soil-moisture investigations.	
	4. Green-manure tests.	
2.	The Furrow Method of Seeding Wheat	State funds.
3.	Tests of Corn Varieties	State funds.
4.	Tests of Forage Sorghum Varieties	State funds.
5.	Tests of Grain Sorghum Varieties	State funds.
6.	Tests of Varieties of Winter Wheat.	State funds.
7.	Tests of Varieties of Spring Wheat.	State funds.
8.	Tests of Varieties of Barley	State funds.
9.	Tests of Varieties of Oats.	State funds.
10.	Feeding Experiments with Dairy Cattle	State funds.
11.	Pasturing Experiments with Dairy Cattle	State funds.

Sudan Grass as a Pasture for Dairy Cattle. For several years the Kansas Agricultural Experiment Station has been working on the problem of securing a satisfactory pasture crop for the hot, dry periods which frequently occur during the growing season and materially reduce the growth of ordinary pasture plants. One of the best crops the station has found for summer pasture is Sudan grass. The station has previously reported favorable results of pasturing experiments with this crop at Manhattan and at Dodge City, but prior to 1921 no pasture experiments were conducted with it in the northwestern part of the state, where the altitude is about 3,000 feet, or 2,000 feet higher than that at Manhattan. The results secured in 1921 in a pasturing experiment at the Colby Branch Experiment Station provide some more impressive evidence of the value of Sudan grass as a summer pasture crop.

A field of 1.7 acres of native sod was plowed in April and seeded to Sudan grass at the rate of 25 pounds per acre on June 15. Thirty-one days later, or on July 16, two dairy cows, with an average weight of 1,050 pounds, were turned on the field. They remained there continuously, night and day except at milking time, for 98 days, or until October 22. In addition to the Sudan-grass pasture the cows received a daily ration of 1 pound of grain for each 4 pounds of milk produced during the 98-day period. One of the cows produced 1,976 pounds of milk and the other 3,029 pounds, a total of 5,005 pounds. This was at the rate of 2,941 pounds of milk per acre. Before going on Sudan grass the cows were pastured on excellent native pasture. That their milk flow was stimulated by Sudan grass is indicated by the fact that their combined production of milk during the last two weeks on native pasture was 790 pounds, while during the first two

* Conducted in cooperation with United States Department of Agriculture, and that department supplements these funds.

weeks on Sudangrass pasture they produced together 883 pounds. The cows gained slightly in weight during their stay on Sudan grass, their average increase in weight being about 17 pounds for the 98-day period. The significant thing about these results is that they demonstrate the high-carrying capacity of Sudan grass as a pasture crop for dairy cows in the high altitudes of northwestern Kansas, and that they show the excellent value of such pasture from the standpoint of milk production. This experiment is being continued for the purpose of determining seasonal variations in the carrying capacity of Sudan grass at the Colby station.

TRIBUNE BRANCH EXPERIMENT STATION.

The Tribune Branch Experiment Station is located in Greeley county. It contains about 100 acres of land. The station is used primarily as a place for testing crops and crop varieties to determine their adaptability to the dry, high-altitude conditions of the extreme western counties of the state, and especially to determine the best crops for use as winter feed for live stock and the best methods of growing them. The following table shows the principal lines of experimentation during the biennium ending June 30, 1922:

<i>Project.</i>	<i>Source of financial support.</i>
1. Tests of Varieties of Sorghums	State funds.
2. Tests of Varieties of Corn	State funds.
3. Tests of Varieties of Oats	State funds.
4. Tests of Varieties of Barley	State funds.
5. Tests of Varieties of Wheat	State funds.
6. Tests of Varieties of Beans	State funds.
7. Methods of Seeding Winter Wheat	State funds.
8. Methods of Seeding Corn	State funds.
9. Methods of Seeding Sorghums	State funds.
10. Experiments in the Use of Barnyard Manure	State funds.
11. Tests of Trees and Ornamental Shrubs for the High Plains of Southwestern Kansas	State funds.

Tables V and VI, showing the yields secured in 1921 in varietal tests of grain sorghums and forage sorghums, respectively, illustrate one important line of work conducted at the Tribune station:

TABLE V. Yields of grain sorghums.
(Tribune Station, 1921.)

<i>Variety.</i>	YIELD PER ACRE.	
	<i>Grain, bushels.</i>	<i>Green fodder, pounds.</i>
Sudan corn	26	15,800
Dwarf Yellow milo	22	10,800
Hegara	19	10,400
Pink kafir	18	14,400
Dwarf White milo	17	11,800
Blackhull kafir	16	13,200
Sunrise kafir	15	17,600
Dorso	15	8,200
Husserita	14	7,400
Dawn kafir	14	8,800
Early White milo	13	8,200
Red kafir	12	11,400
Local kafir	11	8,800
Spur feterita	11	8,800

TABLE VI. Yields of forage sorghums.
 (Tribune Station, 1921)

<i>Variety.</i>	<i>Yield green feed per acre, pounds.</i>
Red Amber	11,600
Sumac	10,000
Early sumac	9,600
Kansas Orange	8,800
Western Orange	8,800
Kentucky Sugar	8,600
Sourless cane	7,600
Shrock kafir	7,600
Black Amber	7,400

SPECIAL SERVICE WORK.

The laws of Kansas charge the Agricultural Experiment Station with the conduct of certain special service work, consisting chiefly of the administration of certain regulatory laws, but in one case relating to the management of the dairy herds at state institutions. A brief summary of the more important features of the work performed under these laws during the biennium ending June 30, 1922, is given below.

Fertilizer Inspection. In the administration of the fertilizer law 254 inspections were made of sales places in 18 counties, and 149 fertilizer samples were analyzed. One inspection circular, No. 12, giving a detailed report of the fertilizer inspection activities, was issued in December, 1920.

Stallion Registry. Under the stallion registry law, 3,019 stallion registrations were made during the fiscal year ending June 30, 1921, and 2,547 registrations were made during the fiscal year ending June 30, 1922. Registrations were made each year in each of the 105 counties of the state.

Dairy Inspection. Under the state dairy law the dairy commissioner and his deputies made a total of 3,555 inspections of cream-buying stations, creameries, dairies, and ice-cream factories in 101 counties.

Feeding Stuffs and Live-stock Remedy Inspection. During the biennium the feed-control office made a total of 5,123 inspections in 103 counties, and analyzed 1,178 samples of feeding stuffs and live-stock remedies from 88 counties. At the close of the biennium 2,569 feeding-stuffs registrations and 528 live-stock remedy registrations were on file.

Management of State Institution Dairy Herds. The Department of Dairy Husbandry exercises advisory supervision over the dairy herds of 13 state institutions, as follows: State Hospital at Topeka, Girls' Industrial School at Beloit, Soldiers' Home at Dodge

City, State Reformatory at Hutchinson, State Hospital at Larned, State Sanatorium at Norton, Boys' Industrial School at Topeka. State Prison at Lansing, State Hospital at Osawatomie, State Hospital at Parsons, Industrial and Educational Institute at Topeka, State Training School at Winfield, and State Orphans' Home at Atchison.

At the close of the biennium the 13 herds at these institutions contained 1,082 producing cows, of which 186 were pure bred. Improvements were made during the biennium in the breeding, feeding and management methods followed in these herds.

GETTING THE RESULTS OF STATION WORK APPLIED.

The chief function of an agricultural experiment station is to ascertain facts for use in agriculture and country life. Obviously, if the exercise of this function is to be effective, knowledge of the results of the station's work must be widely disseminated. In addition to serving as the chief source of information on agricultural science for the use of the college extension service, the Kansas Agricultural Experiment Station has two important methods of getting the results of its work before the public and thus ultimately into practical application. These methods are: (1) The writing of letters in reply to direct inquiries and the publication of reports, both technical and popular; and (2) the holding at the station of meetings of organizations interested in agricultural matters. The station's activities in these two directions during the two past years are discussed briefly in the following pages.

PUBLICATIONS.

STATION PUBLICATIONS.

The regular station publications issued during the biennium are listed in the following table:

GENERAL BULLETINS.				
No.	Title.	Edition.	Pages.	Total pages.
224.	Coöperation Applied to Marketing by Kansas Farmers.....	10,000	61	610,000
225.	Forage Crops in Western Kansas.....	20,000	54	1,080,000
226.	Fertilizers for Alfalfa in Eastern Kansas.....	10,000	30	300,000
227.	Varieties of Corn in Kansas.....	20,000	40	800,000
228.	Relation of Crop Yields to Quantity of Irrigation Water in Southwestern Kansas	5,000	29	145,000
TECHNICAL BULLETINS.				
8.	Bacteriological Studies of Methods of Preparing a Seed Bed for Wheat	3,000	64	192,000
9.	Adsorption at Liquid-vapor and Liquid-liquid Interfaces and Some Related Phenomena.....	2,000	41	82,000

CIRCULARS.			
No.	Title	Edition.	Total pages.
83.	Preparation and Shipment of Specimens for Laboratory		
	Diagnosis	6,000	11 66,000
84.	Principal Noxious Weeds of Kansas.....	10,000	19 190,000
85.	Filing Agricultural Bulletins and Circulars.....	6,000	13 78,000
86.	Cattle Feeding Investigations, 1919-'20..	15,000	11 165,000
87.	Summer Control of the Chinch Bug.....	5,000	8 40,000

INSPECTION CIRCULARS.

12.	Report on Commercial Fertilizers in 1919.....	5,000	43 215,000
13.	State Live Stock Registry Board, Report No. 10.....	4,200	119 499,800
14.	The Enforcement of the Kansas Feeding-stuffs Law.....	5,000	223 1,115,000
15.	State Live Stock Registry Board, Report No. 11.....	10,500	3 31,500

DIRECTOR'S REPORTS.

Director's Report, 1918-'19..	2,500	88	220,000
Director's Report, 1919-'20....	2,500	99	247,500

PUBLICATIONS BY DEPARTMENTS.

The following table contains a list, classified by departments, of the regular station publications and also of the technical articles contributed to scientific journals by members of the station staff:

LIST OF PUBLICATIONS BY DEPARTMENTS.

Department of Agronomy.		
Serial No.	Year of Issue.	Title, author and publication.
135	1921	Forage Crops in Western Kansas. R. E. Getty. Kan. Bul. 225.
136	1922	Rust Resistance in Winter Wheat Varieties Leo E. Melchers and John H. Parker. U. S. Dept. Agr. Bul. 1046.
137	1921	Kanota. An Early Oat for Kansas. S. C. Salmon and John H. Parker. Kan. Cir. 91.
138	1921	Fertilizers for Alfalfa in Eastern Kansas. L. E. Call, R. I. Throckmorton, C. C. Cunningham and B. S. Wilson Kan. Bul. 226.
139	1921	Varieties of Corn in Kansas. C. C. Cunningham and B. S. Wilson, Kan. Bul. 227.
Department of Animal Husbandry.		
63	1921	Cattle Feeding Investigations, 1019-'20. C. W. McCampbell and H. B. Winchester. Kan. Cir. 86
64	1921	Lamb Feeding Investigations, 1919-'20. A. M. Paterson and H. B. Winchester Kan. Cir. 88
65	1921	Swine Feeding, Investigations, 1919-'20. E. F. Ferrin and H. B. Winchester. Kan. Cir. 89.
66	1921	Cattle Feeding Investigations, 1920-'21. C. W. McCampbell and H. B. Winchester. Kan. Cir. 92.
67	1921	Kansas State Live Stock Registry Board Report No 11. B. M. Anderson. Kan. Insp. Cir. 15
Department of Bacteriology.		
35	1921	Oil Folliculitis. C G Page and L D. Bushnell. Jour. Indus, Hygiene, 3:62-75.
Department of Botany.		
184	1920	Plant Diseases Attacking the Wheat Crop in Kansas. L. E Melchers. Quar. Rpt. Kan. St. Bd. Agr., 39:220-248.

Department of Chemistry.

Serial No.	Year of Issue.	Title, author and publication.
91	1921	Relation of the Calcium Content of Some Kansas Soils to the Soil Reaction as Determined by the Electrometric Titrations. C. O. Swanson, W. L. Latslaw, and E. L. Tague. Jour. Agr. Res., 20:855-868.
92	1921	Effect of Ration on the Development of Pigs. C. O. Swanson. Jour. Agr. Res., 21:279-341.
93	1921	Hydrocyanic Acid in Sudan Grass. C. O. Swanson. Jour. Agr. Res., 22:125-138.
94	1922	Adsorption at Liquid-Vapor and Liquid-Liquid Interfaces and Some Related Phenomena. H. H. King. Han. Tech. Bul. 9.
95	1921	Hydrocyanic Acid in Sudan Grass and Its Effect on Cattle. C. O. Swanson. Jour. Amer. Soc. Agron., 13:33-36.

Department of Dairy Husbandry.

41	1921	Dairy Farming. J. B. Fitch. Kan. Cir. 90.
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Department of Entomology.

286	1919	Insects Destructive to Grain and Grain Products Stored in Bins and Granaries. Geo. A. Dean. Twenty-first Bien. Rpt. Kan. St. Bd. Agr., pp. 314-321.
287	1920	Popular Misconceptions Concerning Natural History. R. C. Smith, Scientific Monthly, 10:163-169.
288	1920	A Study of the Biology of the <i>Chrysopidae</i> . R. C. Smith. Ann. Ent. Soc. Amer., 14:27-35.
289	1921	A Method for Studying the Hessian Fly and Other Insects. J. W. McColloch. Ann. Ent. Soc. Amer., 14:227-230.
290	1921	A Malformation in <i>Lachnosterna</i> . Wm. P. Hayes. Brooklyn Ent. Soc. Bul., 16:33-40.
291	1921	Further Notes on the Value of Winter Protection for Bees. J. H. Merrill. Jour. Econ. Ent., 14:111-114.
292	1921	The Corn Leaf Aphis (<i>Aphis maidis Fitch</i>) in Kansas. J. W. McColloch. Jour. Econ. Ent., 14:89-94.
293	1921	Observations on the Fall Army Worm (<i>Laphygma frugiperda</i> Smith and Abbot) and Some Control Experiments. R. C. Smith. Jour. Econ. Ent., 14:299-305.
294	1921	Preliminary Notes on the Relative Value of the Physical Factors Concerned in Honey Gathering. J. H. Merrill. Amer. Bee Jour., 61:130, 131.
295	1921	Some Preventive and Remedial Methods for the Control of Mill and Stored-grain Insects. Geo. A. Dean. Assn. of Oper. Millers, May Bul., pp. 39-45.
296	1921	Summer Measures for the Control of the Chinch Bug. J. W. McColloch. Kan. Cir. 87.
297	1921	It Pays to Protect Bees Even in Open Winters. J. H. Merrill. Amer. Bee Jour., 61:442, 443.

Department of Milling Industry.

21	1921	The Enforcement of the Kansas Feeding-stuffs Law. L. A. Fitz and A. E. Langworthy. Kan. Insp. Cir. 14.
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Department of Poultry Husbandry.

15	1921	Further Data on the Inheritance of Blue in Poultry. Wm. A. Lippincott. Amer. Nat., 55:289-327.
17	1921	Preliminary Notes on the Correlation Between Age at First Laying and Size of First Eggs in Pullets. Wm. A. Lippincott. Jour. Amer. Assoc. Instr. and Invest. Poult. Husb., 7:73, 74.

Department of Zoology.

51	1921	A Sarcophagid Parasite of the Common Field Cricket. Chester A. Herrick. Trans. Amer. Micros. Soc., 40:116, 117.
52	1921	Observations of the Distribution and Life History of <i>Cephalobium microbivorum</i> Cobb and of its Host, <i>Gryllus assimilis</i> Fabricium. James E. Ackert and F. M. Wadley. Trans. Amer. Micros. Soc., 40:97-115.

Director's Report.

28	1921	Director's Report, 1919-'20, F. D. Farrell.
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POPULAR ARTICLES CONTRIBUTED

During the biennium 985 popular articles on agricultural subjects were contributed to newspapers and farm journals by members of the station staff. Through these articles the station is able promptly to place the simpler essentials of the results of its work before the reading public. The newspapers and farm journals have been extremely generous in their cooperation in this connection.

PUBLICATION DIFFICULTIES

While discussing publications it is important that attention be called to the fact that for several years the Kansas station has experienced great difficulty in securing satisfactory publication for its reports, bulletins and circulars. The state printer has been unable to meet the publication requirements of the station. During the past biennium the situation has improved but little, if at all. At the close of the biennium on June 30, 1922, the following manuscripts were on hand awaiting publication:

FOR BULLETINS.

Soil Survey of Montgomery County.
 Soil Survey of Greenwood County.
 Growing Corn in Kansas. C. C. Cunningham. (Revision of Bulletin 205.)
 Marketing Milk in Six Cities of Kansas. F. L. Thomsen.
 Pruning. R. J. Barnett.

FOR CIRCULARS.

Tree Planting in Western Kansas. C. A. Scott.
 The Pecan. C. A. Scott.
 The Russian Wild Olive. C. A. Scott.
 Control of the Maize Billbug. W. P. Hayes.
 Kafir Ants and Their Control. W. P. Hayes.
 Poultry Breeding Records. W. A. Lippincott.
 Cattle Feeding Investigations, 1921-'22. C. W. McCampbell, H. B. Winchester and H. W. Marston.
 Swine Feeding Investigations, 1921-'22. F. W. Bell, H. B. Winchester and H. W. Marston.
 House Plants and Their Care. W. B. Balch.

FOR TECHNICAL BULLETINS.

Hessian Fly. J. W. McColloch.
 Blackleg Vaccines: Their Production and Use. J. P. Scott.
 Relative Water Requirement of Corn and Sorghums. E. C. Miller.

While the newspapers and farm journals of the state have given the station every possible assistance in placing the popular aspects of the station work before the reading public, this assistance, though generous and immensely helpful, does not enable the station properly to fulfill its obligation to the public. It is not practicable to use newspaper articles in replying to requests for information, of which 77,274 came to the station during the past two years. Much time

could be saved and expense reduced if in answering these thousands of direct inquiries the station were able to send to inquirers copies of bulletins and circulars relating to the subjects of the inquiries, instead of being obliged, as it now is in a large number of cases, to write long letters in reply to these inquiries. Neither is it practicable to use articles from newspapers and farm journals in making the results of station work available to the thousands of students and investigators throughout the country, for whom copies of station publications should be deposited in libraries, public and private. So long as the Kansas station is handicapped as it now is in this matter it is unable properly to fulfill its obligations to American agriculture and to do its full share of the work of the forty-eight state agricultural experiment stations.

HOLDING MEETINGS AT THE STATION.

During the past biennium a special effort was made to encourage agricultural organizations to hold some of their regular meetings at the Agricultural Experiment Station, so that the members attending these meetings would become more familiar with the station and its work. During the biennium the following organizations accepted invitations to meet at the station and at each meeting one or more features of the experimental work received special attention:

Organization.	Number of meetings held at station.
Kansas State Board of Agriculture	2
Kansas State Bakers' Association.	2
Kansas Crop Improvement Association	2
Soil Fertility School of the National Fertilizer Association.	1
Kansas Potato Growers' Association	2
Kansas Association of Florists	1
Kansas Honey Producers' League	2
Kansas Improved Live Stock Breeders' Association	2
Kansas Sheep Breeders' Association.	2
Kansas Horse Breeders' Association	2
Kansas Shorthorn Breeders' Association	2
Kansas Hereford Breeders' Association.	1
Tricounty Shorthorn Breeders' Association.	2
Riley County Duroc-Jersey Breeders' Association	2
Kansas Jersey Cattle Club	2
Kansas Guernsey Cattle Club	2
Kansas Ayrshire Cattle Club	2
Kansas Holstein-Friesian Association	2
Kansas Ice Cream Manufacturers' Association.	2
Kansas Creamery Improvement Association	2
Kansas City Section of the American Chemical Society	1

In addition to the above meetings of organizations held at the station during the biennium, two annual round-ups (figure 3) and one Sorghum field day were held at the Fort Hays Branch Station;

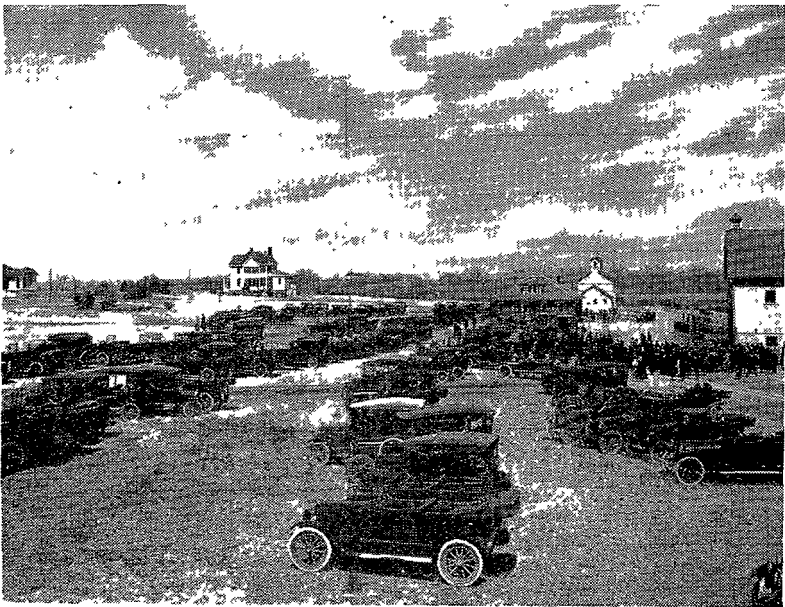


FIG. 3. View at an annual round-up at the Fort Hays Branch Station.



FIG 4 A party of visitors arriving at the agronomy farm to learn about the experiments with soils and crops

two feeders' days were held at the main station at Manhattan; and several excursions (figure 4) were made to the main station and its branches by county farm bureaus, grange locals, farmers' union locals, and other farm organizations. Besides the people who attend these meetings, many hundred visit the station individually each year. This has been particularly noticeable during the past biennium, when the acute agricultural depression caused large numbers of individuals to visit the station in search of useful information. The aggregate number of visitors exceeded 20,000 and represented every county in the state.

CHANGES IN PERSONNEL.

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

APPOINTMENTS

L. C. Aicher, superintendent Fort Hays Branch Experiment Station.
B. M. Anderson, assistant professor of animal husbandry.
Walter B. Balch, greenhouse foreman
B. F. Barnes, superintendent Colby Branch Experiment Station.
R. J. Barnett, professor of horticulture.
R. B. Becker, instructor in dairy husbandry
N. E. Dale, assistant professor of agronomy.
Eric Englund, professor of agricultural economics.
Morris Evans, instructor in agricultural economics.
A. C. Fay, associate professor of bacteriology.
R. M. Green, associate professor of agricultural economics.
Homer J. Henney, research assistant in agricultural economics.
C. A. Herrick, research assistant in zoology.
J. Clifford Jenkins, assistant chemist.
P. C. McGilliard, instructor in dairy husbandry.
David L. Mackintosh, instructor in animal husbandry.
P. L. Mann, assistant professor of milling industry.
Joseph F. Merrill, assistant chemist.
J. H. Moyer, research assistant in agricultural economics.
N. E. Olson, associate professor of dairy husbandry.
Loyal F. Payne, associate professor of poultry husbandry.
Caroline Perkins, assistant in genetics.
Luella Schaumburg, research assistant in poultry husbandry.
Richard P. White, assistant in plant pathology.
W. S. Wiedorn, assistant professor of landscape gardening.

RESIGNATIONS

F. W. Atkeson, assistant professor dairy husbandry.
John J. Bayles, superintendent Colby Branch Experiment Station.
Mrs. Clara Higgins-Clapham, research assistant in poultry husbandry.
Martha Denny, assistant in genetics.
Leila Dunton, associate professor of milling industry.
E. F. Ferrin, associate professor of animal husbandry.
W. W. Fetrow, research assistant in agricultural economics,
F. E. Fox, assistant professor of poultry husbandry.
Blanche French, research assistant in agricultural economics.
O. W. Hunter, associate professor of bacteriology.
H. L. Kent, superintendent Fort Hays Branch Experiment Station.
G. A. Maxey, assistant professor of dairy husbandry.
F. L. Thomsen, assistant professor of agricultural economics.
B. S. Wilson, assistant in cooperative experiments.
B. C. Zimmerman, instructor in animal husbandry.

FINANCIAL STATEMENT, 1920-'21.

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

	<i>Federal appropriations.</i>	<i>appropriations and receipts.</i>	<i>Totals.</i>
Manhattan station	\$30,000.00	\$72,231.48	\$102,231.48
Branch stations, appropriations		27,000.00	27,000.00
Branch stations, sales		65,701.42	65,701.42
Totals	\$30,000.00	\$164,932.90	\$194,932.90
Salaries	\$18,006.67	\$30,024.93	\$48,031.60
Labor	8,499.01	66,014.26	74,513.27
Publications	10.30	288.24	298.54
Postage and stationery	259.54	931.91	1,191.45
Freight and express	5.80	1,310.65	1,316.45
Heat, light, water and power	14.90	4,877.86	4,892.76
Chemicals and laboratory supplies	455.54	1,041.28	1,496.82
Seeds, plants and sundry supplies	619.39	11,689.90	12,309.29
Feeding stuffs	1,250.04	3,473.52	4,723.56
Library	2.00	41.14	43.14
Tools, machinery and appliances	422.20	8,910.10	9,332.30
Furniture and fixtures	23.64	918.32	941.96
Scientific apparatus and specimens	84.73	215.54	300.27
Live stock	96.50	3,511.59	3,608.09
Traveling expenses	168.17	3,680.87	3,849.04
Contingent expenses	1.46	10,276.62	10,278.08
Buildings and land	80.11	9,886.36	9,966.47
Balance, June 30, 1921		7,839.81	7,839.81
Totals	\$30,000.00	\$164,932.90	\$194,932.90

FINANCIAL STATEMENT, 1921-'22.

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

	<i>Federal appropriations.</i>	<i>appropriations and receipts.</i>	<i>Totals.</i>
Manhattan station	\$30,000.00	\$68,596.23	\$98,596.23
Branch stations, appropriations		34,500.00	34,500.00
Branch stations, sales		35,823.78	35,823.78
Totals	\$30,000.00	\$138,920.01	\$168,920.01
Salaries	\$19,937.49	\$34,147.50	\$54,084.99
Labor	7,789.64	50,713.14	58,502.78
Publications	9.68	200.46	210.14
Postage and stationery	149.41	733.49	882.90
Freight and express	9.90	1,351.65	1,361.55
Heat, light, water and power	3.50	3,315.98	3,319.48
Chemical and laboratory supplies	251.89	822.24	1,074.13
Seeds, plants and sundry supplies	443.02	7,576.25	8,019.27
Feeding stuffs	650.46	1,228.02	1,878.48
Library		75.70	75.70
Tools, machinery and appliances	134.96	5,839.08	5,974.04
Furniture and fixtures	25.50	371.01	396.51
Scientific apparatus and specimens		80.00	80.00
Live stock	75.44	1,125.35	1,200.79
Traveling expenses	62.19	2,997.68	3,059.87
Contingent expenses		15,554.47	15,554.47
Buildings and land	456.92	4,733.55	5,190.47
Balance, June 30, 1922		8,054.44	8,054.44
Totals	\$30,000.00	\$138,920.01	\$168,920.01