

# AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE  
AND APPLIED SCIENCE  
MANHATTAN, KANSAS

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## THIRTEENTH BIENNIAL REPORT OF THE DIRECTOR 1944-1946



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# KANSAS AGRICULTURAL EXPERIMENT STATION

MANHATTAN, KANSAS

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## LETTER OF TRANSMITTAL

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OFFICE OF DIRECTOR,  
June 30, 1946.

*To His Excellency, Andrew F. Schoeppel, Governor of Kansas:*

I have the honor to transmit herewith the report of the Agricultural Experiment Station of the Kansas State College of Agriculture and Applied Science for the biennium ending June 30, 1946. The report contains a statement of changes in personnel, a brief account of the work that has been in progress during the biennium, a list of the station publications and of the scientific contributions of the station staff published during the biennium, and a statement of receipts and expenditures for each year of the biennium.

L. E. CALL, *Director.*

# DIRECTOR'S REPORT<sup>1</sup>

## INTRODUCTION

This report contains brief statements of the work of the Kansas Agricultural Experiment Station for the biennium ending June 30, 1946. The station receives support from both state and federal sources and is both a state and a federal agency. The station is a part of the Kansas State College of Agriculture and Applied Science at Manhattan. The central station is located at Manhattan. Work is conducted at the central station; at the branch stations located at Hays, Colby, Garden City, and Tribune; at 13 outlying experiment fields; and on privately-owned farms in 100 counties.

All of the work of the station is conducted on a project basis. This report contains a brief statement of the objectives of each of the more important projects, summaries of the more important results received upon each project during the biennium, the source of the funds for the support of each project, and the names of workers most actively engaged upon the work of the project.

## COOPERATION WITH OTHER AGENCIES

The station has coöperated actively during the biennium with other state agencies of Kansas, state agricultural experiment stations of other states, the United States Department of Agriculture and other federal agencies, commercial agencies, and farmers. A state agency with which coöperative investigational work has been conducted on an extensive scale is the Kansas Industrial Development Commission, which arranged with the college through the agricultural experiment station for conducting investigational work with agricultural products. This coöperation and that of the other agencies have been highly advantageous to the station.

## EFFECTS OF THE WAR UPON STATION WORK

During the war period many adjustments were made in the work of the station to enable it to aid most effectively with the war effort and to operate with reduced personnel. These adjustments were made necessary because of the loss of personnel to the armed forces and to essential work closely associated with the war effort, and because of the need to make the results of research quickly available to aid in increasing production. Emphasis was placed upon increased production. Activity on some of the basic research projects was reduced to a minimum in order to permit the workers to devote most of their time to projects that promised results immediately applicable. Although it was necessary to reduce basic research work, an effort was made to continue as much of this type

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1. Contribution No. 83 from the Office of the Director.

## AGRICULTURAL EXPERIMENT STATION

of research as was possible. Many long-time studies, the discontinuance of which would have meant sacrificing the results of many years of research, were not discontinued but were continued on a restricted basis. Although the activity of basic research was reduced for only a relatively short period of time, the effects are easily observed and emphasize the necessity of long-time, continuing basic research programs. It is the results of basic research applied to practical problems that enable the station to serve the public.

Recognizing the fact that many agricultural problems would face the state and the nation during the postwar period, many station workers devoted much time to postwar planning. In this planning, the contributions of agricultural research were used extensively as a basis.

Since the close of the war, activities in postwar planning have been continued. Some of the basic research that was temporarily reduced has been restored to its former place of importance; and some new phases of research, to aid in solving some of the problems that developed during and after the war, have been initiated.

**BUILDINGS, EQUIPMENT, AND LAND**

No extensive improvements were made to the plant of the station during the biennium because of lack of materials, restriction on construction, and lack of labor. Only a few urgently needed pieces of research equipment were purchased.

The small animals laboratory building mentioned in the last two biennial reports has not been constructed. An appropriation of \$50,000 was made for this building by the Legislature of 1941 and the amount was increased to \$125,000 by the Legislature of 1945. It is expected that this much-needed building will be completed as soon as conditions will permit, although because of increased building costs the funds now available will not be sufficient to construct an adequate building.

Funds were made available by the Legislature of 1945 for the purchase of land for the grass utilization and pasture management project. The land has not been purchased at this time and the project has not been initiated because of difficulties encountered in obtaining a satisfactory site for the project. It is expected that the land will be purchased before the close of the current calendar year.

Some of the improvements and repairs that have been made during the biennium at the central station include widening and deepening the drainage ditch across the Agronomy Farm to reduce flood losses, at a cost of \$1,600, and painting all buildings on the farm at a cost of \$2,100.

Freezer-lockers were installed in a section of the Pavilion for use in research and instruction at a cost of \$3,200. A portion of the materials has been purchased for the stone house on the Horticultural Farm, and it is anticipated that the building will be completed during the current fiscal year at a cost of \$6,000. The funds for this building were made available by the Legislature of 1941.

The Legislature of 1945 provided \$10,000 to modernize the college mill, but the improvements have not been made because the needed equipment could not be obtained. It is anticipated that the work will be completed during the current fiscal year.

At the Garden City Branch Station, progress is being made on the construction of an office and laboratory building, funds for which were provided by the Legislature of 1945. The cost will be \$7,500.

### PERSONNEL CHANGES

Major changes in administrative personnel during the biennium were as follows:

1. On June 30, 1946, L. E. Call, Dean of the School of Agriculture and Director of the Agricultural Experiment Station since 1925, retired as Dean and Director with the title of Dean Emeritus of Agriculture, Director Emeritus of the Agricultural Experiment Station, and Professor of Rural Investigations. He will devote three-fourths time to research and teaching. The retirement of Dean Call resulted in the advancement of R. I. Throckmorton from Head of the Department of Agronomy to Dean of Agriculture and Director of the Agricultural Experiment Station, and in the advancement of H. E. Myers from Professor of Soils to Head of the Department of Agronomy.

2. Professor R. J. Barnett, Department of Horticulture, became Professor Emeritus of Horticulture July 1, 1944.

3. Professor C. O. Swanson, Department of Milling Industry, became Professor Emeritus of Milling Industry July 1, 1945.

4. Professor L. D. Bushnell retired as Head of the Department of Bacteriology June 30, 1946. He will remain on the staff as Professor of Bacteriology. Doctor Bushnell was succeeded as Head of the Department of Bacteriology by P. L. Gainey, Professor of Bacteriology and Soil Bacteriologist of the station.

5. Dr. R. K. Nabours, who retired as Head of the Department of Zoölogy and Zoölogist of the Agricultural Experiment Station July 1, 1944, is remaining on the staff as Professor Emeritus of Zoölogy on a half-time basis. Doctor Nabours was succeeded as head of the department for one year by Dr. J. E. Ackert, Professor of Zoölogy and Parasitologist of the station. Doctor Ackert retired as head of the department June 30, 1945, but retained his position of Parasitologist. Dr. D. J. Ameel, who was acting Head of the Department of Zoölogy from July 1, 1945, to June 30, 1946, was appointed head of the department effective July 1, 1946.

*Leaves of absence* have been granted, or continued, to the following members of the staff, to enter the armed forces or to engage in work essential to the war effort:

- \*Raymond J. Doll, Agricultural Economics.
- \*Wilfred H. Pine, Agricultural Economics.
- \*C. Peairs Wilson, Agricultural Economics.
- Don E. Crumbaker, Agronomy.

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\* Returned from leave before June 30, 1946.

Hilton D. Hollembeak, Agronomy.  
 Ralph E. Krenzin, Agronomy.  
 \*Harold E. Myers, Agronomy.  
 Hugh G. Myers, Agronomy.  
 \*Robert F. Sloan, Agronomy.  
 R. Boyd Cathcart, Animal Husbandry.  
 \*Rufus F. Cox, Animal Husbandry.  
 \*David L. Mackintosh, Animal Husbandry.  
 \*Glen H. Beck, Dairy Husbandry.  
 \*W. H. Martin, Dairy Husbandry.  
 Charles J. Birkeland, Horticulture.  
 Robert P. Ealy, Horticulture.  
 Roland T. Johnson, Milling Industry.  
 Wilbert Greer, Poultry Husbandry.  
 Walter M. Carleton, Agricultural Engineering.  
 \*J. W. Martin, Agricultural Engineering.  
 M. J. Twiehaus, Bacteriology.  
 \*J. W. Greene, Chemical Engineering.  
 Arthur W. Pryor, Chemical Engineering.  
 Edward S. Stickley, Chemistry.  
 C. H. Whitnah, Chemistry.  
 \*R. C. Smith, Entomology.  
 \*H. C. Fryer, Station Statistician.  
 \*C. H. Kitselman, Veterinary Medicine.  
 \*Leo Petri, Zoölogy.

*Appointments.*— The average number of persons employed on the scientific staff of the station was 150. Thirty-two permanent appointments were made during the biennium as follows:

Elbert B. Macy, Station Editor.  
 Morris J. Anderson, Agricultural Economics.  
 Milton L. Manuel, Agricultural Economics.  
 M. L. Axelton, Agronomy.  
 Paul L. Brown, Agronomy.  
 V. F. Bruns, Agronomy.  
 Nicholas Holowaychuk, Agronomy (USDA).  
 Lloyd A. Tatum, Agronomy (USDA).  
 John L. Barnhart, Dairy Husbandry.  
 T. J. Claydon, Dairy Husbandry.  
 G. H. Wise, Dairy Husbandry.  
 E. F. Kientz, Horticulture.  
 W. W. Willis, Horticulture.  
 Eric Kneen, Milling Industry.  
 Byron S. Miller, Milling Industry (USDA).  
 Thos. B. Avery, Poultry Husbandry.  
 Stuart M. Pady, Botany.  
 Ralph A. Warner, Chemical Engineering.  
 Fred A. Kummerow, Chemistry.  
 H. L. Mitchell, Chemistry.  
 A. L. Olsen, Chemistry.  
 Francis Smith, Chemistry.  
 E. L. Eshbaugh, Entomology.  
 Esther Cormany, Home Economics.  
 Jeanne Smith, Home Economics.  
 Edith Wilson, Home Economics.  
 Earl J. Splitter, Veterinary Medicine.  
 D. J. Ameel, Zoölogy.  
 A. B. Erhart, Fort Hays (USDA).

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\* Returned from leave before June 30, 1946.



Frank B. Kessler, Fort Hays.  
F. E. Meenen, Fort Hays (USDA).  
Harold L. Stout, Garden City (USDA).

**Resignations.**— Thirty-two of the staff resigned during the biennium. Those resigning were as follows:

Don E. Crumbaker, Agronomy.  
A. B. Erhart, Agronomy.  
J. C. Hide, Agronomy.  
Hilton D. Hollembeak, Agronomy.  
R. W. Jugenheimer, Agronomy (USDA).  
H. E. Bechtel, Dairy Husbandry.  
W. J. Caulfield, Dairy Husbandry.  
Charles J. Birkeland, Horticulture.  
S. W. Decker, Horticulture.  
Robert P. Ealy, Horticulture.  
Emile F. Kientz, Horticulture.  
J. E. Anderson, Milling Industry.  
E. G. Bayfield, Milling Industry.  
Jehiel Davidson, Milling Industry (USDA).  
E. C. Swanson, Milling Industry.  
Walter M. Carleton, Agricultural Engineering.  
L. H. Schoenleber, Agricultural Engineering.  
M. J. Twiehaus, Bacteriology.  
E. C. Miller, Botany (retired).  
Arthur W. Pryor, Chemical Engineering.  
Joe Bryske, Chemistry.  
Marvin Schreiber, Chemistry.  
A. E. Schumacher, Chemistry.  
R. E. Silker, Chemistry.  
John Wagoner, Chemistry.  
Helen Herren, Home Economics.  
Martha Pittman, Home Economics.  
Edith Wilson, Home Economics.  
V. K. McMahan, Veterinary Medicine.  
A. L. Hallsted, Fort Hays (USDA-retired).  
Robert E. Wagner, Fort Hays (USDA).

## SCOPE OF THE STATION WORK JULY 1, 1944, TO JUNE 30, 1946

### STUDIES IN THE ECONOMICS OF AGRICULTURE

Twelve principal lines of research were under way during the biennium, all of which were continuations from the preceding biennium. Brief reports of progress follow.

*Studies of Factors Affecting the Organization and Operation of Kansas Farms.*— The work for the biennium July 1, 1944, to June 30, 1946, consisted of several phases which were more or less closely correlated. They may be differentiated as follows:

1. *Production adjustments in Kansas agriculture.*— This included work on goals, a postwar pattern of Kansas agriculture, and special study of the economics of flax production. Much of this was by type-of-farming areas. It required coöperation with other departments of the experiment station; the Extension Division, Kansas State College; the Bureau of Agricultural Economics, United States Department of Agriculture; and other agencies.

The study of adjustments, continued from the last biennium, was similar to those carried on by other agricultural experiment stations throughout the nation during this period. It tended to correlate results and information from numerous sources, and furnished a basis for setting agricultural goals and directing policy for agriculture. In general, the postwar pattern suggests less wheat, supplemented with livestock enterprises provided with an abundance of feed and pasture. The trend in increased adoption of improved practices, taken with the continuing trend toward larger farms, indicates that the place for increased numbers of farmers is limited even with the resumption or acceleration of retirement and shorter hours.

The special study on flax indicated a probable downward adjustment in flax acreage and production in Kansas compared with the high wartime level. The main factor affecting flax acreage in eastern Kansas appears to be the price compared with prices of competing crops, mainly wheat, corn, and oats. Expansion appears to have been primarily on the larger and more fully mechanized farms. Use of flax as a nurse crop and the better seasonal use of labor by including it in the farm organization are in its favor.

2. *Analyzing farm records from farm management associations.*— In cooperation with the Extension Division, Kansas State College, approximately 700 records were received for both 1944 and 1945. Brief reports were prepared by type-of-farming areas for the group meetings of association members and additional studies were made later. Records were received from 68 counties,

Net farm incomes on Farm Management Association farms continued to be good in 1944 and 1945, but in most type-of-farming areas they were less than in the preceding biennium and were less in 1945 than in 1944. Size of farm, a good selection of enterprises, and good farm practices continued to be the most important factors in determining relative incomes.

3. *The impact of two wars upon trends in Kansas agriculture.*— The purpose of this study was to show the impact of the two world wars upon price, production, wages, indebtedness, and other related trends in Kansas agriculture; and by means of similarities and differences between the two war periods to anticipate some of the postwar conditions of World War II. Crop and livestock production and prices, wages, and mortgage indebtedness were shown. The five-year prewar averages for World Wars I and II, respectively, were used as bases for the series representing the periods concerned. Comparisons were made by means of tables and graphs. Case studies of a number of farms,

with records covering war and prewar years of World War II, were used for additional information.

Cash farm income in Kansas made spectacular and strikingly similar gains during both wars, but it rose much faster and to a greater height during World War II. Increases in volume of production were more responsible than price increases for the rise in cash farm income accompanying World War II; higher prices had the major role in pushing up the cash farm income during World War I.

Farm wage rates rose faster and to a higher level during World War II than during World War I. Cited among the explanations for this difference were the greater degree of scarcity of farm laborers during World War II, the higher cash income, and the increased efficiency in the use of farm labor.

Relative to the prewar average, farm real estate values in Kansas rose faster and to almost as high a level in World War II as during all the phases of World War I. As yet, the average per-acre value of farm real estate has not reached the level attained during World War I period.

The most significant economic difference of the two war periods is the contrast between the upswing in farm mortgage debt during World War I and the downswing accompanying World War II. From all indications, the problem of agricultural adjustment in the postwar period of World War II will not be complicated by as high fixed charges as followed the land boom of World War I.

4. *Capital needed to farm in the midwest.*— This study was made by a subcommittee of the North Central Regional Land Tenure Committee. The Kansas Agricultural Experiment Station was represented on both committees. Starting with actual records, the investigation shows the quantity and distribution of capital needed for various types of farms and indicates ways of obtaining and using it. It shows that under 1945 prices, most types of farms require a total investment of at least \$14,000 to \$25,000 for successful operation, with an even greater amount desirable, but the bulletin indicates how the operator may secure control over varying amounts of capital for different arrangements such as the usual types of tenancy, father-son agreements, partnerships, and owner operation.

5. *Maintaining files by type-of-farming areas.*— Series of data relating to such items as acreage, yield and production of crops, numbers of livestock, and others are tabulated by type-of-farming areas. The data of the type-of-farming area files are widely used in studies including farm management, adjustments, and many others.

(Project 95. Department of Agricultural Economics. Leaders, J. A. Hodges, R. J. Doll, M. L. Manuel, Dorothy Belle Gudgell. Purnell and State funds.)

***Development of an Agricultural Land-Use Program for the State of Kansas.***— The investigations were conducted jointly by the Department of Agricultural Economics and the Department of Agronomy. Various phases of the investigations were conducted in coöperation with the Soil Conservation Service, Kansas Extension Service, and other agencies. Results of the investigations were as follows:

1. Rural communities tend to mature and develop into a rather stable pattern as to size of farm, tenure and age of operator, and size and composition of the family.

2. Higher wheat yields, particularly in western Kansas, and scarcity of farm labor in 1944 caused more grain to be harvested with combines and hauled directly to elevators than in 1943 or 1942. Wage rates continued to increase in 1944. The wage rates also continued to be higher in western Kansas than in

eastern Kansas. A larger percentage of the workers lived near the farms where they worked in 1944. More women, boys, and elderly persons were in the labor force in 1944. Wives, daughters, and other relatives of the farm operators continued to be the largest group of female farm workers. Nearly one-fourth of the labor supply, excluding farm operators, in 1944 was made up of boys less than 18 years of age.

3. Two maps are provided in the reconnaissance soil survey reports. One map shows the soil groups, slope, and erosion. The other shows the land-use capabilities of the land based upon the extent of conservation practices needed for safe and continued use of the land. This soil survey provides in reconnaissance the characteristics of the soils of Kansas. The report for each county includes a discussion of the soils, crop production, crop rotations, conservation practices, and other information which should help in evaluating the soils and in determining their best use. Acreage data provide the area of land in the different landuse capability classes, in each slope and erosion class, and in each general land-use class. Work during the second year of the biennium and in the future will be included in a state project, "Soil Survey Special No. 19."

4. There has been an increasing demand for an objective evaluation of the productivity of farm land for purposes of assessment for taxation, appraisals for farm loans, land use, and other purposes. For these purposes work in this project has been started in classifying the soils in the reconnaissance survey, and in other surveys as they are made, according to productivity. Considerable literature has been obtained from the various experiment stations and from other agencies on this subject. A study of this literature indicates that a first classification should be a physical grouping based upon the more permanent inherent soil characteristics. Such a classification would be a basis for economic classifications.

(Project 215. Departments of Agricultural Economics and Agronomy. Leaders, W. H. Pine and H. E. Myers. Bankhead-Jones funds.)

***Studies of Land Taxation, Tenure, Income, Values, Conservation, Transfer, and Other Land Problems.***—This project is a continuation of work reported for the preceding biennium.

1. *Land taxation and related finance problems.*—Attention has been devoted to ways of improving the assessment of agricultural land. Use of soil maps for differentiating between land types for assessment purposes is under continuing investigation. An intensive study of problems pertaining to the assessed valuation of agricultural land in Madison township, Riley county, is in progress. Data from the records of the county clerk for the period of 1925-'46 have been tabulated and analyzed. Pertinent facts are being uncovered by means of which the extent of the need for improvement in the assessment of farm land may be ascertained. It appears that the time is rapidly approaching in which there will be not only acceptance but also a certain insistence upon the adoption of improved methods in the assessment of agricultural land.

2. *Land tenure, land acquisition, and related problems.*—Requests for information concerning farm leasing procedures and equitable plans for apportioning income and expense have been numerous and are increasing with the return of men from the armed forces. Two new lease forms have been prepared. One new form is applicable to dairy enterprises; the other is a wage, income-sharing lease designed to fit the needs of returning war veterans who have neither equipment nor livestock with which to become established in farming.

An unpublished manuscript entitled, "A Study of the Acquisition of Land and Its Transfer in Madison Township, Riley County," has been prepared.

3. *Land income, land values, land valuation and related problems.*—The rapid advance in land prices during and following World War II presents a

situation in many respects comparable to the corresponding experience of World War I. Land prices have advanced sharply though not uniformly throughout Kansas. Increases in price have been much greater in western Kansas than elsewhere in the state.

Land price data from the tax study of Madison township, Riley county, have been transcribed for the period of 1941-'45. These data were added to that previously assembled for the period 1860 to 1941, establishing a complete historical record of land price trends in this area. The relation between assessed valuation and sale price has been determined. Tentative plans are to supplement these results with a classification of land based on productive capacity.

Sale price data assembled as a part of this study have been used in part as basic materials for a study of the cyclical nature of land price fluctuations.

Generally speaking, land price advances have occurred at an average annual rate of 12 to 15 percent per year since this nation entered World War II. At this time the state-wide average sale price of Kansas land ranges approximately 75 percent above the 1935-'39 average.

(Project 132. Department of Agricultural Economics. Leaders, Harold Howe and N. J. Anderson. Purnell funds.)

**Marketing Kansas Grain.**— In the summer and early fall of 1945 attention of Kansas farmers was directed to a probable shortage of feed grains during the winter and spring of 1946. The desirability of maintaining adequate reserves of feed grain was emphasized. Also it was pointed out in August and September of 1945 that in spite of the large wheat crop wheat prices would be against the ceiling, and that supplies of wheat in terminal markets in relation to demand would be more scarce than even in 1943 and 1944.

In each year that wheat loans have been available, the time required for the market price to reach the loan level has decreased. Government price actions of recent years have encouraged farmers either to sell at harvest time or to hold until the end of the season. This has resulted in a marked shortage of milling wheat offered for sale during the fall and winter months, even though total stocks of wheat were large.

There has been a marked shift in the seasonal pattern of cash-future relationships in wheat prices. There are indications that the change is not due entirely to governmental price actions influencing wheat.

(Project 143. Department of Agricultural Economics. Leader, George Montgomery. Purnell funds.)

**Marketing Kansas Livestock and Livestock Products.**— Research in the field of livestock marketing during the biennium has included the following three phases:

1. *Analysis of factors affecting current livestock prices.*— During the past biennium, a multitude of governmental regulations and restrictions has been the dominating influence in determining prices received by farmers for their livestock. Interpretation of these regulations as they affect the market in general and farmers' returns in particular has been an important phase of the work of the project.

Results of this phase of the project are the publication of market opinions and forecasts for use by farmers and marketing agencies. The Cattle Producers Industry Advisory Committee has used information furnished by this project in its work.

2. *Livestock transportation.*— A study of the use of trucks in transporting livestock to the Kansas City market was completed early in the biennium. This study was in coöperation with the Missouri Experiment Station, the

United States Department of Agriculture, and other experiment stations participating in the corn belt regional livestock marketing research work. Results of this study were summarized in the twelfth biennial report.

3. *Study of hog price differentials.*— Coöperation with the other experiment stations in the North Central states was continued on a comprehensive study of hog price differentials between markets and between weights and grades on given markets. Preliminary data have been gathered but the analysis has not progressed to the point where definite conclusions can be drawn. No publications have resulted from this phase of the project to date.

(Project 149. Department of Agricultural Economics. Leaders, C. P. Wilson and M. L. Otto. Purnell funds.)

***An Economic Analysis of the Meat Packing Industry in Kansas.***— This project was started in September of 1939 to study the advantages and limitations of Kansas facilities and their relationship and adaptability to the meat packing industry.

In the past biennium, most of the work on this project has concerned the locker plant development of the state. Results of this study are based on a survey of 147 locker plant operators.

On July 1, 1945, there were 325 locker plants in operation in Kansas compared with 185 plants in 1941, at which time a similar study was made. The average number of lockers per plant in 1941 was 312, compared with 421 in 1945. In 1941 plants were operating at 56 percent of their capacity, but in 1945 locker plants had an average waiting list equal to 19 percent of the number of lockers in the average size plant.

The study indicated that 78.6 percent of the locker rentees were farmers. Based on the assumption that all farmers in the state are potential locker users and that the proportion of the urban dwellers who were renting lockers at the time of the study would continue to rent lockers, it was estimated that there were approximately three families of four members each for each two lockers in the state. This estimate does not take into consideration the fact that many families rent more than one locker.

It was found that the locker rental charge had increased materially from 1941 to 1945 due to an increased demand for lockers and an improvement in facilities and services offered.

As a result of this study, it was estimated that approximately 14.8 percent of the poultry and meat consumed in Kansas went through the lockers in locker plants in 1945, compared with an estimated 4.3 percent in 1941.

(Industrial Fellowship Project 5. Department of Agricultural Economics. Leader, M. L. Otto.)

***Economics of the Poultry Industry in Kansas.***— Work on the project during the biennium has included a study of the effects of regulations, controls, and government-sponsored programs on the volume of production, the time of marketing, and the price level of poultry and eggs in Kansas. The egg-feed ratio and the chicken-feed ratio were recalculated and established on a new base period.

In spite of the fact that prices for chickens, turkeys, and eggs were relatively stable and at a profitable level, Kansas poultrymen were faced with many uncertainties during the war period. The probable influence of shortages of feed, government-sponsored programs, and temporary surpluses of eggs were analyzed for Kansas poultrymen in an effort to stabilize the poultry industry of the state on a profitable and efficient basis. The effects of the strong consumer demand and the high per capita consumption of poultry and eggs were emphasized to maintain producers' confidence in periods of uncer-

tainty and shifting programs. Weekly statements on current economic conditions and expected developments in the poultry and egg markets were provided to more than 800 members of the farm management associations and released through radio and the press each week. Longer time outlook information has been provided through the monthly issues of the Kansas Agricultural Situation and the Poultry and Egg Outlook which is published seasonally.

(Project 144. Department of Agricultural Economics. Leader, George Montgomery. Purnell funds.)

**Marketing of Kansas Fruits and Vegetables.**— Work on the project has provided weekly, monthly, and seasonal summaries of statistics on production, movement, receipts, and prices of fruits and vegetables. Information has been made available for answering inquiries in regard to seasonal supplies, movement to market, and price trends of fruits and vegetables. Information about demand and supply outlook has been made available to producers.

(Project 177. Department of Agricultural-Economics. Leader, George Montgomery. Purnell funds.)

**A Study of the Principles Governing the Marketing of Dairy Products in Kansas.**— The work on this project has consisted primarily of analysis and interpretation of current economic developments affecting the dairy industry of Kansas, including especially the effects of price ceilings, subsidies, set aside orders, and other government regulations.

Current governmental and other regulatory influences have overshadowed the normal economic forces of supply and demand, but statistics of production, receipts, storage holdings, and consumption have been maintained and analyzed currently so that information gained from such analysis may be used when the marketing of dairy products returns to competitive conditions.

Wartime regulations and the resulting current economic conditions in the dairy industry indicate the development of long-time trends significant to Kansas dairymen. Feed shortages and higher feed and labor costs, and relatively high income from alternative enterprises have reduced milk cow numbers in Kansas. Price ceilings, set asides, and other distribution orders have changed materially the uses and distribution of milk and dairy products. These governmental influences plus the high level of consumer income resulting in large per capita consumption of milk, ice cream, and dairy products other than butter, will have important long-time influences on the production, marketing, and distribution of dairy products in areas such as Kansas, which prior to the war were areas where the production of sour cream was a major phase of the dairy industry.

In coöperation with the Extension Service, timely economic information has been furnished to Kansas dairymen. Materials prepared for weekly, monthly, and seasonal releases plus radio talks and news stories for the farm press have provided wide distribution of economic information on current and prospective developments affecting Kansas dairymen.

(Project 185. Department of Agricultural Economics. Leader, George Montgomery. Purnell funds.)

**Studies of Factors Affecting the Social Well-Being of Rural People in Kansas.**— Work on the project for the biennium was a continuation of population analysis and health surveys in the state.

*Composition and movement of rural population.*— Field work on this sub-project is in abeyance depending on plans of the Division of Farm Population and Rural Welfare. Consequently no new data were obtained during the biennium.

*Nature and extent of health facilities in rural Kansas.*— Work has continued on the survey of the health resources and problems in Kansas. Tabulations, charts, and maps concerning diseases and health facilities have been made. These concern the number and distribution of physicians, dentists, nurses, hospitals, optometrists, pharmacists, osteopaths, and chiropractors. Additional information regarding physicians and hospitals was obtained from the 1942 directory of the American Medical Association and the Kansas State Board of Health. The information shows many inadequacies in health facilities, the need for more physicians and hospitals, and the importance of health education. The information also indicates considerable progress is being made toward meeting these needs in the way of public health organization and expansion of preventive programs.

(Project 195. Department of Agricultural Economics. Leader, R. C. Hill. Purnell funds.)

*Agricultural Finance and Related Problems.*— During the past biennium the lack of personnel and travel funds have kept this project largely inactive. The project is planned to make a study of short and long time credit for agriculture.

(Project 227. Department of Agricultural Economics. Leader, M. L. Otto. Bankhead-Jones funds.)

*Case Studies of Kansas Rural Institutions.*— The project consists of case studies of various kinds of rural institutions for the purpose of analyzing the organization and work of each institution studied. During the biennium two case studies were completed; one of the Fort Hays Branch Experiment Station and one of a small rural electric coöperative which has been in successful operation in Nemaha county since 1919 and which has had no outside financial aid. Summary of results:

*Hays study.*— The major values of the work of the station were ascertained, the costs of operation were determined, and the dominant reasons for the station's success were found to be favorable location, adequate size and equipment, coördination of the station work with the College and the United States Department of Agriculture, competence and continuity of key personnel, continuity of policy and of research projects, and wide use of educational agencies. The station's average annual cost to the citizens of Kansas, less than two cents per capita, was shown to be a good investment.

*Electric coöperative.*— The study revealed that in a rural community within a reasonable distance of a dependable source of electric energy and where a not-too-sparse population practices good farming it is feasible for the farmers to finance the local distribution of electricity without outside financial help. The essential factors for the quarter-century of success of the coöperative studied were found to include a sturdy, able, coöperative-minded farm population, substantial construction and adequate maintenance of the distribution system, willingness of members to serve without pay as directors and officers, employment of a competent line-maintenance man, maintenance of an adequate financial reserve, and the consistent practice of simplicity, directness, and good will.

(Project 234. Department of Agricultural Economics. Leader, F. D. Farrell. Bankhead-Jones funds)



## SOIL INVESTIGATIONS

Soil problems treated from the standpoint of conservation of the soil were continued through the biennium. Progress of the several projects under this classification are reported in the following pages.

**Soil Fertility Investigations.**— Little change in the procedure occurred in the field work that has been continuous for 35 years. Studies were mainly concerned with yields resulting from various cropping systems and from treatment with fertilizers.

During the last year of the biennium several fertilizer plots were established for corn, wheat, oats, soybeans, and sorghum. Also, work has been initiated to measure the nitrogen and carbon changes in the soils of all plots since the last samples were taken in 1934. In the spring of 1946 all of the plots on the Fertility Series were sampled and the samples were prepared for analysis. Some of the analyses have been completed.

Long-time average yields of the check plots in the rotations indicate the advantage of the crop rotation. Experiments involving various cropping systems have been under way for 35 years. Three rotations and continuous croppings have made up these tests with results as follows:

Alfalfa four years—corn-wheat-wheat for 12 years has given best results with an average yield of nearly 29 bushels for corn and 18 bushels for wheat. Corn-soybeans-wheat has averaged 25 bushels for corn and 17 bushels for wheat. Corn-corn-wheat has averaged short of 21 for corn and less than 15 for wheat. Continuous cropping, no rotation, has given 16 and 15 respectively.

The long-time data also reveal an increasing need for fertilizers, manure, and lime, showing increases in crop yields for fertilized plots as compared with unfertilized plots during 5-year periods from 1911 to 1945. For wheat in 16-year rotation at the beginning of the tests the yield increase due to fertilization was in the neighborhood of 4 bushels. This has increased until results for the last 5-year period show the yield increase for manure treatment at nearly 9 bushels, for manure and superphosphate over 14, and for manure and lime nearly 10 bushels.

(Project 17. Department of Agronomy. Leader, H. E. Myers. Hatch funds.)

**Influence of the Absolute Reaction of the Soil Solution upon the Growth and Activity of *Azotobacter*.**— This is a continuation of a project begun 22 years ago.

The soil in the 32 variously treated cylinders under study in subproject No. 7 were carefully sampled initially and after 20 years. In the meantime the soils were grown either to wheat or oats each year, and the harvest for those years when a crop was obtained was recorded. The primary objective was to ascertain whether the maintenance of an *Azotobacter* flora in the soil in some cylinders and not in others would result in significant alterations either in the crop grown or in the nitrogen content of the soil.

The soil upon which these cylinders was located was devoid of *Azotobacter*, hence would seem to be well adapted to such a study provided an *Azotobacter* flora could be maintained. No difficulty was experienced in maintaining *Azotobacter* flora provided the soil was adequately limed to maintain a pH value above 6.0.

The data obtained in the tests suggest: (a) Losses in the nitrogen content of the soil irrespective and independent of the presence of *Azotobacter* even when organic material, in the form of sugar or straw, was added as a source of energy. (b) The quantity of nitrogen contained in the straw tended to counterbalance such losses. (c) The presence of *Azotobacter* was without signifi-

cant effect upon yield. (d) *Azotobacter* quickly disappeared from unlimed but remained in all limed soils throughout.

In subproject No. 9 all efforts failed to induce the growth of *Azotobacter* at pH levels below 6.0 by supplying calcium in the form of calcium-clay.

(Project 128. Department of Bacteriology. Leader, P. L. Gainey. Adams funds.)

***The Nitrogen Balance and Physical Properties of Soils as Influenced by Different Legumes and Grasses.***— Field work continued on various rotations and sequences of the more important field crops grown in this area to determine yields and protein contents.

1. *Influence of legumes on crop production and nitrogen balance in soils.*— During the biennium, conditions were quite favorable for corn and sorghums. In both years the effect of the legumes on these crops was great. The row crops in the nonlegume rotations showed distinct nitrogen deficiency symptoms. The yield of corn immediately following sweet clover was about seven bushels higher than corn in a sweet clover rotation where a wheat crop intervened. Fall-seeded sweet clover was not as effective in increasing the yield of the crops which followed as was spring-seeded sweet clover. In both instances the sweet clover matured a seed crop.

2. *Effect of legumes on the physical properties of soils and factors influencing aggregation.*— Alfalfa and sweet clover had a marked favorable effect on soil aggregation. The improved aggregation declined rapidly, and by the time of the harvest of the third crop after legumes there was no appreciable difference between plots that had or had not grown the legumes. This change in soil aggregation corresponds closely to the decline in the crop response following the legume.

3. *Factors affecting the "sod-bound" condition in grasses.*— The work consisted of fertilizer studies on old bromegrass sods. Both nitrogen and phosphorus at different levels of application were studied. Both seed and forage yields as well as nitrogen analyses of forage samples were considered.

Nitrogen fertilizer alone was effective in overcoming sod-bound condition of the bromegrass. Superphosphate had little or no effect on yield of either seed or forage. Yields increased sharply with application up to about 100 pounds of nitrogen per acre with the lighter rates having relatively less effect per unit of nitrogen than the higher rates.

(Project 172. Department of Agronomy. Leader, H. E. Myers. Purnell funds.)

***The Storage, Utilization, and Evaporation of Soil Moisture.***— The study of the nature of the loss of soil moisture during evaporation was continued. Electrical equipment was set up for measuring relative humidity in air in an effort to study the vapor conditions in soil layers associated with the daily temperature cycle.

Under controlled conditions a study was undertaken to determine the amount of water which distills into a soil following small rains.

The subsurface tillage study was continued and comparative data were secured on its effect on crop yields, soil nitrates, soil moisture, runoff, and erosion.

Aggregation studies were continued with emphasis on the effect of seasonal changes on soil aggregation.

The Dunmore type of hygrometer was found to be not sufficiently accurate to follow changing vapor conditions in soil layers. Readings did show, however, that in moist soil the relative humidity remains close to 100 percent. When a layer of dry soil occurs on the surface, the relative humidity starts to

decrease rapidly as the test moves from moist soil into the dry layer. This decrease continues to the surface in approximately a straight line relationship.

When moisture equivalent to about 1/10-inch of rain was added to a dry soil it was found that between 5 and 25 percent of the water lost from the moist surface as evaporation was distilled into the lower soil where it would be available for plant use.

In 1944 and 1945 the yields of wheat secured from subtilled land were, respectively, 24.2 and 20.85 bushels per acre, while from plowed land it was 32.5 and 27.05. The nitrates in 1944 were 85 percent as high and in 1945 were 70 percent as high in subtilled land as in plowed land. In both years the soil was wet to the full depth of sampling at harvest time, so differences in the influence of treatment on soil moisture did not occur.

In 1945 there were seven rains between April 1 and July 10 which caused runoff and erosion. The total runoff from the subsurfaced plots amounted to 4.087 inches while that from the plowed plots was 3.052 inches. The erosion from the plowed plots was at the rate of 3,234 pounds per acre, while that from the subtilled plots was only 1,288 pounds per acre. When aggregate determinations were made immediately following sampling, a definite relationship was found between the degree of aggregation in a soil and the moisture content of the soil at sampling time.

(Project 210. Department of Agronomy. Leader, J. C. Hide. Bankhead-Jones funds.)

***A Study of Soil Solution and Its Effects on Soil Minerals and Their Chemical Activities.***— Tests have been made to determine relations between particle sizes of certain minerals and their suspension reactions.

The work has been divided between pure minerals that are commonly found in soils, and representative soils from the state. The specific minerals studied include hematite, limonite, quartz, rutil, ilmenite, and magnetite of the oxide group; muscovite, phlogopite, and biotite of the mica group; kaolin and montmorillonite of the clay group; and margarite, talc, and pyrophyllite. Reaction studies show that as particle size of quartz, hematite, montmorillonite, kaolin, and pyrophyllite decreases and external surface area increases, the reaction of the suspension becomes more acid. The mica minerals and talc increase the alkalinity of the suspension as particle size is reduced. This difference explains why the mica minerals are seldom found among the soil colloids. The most inert minerals are the clay minerals, kaolin showing little reaction at any pH and montmorillonite showing stability at pH values more alkaline than 7.0 but reaction and probable decomposition at pH values in the acid range.

Soils obtained at various locations over the state have been analyzed for their base exchange capacity and the base exchange capacity of their colloids. Surface and subsoils have been studied. Judging from the base exchange capacity of the soil colloids, the type of colloid in Kansas soils is quite uniform throughout the state. Thermal curves have been run on these same colloids, and these curves check the base exchange curves in showing that only minor differences exist in the composition of the soil colloids regardless of their location in the state.

(Project 229, Department of Chemistry. Leader, A. T. Perkins. Purnell funds.)

***A Study of Phosphate Fixation in Kansas Soils with Special Reference to Soil Separates, Fractions, and Minerals.***— Phosphate fixation studies have been made on a variety of soil minerals. The minerals, representative of minerals commonly found in soils,

have been obtained in a high degree of purity. Three general types of studies made on minerals and phosphate fixation are the effect of particle size, of time of reaction, and of several organic acids in replacement of phosphate fixed by soil minerals.

Results show that the mica minerals are very active in fixing phosphate. The structure of the minerals affects phosphate fixation as well as the composition of the mineral. The mica minerals which have one structural silicon replaced by one aluminum are much more active in phosphate fixation than the unsubstituted minerals. In general, phosphate fixation increases with decreasing particle size. With increased time of reaction phosphate fixation increases with most minerals. Exceptions to this general rule are the clay minerals. Kaolin comes to rapid equilibrium with phosphate over a wide range of reactions, and montmorillonite comes to rapid equilibrium with phosphate at reaction more basic than pH 7.0.

Preliminary work on replacement of fixed phosphate indicates that the organic acids containing one or two carbon atoms readily replace fixed phosphate, but there is a good indication that some of the organic acids with larger molecules will not replace phosphoric acid.

(Project 230. Department of Chemistry. Leader, A. T. Perkins. Purnell funds.)

**Soil and Crop Experimental Fields.**— Thirteen outlying experimental fields have been established over the state of Kansas. Each field is fairly representative of the soil and prevailing conditions for the part of the state in which it is located. General location of these fields is indicated by the designation as follows:

Southwest Kansas Experiment Fields (two), Southeast Kansas Experiment Fields (two), South Central Kansas Experiment Fields (three), North Central Kansas Experiment Fields (two), Northeast Kansas Experiment Fields (three), and the Bindweed Experimental Project at Canton in McPherson County. Reports concerning practical experimental work at all of these various fields follow in the order as listed above.

**Southwest Kansas Experiment Fields.**— Experimental work was continued on the Dodge field, in Ford County, and the Meade field, in Meade County, during the biennium. Major attention was given to variety testing, seedbed preparation, methods of fallow, rates and dates of seeding, and crop rotations.

**Meade field.**— Wheat varieties tests provided some good comparisons during the biennium. It will be noted that new varieties head the list. Pawnee, Wichita, and Comanche have replaced much of the Tenmarq and Blackhull in this area in the last two years and are giving Chiefkan and Red Chief considerable competition. Two-year averages for the biennium are as follows for the 10 varieties tested: Pawnee, 40.8 bushels; Cheyenne X Tenmarq C. I. 11972, 40.2; Wichita, 39; Comanche, 37.6; Red Chief, 36.5; Chiefkan, 36.4; Early Blackhull, 36.1; Blackhull, 34.9; Tenmarq, 29.6; Turkey, 29.

**Dodge field.**— A complete line of experimental work was maintained on the Dodge field throughout the biennium and some significant results were obtained. Methods of fallowing for wheat have provided some interesting data. Subsurface or stubble-mulch tillage has shown considerable promise as a method of fallowing.

Tillage methods for continuous wheat production have indicated that stubble-mulch tillage or subsurface tillage may not be as well adapted to continuous wheat production as to alternate crop and fallow system. For wheat under continuous production, yields for 1944-1945 favored tillage by

listing, followed by stubble-in, stubble-mulch, and one-waying in that order.

A comparison of wheat yields on fallow, second year after fallow, and on continuously cropped land showed considerable residual effect of fallowing and indicated the desirability of growing two crops of wheat after a year of fallow.

***Southeast Kansas Experimental Fields.***— At both the Columbus field and the Thayer field tests have been carried out on the use of various fertilizers during the biennium, as well as variety tests on cereal crops and legumes.

In general the data obtained during the past biennium substantiate previous results. Use of lime continued to be essential for establishing and maintaining alfalfa and sweet clover stands. The effect of lime on the yield of other crops is confined primarily to its indirect effect through the alfalfa and sweet clover which precede these crops in the rotation. The average increase from the use of lime on alfalfa was 1.14 tons per acre at Columbus and 0.93 ton per acre at Thayer. The largest and smallest increases on grain crops obtained from the use of lime were on corn and flax, respectively. When considered from the standpoint of returns per dollar invested, lime used with legumes in a good rotation becomes the most profitable soil improvement practice used in Southeast Kansas.

Phosphatic fertilizers continue to give very profitable increases on alfalfa, clover, wheat, and oats. The results that have been obtained do not warrant using phosphate on flax and soybeans. Applications of barnyard manure increase the yield on all crops, and it should be used in combination with lime and phosphatic fertilizers as far as it is available.

The increases from the use of potash during the past biennium are as follows: For the year 1944-'45 at the Columbus field the average increase per acre was corn, 6.0 bushels; wheat, 1.7 bushels; alfalfa, 0.21 ton; flax, 0.3 bushel; oats, 1.2 bushels; soybean seed, 0.1 bushel; and at the Thayer field there was a decrease of 2.2 bushels of wheat; increase of 0.09 ton of alfalfa. These results are about the same as have been obtained in recent years except that the increase from the use of potash on soybeans is somewhat smaller than usual.

A rather extensive flax varietal testing program has been conducted. About 10 of the leading varieties have been grown in triplicate plots, and a fairly large flax breeding nursery has been developed. As a result of this flax testing program, the Koto variety was released to Kansas farmers in 1946.

An oat variety test has been conducted at Thayer each year; Neosho and Osage have been outstanding in comparison with other varieties, due mainly to their rust resistance.

In the sorghum variety test conducted each year at Thayer, Bluckhull and Darso were the leading seed producing varieties. Kansas Orange and Atlas produced the highest yields of forage.

About 15 varieties of soybeans have been grown in triplicate plots at Thayer both years, in addition to Group IV of the uniform soybean nursery. From this program two varieties (Gibson and S-100) have shown much promise for this area.

In the soft wheat nursery conducted at Thayer, several new good quality, disease-resistant, strong-strawed, early varieties have been developed, but as yet are not far enough along for release to farmers. Pawnee and Comanche have been the highest-yielding varieties.

***South Central Kansas Experiment Fields.***— The experimental work on the South Central Kansas Experiment Fields during the past biennium was conducted on fields located near Kingman, Wichita, and Hutchinson, Kan.

The work at the Wichita field has been continued as originally planned. This work is divided into two phases, variety testing and soil fertility studies.

Work at the Kingman and Hutchinson fields has been reduced during this biennium due to reduced travel and shortage of help.

*Wheat.*— New wheat varieties that have been outstanding the past two years are Pawnee, Comanche, and Wichita. A new four-way cross of Kawvale-Marquillo X Kawvale-Tenmarq has shown considerable resistance to leaf rust and Hessian fly, and has given satisfactory yields.

The use of a legume in a rotation has increased the wheat yield three to five bushels per acre at the Wichita field. The different methods of handling the sweet clover in the rotation have not given yields that were materially different.

The use of superphosphate on a rotation of continuous wheat and on a 16-year rotation including alfalfa has increased wheat yields three to eight bushels per acre. Yields on the continuous wheat rotation were higher in 1945 where an application of nitrogen was applied in the spring to a superphosphated plot.

*Oats and Barley.*— Two new oat varieties, Osage and Neosho, have been outstanding in yield and in their resistance to rust strains now prevalent in Kansas. Oat yields were good in 1944 but were only fair in 1945. Late seeding and unfavorable weather conditions were important factors in the low oat yields of 1945.

*Corn.*— A corn test has been continued at the Wichita Field the past two years. The test consisted of 45 entries of new hybrids and open-pollinated varieties. Yields have been good. High-yielding hybrids were Funk G-711, K-1585, K-1583, and K-2234. There was considerable damage due to the Southwestern corn borer. There has been evidence of more borer damage to the later-planted corn than to earlier-planted corn.

*North Central Kansas Experiment Fields.*— The North Central Kansas Experiment Fields include two fields, one located two miles west of Belleville and the other one mile west of Smith Center.

*Belleville field.*— The work at Belleville consists of variety tests of corn, popcorn, sweet corn, sorghums, wheat, oats, barley, soybeans, alfalfa, and garden beans. Other studies include brome, alfalfa, and wheat fertility; grass nursery; date of seeding and seedbed preparation for sweet clover; interstate wheat nursery and crop sequences.

The corn variety test was not harvested in 1945 because the stands were not uniform. In 1944 the highest yield, 77.8 bushels per acre, was produced by K-2234. The average yield of the 81 varieties included in the test was 61.7 bushels per acre. The four open-pollinated varieties produced an average yield of 52.8 bushels.

The sorghum variety test during the last two years has been good. The highest average yield was 51 bushels per acre for Waxy Atlas; Club produced 45 bushels and Western Bluckhull 44.4 bushels. Martin was the highest yielding combine type with 36.4 bushels per acre, and Midland was second with a yield of 35.1 bushels.

Pawnee was the highest yielding wheat variety during the last two years, with an average of 19.3 bushels per acre compared to 17.1 bushels for Red Chief.

*Smith Center field.*— The Smith Center field is used for variety testing of corn, popcorn, sorghums, wheat, oats, and barley. It is also used for seedbed preparation and frequency of fallow for wheat.

In 1944 Early Sumac had the highest yield of grain and in 1945 it was lowest. Early Kalo was the high-yielding grain sorghum during the biennium with an average yield of 33.2 bushels per acre. The average yields in bushels per acre of other varieties were as follows: Midland, 29.2; Wheatland, 28.7; and Martin, 28.

The two-year average yields of oat varieties show Neosho leading with a yield of 51.2 bushels per acre. Yields of other varieties were Kanota, 48.1; Cedar, 47.3; Boone, 45.8; and Fulton, 39.3 bushels per acre.

**Northeast Kansas Experiment Fields.**— Experimental work was conducted on three fields during the biennium. These were the Doniphan experiment orchard, the Blair experiment orchard, and the Wathena small fruits experiment field.

**Doniphan experiment orchard.**— The orchard was planted in the spring of 1942, with the trees being set on the contour. The orchard consists of approximately 16 acres and contains 573 apple trees. About 40 percent of the trees set were the varieties on French crab stock, with the other 60 percent being about equally divided between the hardy stocks, Hibernial and Virginia Crab. A few trees of three Kansas strains selected by Dr. G. A. Filinger were also planted, and a few trees on Malling (dwarf) stocks were also later included (1945).

Tree growth was quite satisfactory in both 1944 and 1945. Conversion of the hardy stocks (Hibernial and Virginia Crab) to the desired varieties started in 1943 was practically completed during the past two seasons.

**Blair experiment orchard.**— Experimental work consisted of the use of various fungicides and insecticides for disease and codling moth control, and the use of harvest sprays and chemically treated bands to aid in codling moth control. The codling moth spray work was conducted by the Department of Entomology and is reported by that department.

Harvest spray studies were made in 1944 only. Three Jonathan trees were included in each treatment. Premature dropping of the fruit was not a serious factor in 1944, and it is doubtful whether the use of harvest sprays was a sound economic practice in that year.

Disease control studies consisted chiefly of a comparison of the effectiveness of various fungicides in apple scab control. Materials used included dry lime sulfur, wettable sulfur, Fermate, Karbam, Dithane, Phygon, and Basicop. Of these, dry lime sulfur, Dithane, and Phygon gave the best control of apple scab. However, dry lime sulfur and Dithane caused an increase in the number of injured leaves and russeted fruit. Also, Dithane was not effective in controlling frog-eye leaf spot on Jonathan foliage. Phygon, in addition to giving good scab control, also gave excellent control of frog-eye leaf spot, with no marked increase in fruit or foliage injury noted. Fermate gave good disease control, without causing the fruit and foliage injury noted where dry lime sulfur and Dithane were used. Wettable sulfur was not effective in controlling apple scab, and Basicop caused a very marked increase in russeted fruit, Karbam was not outstanding, and the product has since been changed by the manufacturing company.

Two-, three-, and four-inch-width chemically treated codling moth bands were placed on the trees to trap the larvae as they sought a place to pupate. Width of the band was found to make little difference in the total numbers of larvae caught; thus from the standpoint of economy, the two-inch bands were the most desirable to use. Bands were placed on the trunk on some trees and on the scaffold branches on others; on still other trees the bands were placed both on the trunk and on the scaffold branches.

Bands on the scaffold branches caught three larvae to two for the trunk bands, but it required about twice as many feet of the banding material where the bands were placed on the scaffold branches. Approximately 60 percent of the larvae caught under the limb bands were from the first brood, while only 40 percent of those caught under the trunk bands were from the first brood. Thus, placing the bands on the scaffold limbs was more effective in cutting down codling moth injury to the current year's crop.

**Wathena experiment field.**— Yields of strawberries in the rotation studies were not conclusive. Average yields in crates per acre for the three rotations used were manure and potatoes, 214; vetch and fallow, 213; and cowpeas and sweet corn, 200.

Mulching was definitely beneficial in fruit production. Mulched strawberry plants producing their first crop yielded an average of 209 crates per acre, while unmulched plants yielded 192 crates. The difference was more marked

for plants producing their second crop, the mulched plants yielding 189 crates per acre and the unmulched plants 123.

Application of a 4-12-4 fertilizer at the rate of 550 pounds per acre resulted in a yield of 247 crates per acre, 23 crates more than the unfertilized plants in the strawberry planting producing its second crop, but the fertilized plants yielded 9 crates per acre less in the planting producing its first crop.

The strawberry variety 1428 is late, requiring a long harvest season such as occurred in 1945, and was very outstanding in yield in that year. Avon and Pathfinder yield well, but their fruit is a little soft for commercial handling. Catskill and Tennessee Beauty both produce firm fruit of good size and quality, and show the most promise of becoming important varieties for the commercial grower in northeast Kansas.

***Bindweed Experimental Field at Canton.***— The bindweed experimental field was established in 1942, and at the present time there are 67 individual experiments conducted on a total of 1,280 plots. The work was, of necessity, reduced to some extent during 1945 because of a lack of labor.

The optimum time of starting intensive cultivation for the eradication of bindweed is immediately after harvesting the small grain crop. The eradication has been accomplished in two seasons with relatively few cultivations and the loss of only one crop, when cultivation is started at this time and the land is fallowed the following season.

Eradication of bindweed by early fall of the second year of continuous cultivation has been more certain when cultivation is performed at two-week intervals throughout the growing season of both years. This method has required 21 cultivations. It seems that the most practical method, however, is to cultivate 12 days after the first appearance of regrowth of the weeds.

Cultivating for the eradication of dogbane had to be continued into a third season before the weed was eradicated.

Johnson grass was eradicated in one season by cultivating at intervals of two, three, or four weeks. The seeding of alfalfa following these cultivations controlled Johnson grass seedlings the following season.

Climbing milkweed has not been eradicated by cultivating at intervals of two and three weeks for a period of two seasons.

Wheat has proved to be an effective competitive crop for bindweed when it is seeded on the fly-free date after a period of one year of intensive cultivation followed by a second year of intensive cultivation, or by intensive cultivation between harvest and seeding time.

Alfalfa is effective in controlling bindweed when the land is fallowed previous to seeding and a good vigorous stand of alfalfa is obtained.

Results indicate that three to four pounds of sodium chlorate per square rod is as effective in killing bindweed as any other rate of application. The highest percentages of kill with sodium chlorate have been obtained when the material was applied on September 15 and October 1, and spring and early summer applications have been much less effective than fall applications. The results for 1945 indicate that Ammate is not effective as a herbicide for bindweed.

Applications of 2,4-D have not progressed far enough to make it possible to draw conclusions. However, within 60 to 90 days following applications of 2,4-D new bindweed shoots began to emerge. Examinations showed that the chemical killed the roots to a depth of only 6 to 18 inches.

(Department of Agronomy. Leaders, R. I. Throckmorton, W. F. Pickett, A. B. Erhart, F. E. Davidson, W. A. Moore, M. C. Axelton, Erwin Abmeyer, V. F. Bruns. State funds.)

***Primary and Secondary Minerals of Kansas Soils.***— A study of the mineralogy of the soils within the Flint Hills area has been



undertaken. Geary county, which lies almost entirely within the Flint Hills area, was chosen as the region in which to initiate the study. The study technic consisted of a mechanical analysis to determine the grade size distribution within the profile and a petrographic study of the light and heavy fractions to determine the mineral composition and distribution. The clay fraction in each case was carefully removed and retained for further study.

These preliminary studies indicate that distinct differences in the mineralogy of these soils are present and suggest that these mineralogic differences may be used to distinguish residual soils from transported soils.

(Project 239. Departments of Agronomy, Chemistry, and Zoology (Geology). Leaders, A. B. Sperry, C. H. Harned, A. T. Perkins, J. C. Hide. State funds.)

*Soil Survey Work.*— The Kansas legislature of 1945 made funds available for soil survey work during the period July 1, 1945, to June 30, 1947. During the biennium the field work of the reconnaissance county surveys of physical land conditions were completed. The work was in coöperation with the Soil Conservation Service, United States Department of Agriculture. The maps and reports have been published for Brown, Coffey, Doniphan, Edwards, Franklin, Marshall, and Wilson counties. The information contained in the publications is of material assistance in community and county planning and in developing soil conservation programs. These surveys will not take the place of basic soil surveys.

(Department of Agronomy. Leader, R. I. Throckmorton. State funds.)

## INVESTIGATIONS IN THE PLANT INDUSTRIES

Work in plant production for the biennium reflected the emphasis on development of new varieties with geographical adaptation, disease resistance, and superior yields and quality. Research in the industrial possibilities of the agricultural products of Kansas expanded under the stimulus first of war needs and later of postwar adjustment.

*Temperature Relations of Crop Plants.*— The work in this project was done with crop plants grown in the greenhouse and tested for resistance to high temperature and to low temperature. One study was made to determine whether the influence of light in hardening plants to heat affected only the portion of the plant exposed to light, as for example, a single leaf, or other portions as well, perhaps even the whole plant. Another study was designed to learn the relative cold resistance and heat resistance of Neosho, Osage, and other varieties of oats developed in the same disease resistance breeding program, compared with Kanota as representing the southern red oat type.

In the study on hardening to light it was found that the exposure of one leaf of a corn plant to light caused the plant to survive exposure to heat better than plants that were wholly in darkness for about 14 hours preceding the test. Plants in which all of the leaves were exposed to light preceding the heat test were more heat hardy than were those with only a part of the leaf area in light. Wheat and oats responded in the same way as corn.

In the study of varieties of oats, Kanota was significantly more resistant to heat and to cold than other varieties of spring oats included in the experiments which were Fulton, Osage, Neosho, Tama, Clinton, Bond, Victoria, Richland, and Markton. Wintock, a winter type, was considerably more resistant both to heat and to cold than Kanota. It is recognized that Osage and Neosho possess resistance to diseases and perhaps certain other characteristics that make them better adapted for planting and capable of producing higher



Resistance to lodging of new varieties of oats developed at the Kansas Agricultural Experiment Station is shown in the field. In the center plot is Kanota, and on each side is a new resistant variety.

yields in Kansas than Kanota. The experiments reported here, however, indicate that these new varieties are inferior to Kanota in certain respects that may limit their usefulness in years when severe spring frosts occur or when warm weather causes damage in the latter part of the season.

(Project 157. Department of Agronomy. Leader, H. H. Laude. Purnell funds.)

***Small Grain and Sorghum Improvement.***— Work on this project is in coöperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. Research on the project is supplemented by coöperative projects involving the Departments of Botany, Entomology, and Milling Industry.

During the biennium Wichita winter wheat, Koto flax, Osage oats, and Neosho oats were released to farmers in Kansas. A part of the breeding and much of the testing of these selections fell under the work of this project. Continued effort was expended to combine more of the desirable characters needed in new varieties of wheat, oats, flax, barley, and sorghum.

(Project 67. Department of Agronomy. Leaders, L. P. Reitz and E. G. Heyne. Hatch funds.)

***Inheritance of Factors Affecting Quality in Wheat.***— Tests during the biennium included milling and baking, meal curve, dough-ball, and pearling determinations on over 400 samples. Meal curves from individual samples showed a range of “very weak” to “very good” types. When baked, all samples gave satisfactory results except two whose meal curves were marked “very weak.” Dough-ball times were lower for these curve types than for the stronger curve types. Among the 12 selections of wheat tested in 1944 and 1945, four gave similar curve type values in the two years while eight gave somewhat different values. Samples from Thayer for pearling were harder in texture than in 1944. Clarkan averaged 10.66, Kawvale 13.38, Wabash 9.80 grams remaining from pearling 20 grams of wheat for one minute. A number of new selections were as soft as Wabash in both years.

(Project 178. Departments of Agronomy and Milling Industry. Leaders, L. P. Reitz and J. A. Shellenberger. Purnell funds.)

***Crop Production Investigations.***— The work under this project included variety tests of wheat, oats, barley, flax, and sorghums at Manhattan, and the coördination of field crop investigations at the various experiment stations and experiment fields in Kansas.

The testing work with oats gave evidence that Neosho C. I. 4141 and Osage C. I. 3991 are superior to varieties being grown, particularly in resistance to crown rust, stem rust, and smut. Seed of these varieties was made available to farmers.

In the testing of dwarf varieties of grain sorghum at Manhattan, higher acre yields of grain were produced where the crop was planted in rows 21 inches apart than in the standard 42 inch rows. Summer drouth has not been serious since this work was begun. Planting in narrow rows may not be an advantage when drouth is a factor.

Several varieties of wheat that were bred with specific objectives have been included in plot tests throughout the state during the biennium. A promising variety in the group that was bred to obtain high resistance to Hessian fly is Kawvale-Marquillo X Kawvale-Tenmarq C. I. 12128. The tests include other varieties which have Mediterranean-Hope as one parent and which were bred especially for resistance to stem rust and leaf rust. A third group combines the high bunt resistance of Oro-Tenmarq and the high test weight of Chiefkan. The limited number of plot tests made so far indicates not only that these new varieties include the particular objectives for which the breeding was done, but also that some of the selections possess the other desirable characteristics necessary for a successful wheat.

(Project 129. Department of Agronomy. Leader, H. H. Laude. Hatch funds.)

***Breeding and Production of Soybeans, Sweet Clover, and Special Crops.***— This study was previously a part of Project, 129. It now includes some of the bean crops, sweet clover, and sesame.

***Soybeans, cowpeas, and field beans.***— During this biennium 33 varieties of soybeans and 37 hybrids in the F<sub>5</sub> and F<sub>6</sub> generations were grown in coöper-

ation with the United States Regional Soybean Research Laboratory. In addition eight varieties were grown to determine their suitability to harvesting with a combine. Six varieties of cowpeas were also tested both years. In 1944 seven varieties and selections of field beans were grown.

Highest yields in replicated rod row tests were produced by four selections from hybrids designated as A3-176 (Illini X Dunfield), C101 (Dunfield X Manchu), S55-10 and S55-35 (Virginia X P. I. 37062), and S100 (a rogue from Illini). Following closely in order were Chief, Gibson, and Lincoln. In the combine tests S100, Chief, Gibson, and Hongkong were the high four varieties with yields of 25.1 to 22.6 bushels. The hybrid A3-176 produced 28.2 bushels.

The strains of cowpeas, four of which were Blackeye hybrids, yielded from 1.8 bushels to 9.3 bushels of seed per acre and from 2.29 to 2.99 tons of air-dry hay. Low yield of seed was associated with high yield of forage. The Blackeye hybrids were unaffected by the disease *Phytophthora vignæ* which has destroyed the stands of some varieties in previous years.

The highest yield of field beans obtained was 7.49 bushels from a strain of the Great Northern variety developed in Michigan. An Early Pink hybrid from California ranked second. On the whole, the low yields and poor quality of the beans make the crop appear unpromising for this section.

*Sweet clover.*— The effect upon vegetative growth and seed production of cutting sweet clover at different heights and at different stages of growth has constituted the main work with this crop.

Cutting the first season's growth after September 1 did not reduce the vigor and yield of the crop the following year. Cutting before September 1 may reduce the yield the following year, especially if the first year's growth has been retarded by drouth or by competition with weeds.

Clipping the second year's growth has reduced the yield of both forage and seed. The height of the plants is reduced, which may add to the convenience of harvesting, but this possible advantage is offset by lower yield and usually results in less uniformity in maturity of the seed. Clipping at 3, 6, and 9 inches in the earlier stage, when the plants were 12 to 15 inches high, resulted in average yields of forage of 0.72, 1.2, and 1.49 tons respectively against 1.93 tons on plots not clipped. Comparative yields of seed were 2.13, 3.89, and 4.25 bushels per acre against 5.41 for plots not clipped. Clipping 6, 9, and 12 inches at the prebud stage showed still greater detrimental effect of the clipping.

Comparison of fall-sown and spring-sown stands showed somewhat higher yields from the spring-sown crop, but there was no appreciable difference in percentage of nitrogen in the forage produced.

*Special Crops.*— Sesame: From 20 selections of sesame made from three parental lines in 1943, 12 were grown during the biennium 1944 and 1945 in addition to the parental lines.

Considerable progress has been made toward obtaining a strain that is shorter, more erect, nearly free from branching, and more uniform in height and maturity than the parents. These strains are better adapted to harvesting with machinery and there is less shattering in the field. Yields of selections designated as K<sub>3</sub> and K<sub>8</sub> were 651 and 615 pounds per acre, respectively, of seed containing approximately 50 percent of high quality edible oil.

(Project 241. Department of Agronomy. Leader, J. W. Zahnley. Hatch funds.)

*Corn Breeding by Means of Controlled Pollination.*— This project is conducted coöperatively with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture. The main objectives during the biennium 1944-'45 were to put into commercial production Kansas-developed hybrid corn and initiate new breeding and research problems.

*Corn breeding.*— The commercial production of Kansas yellow hybrids K1583 and K1585; white hybrid K2234; and popcorn hybrid K4 was greatly expanded. In 1945, seed was produced to plant approximately 240,000 acres of these three late hybrids, and about 17,000 acres of K4 popcorn. K1583 and K1585 are late or full-seasoned hybrids in Kansas and have given good performance on Kansas farms. K4 popcorn has excellent quality and good agronomic characteristics. K2275, a white double cross similar to K2234 but better drying in the fall and easier harvesting, was approved for certification and distribution in 1946. The first release of Kansas inbred lines was made during the biennium; they are K155, K201, K55, and K64 dent lines; Sg 16, Sg 18, Sg 30A, Sg 32, and SA 24 popcorn lines.

*Methods of corn improvement.*— Over 100 open-pollinated varieties were collected in Kansas. Each variety has been in the same community for 25 years or more. These old varieties will provide a supply of germplasm for the development of more inbred lines adapted to Kansas.

Studies on artificial drying of corn indicate that the drying temperatures and moisture in the grain should not be too high. For commercial drying the best quality seed will be obtained if moisture of corn is 30 percent or less and drying temperatures are 110° F. Commercial processing of seed corn through grading and drying results in considerable handling. Damage does occur to the seed coat, and seed treatment with chemicals has given higher germination.

(Project 156. Department of Agronomy. Leader, E. G. Heyne. Purnell funds.)

*Alfalfa Improvement.*— These studies were made in coöperation with the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture.

*Alfalfa cultural and production investigations.*— Studies were made of the effect of methods of haying on amount of carotene in alfalfa hay when stored and the effect of environmental conditions on the amount of carotene loss during the process of curing. Temperature was found to be the chief atmospheric condition causing variations and a loss of carotene during the curing process. Relative humidity had no effect other than lengthening or shortening the curing period. Allowing hay to wilt in the swath for two to four hours and then raking into a small window was found to be the best practice from the standpoint of rapid curing and preserving moisture.

The effect of cutting and irrigation practices on the seed setting of alfalfa was studied at five different stations and experimental fields, Wichita, Garden City, Hays, Belleville, and Manhattan. Comparable yield data were obtained from three of the five stations. The summaries of all of the seed setting studies include six crop years on four stations. The results show that by cutting the hay crop in the bloom stage, previous to the seed crop, the seed yield would be increased by an average of 30 pounds per acre. The maximum difference in yield of seed on any of the test plots was 132 pounds and the minimum was 17 pounds. The results of these tests indicate that, regardless of the condition under which the seed crop is produced, increased seed yields will result if the plants are allowed to have high food reserves in the roots.

*Alfalfa breeding and improvement investigations.*— This project covers the work of adaptation studies in nursery rows, spaced plants, and field plots, and also of increasing the seed production of new varieties and hybridization.

The advanced nursery planted from seed obtained from the polycross nursery consisted of 70 selections of highly self-sterile lines. These plants were largely hybrids because of the self-sterility of the plants used in the polycross. The yields ranged from 9.7 tons of 12-percent moisture hay to 5.81 tons, with a difference of 0.18 tons required for significance at the 5-percent level. Kansas Common ranked thirty-second or at about the mean average yield of the group.

Studies indicate that plants vary widely in vitamin A content. The selec-

tions analyzed ranged from 27.38 to 39.3 mg. per 100 grams of dry hay with a significant difference at the 5-percent level of 7.18 mg. The  $F_1$ 's from these clones were analyzed and it was found that their vitamin A content ranged from 32.98 to 40.7 mg. per 100 grams of dry hay, with a difference of 8.22 mg. required for significance at the 5-percent level.

(Project 183. Department of Agronomy. Leaders, C. O. Grandfield and H. L. Hackerott. Purnell funds.)

***A Study of the Undesirable Physical and Chemical Changes Brought About in the Process of Dehydration.***— The chemical phase of the project has been concerned with the determination of procedures whereby the nutritive content of dehydrated alfalfa could be retained during dehydration and subsequent storage.

Methods for the retention of carotene in dehydrated alfalfa have been studied in a number of different ways. It has been shown that proper blanching of alfalfa previous to dehydration permits the retention of almost all the carotene when the drying process is relatively slow. On storage of blanched, dehydrated meal, carotene is lost at almost the same rate as in untreated meal.

Cold storage of meal aids in preventing destruction of carotene after dehydration. In a carefully controlled experiment conducted with commercial meal in warehouse storage, and in the natural cooler cave at Atchison, it was shown that meal stored in bags that would permit moisture to enter would retain a greater amount of carotene than in waterproof bags. The moisture content increased during storage from about 5 percent to 9 to 10 percent during five months storage. The meal in the bags in which the moisture content increased most had from 25 to 40 percent more carotene remaining than did corresponding samples in waterproof bags. This was true in the warehouse storage as well as in the natural cooler storage. Storage in the natural cooler (about 38° F.) resulted in the retention of almost twice as much carotene as corresponding warehouse storage over a five-month period.

Field chopping of alfalfa has also been studied, since a number of dehydrators have started to use this procedure in obtaining the fresh-cut alfalfa. Studies indicate this procedure causes a slight reduction (3 to 6 percent) in the carotene content of the final product.

In cooperation with the United States Department of Agriculture and the Department of Agronomy the carotene contents of a number of alfalfa varieties are being studied. Results indicate that it may be possible to produce an alfalfa consistently high in carotene.

(Project 1. Department of Chemistry. Leader, W. G. Schrenk. Kansas Industrial Development Commission funds.)

***Pasture Improvement Investigations.***— The work consists of studies on the management of grasslands and of improvement of the pasture grasses through breeding and selection, conducted cooperatively with the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture.

Fertilization studies on "sod-bound" brome-grass pastures have been expanded somewhat to meet the demand for information on this subject. Yields of seed from "sod-bound" fields producing less than 50 pounds of seed per acre without fertilizer were increased in 1945 to more than 500 pounds per acre by applications of 300 pounds of ammonium nitrate made either in September, 1944, or in March, 1945, with no significant difference in results for these two dates of application. Similar applications increased forage yields from approximately 1,000 pounds to more than 5,000 pounds of dry matter per acre.

Livestock have shown marked preference for the areas receiving nitrogen

fertilizer except on plots allowed to approach maturity before beginning grazing.

*Bluestem breeding.*— Promising lines of both big bluestem (*Andropogon furcatus*) and little bluestem (*A. scoparius*) have been increased, but selection for better forage types continues. Test plantings of the selected strain of big bluestem (*A. furcatus*) have been made on a number of farms in eastern Kansas, and the little bluestem (*A. scoparius*) line is being readied for such testing.

*Brome.*— Thirty-two selected lines have been increased and are being grown in a comparative yield test.

*Sudan grass.*— Increased resistance to leaf diseases and chinch bugs together with high forage value are the principal objectives of this program. A selection of sudan grass showing considerable resistance to both has been increased and is being tested at the branch stations and experimental fields.

*Uniform grass nursery trials.*— The information of greatest value from these has been the comparison of northern versus southern bromegrass types. The average southern type has produced a ton of dry matter per acre more than have the northern types during the spring growth period preceding seed maturity. Stands are always better when southern types are sown, and the more rapid spread by rhizomes makes for quicker establishment and a better turf.

(Project 96. Department of Agronomy. Leader, K. L. Anderson. Bankhead-Jones funds.)

*Weed Control.*— The work with sodium chlorate and borax for the control of noxious weeds was carried on through 1944. In 1945 attention was centered mainly on tests of 2,4-D, the new growth-regulating chemical or hormone, recently found to be an effective herbicide.

Applications on lawn weeds in October resulted in complete elimination of dandelion, chickweed, henbit, and common plantain. Similar results were obtained with one treatment applied in March. Bluegrass was not injured. Stands of bindweed and hoary cress were reduced, but in no case was a complete kill obtained with two applications. Treatments in the fall appeared to be most effective on these deep-rooted, herbaceous perennials. Large woody sumac plants and young shoots were killed by a single application made on September 1. Buckbrush was more resistant than sumac, but some plants were killed by two applications. Johnson grass and other weedy grasses were not noticeably affected. This chemical seems to be effective on most broad-leaved annual weeds. A concentration of 1,000 to 1,500 parts per million of 2,4-D is satisfactory for most weeds.

Additional experiments carried on over a longer period of time will be necessary to determine the effectiveness of 2,4-D on most perennial plants, and the best time and rate of application. The relative effectiveness of the different types of preparations, namely the acid form, basic salts, esters, or amines also is yet to be determined.

(Project 166. Department of Agronomy. Leader, J. W. Zahnley. State funds.)

*Coöperative Experiments with Farmers.*— During the biennium 679 tests were located throughout the state with the coöperation of the county agents, vocational teachers, and farmers.

Principal emphasis was placed on variety tests of soybeans, oats, wheat, sorghum, and corn. Soil treatment tests were reduced in number because help and travel facilities were not available. Information on yield, quality as indicated by test weight and protein analysis, and other agronomic characters as

influenced by a wide range of climatic differences and soil type is secured from these tests. The tests are also used for securing information by the entomologists and pathologists.

Three corn performance tests were planted in 1944 and five in 1945. These tests included from 39 to 82 entries consisting of open pollinated varieties, commercial hybrids, and experimental hybrids.

*Wheat varieties.*— The outstanding feature of the results secured from the wheat variety tests for both years of the biennium was the high yield of the three new wheat varieties, Pawnee, Comanche, and Wichita. Pawnee made the highest yield in eastern and central Kansas. Pawnee and Comanche were the highest yielding varieties in the western third. Wichita was the highest yielding early maturing variety. Protein analysis on threshed samples of wheat did not show a significant difference between varieties. There was a characteristic difference between sections of the state, the wheat from the western part of the state containing slightly higher protein than that from the eastern part.

*Oat varieties.*— The two new, rust-resistant varieties of oats, Osage and Neosho, made the highest yield in all sections of the state. Osage made the highest yield in eastern Kansas, and Neosho in the central and western sections. The rust-resistant varieties Osage and Neosho exceeded Fulton 5 to 20 bushels per acre in yield and 5.4 to 7.3 pounds per bushel in test weight in different years and sections of the state.

*Corn varieties.*— The Kansas hybrid K 2234 exceeded all other white hybrids and open-pollinated varieties in yield in the coöperative corn variety tests for 1944 and 1945. Yellow corn hybrids that ranked high in yield were K 1585, Pfister 1897, Pioneer 332, Jewett 453, Illinois 200, U. S. 13, and Funk G-80.

*Soybean varieties.*— Chief, Gibson, and Lincoln were the highest yielding varieties of soybeans in the northern part of the state. Hongkong continues to outyield any of the other varieties tested so far in the southern half of the state.

*Sorghum varieties.*— The combine type of grain sorghums is being grown farther east in the state each year. Martin, a combine kafir type, is making a high yield generally over the state. Midland makes a high yield when good stands are secured. The softness of the seed of this variety frequently makes it difficult to secure full stands. Cody was one of the low yielding varieties in both 1944 and 1945. It is doubtful if the farmer can afford to continue to grow this variety even at an advanced price of 50¢ a hundred over other grain sorghums.

(Department of Agronomy. Leader, A. L. Clapp. State funds.)

***Breeding for Disease Resistance in Wheat, Oats, and Sorghums.***— This project is conducted coöperatively by the Departments of Agronomy and Botany of the station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. It was established in 1938 and breeding material has now reached a point where some varieties have been distributed for commercial production on farms. Other strains of wheat and oats have been advanced for yield, adaptation, and quality studies.

Five selections of Mediterranean-Hope X Pawnee resistant to leaf rust, stem rust, and bunt were advanced to plots. Approximately one thousand  $F_5$  selections were studied for possible resistance to known races of bunt in the United States including dwarf bunt. Some of these are resistant to leaf rust, stem rust, loose smut, and Hessian fly.

Osage and Neosho oats were distributed to Kansas farmers in 1945. About 10,000 bushels of seed were produced for seeding in 1946. Approximately 700



strains of oats with resistance to races 8 and 10 of stem rust and other common races of stem rust, as well as high resistance to crown rust and smut, were advanced and tested for agronomic characters.

Breeding of sorghum strains resistant to smut was continued. Seed of the milo-disease-resistant Colby will be increased with the expectation of releasing it.

(Project 207. Departments of Agronomy and Botany. Leaders, L. P. Reitz, L. E. Melchers, E. D. Hansing, E. G. Heyne, C. O. Johnston. Bankhead-Jones funds.)

***Factors Influencing the Quality of Wheat.***— Work during the biennium has included three phases which are summarized below.

*The response of variety to its environment.*— Six years of wheat quality data are now available. Milling, baking, and analytical determinations have been completed each year on eight varieties of wheat grown under similar environmental conditions at the various branch stations. This series has provided an unusual opportunity for the study of varietal differences in the properties of wheat. Viscosity and maltose values as influenced by variety have been studied. The quality of wheat is largely influenced by the two factors, variety and environment.

*Genetic factors influencing the quality of wheat.*— Many new crosses and varieties were milled and baked. Studies of varietal mixogram patterns were emphasized. A series of 64 samples, representing 13 varieties of varying protein content, were used for studying the effect of protein content on absorption, and baking response. Variety, independent of protein content, was found to have a pronounced effect on absorption as measured by the farinograph. Mixograms and farinograms have been compared for wheat quality evaluation.

*Edaphic factors and their influence upon the quality of wheat.*— Approximately 490 samples of wheat from over-state variety tests were analyzed for protein. Uniform protein composites by varieties were prepared from this series of samples and these were milled and baked. Accurate comparisons of the protein and ash content of the wheat crop from year to year are thus possible.

(Project 60. Departments of Milling Industry and Agronomy. Leaders, J. A. Shellenberger and H. H. Laude. State funds.)

***Moisture and Relative Humidity Factors Affecting the Quantity and Quality of Wheat Flour.***— Additional experience on the conditioning of wheat has been obtained using the milling department's 130-sack semi-commercial mill.

Studies were made of the effect of several tempers on the milling properties of various wheat types, with special emphasis on the problem of properly conditioning the variety Chiefkan. Experiments were made on the removal of the protective wax coat from Chiefkan before tempering. Chiefkan wheat was also soaked for extended periods, dried, and again tempered to determine the influence of such treatment on the milling properties.

Excessive heat during conditioning did not cause Chiefkan wheat to become mellow for milling. Excessive heat does cause a breakdown in the wheat gluten which affects baking quality.

Several entoletters were installed in the milling system and tests have been made to determine the possibilities of replacing the present break roll system of milling with impact machines.

(Project 170. Department of Milling Industry. Leader, R. O. Pence. Purnell funds.)

***Factors Which Influence the Colloidal Properties of Dough.***

—Three principal lines of work have been pursued: (1) Possibilities of using mixograms, farinograms, extensograms, and amylograms in predicting the adaptability of various commercial flours for specific types of baking such as bread, crackers, and cake; (2) factors which influence gas production and gas retention such as flour type, mixing time, and the addition of sugar, surface active, reducing, and oxidizing agents; (3) modification of mixogram patterns by added substances. The last was a limited continuation of previous work. Part 1 employed a type of testing little used before; it was based on 130 commercial flours placed in 11 groups by the donors.

Curve patterns made by the instruments named showed a wide range in characteristics within groups as well as between groups of the 130 commercial flours. However, the main characteristics of one main type such as bread flour were different from other main types such as crackers or cake flours. Protein content is one of the most important factors in classifying flours for specific uses. Mixogram, farinogram, and extensogram patterns aid in this classification and also give information on mixing requirements and dough-handling properties. Amylograph curve heights were negatively correlated with diastatic activity and gassing power. The last two were positively correlated (+0.92).

Rate of gas production depended primarily on the amount of fermentable sugar in the dough but could be increased by the addition of hydrogen peroxide. Gas retention depends both on rate of gas production and on the gas-retaining properties of the cell walls. Optimum mixing produced the best gas retention. Potassium bromate increased gas retention enough to overcome its negative effect on production. By a suitable choice of surface-active, reducing, and oxidizing agents as well as of amounts, it appears possible to influence both gas production and retention.

(Project 200. Department of Milling Industry. Leaders, C. O. Swanson and J. A. Johnson, Bankhead-Jones funds.)

***The Influence of Some Factors Affecting the Physical Properties of Wheat***—

The work on the 1944 harvest was similar to that in the preceding years and the results obtained were confirmatory. In 1945, a start was made in the study of the changes which take place in new wheat after harvest. Cuttings were made of Tenmarq wheat when green, when ripe, and after exposure to several rains. Samples of the various cuttings were treated as follows: Wetted to 30 percent then dried; exposed dry to 40° F. for six days; soaked, drained, then exposed wet to 40° F. for six days and then dried. (Cold-room temperatures are customarily stated in Fahrenheit.) Repeated germination tests of treated as well as untreated samples were made. Diastatic enzymes were stimulated by soaking 50-gram portions of the variously-treated wheats, draining, and then exposing wet for 24, 48, and 72 hours and air drying. Maltose values were obtained both before and after digestion at 30° C.

The dormant period in seeds as indicated by low germination without pre-chilling lasted from two to three months. Neither the wetting to 30 percent and then drying nor the dry treatment at 40° F. for six days influenced the length of the dormant period. However, both these treatments appeared to have effected some stimulation of diastatic enzymes. Exposing the wheat to

40° F. in the wet conditions for six days had large effects. This prechilling greatly increased both the amounts of maltose present and the amounts produced during the digestion at 30° C. for one hour. This stimulation of enzyme activity by prechilling offers one explanation why this treatment promotes the germination of new seeds.

Limited baking tests indicated that wetting once to 30 percent then drying had effects similar to the prolonged exposure in the field. Both this wetting and the exposure in the field increased the loaf volumes. Similar increases on fresh samples were obtained by the use of potassium bromate.

(Project 216. Department of Milling Industry. Leader, C. O. Swanson. Purnell funds.)

***Conditioning Requirements of Wheat and Their Influence upon Milling and Baking.***— The application of infra-red heat on wheat at different moisture contents has been tried as a means of modifying gluten quality. Semihard wheat types were weakened by this treatment and made more nearly suitable for cracker-sponge flour type.

Work has been done on classifying wheats according to their comparative milling value. Also the pearling index of various wheat types has been investigated. Some wheats, such as Chiefkan, do not blend satisfactorily with other wheats because of hardness and resistance to mellowing during tempering.

Experiments on the conditioning of 80 percent extraction flour have been conducted. Wheat should not be allowed to become sticky or even slightly too wet or it becomes increasingly difficult to obtain the desired extraction.

(Project 219. Department of Milling Industry. Leader, R. O. Pence. State funds.)

***The Effect of Factors Influencing the Quality of Kansas Wheat.***— This project was continued, as originally planned, as a research-service enterprise for the benefit of the wheat producer, miller, baker, and ultimate consumer.

Many comparative milling and baking tests have been made in coöperation with such organizations as The Kansas Wheat Improvement Association, The Northwest Crop Improvement Association, The Kansas City Section of the American Association of Cereal Chemists, the Dominion Grain Research Laboratory, and various Kansas fairs.

Coöperative work has been done in connection with the Department of Food Economics and Nutrition of the School of Home Economics and the United States Bureau of Entomology and Plant Quarantine. This work has compared the B-complex vitamin values of several types of flour and has provided information on the extent of damage to flour when over-treated with methyl bromide fumigant. In coöperation with the Soy Flour Association studies were made of the effect of various types and levels of soy flour additions to doughs. Beyond 3 percent soy flour additions bread quality suffers. Formula changes will permit the production of satisfactory bread with as high as 5 percent soy flour.

(Project 220. Department of Milling Industry. Leader, J. A. Shellenberger. State funds.)

***A Physiological Study of the Hard Winter Wheat Plant.***— This study has been continued under two subprojects.

*The effect of defoliation on the physiological functions of winter wheat.*—

The purpose of this investigation was to determine the reduction in the yield of wheat caused by a decrease in the photosynthetic area of the leaves.

The longer defoliation was postponed, the less was the effect on yield. Total defoliation gave a greater reduction in the number and weight of grains than either of the partial methods. Half-leaf removal had a more pronounced effect on the weight of the grain than basal defoliation. The removal of photosynthetically-active leaf tissue from the wheat plant resulted in a decrease in the number of grains produced and in the weight of those grains (maximum yield decrease observed was 33 percent). No evidence of shriveling of the grains was observed, however.

Thus it appears that the stems are the source of much of the material which forms the grain. Part of the decrease in the number of grains is due to the increase in the number of sterile basal spikelets. Specific results are given in Technical Bulletin 62.

*Physiological differences between hard and soft winter wheats.*— During the three growing seasons 1942-'43, 1943-'44, and 1944-'45, six hard and six soft winter wheats have been grown in randomized adjacent rows in triplicate plots at Manhattan. One hundred culms of each variety collected from each plot at flowering and two weeks after flowering were immediately killed by autoclaving. The culms then were divided into heads, leaves, and stems and sheaths, and dried at 100° C. In 1944-'45 a third set was taken six weeks after flowering. All materials were ground to 40-mesh size and ashed.

On a percentage basis calculated on the gram samples ashed, the heads of hard wheats showed a 20-percent higher ash content at flowering than those of soft wheats, were 7 percent higher two weeks after flowering, and 17 percent higher six weeks after flowering. On a basis of actual amount of ash present in complete heads, the hard wheats had 15 percent more at flowering and the soft wheats had almost 5 percent more than the hard wheats two weeks after flowering, while no difference existed six weeks after flowering.

There was an average increase of 137 percent in the ash content of the six hard wheats during the two weeks following flowering as compared to an average increase of 187 percent in the case of the six soft wheats. During the six-week interval following flowering the average increase for the six hard varieties was 275 percent, and 340 percent in the case of the six soft varieties.

In the leaves of soft wheats there was a slightly higher percentage of ash at flowering than in hard wheats. This difference increased to 10 percent by two weeks after flowering and reached 13 percent six weeks after flowering. The actual amount of ash in the leaves of the soft wheats was 45 percent higher than in the hard wheats at flowering, 53 percent higher two weeks after flowering, and 42 percent higher six weeks after flowering.

In the stem and sheath (considered together) there was a slightly higher percentage of ash. On a basis of the actual amount of ash in the stem and sheath, the soft wheats ran 34 percent higher at flowering, 42 percent higher two weeks after flowering, and 59 percent higher six weeks after flowering.

(Project 189. Department of Botany. Leader, J. C. Frazier. Purnell funds.)

*Physiological Studies of Noxious Weeds in Relation to Their Control.*— This project, closed July 1, 1946, included sub-projects on studies of field bindweed, *Convolvulus arvensis L.*; of hoary cress, *Lepidium draba L.*; and of climbing milkweed, *Gonolobus laevis Michx.*

*A study of the food reserves of bindweed.*— The control of perennial weeds by cultivation is based on the reduction of root reserves. An earlier study was based on bindweed plants of unknown age, while this study was made on year-old plants grown from seed.

The seasonal trend shown by these year-old plants showed a rather high reserve in the early spring, which was followed by a marked downward swing

until the seasonal minimum was reached May 1. This was followed by a marked rise to a summer maximum July 1. Renewed growth during late July and early August reduced the reserves, but a high level was attained in most of the divisions by September 1 and this level was maintained until November 1, the date of the last sampling.

*A study of the shade tolerance of bindweed.*— Studies made last biennium on bindweed plants grown in metal containers, each holding 200 pounds of soil and subjected to various degrees of shading, indicated that the plants receiving 18 percent or more of light showed no reduction in the percentage of their readily available carbohydrate reserves.

It was found that the light under most crop plants is 20 to 30 percent of full sunlight, which is much above the degree of shading required for the death of bindweed. Thus it would appear that the real value of a smother crop is to hold, during the time the land is planted to the smother crop, the weed's food reserves at the low point to which they have previously been brought by cultivation procedures.

*The study of the gross morphology of the climbing milkweed plant, particularly the root system.*— This study disclosed the nature of the root system of the climbing milkweed, its rate of development when grown from seed under known environmental conditions, and its relation to the shoot system of the plant. The type of development is much the same as that reported for dogbane, *Apocynum cannabinum* L., last biennium. In such plants the lateral roots which bring about the horizontal spread of the weed continue to grow horizontally and do not bend downward to become vertical roots by continued growth, as is the case with bindweed, hoary cress, and Russian knapweed.

Climbing milkweed forms vertical roots along these lateral roots in the same manner as dogbane, *i.e.*, they arise as vertical roots along the lateral root some distance back of the growing point. One lateral root of a plant 25 weeks old had grown a distance of nine feet through undisturbed soil. Climbing milkweed is a slow-growing weed, particularly in regard to the length of time required for new shoots to replace those removed from the plant.

(Project 202. Department of Botany. Leader, J. C. Frazier. Bankhead-Jones funds.)

**Orchard Investigations.**— During the biennium three of the subprojects have been maintained. Two show progress as reported below.

*Testing spray materials.*— No experimental spraying of fruit plants with insecticides, fungicides, or nursery waxes was done during the biennium. Young apple trees in the new orchard were sprayed each season with 1½ pounds of lead arsenate and 1½ pounds of hydrated lime to 50 gallons, which gave good control of cankerworms. Bordeaux mixture 4-4-50 plus ¼ gallon dormant oil emulsion applied to peaches in the spring before growth started gave control of peach leaf curl.

Since the young orchard produced no fruit, harvest sprays to prevent premature dropping of fruit were applied in Doniphan county.

*Rootstock studies.*— The study of over 40 varieties of French Crab rootstocks in the K series was continued during the biennium. From 25 to 50 trees of each variety are now growing in the station orchard. Some trees of each variety were topworked to Jonared and some to Winesap to determine which of the series will be best suited for those Kansas varieties. Although there was considerable variation, most of the rootstocks united readily with the cions of both Jonared and Winesap. The percent of "failures" was slightly higher for Winesap. The topworked trees will be observed further to note the influence of the stocks on rate of growth of the cions.

Winesap and Jonared made excellent growth on Hiberna and Virginia Crab stock onto which they were topworked in the spring of 1944. Montmorency

and early Richmond cherry buds failed to grow on Chokecherry (*Prunus pennsylvanica*) seedlings. Seedlings of the native crab apple (*Malus ioensis*) have made good growth during the two seasons. Many of the seedlings were severely damaged by cedar rust.

More than 80 varieties of sand cherry hybrids grown on known rootstocks are under observation and have produced sample fruits.

*Orchard soil management frost relations in orchard soils.*— This subproject was in abeyance during both years of the biennium.

*Testing new and promising varieties of tree fruits.*— This study was continued through both years of the biennium. One to six trees of a variety are grown under orchard conditions and the response of each variety is recorded. At this time the principal data collected relate to vegetative behavior, but later the yield and quality of the fruit produced will be equally important. Earliest plantings were made in 1943. Of these, jujube, peach, plum, nectarine, apricot, and cherry should reach bearing age in 1947.

(Project 25. Department of Horticulture. Leaders, G. A. Filinger and R. J. Barnett. State funds.)

***Small Fruits Investigations (Small Fruits Production).***— In this project many varieties of grapes, strawberries, and bramble fruits are being tested under Kansas conditions as to adaptability and production.

The grape varieties Worden and Concord produced high yields of good quality fruit in 1945.

The strawberry yields were fair but varied considerably. The mulched plots gave a higher total yield than the nonmulched plots.

The bramble yields were low. Studies of the winter hardiness of brambles were continued.

(Project 26. Department of Horticulture. Leader, E. F. Kientz. State funds.)

***Flower and Vegetable Investigations.***— Involving variety, crop, and culture tests, this study is divided into two subprojects.

*Vegetable variety testing and crop improvements.*— The project deals with the testing of numerous varieties of vegetable crops grown under Kansas conditions as to production, adaptability, quality, and insect and disease resistance.

Tomatoes and beans have received the most attention. The tomato varieties Sioux, Firesteel, Rutgers, and Stokesdale have given outstanding results.

Many varieties of green beans were tested. The varieties Unrivalled Wax, Green Pod, and Bountiful produced good yields.

*Culture of greenhouse crops.*— For the biennium 1945-1946 this project, included variety tests of greenhouse vegetable and flower crops; trials of new insecticides and fungicides; and cultural methods, with regard to soil treatment, disease control, and the use of artificial light on chrysanthemums.

Waltham tomatoes were superior as to total yield and earliness in spring and fall crops, compared with Michigan State, Rutgers, and Penred varieties.

Fermate gave satisfactory control of carnation rust, but was not effective against carnation yellows-mosaic; it showed partial control of some bulb-rots of gladioli; it controlled damping-off of lettuce seedlings.

Dithane D-14 gave the most effective control of gladiolus bulb-rots, but had no apparent effect on carnation yellows-mosaic.

Dinitro compounds used as sprays were superior in red spider control. Hypozene was an outstanding fumigant in red spider control.

DDT (Gesarol AK-20) used alone gave poor control of red spider mites, but up to 50-percent kill of mealy bugs and aphids. With nicotine sulphate

or fish-oil, soap toxicity was increased, except for the red spider mites. It appeared to increase the rate of growth in lettuce, with no apparent residual effect in the soil.

Sulphur dust, lime-sulphur spray, and Deenate nicotine sulphate spray were highly effective in the control of potato psyllid on tomatoes. Tobacine gave satisfactory control of green aphids on chrysanthemums.

Blooming of latest pompon varieties was delayed four to five weeks by irradiation. Peat in carnation soil improved the texture and water-holding capacity.

(Project 27. Department of Horticulture. Leaders, W. W. Willis and E. F. Kientz. State funds.)

***Relation of Leaf Structure to Rate of Photosynthesis in Fruit Plants.***— Previous reports on this project have shown that positive correlation exists between the ratio of the internally-exposed surface to the external surface of apple leaves (R value) and photosynthetic activity. The influence of several different treatments on the R value of the leaves has also been reported.

The differences in R value of the leaves between trees receiving both ammonium sulphate fertilizer and wettable sulphur-lead arsenate foliage spray treatments combined, and untreated trees or trees receiving the foliage spray treatment alone, were significantly greater than variance between trees; the trees receiving the combination of both fertilizer and foliage spray treatments had the higher R value.

The differences in R value between orchard-grown leaves sprayed with DDT and those sprayed with lead arsenate, and between greenhouse-grown leaves sprayed with Fermate and untreated leaves, were significantly greater than variance between leaves; the DDT treated and untreated leaves had the higher R values respectively.

Although other data obtained on the R values of the leaves of treated and untreated trees indicate the following influences of different treatments on R value, the differences obtained between the treated and untreated trees were not significantly greater than variance between trees.

The R value of apple leaves was apparently increased by both Curbay and Uramon used separately, the latter being applied as a foliage spray, and by each when used in combination with either wettable sulphur-lead arsenate or Fermate-lime-lead arsenate foliage sprays. It was apparently increased also by ammonium sulphate when used in combination with Fermate-lime-lead arsenate.

Of five comparisons made involving the use of wettable sulphur-lead arsenate foliage spray on R value, apparently four showed positive and one no influence.

Of five comparisons made involving the influence of Fermate-lime-lead arsenate on R value, apparently three showed negative and two positive influence.

Gesarol AK 20 spray and Gesarol A 3 dust decreased the R value of field-grown apple leaves in 1944 and increased it in 1945.

Gesarol AK 20 and lead arsenate foliage sprays each apparently decreased the R value of greenhouse-grown apple leaves.

Data obtained from apple trees growing in the greenhouse since February show that there is a large difference between trees in the ratio of the leaf area at a given time to the "leaf area-days."

(Project 199. Department of Horticulture. Leaders, W. F. Pickett and J. C. Bates. Bankhead-Jones funds.)

***Investigations with Ornamental Plants.***— No introductions have been made to the peonies and irises, but 27 new varieties of

perennials were planted in the formal gardens. Seventeen varieties of peony buds were cut in order to determine which varieties could be cut and satisfactorily stored 18 to 21 days. The best stage of development of the buds for storage was also studied. The following varieties gave the best results: M. Jules Elie, Van Leeuwen, Shawnee Chief, Kelway Glorious, Baroness Schroeder, Reine Hortense, and Adolphe Rosseau. Pink and white varieties should be picked at the medium-firm stage, while the red varieties should be picked in soft or very soft stages.

Complete control of Phomopsis on red cedar was not obtained by spraying with Fermate or Special Semesan. Splendid control of blackspot on roses was obtained by both the above fungicides. Four spray applications of Fermate to *Crataegus crus-galli* gave approximately 95 percent control of cedar-apple rust. After a trial of one year, Manila grass (*Zoysia matrella*) shows promise as a desirable turf grass for Kansas.

(Project 213. Department of Horticulture. Leader, L. R. Quinlan. State funds.)

***Factors Affecting Survival and Growth in Forest Plantations.***— Soil moisture is the most important factor in limiting the survival and growth of forest plantings on upland soils in Kansas. The spacing distances determine, to a large degree, the amount of moisture available to individual trees. The trees were planted in the spring of 1942 at distances ranging from 4 x 6 feet to 8 x 18 feet. Eighteen species were used.

Though organized to run for a long term of years, this project was ended June 30, 1945, because sufficient labor was not available.

(Project 221. Subproject No. 1. Department of Horticulture. Leader, W. F. Pickett. Bankhead-Jones funds.)

***Industrial Utilization of Sorghum Grains.***— Work on this project included two phases as carried on coöperatively by the Departments of Chemistry and Chemical Engineering. Emphasis is on finding commercial uses for the sorghum grains that have proved well adapted to the state.

***Chemical phase.***— Work has continued on a study of those factors which contribute to the study of starch pastes. Viscosity records have been made of numerous experimental starches and, where possible, related to the composition and other properties. Sorghum starches, prepared from 14 standard varieties (1941 crop), have been rated with respect to their paste-forming characteristics and compared with commercial starches.

The arrangement of 14 varieties of sorghum grains (and several glutinous hybrids) in accordance with indices taken from the viscosity records of their starches corresponds in a general way to their classification with respect to variety. The kafirs yield starches which are superior to those of other groups for food purposes. Pink kafir excels in this respect.

A study is being made of the corn wet milling process with the view of adapting it to sorghum grains. Special attention is being given the grinding and steeping of the grain, tabling, and the recovery of fats and waxes.

Blackhull kafir starches obtained from grains grown in different years and in different places have given some confirmation of the stability of the varietal factor as it affects starch quality. Their viscosity records indicate that the conditions of growth have not greatly altered starch quality.



There has been continued progress in the preparation of chlorine derivatives of starch. Patent application was filed for part of this work February 20, 1945.

*Engineering phase.*— A series of wet milling experiments begun in 1943 was completed in 1945. Steeping and tabling operations were studied. Some dry milling experiments were also carried out.

During the year 1945-'46, the Departments of Chemistry and Chemical Engineering combined their efforts in wet milling research. The experiments during this time were on a laboratory scale. As soon as the results permit, it is planned to subject them to pilot plant studies.

In the wet milling experiments carried out in 1943-'45, some attention was given to steeping. The time and temperature of steeping was varied. Lower temperatures appeared to improve starch quality. The steeping time seemed to have little effect upon starch quality (earlier experiments indicated that there was an optimum steeping time at a given temperature). In fact, preliminary results indicated that it may be advantageous to omit the high temperature Steep entirely. The partial fermentation of the starch-water suspension after grinding and screening had no discernible effect on starch quality.

Increased fineness of grinding gave larger yields but there was little effect on starch quality.

Lowering the drying temperature improved the quality of the starch.

Some dry milling experiments were run in equipment of the Department of Milling Industry. The yield of starch was found to increase with increasing moisture content of the grain. The maximum yield of starch was obtained at a moisture content of 22 percent.

(Project 208. Departments of Chemistry and Chemical Engineering. Leaders, H. N. Barham and J. W. Greene. Bankhead-Jones funds.)

***A Study of Native and Introduced Plants for Rubber, Oil, and Medicinal Purposes.***— War conditions created many national emergencies. Among them, the scarcity of rubber, certain of the finer oils, and some drugs which were no longer obtainable from former sources of supply appeared as a real problem.

Collection and analysis of over 30 species of native plants as possible sources of rubber were accomplished in 1942 and 1943. Four species of milkweed were grown under cultivation in an effort to increase the yield and rubber content. In 1944 individual plant selections and analyses were made of common milkweed (*Asclepias syriaca*) from 11 locations in Kansas to determine the effect of strains or soil differences upon the production of rubber in the plants.

Guayule, Desert milkweed (*Asclepias subulata*), and California milkweed (*A. erosa*) were unable to survive the winters in Kansas. Extensive tests of Russian dandelion (*Taraxacum kok-saghyz*) were made in 1942 and 1943. The rubber content of the roots was satisfactory, but the plant was regarded as poorly adapted to Kansas. The low yield of roots and difficulties of production render it unpromising as a source of rubber in this state.

Analyses of common milkweed from 11 locations within the state show considerable variation in rubber content, indicating possibility of obtaining higher rubber-yielding strains of this plant by selection and breeding. Floss on the seed and fiber in the stems were given only casual attention but may be worthy of further investigation.

Sesame has been tested as a source of oil. Selections for erectness and tests of harvesting with machinery were made. The crop holds some promise as a source of oil.

The Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture, was a cooperating agency on the project.

(Project 231. Departments of Agronomy and Chemistry. Leaders, J. W. Zahnley and A. T. Perkins. Bankhead-Jones funds.)

***Nutritive Value of Kansas Wheat and Wheat Pasture with Special Reference to Mineral Composition.***— The work on this project has been divided into studies of the chemical composition of wheat grain and of the composition of wheat grasses. Special attention has been given in each case to the mineral content. The purpose has been to determine any significant differences in the composition of a few selected varieties of wheat and also differences which are dependent on the environment in which the wheat is grown.

*Wheat grain.*— Turkey, Blackhull, and Tenmarq wheat produced on the Department of Agronomy test plots in 13 different locations in Kansas were analyzed for protein, moisture, ash, and the following mineral constituents: Potassium, phosphorus, calcium, magnesium, sodium, manganese, iron, and copper. Analyses were made on the wheat produced in 1943, 1944, and 1945. The following facts seem pertinent: Wheat in the western half of Kansas had higher protein and higher ash. Calcium, potassium, and phosphorus were also higher in the west. Copper and sodium content were relatively constant. Manganese showed quite marked variation. The amount of manganese seemed to vary considerably with moisture conditions. The change in manganese content is especially significant because of its effect in chicken rations and also because it is thought to be active in enzymic systems.

*Wheat grasses.*— Samples of the three varieties previously mentioned were obtained from each of the plots at three different dates (until the pasturing stage had passed), in order to collect data considered useful particularly from the standpoint of grass tetany studies. These were obtained for the first time in 1945. Analyses of these samples were made for the same constituents as the grain and also for carotene, fiber, and other extractable material. Samples from the Manhattan plots were taken until the wheat headed. The following information is available from these analyses. Wheat grass is a rich source of carotene (up to 500,000 I. U. per pound dry weight), of protein (to 37 percent dry weight), and of minerals (ash up to 12.5 percent dry weight). The ash is very high in potassium in the western half of the state and is lower in the east, being lowest in the southeast corner of the state. Calcium is relatively low over the entire state.

The earliest samples are highest in percent potassium. This value decreases as the plant matures. Calcium and phosphorus follow the same trend. Protein and carotene reach a maximum a few weeks after spring growth begins and then start a gradual decline. The data are considered important in regard to mineral and protein balance when pasturing livestock on wheat grass.

(Project 3. Departments of Chemistry and Agronomy. Leaders, W. G. Schrenk and H. H. Laude. Kansas Industrial Development Commission funds.)

***A Study of the Composition of Sorghum Grain Wax and Oil.***— In the manufacture of starch from sorghum grain or corn, the wax and oil obtained are valuable by-products. As sorghum grain wax and oil have not been previously characterized, it was deemed necessary to compare the composition of the wax and oil with products available commercially.

Sorghum grain (Western Blackhull) was found to contain approximately 50 times more wax and two-thirds as much oil as corn. The wax, which had

properties similar to carnauba wax, could be removed by extracting the unground grain with hot solvent.

Sorghum grain oil was found to be similar to corn oil in composition and at least as stable as corn oil.

The extraction of 14 varieties of sorghum grain under standardized conditions revealed variations between varieties of approximately 50 percent in the yield of wax and 20 percent in the yield of oil. These variations may have been influenced by soil fertility and climatic conditions, as well as by genetic factors, although all 14 varieties were grown during the same season in experimental plots under identical conditions.

(Project 4. Department of Chemistry. Leader, F. A. Kummerow. Kansas Industrial Development Commission funds.)

***Insect Pollination of Legumes.***— This project was begun July 1, 1945. The work consisted of field observations of the insects visiting alfalfa flowers, the seasonal populations of each, and the factor of plant competition to attract bees.

***Field observations.***— During August, 1945, field observations were made of the pollination activities and ecological conditions affecting nectar gathering by insects attracted to alfalfa blossoms. Fourteen different species of insects, chiefly bees, were observed to visit alfalfa flowers. Of the insects most numerous in alfalfa fields at the time of bloom, the most effective in tripping alfalfa flowers was a leaf cutter bee, *Magachile brevis*, with 302 bees tripping 6,537 out of 6,821 flowers visited, or 95.8 percent tripped. During the same period 629 bumble bees tripped 3,823 out of 12,606 flowers visited or 30.2 percent tripped; and 565 honeybees tripped 246 out of 5,115 flowers visited, or 4.8 percent tripped. Honeybees tripped the flowers when gathering pollen.

***Plant competition.***— There is competition in nature among flowering plants to attract insects. One factor is the number of flowers of any one species and another is the quality of the nectar available. Honeybees are more attracted by nectar of high sugar content, and presumably this is also true of other hymenopterous insects. On July 31 the white sweet clover honey-flow was declining, and therefore alfalfa flowers were more attractive to bees. The numbers of honeybees working on alfalfa flowers increased from the early part of August until the smartweed honey-flow began on August 14. At this time, the numbers of honeybees observed gathering food from alfalfa flowers and tripping them declined sharply.

(Project 28. Department of Entomology. Leader, R. L. Parker. Midwest Agricultural Foundation Research funds.)

## INVESTIGATIONS IN THE ANIMAL INDUSTRIES

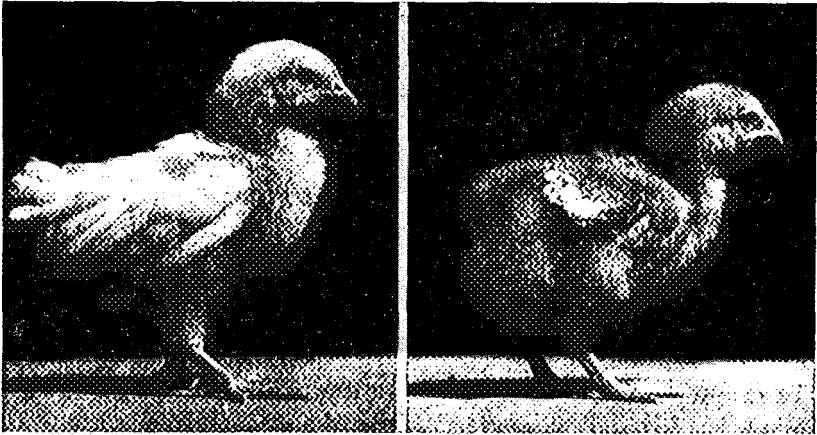
The following pages contain brief reports of research conducted during the biennium in problems relating to the animal industries.

***Animal Nutrition Investigations with Swine.***— During the first year of the biennium the study of phosphorus and calcium requirements of growing pigs was continued and the project completed. This year two groups of six pigs each and one group of five pigs were fed six months a basal ration of 75 percent pearl hominy, 10 percent tapioca flour, 10 percent blood meal, 4 percent alfalfa leaf meal dehydrated, 15 percent dried brewers' yeast, and 0.5 percent iodized salt. To this feed mono-calcium phosphate was added to bring the percent of phosphorus to 0.3. Each group was allowed

outdoors and exposed to sunshine. Group I of this experiment received 0.4 percent calcium. Group II received 0.45 percent calcium, and Group III received 0.5 percent calcium.

At the end of six months of feeding, judging from growth and daily gains, little difference was apparent in the pigs fed the three levels of calcium. The chemical and breaking tests of the bones and the blood analysis also disclosed no differences.

The results from this study show that under the conditions of these tests growing pigs need about .45 to 0.5 percent calcium to give normal growth and bone development.



Two 10-day-old chicks represent the early-feathering and late-feathering strains of White Plymouth Rocks. The strain with the early-feathering tendency has been developed in the Department of Poultry Husbandry, Kansas Agricultural Experiment Station. Birds of this strain command better prices at broiler age because of better appearance and ease of picking.

*Availability of phosphorus.*— In this experiment four lots of pigs were fed, each containing a low phosphorus basal ration, but each containing a different phosphorus supplement, namely bone meal and three kinds of defluorinated rock phosphates. These were incorporated in the feed at a level of 0.25 percent, a level which would not permit of satisfactory growth unless the phosphorus was completely utilized.

After five months of feeding, records of growth and especially blood analysis indicated that the pigs (Lot 3) receiving the low or the defluorinated rock phosphate did not grow normally. The steamed bone meal and the other two defluorinated phosphates fed in Lots 1, 2, and 4 respectively seem to be satisfactory. The breaking tests on the bones showed that the bones of the pigs of Lot 3 were not so strong as those in the lots that received the satisfactory phosphorus supplements.

(Project 38. Department of Animal Husbandry, Leaders, C. E. Aubel, J. S. Hughes, L. M. Roderick. State and Adams funds.)

*Swine Feeding Investigations.* — During the biennium, four experiments have been conducted. Two were studies with spring pigs on alfalfa pasture concerning full feeding versus growing on a lim-

ited grain ration, and then full feeding to market weight. Two experiments were with fall pigs fed in the dry lot.

*Full feeding vs. deferred feeding on alfalfa pasture.*— Full-fed corn pigs on alfalfa pasture, hand-fed 25 pound tankage per head daily, made more rapid growth and reached a finish weight 30 days earlier than those that received only 1 pound or 1½ pounds of corn daily with 0.25 pound of tankage. The daily grains for the full-fed pigs were 1.53 pounds, and for the limited-fed pigs for the same period, 0.75 pound. The limited-fed pigs gained 2.63 pounds daily the last 30 days when on full feed. The limited-fed pigs for their entire feeding period required only 296.5 pounds of corn per 100 pounds gain. Thus a considerable saving of grain occurred in this method of feeding.

*Fattening pigs in the dry lot.*— Two experiments were conducted in this phase. One was on the maximum use of alfalfa hay in swine fattening rations. Six lots of pigs were fed in this experiment. The results are summarized as follows :

The pigs that received mixed protein supplements gained faster and made more economical gains than the pigs that received shelled corn, tankage, and alfalfa hay, self-fed free choice.

In the lot where loose alfalfa hay self-fed replaced the alfalfa meal as fed in the mixed protein supplement lot, the gains were identical but a saving was made in the economy of gain. However, where alfalfa hay replaced the meal a decrease in the gains occurred, with an increase in the cost of gains.

In lots where self-fed alfalfa hay replaced the meal in the protein mixture, there was a small decrease in the amount of corn required per 100 pounds gain, but more alfalfa hay was consumed.

In the lot which received 15 percent chopped alfalfa hay in the grain mixture, the gains were less than in the mixed protein supplement fed lots but higher than in the lot where the tankage and alfalfa hay only were fed as protein supplements.

The other experiment carried out limited the protein supplement in the final stages of fattening fall pigs fed in the dry lot. The results are summarized as follows:

In this experiment one lot of pigs, weight about 150 pounds, was self-fed shelled corn without a protein supplement. Another lot was self-fed corn and self-fed a mixed protein supplement. A third lot was self-fed corn and hand-fed protein supplement 0.2 pound per head daily.

The limited-fed pigs made the cheaper gain. They consumed less corn per 100 pounds gain, and were given less than half as much protein supplement, as the lot which was self-fed on protein. The self-fed corn and supplement pigs made cheaper gains than the pigs fed corn alone; they made the largest daily gains but utilized more feed per 100 pounds gain than the limited-protein-fed pigs.

(Project 110. Department of Animal Husbandry. Leader, C. E. Aubel. State funds.)

*Swine Breeding Investigations.*— During the past year an experiment was begun in swine production to produce a superior inbred line of swine by using an inbred Minnesota No. 1 boar on purebred Poland China and Duroc sows. It was planned to select the best gilts from these matings or first cross pigs and mate them back to their sire or another inbred Minnesota No. 1 boar for several generations, then inbreed them among the progeny available.

The first cross-bred pigs farrowed in the spring of 1945 consisted of three litters. They were as good or better in number per litter, birth weight, weaning 56-day weight, and at finish 168-day weight, than similarly-raised purebred litters. The dressing percentage and carcass grades were inferior, however, at the finish weight.

The second farrow of cross-bred pigs this spring consisted of four litters from the first year's cross-bred gilts mated back to their sire, the Minnesota No. 1 boar. These cross-bred pigs again averaged as good or better than similarly raised purebred pigs in number per litter, birth weight, and weaning 56-day weight. The 168-day weight has not been determined.

A fifth litter in this year's farrow consisted of one of the original purebred sows that was then bred to the Minnesota No. 1 boar, but mated to her cross-bred son for this year's farrow.

In both cross-bred farrowings some good, large litters have appeared; also some very good individual pigs, as judged by weight and conformation. It is from these better ones the selections are being made.

(Project 242. Department of Animal Husbandry. Leaders, C. E. Aubel and H. L. Ibsen. State funds.)

**Silage Feeding Investigations.**— The work conducted during the biennium has related to methods of fattening heifers for the summer market. One feeding trial has been completed and one is in progress. In the wintering phase of the test completed in 1945, each lot received a full feed of silage and one-tenth pound of ground limestone per head daily. Ground shelled corn and cottonseed meal were fed as follows per heifer daily: Lot 1—corn, full feed; cottonseed meal, 1½ pounds; Lot 2—corn, one-half feed; cottonseed meal, 1½ pounds; Lot 3—corn, 3 pounds, no cottonseed meal; Lot 4—no corn, cottonseed meal, 3 pounds; Lot 5—no corn, cottonseed meal, 1½ pounds.

At the close of the wintering phase, each lot was full-fed and marketed averaging approximately 850 pounds per heifer. Marketing information and slaughter data were obtained for each lot.

The results of this test indicate that full-feeding grain during the winter to heifer calves that are to be fattened for the summer market is not justified. On the basis of total feeds consumed, especially grain, total gain, date marketed, and margin per heifer, the system represented by Lot 2, fed a half-feed of grain, appeared to have an advantage over those represented by the other lots in this test.

Each lot in the second test, which is still in progress, received silage, cottonseed meal, and ground limestone during the wintering phase. In addition, ground shelled corn was fed as follows: Lot 1, full feed; Lot 2, one-half feed; Lot 3, one-fourth feed; Lot 4, none. It is planned to market each lot when an average weight of approximately 850 pounds per heifer is reached.

(Project. 78. Department of Animal Husbandry. Leader, A. D. Weber. State funds.)

**Utilizing Native Grass.**— The influence of winter rations upon returns from wintering, grazing, and full-feeding yearling steers was studied in a test which was completed November 24, 1945. Five lots of yearling steers were wintered as follows: Lot 1—silage and 1 pound of cottonseed meal per head daily; Lot 2—prairie hay and 1 pound of cottonseed meal per head daily; Lot 3—prairie hay and 2 pounds of cottonseed meal per head daily; Lot 4—silage, prairie hay, and 1 pound of cottonseed meal per head daily; Lot 5—silage, prairie hay, urea, grain, and bone meal.

All lots were grazed together for 128 days during the summer of 1945, after which they were full-fed in the original lots for 35 days. Each lot received the same feeds during the full-feeding period.

Gains during the wintering period were as follows: Lot 1, 222 pounds; Lot 2, 102 pounds; Lot 3, 167 pounds; Lot 4, 218 pounds; Lot 5, 163 pounds.

Gains on pasture were inversely proportional to winter gains, but the steers in Lot 3 made the largest total gain for the combined wintering and grazing phases. While the steers in Lot 2 made the largest gain on pasture, they were still the low-gaining lot for the combined wintering and grazing phases. The results of this test indicate, therefore, that yearling steers should be fed to gain approximately 150 pounds during the winter when the objective is to secure maximum returns from wintering plus grazing. On the other hand, if maximum pasture gains are the primary objective, winter gains should be approximately 100 pounds per steer.

The supplementary mixture comprised of ground shelled corn, urea, and bone meal produced reasonably satisfactory results but was not equal to cottonseed meal as a supplement to silage and prairie hay.

While gains made during the winter had a direct bearing on pasture gains, they did not appear to have any influence on the results obtained in the full-feeding period. Feed consumption, gains, selling price, dressing percentages, and carcass grades were satisfactory in all lots, and no significant differences were noted.

A similar experiment is being conducted now with steer calves.

(Project 151. Department of Animal Husbandry. Leader, A. D. Weber. State funds.)

***Studies of the Influence of Insect Control on Meat Production.***— The object of the cattle-grub control project is to determine the effect of treatment for grubs on the rate of gain, and the damage to carcasses and hides, on range-fed calves and beef cattle. The cattle in this year's test were 40 heifer calves from South Texas. A count of the number of grubs was made and one-half of the calves was treated with derris powder. The calves were fattened, and at the time of slaughter data were obtained concerning the damage by grubs to hides and carcasses.

(Project 245. Departments of Animal Husbandry and Entomology. Leaders, F. W. Bell and G. A. Dean. Department funds.)

***Beef Cattle Breeding Investigations: The "Double-Muscled" Character.***— A "double-muscled" purebred Angus cow was mated to a purebred Hereford bull, producing offspring all of which were normal. Later, when bred to her son, she produced both normal and "double-muscled" offspring, thus furnishing evidence that the character is inherited as a recessive. At present, "double-muscled" animals are being mated to each other for the purpose of obtaining further evidence in regard to the mode of inheritance. If the theory is correct, only "double-muscled" offspring should be obtained from the above mating.

(Project 243. Department of Animal Husbandry. Leaders, A. D. Weber, H. L. Ibsen, D. L. Mackintosh. State funds.)

***Effects of Inbreeding and Linebreeding on Sheep.***— Various degrees of inbreeding and linebreeding have been studied in Shropshire and Rambouillet sheep for six years.

Different systems of breeding, chiefly sire-daughter and brother-sister mat-

ings, have been made simultaneously with the mating of unrelated individuals of similar type. Wherever possible, twin ewes were mated by different systems in an effort to eliminate factors of variability.

Several different methods have been used to measure results. In addition to taking of weights periodically and carefully noting and recording characteristics commonly used in judging and selection, investigators took a series of carefully designed body measurements. It is the purpose of the study to make and compare measurements of all offspring at the ages of one day, three months, six months, nine months, and one year. No measurements have been taken on individuals beyond one year of age except on the original breeding stock.

Hormone studies have also been made for two years under this project. To date the study has been confined to an investigation of periodic intramuscular injections of the male sex hormone, testosterone, on horn growth and other characteristics of Rambouillet ewes.

Almost 200 measurements have been made, some being repetitions, since it is the purpose to measure each animal at five different stages of development. It has been necessary to reduce the number of animals used in this study because of the small size of the flocks and lack of student assistance, and during the past year it has not been possible to make additional measurements. Records have been kept, however, on the few animals involved, and can be used in later studies whenever it is possible to resume the measurements. Additional hormone studies have been made and are being continued.

(Project 205. Department of Animal Husbandry. Leaders, R. F. Cox and H. L. Ibsen. State funds.)

**Lamb Feeding Investigations.**— Between 500 and 600 range feeder lambs have been fed each year of the biennium in 10 to 12 lots involving studies and comparisons of various combinations of roughage, concentrates, and minerals in their ration, emphasizing use of sorghums.

A brief summary of the results of the work of this biennium follows:

Ground Finney milo stover was worth 95 percent as much as Leoti X Atlas stover as a roughage.

Leoti X Atlas grain was slightly inferior to Westland or Finney milo grain. Leoti X Atlas grain and dried beet pulp in equal parts produced nearly 10 percent more gain on lambs than an equal weight of the grain without the pulp.

Green and brown alfalfa hay were approximately equal in gains produced on lambs, and were about 25 percent more efficient than Leoti X Atlas stover.

A complete and complex mineral mixture was of no value to lambs when added to a ration of Westland milo grain, linseed oil meal, and either brown alfalfa hay or Leoti X Atlas stover.

Somewhat larger gains were made by lambs fed Westland grain, linseed cake, and Leoti X Atlas stover when it was fed ground and mixed than when fed separately and whole.

Increasing the percentage of concentrates (grain and protein supplement) in the ration from 45 percent to 50 percent and to 55 percent did not result in a significant increase in gains, but did increase the cost of gains.

Periodic increases in the proportion of concentrates to roughage throughout the feeding period showed no advantage over feeding a ration of constant concentration throughout the feeding period.

Lambs fed threshed Westland grain made slightly more gain at a little lower cost than lambs fed Westland heads.

Mature Westland grain produced slightly larger gains at slightly lower cost than Westland grain of low test weight, when the two were charged at the same price.

Waxy endosperm (Leoti X Atlas) grain produced virtually the same (slightly more) gain at a slight reduction in cost of gains compared with Westland grain.

Self-feeding Westland grain, linseed cake, and Leoti X Atlas stover resulted



in a considerable increase in the rate of gain but also increased the cost of gains.

Alfalfa hay produced larger gains than Sumac stover, which in turn produced slightly larger gains than Leoti X Atlas stover. The cost of gains was lowest for lambs fed Sumac stover, second for those fed Leoti X Atlas stover, and highest for those fed alfalfa hay.

(Project 111. Department of Animal Husbandry. Leaders, R. F. Cox and L. M. Sloan. State funds.)

***The Relationship of Physical Balance and Energy Value in Sheep Rations.***— Three lots of 15 lambs each were fed rations composed of ground corn and cottonseed meal with either bleached poplar sulphite (paper-wood pulp) or biron groundwood screenings serving as bulk. The three lots consumed the same quantities of corn and cottonseed meal, and consequently the same amount of nutrients. However, the physical nature (concentration and bulkiness) of the rations was varied by the introduction of different amounts of wood pulp.

In addition to the usual feed-lot experimental methods of testing results, three digestion trials were run on five lambs in each lot.

Lot 2, whose ration was nearest the optimum physical balance as determined in a number of previous feeding experiments, made generally larger gains than the other lots. Lot 1 gained more rapidly during the last 30 days of feeding, both years, indicating some ability to adjust themselves to the imbalance. The digestion coefficients were higher for the fiber in the ration of Lot 2, but either lower or not significantly different for the other nutrients.

(Project 236. Departments of Animal Husbandry and Chemistry. Leaders, R. F. Cox and J. F. Hughes. Bankhead-Jones funds.)

***Fundamental Nutrition Studies of Sorghum Roughages and Grain.***— During the first year of the biennium, chemical analyses and computations were completed for the digestion trial conducted in the spring of 1945. In this trial three rations were used; namely, silage, cottonseed meal, and limestone; silage, cottonseed meal, prairie hay, and limestone; and silage, prairie hay, urea, cornmeal, and bone meal. Three steers were used in each lot. Results show no significant differences. The addition of a limited amount of prairie hay to the silage and cottonseed meal ration seemed to increase the digestibility slightly.

In the spring of 1946 digestion trials were conducted with three rations. Four steers were used on each ration. Ration No. 1 contained a combination of silage and prairie hay as roughage, ration No. 2 contained only prairie hay, and ration No. 3 contained only silage as roughage. The chemical analysis for this digestion trial has not been completed.

(Project 222. Departments of Animal Husbandry and Chemistry. Leaders, A. D. Weber and J. S. Hughes. Bankhead-Jones funds.)

***Deficiencies of Sorghum Crops as Feed for Dairy Cows.***— The report on subproject 3a is included here; it is one of the phases of long-time feeding experiments with dairy cows.

*The influence of modified sorgo rations on the vitamin content and microbial flora of the rumen of cattle.*— Special attention has been given to developing quantitative methods of determining the cellulose-digesting microorganisms. There are now fairly satisfactory media for determination of total numbers of various types of bacteria, but efforts to develop such media from the cellulose-digesting types have not been successful. Although it was possible to obtain various types of cellulose-digesting bacteria, all grew too slowly to account for the rapid disappearance of the crude fiber from the rumen of cattle. There is some factor which appears to be very active in the paunch of ruminants which has not yet been duplicated in the laboratory studies.

The total bacteria vary greatly in different rumen samples. This is inevitable, due to the present methods of sampling. Total microscopic counts averaged about five billion per ml. The total number of bacteria which grew on culture media varied from 1,500,000 to 116,000,000 per ml. with an average of 17,000,000 per ml. From this it would appear that most of the bacteria in the rumen contents are dead. It may be necessary to undertake studies of the cellulose-digesting enzymes in order to explain the changes which occur.

(Project 206. Department of Bacteriology. Leader, L. D. Bushnell. Bankhead-Jones funds.)

***Factors Affecting the Composition and Quality of Milk.***— Work on this project during the biennium has been done by both the Department of Chemistry and the Department of Dairy Husbandry. Three phases of milk composition studies have been reported.

*Variations of milk constituents as related to the history, care, and environments of the cow.*— This phase of the project has been continued during the biennium by the Department of Dairy Husbandry. The primary objectives were first, to obtain data on a larger number of complete lactation records; and second, to accumulate data which will eventually make it possible to establish norms for the solids-not-fat content of milk produced by the breeds at different seasons of the year and to determine the possible effects of environmental and genetic factors on the composition of milk.

During the period June 1, 1944, to June 1, 1946, a total of 324 three-day composite samples of milk from 60 different cows taken at approximately monthly intervals were analyzed for total solids and butterfat, and the solids-not-fat content of the milk computed. The data attained during this period made it possible to obtain complete lactation records on each of 22 cows distributed by breeds as follows: Ayrshire, 6; Holstein, 9; Guernsey, 1; and Jersey, 6.

The cumulative total of nine and ten months lactation records since the study started is now 198. The distribution of all lactation records obtained to date by breeds is as follows: Ayrshire, 47; Holstein, 66; Guernsey, 37; and Jersey, 48.

*The effect of the vitamin A activity of the ration fed during the latter stages of gestation on the concentration of carotene and vitamin A in colostrum.*— During the past two years the comparative effects of various feed supplements on the vitamin A and carotene content of colostrum and early milk were determined on a total of 65 cows. Using 29 of the foregoing cows, workers made a study of the effect of high and low protein rations upon other constituents and properties of colostrum, protein fractions, specific gravity, fat, solids, ash solids-not-fat, lactose, viscosity, and creaming.

The results to date indicate that the carotene content of colostrum may be influenced by the use of green forage. Rations fortified with vitamin A increase the amount of this constituent but may decrease the carotene content in the colostrum from Holsteins and Ayrshires. The trends are inconclusive for Jerseys. In these experiments the vitamin A fed has been largely in the form of the ester.

No marked differences have been found in the concentrations of the constituents of the colostrum from cows fed the high and low protein rations.

As colostrum changes to milk, the concentration of vitamin A, carotene, albumin, globulin, nonprotein nitrogen, ash, total solids, specific gravity, and viscosity decreases rapidly during the first few milkings. The lactose values increase as colostrum changes to milk, and the fat content has shown considerable variation.

*Vitamin A potency of butter.*— This project was started in January, 1943, as a part of a national coöperative project on the vitamin A potency of butter. During the calendar year 1944 a total of 84 samples of butter was collected from seven Kansas creameries and analyzed for vitamin A and carotene. In addition, each sample was graded, the color measured, and the chemical composition determined. A total of 165 samples of butter was examined at monthly intervals since the project started in 1945.

The mean total vitamin A potency for all samples examined during the period June, 1943, through May, 1944, was found to be 13,417 I.U. per pound of butter or 16,726 I.U. per pound of butterfat. The average vitamin A potency ranged from a low of 9,346 I.U. per pound of butter in January to a high of 19,579 in May. The vitamin A potency of Kansas butter seems to be influenced more by seasonal factors than by any others observed.

(Project 209. Departments of Dairy Husbandry and Chemistry. Leaders, W. H. Martin, D. B. Parrish, F. W. Atkeson. Bankhead-Jones funds.)

***The Effects of Certain Prepartum Feeding and Managerial Practices on the Physiopathology of the Dairy Cow and Her Offspring.***—

From a series of studies designed to determine the effects of certain prepartal feeding practices on the cow, on her newborn offspring, and on her mammary secretions, the effects of the following factors have been investigated: (1) Different levels of carotene and vitamin A intake and (2) different levels of protein consumption. These studies involved the use of five groups of heifers and cows in the terminal one to two months of gestation.

The various rations produced no significant differences in the general health of the cattle and in the conditions of their mammary systems. The carotene and the vitamin A of the blood serum varied with the intake of these constituents, and the level of nonprotein nitrogen raised as the ingestion of "crude protein" increased. In all the cows, irrespective of diet, the vitamin A of the serum decreased and the hemoglobin of the blood increased near the time of parturition.

The vitality of the newborn calves was variable, the individual differences being more marked than the group differences. The vitamin A reserves of the calves from cows receiving the vitamin A fortified ration (approximately one million U. S. P. units daily) were strikingly higher than observed in the offspring of other groups. The serological reactions of the blood from newborn calves were similar for all groups.

The microbiological properties of the colostrum were erratic, showing no definite relationship to the rations fed. The carotene and vitamin A, however, varied with the prepartal intake of these constituents (see Bankhead-Jones Project 209).

(Project 240. Departments of Dairy Husbandry and Chemistry. Leaders, G. H. Wise, F. W. Atkeson, M. J. Caldwell. D. B. Parrish, J. S. Hughes, D. V. Foltz. Bankhead-Jones funds.)

***Calf Investigations.***— This report deals with subproject 5a, which is one phase of the study of methods of raising calves.

*Investigations of possible methods of determining the role of the rumen in the physiology of the nutrition of the calf.*— Removal of the rumen was employed as an indirect means of determining the nutritional role of this organ in the young calf. The operation was performed successfully on two calves, which were subjected to the standard herd dietary and managerial regimes until the health of the calves indicated the need for corrective measures. These consisted of administering ruminal fluids and vitamin A.

One of the calves developed normally, manifesting no ill effects except a marked tendency to bloat, particularly while grazing spring grasses. The chronic nature of the case suggested an impairment of the rumen activity. Postmortem examination revealed marked regeneration of the rumen, which was normal in total size but slightly malformed and deficient in the posterior region, including dorsal and ventral sacs.

The second calf developed normally during the first two months following the operation but subsequently became extremely unthrifty. Daily administrations of vitamin A effected little change other than an increase in the concentration of this constituent in the blood serum. The addition of ruminal fluids to the vitamin A treatment stimulated the appetite, accelerated the growth, increased the vigor, improved the general appearance, and reduced the number of poikilocytes of the blood.

(Project 154. Departments of Dairy Husbandry and Veterinary Medicine. Leaders, G. H. Wise, R. P. Link, E. E. Leasure, W. W. Thompson. State funds.)

*Dairy Production Investigations.*— Of the various studies that have been included in this project through the years, three are reported on here.

*Grass tetany.*— Since a high concentration of potassium in the wheat plant seems to be associated with a high incidence of losses of cattle grazing the wheat pastures, the effects of the potassium on calves were determined. Three calves received intravenous injections of a potassium chloride solution. In two cases the solution was administered intermittently in increasing doses over a period of several days, but in the third case, the potassium was infused continuously until a lethal concentration was attained.

Whenever the systemic concentration of the potassium chloride increased sufficiently, the calves invariably succumbed. The symptoms in the terminal stages were as follows: Increased rates of respiration, of micturation, and of secretion by the glands in the upper respiratory system and eyelids; the development of hyperirritability as manifested by spasms and tetany, and finally death without significant post-mortem lesions. Intravenous injections of calcium chloride were ineffective in overcoming the convulsive seizures. The large quantities of potassium necessary to produce death experimentally suggest that under practical grazing conditions potassium alone probably is not the principal cause of death.

*The therapeutic value of feeding massive amounts of vitamin A in the control of mastitis in lactating cows.*— A limited number of field observations reported in the popular dairy literature suggested a relationship of the vitamin A nutrition of dairy cows to the incidence and severity of mastitis. To obtain specific information on the curative role of vitamin A, feeding trials comparing a high vitamin A ration with a standard winter ration were conducted on mastitic cows, 10 in each group. All the cows were fed a normal basal winter ration, but the supplemental group received in addition 1,250,000 U. S. P. units of vitamin A daily. The trial was continued over a period of 100 days, during which time observations were made on the physical condition of the udder and the general health of the cow, and samples of milk were collected for bacteriological examinations.

Fortification of the winter ration with massive amounts of vitamin A produced no detectable improvement in the health of the cows nor in the condition of their mastitic glands.

*The assimilation and the storage of vitamin A and carotene in dairy cows.*— The effect of the level of carotene and vitamin A intake on the concentrations of these constituents in the blood and the liver of lactating dairy cows was determined on two groups of cattle. One group received a standard winter ration, while the other group received a similar ration supplemented with 1,250,000 U. S. P. units of vitamin A daily. Analyses were made on samples of blood collected at irregular intervals during the latter half of a 100-day feeding trial and on livers salvaged from representatives of the respective groups slaughtered immediately after the termination of the trial.

The vitamin A concentration in the blood serum and in the livers of the cows receiving the A-supplemented ration were strikingly higher than observed in the group receiving the standard ration, but the carotene values were lower. These results indicate that when excess quantities of vitamin A are ingested over a prolonged period, the cow establishes large reserves.

(Project 34. Department of Dairy Husbandry. Leaders, G. H. Wise, M. J. Caldwell, F. W. Atkeson, J. S. Hughes. State funds.)

*Evaluation of the Phosphatase Test as a Measure of Pasteurization Efficiency of Dairy Products.*— Freshly-made cheddar cheese curd and the whey from the cheese were found to give a phosphatase reaction similar to that of the milk from which they were produced. The addition of as little as 0.25 percent of raw milk to properly pasteurized milk resulted in positive phosphatase tests in the freshly-made cheddar cheese curd produced from such milk.

No phosphatase activity was observed in many samples of aged cheddar cheese when the cheese was added directly to the buffered substrate in performing the phosphatase test. This was due to lowering of the pH of the mixture. The pH of the mixture could be maintained at the optimum level for phosphatase activity by first mixing the cheese with buffered water and then adding a portion of the mixture to the buffered substrate.

(Project 124. Department of Dairy Husbandry. Leaders, W. H. Martin and W. J. Cauldfield. State funds.)

*Improvement and Conservation of Farm Poultry.*— During the biennium the work of this project has dealt with five problems related to turkey and chicken production.

*Turkey production: progeny testing.*— Four lots of broad-breasted Bronze turkeys with 12 to 15 females and one male per lot have been trapnested and pedigreed the past three seasons. Management conditions have been the same each year. Artificial lights were turned on the toms at 4 a.m. daily for the last three weeks in December, and on the hens when they were mated January 1. Running water, mash, grain, grit, and shell were available at all times. The crude protein content of the mash was calculated to be 19.5, 17.66, and 21.4 percent for 1944, 1945, and 1946 respectively. Fish meal was not available in 1946. Other essential nutrients appeared to be adequate for good results.

Progeny from superior families was chosen each year for the breeding pens. Families were rated on egg production, fertility, hatchability, width of breast, rate of growth, and weight of progeny at 16 and 28 weeks of age. Individual egg records were kept from late January to May 31.

*Turkey production: mash vs. pellets for feeding growing turkeys.*— This was a study of the relative merits of feeding pellets vs. mash to growing turkeys, and a comparison of the different systems of grain feeding. On June 30, 1945, 135 turkey poults were divided into three lots of 45 birds each. All birds were given the same mash diet; however, the mash fed to Lots 2 and 3 was in pellet form. Lot 1 was given mash, which was supplemented with wheat after the

poults were 10 weeks old. Lot 2 was fed pellets, plus wheat after 10 weeks, and Lot 3 was fed pellets, plus corn, wheat, and oats after 10 weeks.

When the poults were approximately five weeks of age the birds in Lots 2 and 3 developed rickets, which might indicate that the process of pelleting mash may destroy vitamin D in the ration. Mortality was quite heavy during the first eight weeks, but thereafter very few losses occurred.

The average weights for males and females at the end of the 20-week experiment were as follows: Lot 1, 15.03; Lot 2, 13.54; Lot 3, 14.07 pounds. The fact that Lot 1 had more appetite for the mash than Lots 2 or 3 had for pellets would indicate that at least during the early stages of growth mash feeding is preferred over pellet feeding. Birds fed a combination of scratch grain with pellets appear to have gained more than birds fed pellets and whole wheat as the sole source of scratch grain.

*Broiler production.*— Four hundred New Hampshire chicks were used in a 12-week feeding period to study the value of certain vitamin supplements when used with low-grade sun-cured alfalfa meal. Another object was to determine whether alfalfa meal possessed any nutritive value lacking in the basal ration other than that of vitamins A and G. The results indicated that low-grade alfalfa and the substitute for alfalfa, when fortified with vitamins A and G, gave more satisfactory results than unfortified dehydrated alfalfa meal.

In the second series, 570 White Plymouth Rock chicks were divided into six lots of 95 each. When the chicks were five weeks old they were given whole wheat, free choice, in addition to their mash. The males were removed at eight weeks: therefore the 12-week weights are for females only. All lots made good growth and showed low mortality.

The average weight at 12 weeks was 2.37, 2.46, 2.58, 2.45, 2.41, and 2.48, with a mortality of 11-11-9-8-7-7 for Lots 1 to 6 respectively. The average for the three lots receiving dehydrated meal (1, 4, and 5) was 2.41 pounds each, while the average for the three lots fed sun-cured alfalfa averaged 2.51 pounds each. There was little difference in body weight between the various vitamin concentrates. In other words, the source of alfalfa in the diet appears to have more effect upon growth in chicks to 12 weeks of age than does the source of vitamins.

The results of the first two experiments indicated that dehydrated alfalfa at the levels used retarded growth, compared with sun-cured. The third experiment was run to determine the effect on results when the quantity of dehydrated and sun-cured alfalfa was the only variable.

In the third experiment, six lots of 25 New Hampshire chicks each were fed for four weeks, rations which varied in the amount of dehydrated and sun-cured alfalfa meal. Again the chicks fed the sun-cured alfalfa meal averaged slightly more than those fed the dehydrated meal, and in both groups the lots which received 3 percent alfalfa meal made greater gains than those which received a larger amount.

*Value of DDT for control of chicken lice.*— The project was undertaken to compare the effectiveness of DDT with sodium fluoride for the control of the chicken louse. DDT was used as a dust applied to the plumage.

Concentrations of 3, 5, and 10 percent DDT proved to be no better than commercial sodium fluoride, either in their immediate or residual killing power. Both DDT and sodium fluoride were effective in killing lice on the bird, but neither seemed to have much residual value in the case of artificial reinfestations.

*The effect of the rate of feathering gene on growth of chicks.*— This project was planned to obtain data on the influence of the rate of feathering gene on growth on a group of New Hampshires which were found to run about half late and half early feathering. These chicks were reared in lots of 100 chicks on four slightly differing rations. Each chick was classified for rate of feathering and weighed at eight weeks.

In each of the lots, both early-feathering males and females outgrew their late-feathering pen mates of the same breeding. It would therefore seem that

the early-feathering tendency aids the chick in growth as well as improves its dressing-out qualities.

(Project 77. Department of Poultry Husbandry. Leaders, L. F. Payne, T. B. Avery, D. C. Warren. State funds.)

***The Role of Carotenoid Pigments and Related Compounds in Poultry Nutrition.***— During the past biennium investigations centered on use of alfalfa meals in the carotenoid pigment research.

Four lots of 100 White Leghorn pullets each were fed rations which differed in the amounts of vitamins A and G supplied. All lots received the same basal ration with the following supplements: Lot 1—10 percent dehydrated alfalfa meal, 17 percent protein; Lot 2—10 percent dehydrated alfalfa meal, 17 percent protein; Lot 3—10 percent low-grade sun-cured alfalfa meal, 14 percent protein; and Lot 4—10 percent of a substitute for alfalfa, 17 percent protein.

The vitamin A potency for Lots 3 and 4 was increased to 10,500 U. per pound, or the equivalent of the amounts present in Lots 1 and 2. The source of vitamin A was a commercial concentrate which contained a liver residue as a stabilizing agent. No riboflavin supplement was used in Lot 1, which contained 1.295 units of vitamin G per pound. Lots 2, 3, and 4 were increased to 1,800 units per pound by adding a synthetic riboflavin. The product used in place of the alfalfa for Lot 4 was bagasse, a sugarcane by-product, for fiber, and soybean oil meal as a source of protein. The protein content of each ration was about 17.5 percent, and each ration contained 400 units of vitamin D per pound.

The results in Lot 4, except for mortality, surpass those in the other lots. Obviously, alfalfa meal served no important function in this ration other than being a source of protein and vitamins A and G. Lower hatchability in Lot 1 substantiates the fact that riboflavin is needed for satisfactory hatchability.

(Project 232. Departments of Poultry Husbandry and Chemistry. Leaders, L. F. Payne and J. S. Hughes. Adams funds.)

***Mechanism and Chemistry of Egg Production.***— The studies of this biennium include portions of three of the four repetitions of the study involving two lots of White Leghorns, one of Rhode Island Reds, and one of Austra Whites. The four years' results have been in good agreement for most egg characteristics being studied. There is clean-cut evidence that high summer temperatures suppress egg size even though the summers included have been exceptionally mild. There is also evidence that the temperature of 65° F. maintained constantly is too high for maximum egg size. Egg shell thickness was suppressed by summer temperatures, but there was evidence for some seasonal decline in shell thickness which was independent of temperature variation. There was seasonal variation in quality of egg white, percentage of yolk, rate of lay, and incidence of blood spots which appeared to be independent of seasonal temperature or light variations.

(Project 198. Departments of Poultry Husbandry and Chemistry. Leaders, D. C. Warren, R. M. Conrad, T. B. Avery. Bankhead-Jones funds.)

***Chromosome Mapping of the Genes of the Fowl.***— The objective of this project is the identification of genetic factors in poul-

try suitable for establishing chromosome maps of this animal. Suitable new characters are then used for testing linkage relations with other known characters in the fowl. Recent studies have involved four new genetic variations. They are ropy, stringy, syndactylism, and autosomal slow feathering. Stringy and ropy are feather defects, each producing a sticky chick down, but influencing the adult plumage in a different manner. Syndactylism causes toe webbing, while autosomal feathering is similar to the sex-linked slow feathering.

Although similar in effects, the factors ropy and stringy proved to be independently inherited feather defects. Tests with known linkage groups and most of the better known factors have failed to reveal any evidence for linkage. Syndactylism has proved to be an autosomal recessive with somewhat irregular inheritance. Evidence has accumulated which indicates that syndactylism shows linkage with polydactylism and duplicate. Earlier studies at this institution had shown that polydactylism and duplicate belong to a multiple allelomorphous series, and this would mean that if syndactylism showed linkage with one of the pair it should also show linkage with the other. Recent data have confirmed this expectation. Recessive autosomal slow feathering was very similar in expression to the earlier-known dominant sex-linked slow feathering. It has been demonstrated by proper crosses that the autosomal slow feathering found in Kansas is identical with one found in Canada.

(Project 197. Department of Poultry Husbandry. Leader, D. C. Warren. Bankhead-Jones funds.)

***Development of Strains of General Purpose Breeds Possessing Early-Feathering and High Egg-Producing Tendencies.***— This project is concerned with the improvement of the White Plymouth Rock. The late-feathering tendency has been completely eliminated from this strain and no longer remains a breeding problem. There has been a definite recent improvement in the age at which the stock begins to lay. This improvement was due to critical selection of parent stock in the early years of the project. The rate of growth has been improved, and egg size and hatchability remain satisfactory. During the past year the Kansas strain of White Plymouth Rocks was compared with two of the more favorably-known commercial strains of the variety, and in virtually all characteristics recorded the Kansas strain was equal or superior to these commercial strains. Low rate of laying remains a weakness of the Kansas strain. Too high an incidence of green legs and buffish color in chick down continue to be troublesome breeding problems.

(Project 212. Department of Poultry Husbandry. Leader, D. C. Warren. Bankhead-Jones funds.)

***Physiology of Reproduction.***— Experiments on three phases of endocrine gland, reproduction, and vitamin relationships were conducted during the biennium.

***Effect of male sex hormone.***— Young female fowls and also capons were given male sex hormone. Subsequently, treated and untreated fowls were tested for tensile strength of skin and muscle tissue. Tissues also were analysed chemically for collagen content.



Skin from fowls treated with 50 mg. of male sex hormone showed an increase in tensile strength of 100 percent over the untreated fowls; muscle tissue showed 50 percent increase. Chemical analysis indicated there was nearly 100 percent greater collagen content in the skin from treated than from untreated birds, and approximately 50 percent greater collagen in the muscle tissue.

*Vitamin E comparisons.*— Groups of male chickens were given a synthetic diet containing vitamin E, and others were given the same diet but with no vitamin E. The combs were measured, the gonads weighed, and the pituitary glands were removed to be studied histologically or utilized in a bioassay for gonadotropic hormone.

Fowls receiving no vitamin E had smaller combs and testes than those supplied with vitamin E. The pituitary glands showed a lower level of gonadotropic hormone in the groups deprived of vitamin E. The pituitaries of these fowls gave a histological picture of reduced activity as indicated by the condition and number of basophil cells.

*Effect of ultra violet light.*— One group of adult male chickens and a group of young male chickens were exposed to ultra violet light for regulated periods of time. Comparable groups of chickens were exposed to an incandescent lamp. Measurements of combs were made and weights of testes were taken at the end of the experiment. Assays of the pituitary glands were also made.

The combs from the experimental and control birds were not significantly different in size. The testes were slightly larger in the fowls exposed to the ultraviolet light. The assays of the pituitary glands have not been completed.

(Project 218. Department of Zoölogy. Leader, E. H. Herrick. Purnell funds.)

### *Inheritance and Physiology of Reproduction in Mammals.*

— Data on size inheritance with guinea pigs are accumulating very slowly, since the animals are usually not mated until they are 15 months old. From present indications it seems probable that some of the inbred lines will be made up of individuals that are much larger than those in U. S. D. A. inbred families 2 and 13. There is also a possibility of producing an inbred line made up of very small individuals.

Two mutations have occurred in the guinea pig colony. Each has been found among the descendants of animals bought from a particular dealer. One group of the affected animals are called "wobblers" because of their difficulty in walking. They remain small and thin and do not seem to be able to reproduce. Since they come from normal appearing parents in the proportion of approximately one out of every four, the indications are that the mutation is due to a recessive gene. An effort will be made to determine whether the gene in some way causes a hormone disturbance.

The other mutation has been found among the descendants of some black animals bought some time ago. It affects only the males, and as a rule only after they are about two years old. They suddenly begin to lose weight and to show signs of premature senility. They may remain alive for over a year after they begin to lose weight, but they continue to weigh less and less, become sterile, and finally die. It is not known yet whether all the sons of an affected male become prematurely senile. If they prove to be so, it will appear to be a case of allosomal sex-linked inheritance.

(Project 93. Department of Animal Husbandry. Leader, H. L. Ibsen. State funds.)

### *Studies in Inheritance in Orthoptera.*—

*Inheritance of characteristics in orthoptera: sub family Tetriginæ: the grouse locusts.*— The study has continued the genetic analyses of the color

patterns in the species *Apotettix eurycephalus* and *Paratettix texanus*. Several hundred thousand pairings of characteristics have been made by the breeding of 25,000 to 30,000 specimens of the species named. Besides contributing to the reliability of the gene diagrams or chromosome maps as represented by the already well-known color pattern markers, the project has made two new locations in *P. texanus* and one in *Apotettix eurycephalus*.

(Project 72. Department of Zoölogy. Leader; R. K. Nabours. Adams funds.)

***Influence of Some Environmental Agencies on the Germ Plasm of Tetriginæ (Orthoptera).***— The study has continued with influence of the environment on the inheritance of characteristics in the grouse locust *Tetriginæ*.

X-ray of males at about the time the sperms are mature has been continued. There have been no anomalies observed from the treatments of 1945-46. However, the progenies are still under observation. Sometimes it requires two or three years to detect and describe X-ray induced modifications.

Many more of the affected progenies of previous X-rayings have been bred. The accumulation of data is now sufficient for publication. Briefly, a gene for the color pattern T has been translocated from the normal No. 1 autosome to some other, not yet designated, autosome.

(Project 104. Department of Zoölogy. Leader, R. K. Nabours. Adams funds.)

***Honeybee Investigations.***— Ecological observations in relation to honeyflow and beekeeping conditions were continued, as well as comparison of various strains of bees.

***Ecological and apicultural conditions.***— In general, during the spring and early summer of the 1944 growing season, the weather was unfavorable for the growing of crops. This reduced the nectar flow. At the same time, the weather which influenced plant growth unfavorably prevented colonies from building up to peak strength for the major honeyflow.

The late spring of 1945 was cool, with an excess of rainfall during May and June. The weather during a greater part of the period prevented bee flight and gathering of available food. This condition caused colonies to use honey stores in excess of normal and necessitated feeding sugar syrup to supplement honey stores. Colonies given proper feeding care during the months of May and June were ready for the major honeyflow which materialized the last part of June.

The colonies on scales made net gains of from 132 to 232 pounds from June 3 to September 15, 1945, during the major and minor honeyflows. The major honeyflow was from white clover, white sweet clover, basswood, and alfalfa, while the short minor one in late August was from smartweed.

***Testing of strains of superior quality.***— This work was continued with strains of three-banded Italian, Caucasian, and Carniolan bees. Queens of a strain of American foulbrood-resistant Italian bees were supplied by the coöperative agencies, the Division of Bee Culture, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, and the Texas Agricultural Experiment Station. The third and fourth lots of queens received in 1943 and 1944 were established late in each of the years. One queen in each of these groups headed a colony which produced, in 1944 and 1945 respectively, the largest amount of extracted honey of all the colonies in the apiary. Other characteristics of colonies of this strain are propensity to sting and little tendency to swarm.

(Project 126. Department of Entomology. Leader, R. L. Parker. State funds.)

***Studies in the Social Behavior of Domestic Animals.***— This study was reported under two subprojects, one relating to cattle and the other to poultry.

*Social behavior in a herd of dairy cows.*— This study is being made to determine the character of the dominance-subordination relationship among the individuals in a herd of dairy cows and its significance, if any, to their general management and methods of stabling.

A herd of dairy cows was observed in the pasture, in the corral, and during their entrance to the barn. A dominance order was found among them which was based on individual-to-individual bunts occurring during competitive situations. The relative freedom to feed at the hayrack showed some correlation with the dominance rank of the individuals in the social order. The cows tended to enter the barn in an order which reflected the bunt-order. Factors such as breed differences, body weight, and age appeared to influence the ability of an individual to dominate others.

*Social behavior in flocks of the domestic fowl.*— The aim of this project is to determine the relation of social behavior to feeding, egg production, roosting, mating behavior, and fertility in the flock.

Observations of a flock of 96 pullets, made from the time the flock was assembled in the fall until it was subflocked for breeding purposes, have shown that the most dominant individuals have definite advantages over their most subordinate penmates. Significant correlations were found between ranks in the social order of the flock and freedom to feed, choice of favorable roosting sites during cold winter nights, and the number of eggs produced.

The relation of the social behavior of cockerels to their success in mating was studied in two flocks. It was found that the socially-dominant males had a greater freedom to mate, fertilized more eggs, and sired more chicks than did their socially-inferior cockerels. Competition among the males for mates caused many of the attempts to mate to be unsuccessful. An inferior male may be completely inhibited from mating.

(Project 237. Department of Zoölogy. Leader, A. M. Guhl. State funds.)

***Studies in the Development of the Livestock Industry of Kansas.***— The chief purpose of this project is to develop, record, and preserve the individual achievements of the men and the sires that have made noteworthy contributions to the development of the livestock industry in Kansas. Present studies are limited to men who were established on Kansas land previous to 1880, and to sires that were produced or used in Kansas previous to 1900. This project did not become officially operative until January 1, 1946, which has not provided enough time to do a great deal.

(Project 246. Department of Animal Husbandry. Leader, C. W. McCampbell. Department funds.)

## DISEASES, INSECTS, AND OTHER PESTS INJURIOUS TO PLANTS

The following pages contain summaries of the more important research projects conducted during the biennium in eradication or control of diseases, insects, and other pests injurious to plants.

***Cereal and Forage Crop Disease Investigations.***— This project, coöperative with the Bureau of Plant Industry, Soils, and Agricultural Engineering, of the United States Department of Agricul-

ture, has consisted of the study of the diseases of sorghum, wheat, oats, barley, alfalfa, flax, corn, and soybeans, together with a plant disease survey.

*Sorghum disease investigations.*— The weak-neck disease of milos is of nonparasitic nature, and indicates that the weakness of the peduncles may be partially explained by physiologic functions of this group of sorghums. Milos do not appear to maintain a sufficiently high concentration of noncellulose carbohydrates to mature properly the grain and also maintain sufficient strength in the base of the peduncle to support the head.

*Wheat disease investigations.*—Wheat disease investigations consisted of studies on several common maladies, among them speckled leaf blotch, *Septoria tritici*. Several new varieties and hybrids were found to be resistant, and breeding for resistance in hard red winter varieties continues. No evidence has been found to date that physiologic races of the organism will complicate the breeding program.

A severe outbreak of wheat take-all disease, *Ophiobolus graminis*, in central and western Kansas occurred in 1945. Some fields had losses approaching 33 percent of the crop. Crop rotation and fallow practices showed that less disease occurred when certain of these are followed. Dry-land foot-rot was nonexistent.

Kansas collections of bunt, *Tilletia foetida*, were classified as race 3 (82 collections), race 4 (1 collection), race 5 (7 collections), and race 7 (10 collections). Comanche, Nebred, and Oro were resistant to *T. foetida* races 3, 4, 5, 7, and 10 and intermediate in susceptibility to race 8. Pawnee was moderately resistant to all of the races. Iobred selection was resistant to races 3, 8, and 10 and susceptible to races 4, 5, and 7.

Five years' data were completed on the reaction of hard red, soft red, white, and miscellaneous winter wheat varieties to loose smut. The Kansas varieties, Kawvale and Pawnee, were highly resistant, averaging 0.2 and 0.1 percent, respectively, in comparison with Early Blackhull and Red Chief with 67 and 78 percent, respectively.

*Oat disease investigations.*— Two new races of oat smut, *Ustilago avenae*, were collected in Kansas, tentatively designated as A and D. Race A is characterized by the susceptibility of the varieties Fulghum and Monarch and the resistance of Canadian. Race D is characterized by the susceptibility of Richland and Victoria and the resistance of Fulghum. Of commercial varieties tested, Kanota was susceptible to race A while Richland, Boone, Cedar, Tama, Fultex, Vicland, Florilee, and Traveler were susceptible to race D. Osage was resistant to race A but intermediate in susceptibility to race D. Neosho was highly resistant to both new races; thereby this variety remains the most smut-resistant commercial oat in the Mississippi Valley.

Anthraxnose of oats (*Colletotrichum graminicolum*), which was found for the first time in the state in 1944, has been isolated and its pathogenicity determined. Studies on varietal susceptibility are in progress.

*Flax disease investigations.*— Phygon was found to be effective in increasing the stand of flax. New Improved Ceresan and DuBay 1452F at the rate of 1 ounce per bushel were more effective in increasing the stand of flax than at ½ ounce per bushel.

*Plant disease survey.*— The plant disease survey was limited in scope to the wheat, oat, and barley crops, but it gave data on the prevalence, distribution, and losses from the rusts, smuts, and root rots of cereals.

(Project 76. Department of Botany. Leaders, L. E. Melchers, E. D. Hansing, J. C. Bates, H. Fellows, Stuart M. Pady. State funds.)

*Fruit and Vegetable Disease Investigations.*— Investigations during the biennium indicated that momentary dip treatment of

tubers in acidulated corrosive sublimate at a concentration of 9 to 12 ounces of corrosive sublimate to 25 gallons of water is as effective for potato seed treatment as is the 10-minute treatment in 6 ounces corrosive sublimate to 25 gallons of water.

Quantitative determinations of the amount of corrosive sublimate removed from the treating solution during treatment of potato tubers were continued. Provided the volume of the treating solution at original concentration is maintained, addition of approximately  $\frac{1}{2}$  ounce corrosive sublimate following treatment of every 800 to 1000 pounds of tubers will approximately maintain the initial concentration of corrosive sublimate in the treating solution.

Approximately one-third to one-half more corrosive sublimate is required to maintain its concentration in the treatment of cut seed pieces than for treatment of whole tubers.

Late blight of potatoes was prevalent in Kansas for the first time in 1945 and caused severe losses. The reasons for the severity of this disease and the severe losses caused were (1) considerable infection in seed stocks planted here; (2) a wet spring in which much cloudy weather occurred and temperatures remained unusually cool until near harvest time, and (3) inability of growers to obtain necessary fungicides or spraying equipment.

Sweet-potato seed and sprout treatments again indicated the superiority of wettable Spergon in (1) seed treatment for production of sprouts, and (2) sprout treatment for prevention of infection with soil-borne stem rot in the field. Spergon-treated sweet potatoes yielded 3,417 sprouts as compared to 2,716 for a similar amount of untreated controls, 2,420 for corrosive sublimate, and 2,632 for Semesan Bel treated seed. Spergon was found inadequate for protection against black rot infection.

Self pollinations of the mosaic-resistant cucumber varieties Kanmore and Madame Chiang were continued. Fruit type and resistance to mosaic apparently are now homozygous in these varieties.

(Project 130. Department of Botany. Leader, O. H. Elmer. State funds.)

***A Study of Combined Resistance of Winter Wheat to Leaf and Stem Rust Races.***— A total of 63 common wheat crosses, 29 of which were backcrosses, were made during the biennium. In addition, the backcross progenies of the interspecific cross Marquillo-Oro  $\times$  *Triticum timopheevi* and the intergeneric cross Mindum durum  $\times$  *Agropyron trichophorum* were studied for resistance to both rusts. Epidemics of leaf and stem rust were produced, rust readings recorded, and further selections for resistance made.

The most promising material was obtained from crosses in which combined resistance to leaf and stem rust was obtained from selections of Mediterranean  $\times$  Hope. Selections of Mediterranean-Hope  $\times$  Pawnee, Comanche  $\times$  Mediterranean-Hope, Nebred  $\times$  Mediterranean-Hope, and Marquillo-Oro  $\times$  Mediterranean-Hope-Pawnee among the hard red winter crosses, and Thorne  $\times$  Mediterranean-Hope among the soft red winter crosses, were particularly promising.

In the intergeneric cross, Mindum  $\times$  *Ag. trichophorum*, sterility was extremely high, but some fertility has been obtained by backcrossing with winter wheat. Many types of plants have been obtained and most of them were highly resistant to leaf rust. Resistance to stem rust is not so marked in this cross, some lines being very susceptible.

(Project 171. Department of Botany. Leaders, C. O Johnston, L. E. Melchers, L. P Reitz. Purnell funds.)

*Climate and Injurious Insect Investigations.*— The work done on this project during the last biennium has consisted largely of gathering the data and publishing the insect population summaries for the years 1944 and 1945. It included sponsoring the research of Mr. Charles H. Brett, now of the Oklahoma A. and M. College, on the “Interrelated effects of food, temperature, and humidity on the development of the migratory grasshopper (*Melanoplus mexicanus* (Saussure).”

The fourteenth and fifteenth annual insect population summaries, covering the years 1944 and 1945, respectively, were completed and published.

Secondary aspects of the coöperative investigations with the Department of Dairy Husbandry on the use of thanite in the control of flies on dairy cattle and in dairy barns, and coöperative investigations on insect and tick vectors of equine encephalomyelitis with the Department of Veterinary Medicine, were related to past work on this subject.

(Project 6. Department of Entomology. Leader, R. C. Smith. Hatch funds.)

*The Hessian Fly and Other Wheat Insects.*— Studies were continued of the biology, seasonal history near Manhattan, and area of infestation in Kansas, of the Hessian fly and of other insects injuring wheat both above and below the ground, especially when these other insects appeared in abundance.

The annual increase in Hessian fly infestations which began in 1940 has continued and the distribution has spread westward. In 1945 infestations were found for the first time since 1932 in such western counties as Wallace, Greeley, Kearny, Gray, and Meade. In the spring of 1944 and of 1945 the fly emerged late and over a considerable period of time. As a result, the flaxseed often occurred high on the stem and less lodging took place than usual. In 1944 the puparia or flaxseeds were heavily parasitized.

In 1944 the western border of Hessian fly infestation was found in Pratt, Stafford, Barton, Ellis, and Thomas counties. Infestation also occurred along the northern tier of counties. In 1945 the most heavily infested counties were Kingman, Marion, Mitchell, Pratt, Saline, and Sumner, while individually heavily infested fields occurred in Anderson, Cowley, Harvey, Neosho, Reno, and Sedgwick counties.

*Subterranean insects of wheat.*— The outstanding underground insect attacking the roots of wheat during the past biennium was a small white grub. Identified as a species of *Cyclocephala* (*Ochrosidia*) *sp.*, this grub requires one year in which to complete its life cycle and bears a close resemblance to the grub of the carrot beetle, *Ligyris gibbosus*, in external morphological characteristics. The adults of the two species are easily distinguished from each other.

While the larvæ of both species have been known to feed upon young wheat plants, neither has been reported previously as causing any considerable damage to growing wheat. The greatest injury occurred on fields where the wheat straw had been rank a year or two before the damage was reported. Both fall and spring damage occurred, but the greatest injury was reported in the fall soon after the wheat plants were started.

Seed treatment studies have been started in order to test certain recently-introduced dusts and insecticides in regard to their effectiveness in protecting newly-planted wheat seed from the attacks of wireworms and false wireworms.

(Project 8. Department of Entomology. Leaders, R. H. Painter and H. R. Bryson. Hatch funds.)

*The Corn Earworm and Other Corn Insects.*— The following phases of the project have been emphasized during the past biennium: Control of the corn earworm attacking sweet corn; life history, habits, and control of the Southwestern corn borer; chinch bug investigations; and subterranean insects attacking corn.

*Corn earworm.*— Previous observations on the relationship between the date of silking and earworm infestations were confirmed as were the recommended planting dates. Varieties requiring a long growing season should be planted about May 1; varieties with medium growing season, after May 15; varieties with short growing season, after May 20.

Some 18 varieties and hybrids of sweet corn were planted on four different dates during the 1945 growing season. The more susceptible varieties to corn earworm included Golden Cross Bantam, Old Hickory, Carmel Cross, and Tendermost. Less susceptible varieties were Silver Cross Bantam, Tendergold, Golden Bantam (open pollinated), and Aristogold.

*Southwestern corn borer.*— A total of 63 counties in Kansas have reported Southwestern corn borer infestations, and it is likely that at least 75 counties would be found infested if adequate surveys were made.

During the 1944 season there was extensive deadheart injury and less girdling, while during 1945 there was very little deadheart and severe girdling. The population of borers decreased in the center of the infestation and increased along the periphery. There was a great decrease in corn acreage throughout the more heavily infested area.

During both seasons plots in Barber, Stafford, and Ellis counties were under observation, and in 1945 an additional plot was established in Reno County. All data obtained supported previous observations to the effect that earlier-planted corn in southern and central Kansas had a smaller number of holes and a lesser amount of girdling than corn planted at later dates.

In corn grown on the Reno County plots (1945) no correlation could be determined between weight of larvæ and yield or weight of larvæ and injury to stalk, though there did appear to be a definite relationship between number and weight of larvæ and time of planting. There were no clues on causes for girdling. Popcorn was found to be the most severely girdled of all types of corn, with damage as high as 90 percent.

*Chinch bug investigations.*— A chinch bug survey conducted during the fall and winter of 1944-'45 in the western half of Kansas by the United States Bureau of Entomology and Plant Quarantine in cooperation with the Department of Entomology showed more chinch bugs in hibernation than had occurred for several years. The potentialities for a severe outbreak were great over the entire area, but the spring weather and growing conditions checked the development of the spring generation until only local infestations occurred.

Plans were laid for an extensive test of various percentages of dinitro-ortho-cresol dust when used as a dust barrier to destroy migrating chinch bugs as well as to compare with creosote and other barriers which have been used in the past. Preliminary field and laboratory observations indicated that a 1-percent dust would kill the bugs crawling through a line of it one inch wide within 15 to 20 minutes. While the dust line did not blow readily, soil splashed over the surface of the line during a shower formed a crust over the barrier, necessitating a new dust line.

*Subterranean insects attacking corn.*— Some time was spent during June, 1945, and May and June, 1946, making a study of the effect which the preceding crop has upon the population of the southern corn rootworm. Alfalfa land plowed in the spring and planted to corn furnished an attractive environment in which the female deposited eggs. The larvæ caused considerable injury to the corn planted in the area.

Seed treatment studies with DDT and other new insecticides have been started to determine the effectiveness against wireworms and other insects which often attack germinating seed.

(Project 9. Department of Entomology. Leader, H. R. Bryson. Hatch funds.)

***Fruit and Vegetable Insect investigations.***— Work on this project was limited to observations on cankerworms, sweet potato leaf beetle, liberation of adults of the Oriental fruit moth parasite, *Macrocentrus ancylicvorous*, and a study of the control of certain vegetable insects by means of sabadilla and DDT.

***Observations on the fall and spring cankerworm moths.***— The first fall cankerworm females were trapped January 12, 1945, and January 20, 1946, with the bulk of emergence occurring February 10 to 16, 1945, and the second week of February, 1946.

The first spring cankerworm females were trapped February 9, 1945, and February 16, 1946, with the bulk of emergence occurring during the week of March 10 to 16, 1945, and the third week of March, 1946.

***Sweet-potato leaf beetle, Typophorus viridicyaneus (Crotch).***— During the third week of September, 1945, a sweet potato grower at Oxford, Kansas, reported the serious injury which larvæ of this insect were doing to sweet-potato tubers. This was the first observed damage by the sweet-potato leaf beetle in Kansas. The adults eat the leaves, and the larvæ, which are the most destructive stage, tunnel through the vines into the tubers causing injury readily mistaken for that of the sweet-potato weevil.

***Colonization of the Oriental fruit moth parasite Macrocentrus ancylicvorous Rohwer.***— In 1943 adults of this parasite were liberated in peach orchards in Doniphan and Wyandotte counties. In 1944 others were released in Crawford, Montgomery, and Sedgwick counties. During the latter part of May, 1946, Oriental fruit moth-infested peach twigs were collected to determine the status of colonization of this parasite. The infested twigs were sent to the Oriental Fruit Moth Laboratory, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Moorestown, New Jersey, for rearing either the host or the parasite. No Oriental fruit moth injury was noted in the large peach orchards of Emmett Blood south of Wichita, George Hafer east of Oxford, and Pat Smith (S. Hahn orchard) south of Coffeyville. Well scattered infested twigs were found in the M. Boggio and H. Herlocker orchards east of Girard, in the E. A. Pitts and H. L. Drake orchards at Bethel, and in the George T. Groh and Walter Schuler orchards at Wathena. The majority of these orchardists are using or plan to use DDT in the control of the Oriental fruit moth, which will at the same time kill the parasite. This parasite liberation work therefore will be discontinued.

***Tests with sabadilla and DDT dusts against certain vegetable garden insects.***— Bean leafhoppers collected from growing string beans were all dead in 24 hours when dusted with a mixture of three parts of 10-percent sabadilla dust and one part of sulfur.

Adults and nymphs of squash bugs were killed within 24 hours by the use of the above dust mixture.

Another mixture made in the same manner but using 20-percent sabadilla dust gave complete control in much less time.

A 5-percent sabadilla dust in sulfur gave slower but satisfactory results.

The 10- and 20-percent sabadilla dusts gave the same results against several species of blister beetles.

DDT "Gesarol A 3" dust (3 percent DDT) gave a complete kill of squash bugs in two to three days. Nymphs died in a shorter time than adults.

(Project 13. Department of Entomology. Leader, R. L. Parker. Hatch funds.)

***Insects Attacking the Roots of Staple Crops.***— Investigations conducted during the biennium were confined to three principal



phases of the project; namely, life history studies of wireworms and white grubs, feeding habits and ecology of wireworms and white grubs, and the compilation of a bibliography of the literature on seed treatments and the use of soil insecticides as controls against subterranean insects.

The strawberry plots on which grub population studies have been conducted during the past three years were plowed up and the population of grubs recorded. The population in the plots increased slightly from the first to the third year. The area had been freed of grubs by growing sweet clover on the plots before setting out the strawberry plants three years ago.

A summary of the observations and data covering several years showed that at Manhattan *Melanotus spp.* is the most common wireworm of corn, *Aeolus elegans* the most generally observed attacking germinating seed, *Monocrepidius vespertinus* most common in wheat, while all three species are common in gardens. More specimens of the genus *Melanotus* than other species were collected in potato tubers. While white grubs and wireworms are most prevalent in grassy areas, infestations also occurred in fields kept relatively free of grass.

A series of tests using DDT in comparison with other materials recommended as fungicides has been started using corn as the seed. Wireworms and other soil insects which attack the planted seed are being collected to use as experimental animals. Plans have been outlined to develop or find a satisfactory and safe seed treatment which can be recommended for use against the kafir ant, false wireworms, and wireworms which attack planted kafir, wheat, and corn, respectively.

(Project 100. Department of Entomology. Leader, H. R. Bryson. Hatch funds.)

***Insects Affecting Alfalfa and Allied Plants.***— The work during the biennium consisted of following the insect populations each year in local fields of alfalfa, sweet clover, cowpeas, and soybeans, and over the state in general.

*Pea aphids* were abundant during the spring months both of 1945 and 1946 in the southern half of the state, especially in the southwestern counties. Lethane A70 gave excellent control of pea aphids on alfalfa being grown in the greenhouse.

*Plant bugs* were controlled in experimental plots by a single dusting of 3-percent DDT-pyrophyllite dust.

*Sweet-potato leaf miners* may be controlled in Hawaii by importation of bindweed parasites from Kansas as a result of Roger C. Smith's paper "A preliminary report on the insects attacking bindweed with special reference to Kansas." The paper stated that the common morning glory leaf miner was severely attacked in Kansas by a parasite which prevented the host from doing much damage to bindweed. Experiments are now under way in Hawaii to use the same parasite to prey on the sweet-potato leaf miner, a source of much agricultural loss in the Islands.

(Project 115. Department of Entomology. Leader, R. C. Smith. State funds.)

***A Study of the Biology and Control of Fruit and Vegetable Insects.***— Paul G. Lamerson and E. L. Eshbaugh, assistant entomologists, helped in the project work on the study of the strawberry rootworm *Pariacanella* (Fab.). Observations have been made on the types of injury by both adults and larvæ. Life history studies

were continued and further tests made of home-made and proprietary poison apple pomace baits in the control of the adults.

The strawberry rootworm overwinters in the adult stage, and a new generation of adults appears after the middle of summer. Eggs were laid from May 17 to June 26 during 1944. No information was obtained in regard to the larval stage. Progressive girdling of the crown of the strawberry plants by the adults and the destruction of the roots and rootlets by the larvæ kill the plants. As high as 80 percent of the plant stand in a field may be killed.

Four experimental apple pomace poison baits, "Go-West" apple poison bait, "Gesarol A 3" dust (3 percent DDT), "Gesarol AK 40" (40 percent DDT), and "Niatox 50" (50 percent DDT) spray concentrates were used to control the overwintering beetles and the first generation adults in midsummer.

The most satisfactory poison baits are combinations of apple pomace, 15 pounds; cane sugar, 1 pound; and insecticide,  $\frac{3}{4}$  pound. The best insecticides of those tested to use in the baits are calcium arsenate, "Kryocide," and sodium flousilicate. DDT, either in the 3 percent dust or 1 pound of the 50-percent spray concentrate in 100 gallons of water, when applied to infested strawberry plants gives 30 to 50 percent better control than the poison apple pomace baits for the control of either the overwintering or midsummer generation adults.

(Project 187. Department of Entomology. Leader, R. L. Parker. Purnell funds.)

***Biology and Control of Fruit and Vegetable Insects.***— The work consisted of testing new insecticides and combinations for codling moth and strawberry insect control for the entire season. Summer-dropped, preharvest-dropped, and harvested-apple counts were made of injured and uninjured fruits to obtain the entire season records. Zinc sulfate used as a safener for lead arsenate gave good foliage protection. Naphthalene acetic acid used as a preventive to premature dropping of fruit did not cause any difference in 1945. The hydrochloric acid wash did not reduce the 1944 residue deposit of arsenic below the tolerance of 0.025 grain of arsenic per pound of fruit, because samples of unwashed, stored harvest apples form a surface wax which prevents all of the arsenic from being removed.

*Strawberry insect control.*— The strawberry rootworm work is presented in the report for project 187.

*Apple aphid outbreak in Doniphan County.*— During the spring of 1945 a serious outbreak of apple aphids caused much damage and a partial loss of the apple crop. Where the orchardists acted quickly the outbreak was controlled before a total loss resulted. The standard recommended control, namely, 1 pint of 40-percent nicotine sulfate plus 5 pounds of soap (liquified) to 100 gallons of water, was used by the orchardists.

(Project 9. Northeast Kansas Experiment Fields. Department of Entomology. Leader, R. L. Parker. State Funds.)

***Resistance of Crop Plants to Insect Attack.***— At Manhattan a Hessian fly nursery was grown in 1944-'45 and in 1945-'46. Through coöperation with the Bureau of Entomology and Plant Quarantine these nurseries were partially duplicated each year at Springfield, Missouri, and Bennington, Kansas. In 1944-'45 the infestation level was relatively low and permitted the elimination of only the most susceptible strains. In 1945-'46 the infestation was heavy enough to give good records.

In 1944 more than one-third of these strains in the agronomy rod-row yield nursery carried a greater resistance to fly than do Kawvale and Pawnee. Many of these strains gave satisfactory yield records both years. A number of compound Marquillo hybrids tested for several years have given records of fly infestation below 10 percent in comparison with susceptible varieties averaging above 75 percent to 80 percent.

There appears to be a tendency for lower corn borer infestation to be present in related lines or in the same line for two or three years. In these cases the same lines often have been lower than the average in infestation by both generations. There appeared to be a relationship between the percentage of plants infested by the first generation and the average number of holes per stalk at the end of the season. Information was obtained on the relative susceptibility to the borer of a number of commercially-used inbred lines and hybrids.

Project 9 also included work with the Southwestern corn borer.

(Project 164. Departments of Entomology and Agronomy. Leaders, R. H. Painter, L. P. Reitz, E. G. Heyne. Purnell funds.)

*The Effects of Different Systems of Management of Grasslands and Conservation Areas upon the Grasshopper, Cutworm, and Other Insect Populations.*— Work on this subproject has been greatly curtailed during the past biennium. Assistance was given the Bureau of Entomology and Plant Quarantine in re-opening the grasshopper study area at Garden City, the strip cropping study in Greeley County, and the rangeland study in Morton County. At the present time these projects are being conducted by Mr. Fred Butcher of the Bureau of Entomology and Plant Quarantine.

The accumulation of data on grassland insect—their life history, habits, injury, and host preference—has been continued. A considerable number of stem-inhabiting insects has been reared from western Kansas grasses.

(Project 211. Department of Entomology. Leader, D. A. Wilbur. Bankhead-Jones funds.)

## DISEASES OF FARM ANIMALS

Some of the more important features of the work of the station during the past biennium relating to animal diseases and parasites are reported below.

*Miscellaneous Diseases of Farm Animals.*— For the biennium to June 1, 1946, the following diagnostic examinations have been made in the laboratories of the Department of Pathology: 43 positive examinations for rabies, 120 negative examinations for rabies, 65 miscellaneous specimens, 14 urine examinations, 61 bacteriologic examinations, 258 tissue examinations, 3 feed examinations, 623 autopsies, and 14,410 agglutination tests for brucellosis.

*Anaplasmosis-like disease of swine.*— Field cases in two herds were studied. Stained blood smears failed to reveal presence of anaplasma bodies in the red blood cells of sick swine. Intracardial injections of blood from sick pigs into experimental pigs and intravenous injections into a splenectomized steer failed to reproduce the disease.

A hemolytic colon organism, isolated from a field case of the disease, fed to two pigs gave negative results. When later injected intracardially into the

same two pigs it caused the death of one pig within 24 hours, with lesions similar to those found in field cases, and gave negative results in the other pig.

*Studies on bovine lymphogenous leukemia.*— All cases of leukemia submitted to the veterinary hospital, regardless of type or species of animal, have been studied. Attempts to reproduce the disease in three dogs by injection of blood from a dog suffering from an acute case of lymphogenous leukemia failed.

Three Jersey females of leukemic parentage have been obtained as the foundation of a herd for genetic studies of this disease.

*Investigation of fistulous withers and poll evil in horses.*— In the annual report for 1945, E. R. Frank and Miss Alice Kimball reported the consistent bacteriologic isolation of *Actinomyces bovis* from clinical cases of fistulous withers and poll evil of horses. The results of their work were reported in a journal article.

It was decided to continue the further study of this problem from a more comprehensive viewpoint to include its anatomical and pathological aspects in addition to the surgical and bacteriologic features of the disease.

The anatomical description of the supraspinous bursal region of the horse is somewhat sketchy and the surgical anatomy is even more confusing. The help of W. M. McLeod was accordingly enlisted on the anatomical features of the process, while L. M. Roderick has been participating in the pathologic and experimental phases of the problem.

The material available in the dissection room of the anatomy department is being scrutinized anew. The supraspinous bursa of a series of horses utilized in the work in surgical exercises are injected with stained gelatin to distend the bursae. The areas are then dissected and the anatomical relationships and variations noted. A series of nine horses with unopened cases of fistulous withers and poll evil have been obtained, and a careful dissection of the pathological process followed to determine the anatomical relations and the character of the diseased process. It has been possible in almost all cases to isolate and dissect out the affected bursal sacs. This material is then examined bacteriologically and pathologically. Inoculation experiments were started in an attempt to reproduce fistulous withers in experimental horses. The presence of brucella infection in these two conditions has been a recognized fact for some years.

It appears that the condition in its incipiency is a bursitis rather than a true fistula until rupture of the bursal sac occurs. The chronic inflammation of the sac is accompanied by a marked connective tissue thickening of the sac. Six strains of *Brucella abortus* and one of *Brucella suis* have been recovered to date and typed from the fluids of unopened bursal sacs. The repeated inoculation of cultures of *B. abortus* and of *B. suis* cultures alone in the supraspinous bursa of horses has failed to induce any reaction simulating fistulous withers. Negative results have likewise followed the inoculation of horses in similar manner with cultures of *A. bovis*. Three horses have been inoculated with a mixture of actinomyces and brucella, and a condition developed in the supraspinous bursae resembling or identical with field clinical cases of fistulous withers.

(Project 102. Department of Veterinary Medicine. Leaders, Alice D. Kimball and L. M. Roderick. State funds.)

*Anaplasmosis Investigations.*— The work on this problem at the research laboratory was interrupted by the resignation of Dr. V. K. McMahan effective July 1, 1945. The present incumbent, Dr. Earl Splitter, assumed the position January 1, 1946.

The service features of the investigation were continued. This included field trips to study the disease and laboratory aid in making diagnosis. The inability to find the infected carriers involved in a field outbreak of the disease was again encountered.

Four drug compounds, cobalt chloride, pentamidine, stilbamidine, and

sulfapyridine sodium were used in treating chronic carriers of the infection and acute cases of the disease. With the limited number of animals employed, no encouraging results were obtained. Observations on the effects of injections of sodium cacodylate indicated that this material had little beneficial value either in preventing the onset of the disease or in promoting actual and complete recovery. The anaplasma bodies were not destroyed in three hours in one trial in vitro with anaplasmosis blood mixed with sodium cacodylate solution.

Transfusions of normal bovine blood seemed a useful supportive treatment in promoting recovery from the acute stage of the disease. Morphologic studies of the erythrocytes of the blood of infective cows indicates that there is a macrocytic anemia in anaplasmosis.

In a field survey of the disease, 1,620 cases were reported from the eastern and southeastern parts of Kansas. Of 1,378 cases which were treated 1,080 survived, with a mortality of about 22 percent. Cases were observed in every month of the year but reached the low point in February and the highest frequency in September.

*Nonspecific antigenic tests.*— The work of the project was intended to find some nonspecific antigenic substance that would react with positive anaplasmosis-infected or carrier blood of cattle, thus serving as a serological method for the diagnosis of anaplasmosis.

To date 190 nonspecific antigens have been tested on positive and negative cattle serum using the rapid plate and tube agglutination method, the precipitation and complement fixation test methods. Two thousand six hundred eight individual tests on negative and positive sera were set up.

The interpretation of the results of these tests indicates that none of the various nonspecific antigens employed is of value in detecting anaplasmosis in cattle.

(Project. 180. Department of Veterinary Medicine. Leaders, L. M. Roderick and E. E. Leasure. State funds.)

*Studies on Mastitis.*— Since 1941 several phases of investigation have been undertaken on mastitis control. These studies have been very helpful in calling attention to the difficult job ahead in learning how to control mastitis in dairy cattle.

During the first half of the biennium the Departments of Dairy Husbandry, Chemistry, and Bacteriology studied the effect of massive doses of vitamin A on mastitis-infected cows. No curative benefits were evidenced.

The routine bacteriological studies on the College dairy herd have been continued over the past biennium. These studies are also made at intervals for the branch experiment station at Garden City. Many dairymen pattern their tests after those made on the two College herds.

(Departments of Bacteriology and Dairy Husbandry. Leaders, V. D. Foltz, F. W. Atkeson, G. H. Beck. State funds.)

*Feeder Cattle Disease Investigations.*— During the biennium work on infectious keratitis was conducted intermittently. Confinement in darkened stalls was more effective in treating this condition than were two medicinal preparations tried.

The infection was readily spread by contact exposure.

Calves on high vitamin A supplement were as susceptible to infective material obtained from field cases as calves having adequate blood levels of vitamin A but receiving no vitamin A supplement.

A feeding experiment was conducted in cooperation with the United States Soil Conservation Nursery with *Astragalus chinensis*. No toxic properties for the plant were demonstrated in this feeding trial, but it was both unpalatable and

of little value for forage. Several field trips have been made to investigate disease conditions among livestock and to formulate control measures for the prevention of further losses.

(Project 194. Department of Veterinary Medicine. Leader, L. M. Roderick. State funds.)

***Poultry Disease Investigations.***— Investigations conducted under this project included service activities in examining flocks and testing samples as well as pullorum studies.

*Study of pullorum disease in turkeys.*— During the past biennium the Department of Bacteriology has tested some 94,800 samples of turkey blood in order to detect pullorum carriers. The tube test was used for these samples due to the fact that the field test, using a whole blood and stained pullorum antigen, does not appear to be satisfactory for testing turkeys.

During the 1944-'45 testing season, with 30,300 samples tested, 75.0 percent of the flocks contained reactors with 7.12 percent of the birds reacting. In 1945-'46 there were 59.9 percent of the flocks with reactors and 3.53 percent of the birds reacted.

During 1944-'45 rather extensive investigations were conducted on the relation between different types of pullorum reaction and actual infection in turkeys. Reports by Hinshaw in California had indicated that the stained antigen was not satisfactory for this purpose.

In order to check the significance of these reactions 187 adult turkeys were collected on the basis of the rapid whole-blood tests. These birds were killed and the viscera removed to the laboratory where cultures were made in an attempt to isolate the pullorum organism.

Results of different types of culture media on the isolation of pullorum organisms indicate that no one medium is entirely satisfactory for this type of work. For this reason at least three types of media are now recommended for the isolation of the pullorum organism. These are desoxycholate citrate agar, bismuth sulfite agar, and S S agar.

(Project 85. Department of Bacteriology. Leader, L. D. Bushnell. State funds.)

***Poultry Disease Investigations (Precipitin Test).***— Some time has been spent in studying the precipitin test and its application to the diagnosis of leucosis in chickens. This infection has been found to be a virus disease which manifests itself in many forms. At present there is no rapid method for detecting birds which are infected and may be carriers of the infection. It was believed that, by developing a method of early diagnosis it would be possible to detect such carriers and remove them from the breeding stock.

Various serological methods of diagnosis were studied, and the precipitin test appeared to be the most easily conducted. Some time has been used in the development of different antigens. Ten agents were used for extracting diseased tissues, and salt solution appeared to give the most satisfactory results. To date the results obtained indicate that there may be more than one type of virus involved. This appears to be contrary to the results obtained by others, and it will be necessary to continue the work until enough data are accumulated to settle the question.

(Project 228. Department of Bacteriology. Leader, L. D. Bushnell. Bankhead-Jones funds.)

**Parasitological Investigations.**— During the past biennium work has been done on liquid skim milk as a factor in roundworm control. Growing chickens on an adequate ration were given also liquid skim milk on alternate days. Each chicken was parasitized with about 100 eggs of the fowl nematode *Ascaridia galli*.

Chickens that received the skim milk were found to harbor only two-fifths as many worms as did the groups of chickens whose diet was similar except for replacement of the liquid skim milk by water. The results of these experiments carried out five times show that liquid skim milk given on alternate days as a supplement to an adequate ration is a valuable aid in controlling the large roundworm *Ascaridia galli* of chickens. The milk supplement also aids in producing smoother feathers at an earlier period of development.

Results of previous work indicated that chickens on a completely adequate diet and under good management could harbor moderate worm infections without showing ill effects. Tests were then run to determine if moderate infections of the fowl nematode *Ascaridia galli* will predispose chickens to bacterial infections.

Two groups of young chickens of the same age and weight were placed in separate cages. One group was parasitized with about 300 *Ascaridia galli* eggs. Two weeks later both groups were given small injections of Botulinus Toxin type A. In two tests upon 153 chickens the parasitized chickens showed Botulinus symptoms earlier and more severely than did the unparasitized groups. There were significantly more ailing birds and higher mortality in the parasitized groups than in the unparasitized (control) groups. Experimental evidence is presented, apparently for the first time, which shows that moderate infections of the fowl nematode, *Ascaridia galli*, will predispose chickens to the effects of a bacterial toxin.

(Project 79. Department of Zoölogy. Leader, J. E. Ackert. Adams funds.)

**Resistance of Animals to Parasitism.**— The work during the biennium has been upon protein supplements as factors in the resistance of chickens to the nematode *Ascaridia galli*.

In a comparison of soybean oil meal with meat scrap, it was found that a supplement of 14.4 percent soybean oil meal could be substituted for 14.4 percent of meat scrap as a supplement to a cereal basal ration without lowering the resistance of the chickens to the parasites.

Effects of protein supplements upon the resistance of chickens to the ascarids was tested by feeding respective groups of chickens a supplement of plant and animal sources (Group I), a low plant protein supplement (Group II), and a high protein meat supplement (Group III). All chickens were given about 500 *Ascaridia galli* eggs. The chickens of Group I (plant and animal proteins) were the most resistant (16.5 worms per chicken); those of Group II (low plant protein) had the most worms (average of 56); and Group III (high protein meat meal) had an average of 53.5 worms. The greater resistance of Group I is attributed to a more favorable amino acid content of the Group I diet which contained all the amino acids required for normal chick growth. The Group II diet was a weak source of the necessary amino acids, chiefly lysine, and the Group III diet was low in the amino acid content of methionine and lysine.

(Project 169. Department of Zoölogy. Leader, J. E. Ackert. Purnell funds.)

STUDIES IN HOME ECONOMICS AND FOOD  
RESEARCH

Among the lines of research conducted by the Department of Home Economics are studies in nutrition, food preservation by various methods, food preparations factors, and economy in the home. Improvement in methods of freezing and dehydration has accounted for several new studies in food preservation by this department and coöperating departments.

*The Nutritional Status of College Women.*— Nutrition and dietary habits of college women were studied in coöperation with home economics and nutrition departments in Iowa, Oklahoma, and Minnesota.

*Basal metabolism of women and girls of varying ages in Kansas.*— A number of basal tests were made on subjects under 19 and over 24 years of age. Also one subject was tested for a period of four years, from 11 to 15 years of age, and other subjects were tested at frequent intervals over a period of two years. Growth, adolescence, age, body temperature, seasonal differences, humidity, and hours of sunshine were factors studied to determine how they may have influenced the basal rate.

Data on midwestern women, and especially those in Kansas, indicate that the basal rate is considerably lower than is published in the literature.

Not all the factors studied have as yet been correlated with the basal data.

*Vitamin C status of college women.*— All analyses for this project were completed and data for three phases prepared for a coöperative report.

Girls with gum trouble given extra vitamin C (ascorbic acid) found much improvement, but some of the subjects did not clear entirely. Dental examinations at regular intervals confirmed these findings but they also revealed other conditions superimposed causing irritation, such as malocclusion.

The mean ascorbic acid values of 582 college women tested in a survey covered in five states was 0.66 mg. per 100 cc. of plasma. Nebraska was lowest with 0.47 mg., and Iowa was highest, 0.81 mg. The 157 subjects in Kansas had a mean value of 0.7 mg.

(Project 201. Department of Home Economics. Leaders, Martha S. Pittman and Leah Ascham. Purnell funds.)

*A Study of the Factors Affecting the Service Qualities of Fabrics.*— A study was made to determine the effects of fiber content, laundering, dry cleaning, and storage on the resiliency, thickness, and thermal conductivity of certain selected blankets.

Fiber content of 100-percent wool has no more effect on the flow of heat than blends of fibers and all-cotton. Blends of cotton and rayon, of wool, rayon, and cotton, and all-cotton were warmer than all-wool. The blend of new and reused wool and Aralac was slightly warmer than all-wool. The thickest blankets were the warmest.

Laundering and dry cleaning increased the protection of blankets containing wool. Laundering greatly decreased the protection of blankets containing cotton; dry cleaning decreased protection but slightly.

Storage increased the warmth of one wool, one cotton and wool, two cotton and rayon, and the wool and Aralac, but decreased it for one blanket containing less than 5 percent wool and had no noticeable effect on the rest.

Dry cleaning caused less shrinkage than laundering. Five launderings resulted in warp shrinkage of from 6 to 16 percent. Wool shrank the least. Dry cleaning caused only .1 to .5 percent as much shrinkage as laundering and left blankets in better condition.



Comparison of effect of abrasion on weight, thickness, and breaking strength of these blankets has not been completed.

*The serviceability of a cotton fabric used for utility garments as affected by laundering with certain detergents.*— A survey of selected areas in Kansas has been made to learn the detergents used in laundering. Analysis of the findings provided information as to the most commonly used detergents. These are the subject of study in this problem. Approximately 80 uniforms are being worn, and the effect of laundering on the service qualities of the fabric used in these uniforms is being studied when (1) some are laundered with selected detergents under conditions duplicating home laundry and (2) some are laundered by a commercial laundry. Fabric samples are being laundered with various detergents under laboratory conditions. A comparison will be made of (1) the effect of each of the detergents used on the fabric when merely laundered and when laundered and subjected to wear, and (2) the effect of home and commercial laundering on the service qualities of a known fabric.

(Project 161. Department of Home Economics. Leaders, Katherine P. Hess and Esther M. Cormany. Purnell funds.)

*Studies of Factors Affecting the Expenditures for Family Living Among Kansas Farm Families.*— Two preliminary reports on "Farm Income and Living Costs for Kansas Farm Management Association Families" were prepared. The first one was for 183 families in 1944 and the second for 182 families in 1945.

The average net farm income for 183 families in 1944 was \$4,535, and in 1945, \$4,092. The cost of family living was \$1,848 in 1944 and \$2,241 in 1945. In addition, in 1944 \$170 was classified as gifts and \$627 as savings and life insurance. In 1945, \$207 was classified as gifts and \$856 as savings and life insurance.

The 802 income and expense records covering the period 1934-'40 showed that the net farm incomes varied widely. Six percent of the annual records showed a loss; 9 percent showed incomes of less than \$500; 66 percent between \$500 and \$2,500; and 22 percent showed incomes above \$2,500.

The cost of living in these families tended to move upward from 1934 through 1937, decreased slightly in 1938 and 1939, but rose again in 1940. The average value of living, including gifts and nonfarm investments in the form of small savings and life insurance payments, was \$1,426 for the seven-year period. One-third of this amount was the value of the food used. Of this food, 55 percent was supplied by the farm. Dairy items accounted for slightly less than one-half of the value of all farm products, and poultry and eggs accounted for approximately one-fourth. The value of meat approximated that of vegetables and fruit.

(Project 196. Department of Home Economics. Leader, Myrtle A. Gunselman. Purnell funds.)

*An Investigation of the Effect upon the Animal Body of Varying the Amount of Vitamin in the Diet.*— An investigation of the effect upon the animal body of varying the amount of vitamin C in the diet of the guinea pig with special reference to (a) the relation of the connective tissue in the bones and their mineral content, (b) tensile strength and histology of the muscle, (c) the effect of vitamin C-deficiency upon the blood, (d) the effect of a limited amount of vitamin C on the male guinea pig.

The effects of vitamin C-deficiency on the blood of guinea pigs were as follows: (1) A decrease in the number of erythrocytes but the decrease was

not constant; (2) decrease in the number of leucocytes; (3) a decrease in the hemoglobin content; (4) a decrease in the amount of blood. This last was the most significant, since just before death from scurvy there was very little blood in an animal.

The effects of vitamin C-deficiency in the diet on male guinea pigs were the following: (1) Younger animals succumb much sooner than older animals; (2) males in the same cage with females succumb from two to five days sooner than females; (3) of 18 experimental male guinea pigs only one showed any sexual activity after being on a vitamin C-free diet for two weeks; (4) with one exception pus was found in the seminal vesicles.

(Project 188. Department of Home Economics. Leader, Mary T. Harman. Purnell funds.)

*Vitamin Content of Food in Relation to Human Nutrition.*

—Several series of experiments were conducted on albino rats to compare the relative growth-promoting values of whole wheat, Morris-type flour, and enriched flour as sources of the B-complex vitamins. The flour was incorporated into the diets at the 30-, 40-, and 50-percent levels.

The effect of enriching the flour with other B-complex vitamins besides thiamine, niacin, and riboflavin was studied. Calcium pantothenate, pyridoxine, and choline were the enriching agents used.

Under the conditions of the experiments, the results indicate that whole wheat is a better source of the B-complex vitamins than either Morris-type flour or patent flour, enriched at the old levels, when these materials make up 30 or 50 percent of the diet. At a 30-percent level whole wheat is slightly better than patent flour, which has been enriched at the new levels. Whole wheat and new enriched flour promote the same amount of growth when fed at a 40-percent level, while at a 50-percent level the new enriched flour is better as a source of the B-complex vitamins than whole wheat. The addition of calcium pantothenate, pyridoxine, and choline to enriched flour promoted better growth than the enriched flour without the added vitamins.

(Project 158. Department of Home Economics. Leader, Beulah D. Westerman. Purnell funds.)

*Meat Investigations.*— Studies were carried out, on the sub-project dealing with factors influencing the vitamin B-complex content of meat.

*Chemical and physical properties of meat.*— Work has continued on the problem of dark-cutting beef. Factors affecting relative rate of formation and retention of lactic acid in bright and dark beef have been investigated.

1944-'45. Characteristic rapid conversion of glycogen to lactic acid in dark beef was found to be entirely inhibited by raising the acidity to a value characteristic of bright beef. Previous inability to demonstrate conversion of glucose to lactic acid, in either bright or dark beef, was reversed when greater amounts of glucose were added and pH was raised to upper limits of dark beef (6.6). Indications pointed to lower stability of lactic acid in dark beef than in bright beef.

1945-'46. As a part of the study of the changes in concentration of lactic acid and its precursor materials in meat, opportunity was taken to observe changes in glucose, glycogen, inorganic phosphate, and lactic acid during cooking of 16 samples of beef by the home economics department.

After roasting, beef contained on the average 57 percent as much glucose, 64 percent as much glycogen, 66 percent as much inorganic phosphate, and 51 percent as much lactic acid as the raw sample, both on moisture-free, fat-free basis.

Incubation experiments showed lactic acid disappearing much more rapidly in dark beef than in bright beef, with glucose and glycogen added to dark beef equal to concentration in bright sample, and at same pH as dark sample.

Added glucose and glycogen had no effect on oxygen uptake of dark beef at pH 6.6. When pH of bright beef was changed from 5.5 to 6.6, the oxygen uptake was doubled; however, it was yet only half as fast as dark beef at the same pH (6.6).

Twelve percent more of thiamine was found in a bright sample of beef than in a dark one, but 25 percent more of thiamine pyrophosphate (cocarboxylase) occurred in the dark sample. Preliminary investigation indicated greater activity of succinic dehydrogenase in dark beef.

The round from a dark cutter contained 64 percent more selenium than the average between a two- and a four-year old bright beef animal. A medium dark sample contained 24 percent more selenium than the average of the two bright samples. A bright round from a yearling contained 37 percent as much selenium as the average of the two- and four-year old.

*The thiamine and riboflavin content of meat.*— The effect of braising, of roasting, of holding after cooking, and of reheating upon certain cuts of pork was studied.

Pork roasts and braised pork chops showed practically the same thiamine loss in cooking. However, when the drippings were analyzed it was found that only about 20 percent of the thiamine from the chops was destroyed as compared with 43 percent from the roasts. The roasts retained a higher percentage of riboflavin but had a higher total loss than did the chops.

Pork roasts held overnight retained 93 percent of the thiamine present in the cooked roasts.

Pork roasts sliced and held over steam for 30 minutes retained 91 percent of the thiamine in the cooked meat.

Pork roasts held overnight, sliced, and reheated retained 93 percent of the thiamine held overnight, and 90 percent of that in the meat immediately after cooking.

*The thiamine, riboflavin, niacin, and pantothenic acid in meat.*— Several different cuts of beef were analyzed for these vitamins. Analyses were made on both raw and cooked samples in order to study the effect of different methods of thawing and the cooking losses.

The cooking methods were oven roasting and braising. The methods of thawing were room temperature, cooking temperature, and warming oven (73° C.).

The study has not been finished, but the results obtained so far seem to indicate that in pot roasts the percentage retention of these vitamins varies only slightly, on the average, between the samples thawed at room temperature and those thawed at cooking temperature. In the oven roasts there is a greater difference in the retention in the samples thawed at room and at oven temperatures. The braised steaks thawed at room temperatures and at 73° C. show little difference in the retention of thiamine and riboflavin, but those thawed at 73° C. show greater retention of niacin and pantothenic acid. When the data are considered according to methods of cooking, the greatest losses of all of these vitamins occur in the braised steaks. More of the thiamine is retained in oven roasts than in pot roasts, while the retention of the other three vitamins is about the same for the two products. Of the vitamins studied, thiamine losses are the greatest.

(Project, 217. Departments of Home Economics and Chemistry Leaders, Beulah D. Westerman, Gladys E. Vail. J. L. Hall. Purnell funds.)

*Cooking and Baking Quality of Dried Egg Products.*— Work on this project has been principally in developing methods for the production of dried egg white and in studying its uses. Satisfactory methods for the continuous fermentation and drying of egg

white have been developed. A method for the continuous concentration of egg white has been developed and studied on a pilot-plant scale.

(Commercial Project 6. Departments of Chemistry and Home Economics. Leaders, R. M. Conrad and Gladys E. Vail. Seymour Packing Company funds.)

*The Utilization of Dried and Frozen Egg Products in Foods.*— As a result of this work much information is available regarding the various egg products developed during the past few years as to their desirability and acceptability. Recommended methods for incorporating dried eggs in cakes have been formulated and tested. Recipes using dried egg have been developed, and as soon as it is deemed feasible it is planned that these will be published.

(Industrial Research Project 8. Department of Home Economics. Leaders, Gwendolyn L. Tinklin and Gladys E. Vail. State funds.)

*Coördinated Dried Egg Research Program.*— Studies have been made of changes in the nutritive and culinary properties of eggs during drying and dry storage. Methods of processing whole eggs so as to preserve better the desirable qualities have been developed.

It has been found that the stability of thiamin in dried eggs stored at 100° F. varies inversely with the moisture content of the powder from approximately 1 to 6 percent. At moisture levels below 2 percent the amount of the vitamin retained after several months storage is greater than in dehydrated pork.

Liquid whole egg can be easily acidified to pH 5.5 before drying. Our results indicate that the desired acidification can be produced by the addition to 1,000 pounds of liquid egg of 4.5 pounds of C. P. concentrated hydrochloric acid diluted with 10 to 15 volumes of water. Deviations of as much as 10 percent from the recommended amount of acid are permissible. By incorporating in the powder 1.3 to 1.8 pounds of sodium bicarbonate for every 100 pounds of egg powder, provision is made for neutralizing the acid when the powder is reconstituted.

Spraying alone has no significant effect on the culinary properties of liquid egg.

In making sponge cakes, the foaming property of the white of the egg is of practically no importance. However, the binding or coagulating power is of importance.

Addition of sugar to liquid egg before drying tends to prevent the changes which make ordinary dried egg unsuitable for use in sponge cakes. In a study it was found that 10 percent sugar on the liquid egg basis was far superior to smaller amounts, and slightly superior to 15 percent. Samples of dried egg made from liquid containing 10 percent sugar consistently produced better cakes than commercial frozen eggs being used for control. After storage in a gas-filled package for one month at 100° F., or six months at 35° F., these samples showed no significant changes in culinary properties.

(Commercial Project 9. Departments of Chemistry, Chemical Engineering, and Home Economics. Leaders, R. M. Conrad, A. L. Olsen, J. W. Greene, Gladys E. Vail. National Egg Products Association funds.)

***Factors Affecting the Quality and Nutritive Value of Fruits and Vegetables Preserved by Freezing.***— Various kinds and varieties of the following fruits and vegetables were grown and prepared for the frozen food locker: strawberries, purple raspberries, black raspberries, dewberries, peaches, grapes, beans, corn, and tomatoes.

No substitute equal to sugar or sugar syrup was found. The best combinations were 50 percent sugar syrup and 50 percent corn syrup or 50 percent honey and 50 percent sugar syrup.

All the vegetables produced desirable results harvested at proper stage of maturity and handled quickly. Fruits stored at 0° F. to +10° F. were not so good as those stored at 0° F. Vitamin C, thiocarbamide, and sodium sulphite prevented discoloration of processed peaches.

*The determination of ascorbic acid and palatability scores as indices of nutritive value and quality.*— Without exception, ascorbic acid is lowered in fruits and vegetables kept in a commercial freezer locker. However, there are apparently variations in the percentage loss with different products. For example, asparagus lost approximately 15 percent in nine months, while the losses in strawberries, snap beans, soybeans, and lima beans were much higher, around 40 to 60 percent. The greatest losses occurred within the first few weeks. After that they continued but at a slower rate.

Inquiries were made as to relative losses in preservation by freezing vs. canning. The canned asparagus tested at intervals contained as much ascorbic acid after a year's storage as did the frozen, if not slightly more.

(Project 233. Departments of Horticulture and Home Economics. Leaders, G. A. Filinger and Leah Ascham. Bankhead-Jones funds.)

***Nutritive Value and Eating Quality of Foods Prepared and Served in Large Quantity to College Students.***— For two weeks, February 19 to March 3, 1944, nutritive values and costs were studied for food of the army students at Kansas State College. Food costs averaged \$0.632 per man per day, with waste of edible food only 0.06 pound per man per day. Four groups of foods accounted for over 90 percent of the food costs, as follows: meat, fish, poultry, eggs—42 percent; milk, milk products—23 percent; vegetables and fruits—16 percent; grains, grain products—10 percent.

The average energy intake, 3,318 calories, was lower than planned for the army. This was probably due to less physical activity on the campus than in the field. The protein intake of 118 grams per man per day was lower than the 128 grams planned, but still generous according to present-day standards for civilians. The quality was commendable, with 70 percent from animal sources. Army rations provided a little over 12 percent of the calories from protein, compared with 14 percent in this study. Vitamin and mineral intakes seemed more than adequate. The specified servings of food and the daily nutritive requirements as recommended by the National Research Council per man per day were supplied with generous margins.

Food served army students at Kansas State College was studied for ascorbic acid content. Determinations showed that the army students received an average of 82.9 milligrams of ascorbic acid per day, with a minimum of 34.1 and a maximum of 131.3 milligrams. The standard of the National Research Council was met with a margin of 10 percent.

*Ascorbic acid studies of the diet served to women in a coöperative residence hall on the Kansas State College campus.*— The ascorbic acid content of food

served to students in a coöperative residence hall for women at Kansas State College was determined. It averaged 70.9 mg. per person per day, and ranged from 24.5 to 146.3 mg. In two periods the ascorbic acid supplied was about, 15 percent more than the recommended 70 mg. daily. However, during three periods the averages were about 10 percent below this.

More than one-third the total ascorbic acid was supplied by citrus fruits; leafy vegetables were the next best source, supplying more than one-fifth the total. Vegetables of the cabbage family were particularly useful.

In the residence hall, 137 persons were fed regularly during 30 days of the fall semester, plus three workers each noon.

During this 30-day study there were only 12 days when ascorbic acid was provided sufficient to meet the 70 mg. recommendation. Menus for these 12 days included one or more servings of citrus fruit or servings of vegetables of good ascorbic acid value. Averages for the 30 days showed the ascorbic acid of the diet to have been provided as follows: citrus fruits, 35.6 percent; other fruits, 10.7 percent; tomatoes, 4.6 percent; leafy vegetables, 20.9 percent; potatoes, 11.8 percent; other vegetables, 12.5 percent; milk, 3.9 percent.

Costs were studied and citrus fruits, along with certain of the leafy vegetables, were found to be inexpensive sources of ascorbic acid. Methods of handling and preparing these foods accounted for many variations.

(Project 238. Department of Home Economics. Leader, Martha M. Kramer. State and department funds.)

***The Effect of Method of Handling Frozen Meat After Removal from Frozen Storage on Quality and Palatability of the Cooked Product.***— Although the project is still in progress, results to date indicate a significantly greater shrinkage of braised beef steaks thawed in water than of those thawed by any other method. Steaks thawed in a warming oven at 73° C. and overnight at room temperature showed practically the same shrinkage, while those thawed in the refrigerator and those not thawed before cooking showed slightly higher losses.

Pot roasts of beef not thawed before cooking shrank less than those which were thawed at room temperature, but required an average of 10 minutes a pound longer cooking time. Results to date indicate that meat thaws faster in running water than in infra-red light, while that thawed in the warming oven seems to require more time than either of the others. The steaks thawed in water were considered by the palatability committee to have a less desirable flavor than paired cuts thawed in the refrigerator.

(Commercial Project 17. Department of Home Economics. Leader, Gladys E. Vail. Refrigerator Research Foundation funds.)

***The Effect of Different Frozen Storage Temperatures upon Certain Characteristics of Meat.***— Pork loins from nine hogs raised under experimental conditions were cut to give paired roasts. One cut from each animal was reserved for immediate study and the remaining cuts weighed, wrapped, and frozen. They were then divided into three lots and each lot stored at a different temperature.

The fresh uncooked samples of the longissimus dorsi muscle, frozen and unfrozen, were analyzed for total nitrogen, nonprotein nitrogen, water imbibition, pH, press fluid yield, total nitrogen in press fluid, nonprotein nitrogen in press fluid, and proteolytic activity. Acid numbers and peroxide numbers were determined on raw and cooked fat. Percentage cooking losses, palatability, press fluid, and shear were determined on the cooked pork loin

roast. Thiamine, riboflavin, pantothenic acid, and niacin contents were determined on both the raw and cooked muscle.

Similar tests on the frozen stored samples will be run at approximately three-month intervals.

Only the fresh cuts and those stored for 12 weeks have been tested, so results are not yet available.

(Commercial Project 30. Departments of Chemistry, Home Economics, and Animal Husbandry. Leaders, J. L. Hall, Beulah D. Westerman, Gladys E. Vail, D. L. Mackintosh. Refrigerator Research Foundation funds.)

***Some Effects of Packing Fresh Fruits and Vegetables in Ice.***— Iced samples of asparagus at the end of 14 days storage had good color, crisp spears, and fresh appearance. The iced sample was in better condition at the end of eight days than the sample kept in a refrigerator. Asparagus having no protection of ice was considered inedible at the end of six days.

Iced green beans were in excellent condition after 14 days. Beans without ice protection had lost much flavor after three days, and were shriveled and spotty after five days.

Iced carrots retained flavor, crisp texture, firm condition, and showed no wilting of tops during a six-day storage period. Carrots without ice protection were too wilted to use after four days; poor flavor was quite evident after three days in storage.

Iced lettuce improved in crispness. Room temperature lettuce wilted readily; approximately half was discarded after three days.

Iced sweet corn retained most of its characteristic sweet flavor for five days; kernels were still plump with no denting after six days. Sweet corn held without ice protection showed flavor loss within 12 hours after harvest; denting of kernels was evident in two days.

Iced peppers were crisp, tender, firm, and acceptable for immediate use in salads or on relish plate. Peppers at room temperature became flabby in texture and declined in flavor after three days. Iced tomatoes remained firm and had minimum juice leakage when cut; this condition was more satisfactory for sandwich or salad use than that of tomatoes without ice protection.

(Commercial Project 24. Departments of Horticulture and Home Economics. Leaders, W. F. Pickett and Gladys E. Vail. Kansas Ice Men's Association funds.)

***Some of the Factors Affecting the Quality of Green Beans Preserved by Freezing.***— The following are recommendations based on the studies: Choose varieties of beans adapted for freezing, such as Tender Green, Stringless Green Pod, and Bountiful, of the green pod varieties; Pencil Pod, Golden Bountiful Wax, and Unrivaled Wax of yellow pod varieties. Harvest beans at stage of maturity just under that judged suitable for canning. Do not plan to freeze overmature nor very young pods.

Work with bean quantities not exceeding four pints when blanching. Allow more than one gallon boiling water per pound of prepared vegetables. Use at least two minutes blanching time. Enzymes not destroyed may cause off flavors and color changes. Promptly and thoroughly cool blanched beans in running water having temperature of 50° to 60° F. or in ice water.

Dry pack is satisfactory under most conditions. Up to seven months stor-

age at zero temperature, no undesirable changes had occurred in beans which had been harvested at the right stage of maturity, properly blanched, and packed in moisture-vapor-proof containers. Beans stored at temperature above 5° F. were not so desirable.

(Commercial Project 26. Department of Horticulture. Leader, G. A. Filinger. Kansas Frozen Food Locker Association funds.)

***New Cookery Methods Used for Cut-up Turkey.***— Several turkeys and portions of turkeys were used for experimental cookery. Some of the methods tried were turkey burgers, baked turkey loaf, jellied turkey loaf, molded turkey loaf, crisp turkey slices, fried turkey, braised turkey cutlets, turkey cutlets, turkey steaks, stuffed baby roasts, roast quarter turkeys, roast, half turkeys, roast smoked turkeys, and turkey filets.

After completing the experimental cooking, the turkey filets, which proved to be the most satisfactory method of preparing cut-up turkey, were prepared and served at the College Cafeteria on five different occasions. On two of these occasions the patrons who were served turkey filet were given a "Consumer's Report" in order to obtain information on the acceptability of this product. The returns indicated that turkey filets are quite acceptable.

(Project 77. Departments of Poultry Husbandry and Home Economics. Leaders, L. F. Payne, Gladys E. Vail, and Eula Morris. State funds.)

***Fat Rancidity in Eviscerated Poultry.***— This project is a study of the factors which are responsible for the development of rancidity in eviscerated poultry. A group of White Plymouth Rock cockerels were killed and dressed by various practices and placed in cold storage. Over a period of 20 months samples were examined organoleptically and chemically nine times. The data obtained were treated statistically and the following conclusions reached:

1. Starving poultry 16 hours before killing tends to improve the keeping quality.
2. Eviscerating poultry before freezing causes more peroxide and aldehyde formation than is formed in uneviscerated poultry
2. Cutting poultry in pieces and wrapping in MSAT cellophane bags instead of wrapping whole birds in plain cellophane improves the keeping quality.
4. Holding the poultry 24 hours in a cooler before eviscerating and freezing tends to decrease the keeping quality of the poultry
5. Freezing after killing, thawing two weeks later, eviscerating, and re-freezing, decreases the keeping quality of the poultry.
6. Holding poultry New York-dressed at 5° C. for six days before eviscerating and freezing is extremely damaging to keeping quality.

Significant changes were noted in the induction period of fat extracted from the skin of turkeys kept on the same basal diet but receiving different supplements. The fat from turkeys supplemented with choline and ethanolamine was 5.5 and 3.1 times more stable than fat from turkeys receiving no supplement. The induction period of fat from turkeys supplemented with alfalfa meal or crystalline carotene indicated only a transitory stabilizing effect.

The induction periods of fat extracted from the skin and adipose tissues of mature turkeys were also determined. Two groups of turkeys had been



supplemented with either choline or ethanolamine and one group with both choline and ethanolamine for two weeks before they were killed. Another group received both supplements three days before they were killed. The induction periods indicated that when compared with a control group ingested choline or ethanolamine had no stabilizing effect on the fat deposited in the skin and adipose tissue of mature turkeys.

(Commercial Project 20. Departments of Chemistry, Home Economics, and Poultry Husbandry. Leaders, F. A. Kummerow, R. M. Conrad, Gladys E. Vail, L. F. Payne. Army Quartermaster Corps fund.)

*The Relative Nutritive Value of Butter and Vegetable Fats.*

—The object was to determine whether there is a difference in the nutritive values of butterfat and corn oil. In each of the seven experiments the rats fed butterfat made greater average gains in weight than did those fed corn oil. The results were statistically significant in four of these experiments. The rats fed butterfat showed a greater average consumption of the ration than did those fed corn oil, the results being significant in three of the experiments. The average efficiency of conversion of the ration to tissue was similar for rats of the same age fed either ration.

In the maze-learning trials both the error and time scores were kept. These data showed that although differences found were frequently favorable to the rats fed butterfat, the differences were not statistically significant in most cases; thus a superiority of one ration over the other was not demonstrated.

(Commercial Project 19. Department of Chemistry. Leaders, J. S. Hughes and D. B. Parrish. American Dairy Association Research funds.)

## BRANCH EXPERIMENT STATIONS

The work at each of the four branch experiment stations is closely correlated with that of the central station, but planned and conducted with particular reference to local conditions. A brief description of the work under way and the results secured are given in the following pages.

### FORT HAYS BRANCH EXPERIMENT STATION

The Fort Hays Branch Experiment Station located at Hays is equipped to conduct experimental work with soils, crops, livestock, horticulture, and forestry. All of the soils and crops work is in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering or the Soil Conservation Service, United States Department of Agriculture. Brief statements about the more important projects follow:

**Cereal Investigations.** —Varietal testing and plant breeding work are being conducted with winter wheat, sorghums, winter and spring barley, and spring oats to develop and determine the best varieties for the Central Plains region.

Progenies from the cross Chiefkan X (Oro X Tenmarq) now in the eighth generation have shown high resistance to bunt, some tolerance to head and stem rust, stiff straw, high test weight, good yield, and milling and baking qualities equal to the old Turkey type. Crosses are being carried between Marquillo X (Oro-Early Blackhull Sel.) and (Chiefkan-Oro-Tenmarq) X (Marquillo-Oro) for resistance to the rusts and Hessian fly along with yield and quality.

The control of loose smut (*Ustilago nuda*) in barley is being made through the crosses Mykden Black X Flynn, Dorsett X Trebi, Beecher X Trebi, and Flynn X (Trebi-Wisconsin Barbless Sel.) An attempt is being made to secure stiff-strawed barley types in both spring and winter varieties.

The sorghum improvement work continues as a major project. The release of Cody as a source of waxy starch has made possible a new commercial enterprise, the use of sorghum starch in manufacture of tapioca.

Work at the Fort Hays Branch Experiment Station in cooperation with the Northern Regional Research Laboratory, Peoria, Illinois, has shown that the niacin content varies widely in sorghum. In many sorghums the range is from 35 to 45 micrograms per gram as represented by Westland, a well-known combine type. Cody has shown an average of 70 micrograms.

The  $F_2$  generation from the cross Westland X Cody showed transgressive inheritance with one progeny running as high as 102 micrograms, and with more than 18 percent of population running higher than the amount found in the Cody parent. The niacin content in Cody was found to be rather constant in amount for the crops from three successive years.

Since the last biennial report, Midland, a new combine sorghum, has been released to the farmers. The variety has met with favorable reception. (A. F. SWANSON, *in charge.*)

**Dry Land Agriculture.** —Tillage, seedbed preparation, and rotation experiments including the use of various small grain and row crops, green manure crops, commercial fertilizers and barnyard manure, various types of tillage machinery, and soil moisture studies were continued in the usual manner. Soil moisture investigations were reduced to a considerable extent in 1944 and were further reduced in 1945. After the close of the season of 1945, 37 three-year rotations, which had served their purpose, were discontinued to be replaced by new experimental work.

During the seasons of 1944 and 1945, soil structure studies were conducted by Dr. Olmstead, soil physicist, Bureau of Agricultural and Industrial Chem-

istry, on plots having received different cultural treatments since 1906, and infiltration studies were conducted on several of the same plots during the season of 1944 by Dr. Musgrave, research specialist, Soil Conservation Service. (A. L. HALSTEAD, *in charge.*)

**Forage Crop Investigations.**— The forage crop studies at this station include investigational work on grass, sweet clover, and alfalfa. Buffalo grass, blue grama, and side-oat grama receive the greatest attention.

Investigations of the germination of buffalo grass seed are being given special attention with the hope that an easier yet effective method may be found to replace the saltpetre-refrigeration and drying method discovered by this station a few years ago. The latter method requires nearly seven weeks to complete the treating process.

The use of nitrogen fertilizer to increase buffalo grass seed production under irrigation has greatly stimulated seed production. The successful reseeded of over 400 acres of station cultivated land has shown April and May to be the most satisfactory months for planting buffalo, blue grama, and side-oat grama grasses. (F. E. MEENEN, *in charge.*)

**Noxious Weed Control Investigations.**— Investigations with the various phases of controlling bindweed, dogbane, hoary cress, and Russian knapweed by intensive cultivation, competitive cropping, and herbicides were conducted during the biennium with results quite similar to those reported previously.

Extensive experiments with 2,4-D in the control of bindweed and other noxious weeds with creeping perennial roots and in the control of dandelions, wild lettuce, fleabane, and other weeds in lawns and other grass plantings were begun in 1945 in coöperation with a uniform program of experimentation which is being conducted throughout the north central states region under the auspices of the North Central States Weed Control Conference.

The results of the first year's experiments showed 2,4-D to be a satisfactory selective herbicide for controlling dandelion, wild lettuce, fleabane, most species of mustard, and many other kinds of broad-leaved weeds in lawns, grass seed-increase fields, and other grass plantings. Experimental applications of 2,4-D in a buffalo grass seed-increase field, heavily infested with wild lettuce and fleabane, increased the yield of buffalo grass seed from 100 to as much as 500, pounds per acre in 1945. Applications, of Sinox increased the yield of buffalo grass seed approximately 600 pounds per acre. Applications of 2,4-D and of Sinox in the spring of 1946 gave good control of weeds in buffalo grass, and the effect on seed yields will be determined at harvest time.

The results of experimental applications of 2,4-D on bindweed, dogbane, hoary cress, and similar perennial weeds were quite promising but somewhat erratic, and are not sufficiently complete to permit making definite recommendations on the use of 2,4-D for the control of deeprooted perennial weeds.

2,4-D spray applications killed or severely damaged most kinds of vegetable crops and legumes, but caused relatively little injury to the cereals and other grass-type crops. Residual 2,4-D in the soil caused injury to susceptible crops during a period of six to eight weeks after the spray application. Investigations are being conducted to determine the duration of the residual effect of 2,4-D in the soil under various conditions of rainfall and temperature. (F. L. TIMMONS, *in charge.*)

**Beef Cattle Feeding Investigations.**— The beef cattle feeding trials conducted during the biennium were a continuation and completion of a series of investigations begun in 1942 on the influence of different levels of nutrition upon the ultimate development of stock calves when wintered in the feedlot and then summer-grazed on native pasture. A series of investigations on the comparative feeding values of Westland, Midland, Pink Kafir, and corn when full-fed with silage-cottonseed cake and mineral supplement to yearling steers was begun in 1944. Detailed reports of the results of these investigations will be found in Progress Reports B-45 and B-46. (L. C. AICHER, C. W. McCAMPBELL, A. D. WEBER, *in charge.*)

**State Forest Nursery.**— The sale of seedling trees in 1945 was lower than

usual. However, 367,357 seedlings of 18 species were distributed in 92 counties in Kansas.

In addition to the tree-distribution program the nursery carries on an experimental test plot of trees and shrubs. Many of these are new introductions from the United States Department of Agriculture. Some are new varieties developed in this country. Careful notes on the behavior of these species are taken.

In 1945 a trial planting of trees held in storage over winter at Halsey, Nebraska, by the United States Forest Service was undertaken in cooperation with the Forest Service. It was determined that evergreen trees dug in the fall and held in storage under refrigeration and certain conditions of humidity until planting time in early spring were not satisfactory. Storage tests of eastern red cedar and ponderosa pine to determine how long good healthy trees could be kept under approved tree storage conditions were undertaken in 1945. The trees were stored 30 days and then planted. Sixty-eight out of 100 red cedar and 43 out of 100 ponderosa pine survived the tests. (J. G. HARRISON, *in charge.*)

**Pure Seed Distribution.**— Sales of pure certified seed of adapted and approved farm crop varieties were the highest ever recorded during any biennium in the station's history. The 1945 seed sales amounted to 851,124 pounds, of which 483,780 pounds were sorghum seed; over half of this sorghum seed was of the Midland variety, a new early combine grain sorghum especially adapted to north central and west central Kansas. Cody, the new waxy starch variety, comprised 35,760 pounds. Seed wheat sales amounted to 355,890 pounds; Hays Buffalo grass, 6,434 pounds; Side Oat Grama, 2,451 pounds; and Buffalo alfalfa seed, the new wilt-resistant alfalfa released for the first time, 1,265 pounds. The station distributed 1,068 pounds of Hays Golden seed corn.

The 1946 fiscal year seed sales, the highest on record, amounted to 959,235 pounds of which 552,270 pounds was Comanche seed wheat; 386,183 was sorghum seed, much of which was Midland and the new Cody; 5,055 pounds was the new Hays Buffalo grass selection; 2,500 pounds was side-oat grama; and 12,849 pounds was the new wilt-resistant Buffalo alfalfa seed. Approximately 9,000 pounds of the latter remained in Kansas for increase fields to produce seed of this very valuable new alfalfa selection. (L. C. AICHER, *in charge.*)

### GARDEN CITY BRANCH EXPERIMENT STATION

The Garden City Station was established in 1908. The original station consisted of 320 acres, but later additions were made by purchase, bringing the total acreage to 556, approximately 100 acres of which are under irrigation. Approximately 350 acres are cultivated, 120 are in native grass, and the balance is in farmstead and roadways.

Major projects were conducted in dry land agriculture investigations, crop improvement, livestock feeding, and dairying.

**Field Trials of Summer Fallow Cropping.**— Sorghums and wheat are seeded only on fields prepared by summer fallowing. Results from a five-year period support strongly the theory that an alternate crop and fallow system is economically feasible, and has great advantage over continuous cropping practices for this section of Kansas. (L. M. SLOAN, *in charge.*)

**Soil Conservation Investigations.**— This work was continued cooperatively with the Soil Conservation Service and Bureau of Plant Industry, Soils, and Agricultural Engineering. Contour cultivation has given about 20 percent increase over up-and-down-hill seedbed preparation for wheat, but no advantage has appeared for basining on contours over ordinary contouring. Ordinary listing on contour for sorghums was equal to basin listing on contour, both of which gave about 25 percent increase in yield over up-and-down-hill listing and basin listing. Basin listing for sorghums up-and-down-hill gave 10 percent increase over ordinary listing up-and-down-hill.

Subsurface tillage (trashy fallow) yields have been equal to other good methods of seedbed preparation for wheat, but are much more difficult to execute with the equipment now available. (H. L. STOUT, A. E. LOWE, and L. M. SLOAN, *in charge*.)

**Crop Improvement.** —The major objective of this work is to test the adaptation and yielding ability of numerous varieties of sorghum, wheat, winter barley, spring barley, oats, corn, and soybeans. Intensive work is carried on in testing varieties of sorghum for resistance to milo disease. The development of new varieties of sorghum by hybridization and selection is being carried on, emphasizing the combine types.

A unit of the Kansas intrastate winter wheat nursery is grown in which new hybrid lines and varieties are given a preliminary yield and adaptation test.

In 1942 a test comparing five rates with five dates of planting was started with winter wheat. The 20-pound rate on the 15th of September is the highest yielding for the limited number of years tested. Wheat variety data secured were helpful in proving the value of two new wheat varieties, Comanche and Wichita, both specifically recommended for southwest Kansas.

Alfalfa strains were tested, seed increased, and selections made for resistance to bacterial wilt. This work is in coöperation with C. O. Grandfield, Division of Forage Crops and Diseases. (A. E. LOWE, *in charge*.)

**Dry Land Agriculture Investigations.** —The Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture, and the Kansas Agricultural Experiment Station continued joint investigations of Dry Land Agriculture at Garden City during the biennium. Extensive project changes were made by Dr. J. C. Hide and Mr. J. S. Cole in 1944 and were put into effect during the fall of 1944 and the spring of 1945. These changes modernized the tillage work, incorporated new problems, and improved the plot technique.

Wheat yields were high on alternate crop and fallow in 1944 as well as 1945, with acre yields ranging up to 42 bushels in 1944 and 38 bushels in 1945. Continuous cropping produced excellent yields in 1944 where stands were secured, but in many cases the continuous plots had to be planted to spring barley because of the poor stand. Wheat yields on continuous cropping in 1945 were quite low for the most part, with maximum yields of around seven bushels an acre.

Sorghum yields were record-breaking in 1944 for this area, ranging as high as 70 bushels on continuous cropping. Sorghum following a fallow period seemed to be slightly inferior. Yields for the year 1945 were more nearly normal, with average acre yields of approximately 40 bushels on alternate crop and fallow and 17 bushels on continuous cropping. (HAROLD L. STOUT, *in charge*.)

**Sheep Feeding Investigations.**— The results of this work are given elsewhere in this report under "Investigations in the Animal Industries." (L. M. SLOAN and R. F. COX, *in charge*.)

**Dairy Investigations.**— General management problems in connection with the Brown Swiss herd have been studied with special emphasis on irrigated pastures for this irrigated section of Kansas. A mixture of alfalfa and Brome grass has been found satisfactory for early spring and fall pasture. For mid-summer pasture, irrigated Sudan grass has been found to provide approximately two cow units grazing capacity per acre. (L. M. SLOAN, *in charge*.)

#### COLBY BRANCH EXPERIMENT STATION

The Colby Branch Experiment Station consists of 634 acres of state-owned land. The work of the station is divided into five major projects: (1) dry-land agriculture investigations; (2) general crops investigations; (3) field trials; (4) dairy investigations; and (5) horticultural investigations.

**Dry-Land Agriculture.**— The experiments in cultural practices and soil management studies under dry land conditions were continued in coöperation

with the Divisions of Soils, Fertilizers, and Irrigation, United States Department of Agriculture, without change during the biennium. The year 1944 was one of the station's wettest years. On the dry land plots winter wheat averaged 33.2 bushels an acre on fallow and 17.5 bushels on crop land. Barley yielded 26.5 bushels on fallow and 18.4 on crop land. Corn yielded 30 bushels on fallow and 33 on crop land. Milo averaged 37.2 bushels on fallow and 29.8 on crop land. It was one of the most favorable years for storing moisture on fallow.

On the dry land project the winter wheat averaged 38.7 bushels an acre on fallow and 15.9 on crop land. Barley yielded 54.2 bushels on fallow and 21.7 on crop land. Corn yielded 37.1 bushels on fallow and 19 on crop land; milo averaged 32 bushels on fallow and 15.7 on crop land. It was a fairly good year for storing moisture on fallow. (J. B. KUSKA, *in charge.* )

**General Crops.**— Variety tests with winter wheat, barley, oats, corn, and the sorghums were conducted during both years of the biennium. The three newer varieties of wheat, Pawnee, Wichita, and Comanche, are at the top of the list in the yield table for the five-year period 1941 to 1945. The two new varieties of oats, Osage and Neosho, produced well in the 1945 test, but were not included in the 1944 test. Munsing, a two-row barley that has produced good yields formerly in this nursery, was the highest yielder in the 1945 variety test. This is an unattractive variety, but it does seem to have the ability to produce well.

Several of the so-called early varieties of grain sorghum were added to the variety test, but none of them has proven to be early enough for local conditions. A rather large nursery of hybrids of which Colby milo is one parent were studied in an effort to select one that is as early as Colby milo, but with a stronger stalk than that variety. Some progress can be reported. (E. H. COLES, *in charge.* )

**Field Trials.**— A quarter section of land is being utilized for the field trial studies. All of the area is being contour-farmed following tillage practices and planting varieties that have proved best in plot tests. Certified seed is produced on part of the area. In 1944, 1,390 bushels and, in 1945, 1,563 bushels of certified Comanche seed wheat were produced and distributed to growers. (E. H. COLES, *in charge.* )

**Dairy Herd Improvement.**— This project was continued as outlined in the last biennial report. Four steers from the red cows, sired by a purebred Ayrshire, have been baby-beefed. They showed an average dressing percentage of slightly over 60 percent, and gained well while on feed. Only one heifer in this project has completed a lactation, in which she produced 7,529 pounds of milk containing 302 pounds of butterfat. This record is 2,000 pounds more milk and 76 pounds more fat than was produced by her dam in that animal's highest-producing period. (E. H. COLES, *in charge.* )

**Horticulture Investigations.**— Little fruit was produced in the orchard in either year of the biennium. The trees have made an excellent growth and are old enough to start bearing soon. The chrysanthemum test carried in coöperation with the Cheyenne (Wyoming) Horticultural Field Station continued to be very attractive. Seventy-six varieties of this hardy flowering plant are being studied. Most of the varieties tested are winter-hardy and produce an abundance of flowers. (E. H. COLES, *in charge.* )

### TRIBUNE BRANCH EXPERIMENT STATION

Located in Greeley county, 16 miles from the Colorado line, the Tribune Branch Experiment Station includes about 110 acres of land typical of the high plains of western Kansas. Crop yields vary from year to year because of great differences in rainfall.

A time-of-summer-fallow project for wheat has been started. Tests will be conducted to show results of summer fallow started immediately after harvest, started April 1 of the next spring, and started the following June 1.

In 1945 the 30-pound rate of seeding wheat gave the highest yield in most cases, with September 15 being the optimum seeding date. The highest single yield, 55.1 bushels to the acre, was made by Cheyenne X Early Black-hull planted 30 pounds to the acre on September 25. These tests were after fallow.

A good crop of corn was produced for the fifth successive year, making the best record for the station since it was established in 1911. Kansas hybrids continued to make the highest yields. Date-of-planting tests showed May 18 to be the optimum date in 1944 and June 1 in 1945. In the corn fertility tests best yields came from 10-ton manure treatment in 1944 and from no treatment in 1945. In width-of-row tests for both years best results came from fields having every third row skipped.

Popcorn yields for both years showed all hybrid varieties tested to be superior to the open-pollinated varieties Supergold and South American.

Sorghum variety tests for the 1942-'45 four-year average show Norkan producing the best forage yields, slightly better than Early Sumac or Leoti Red. Sooner was best in grain yield for the period. These results were for June 5 planting, both after fallow and after corn. Fertility tests for sorghums showed best results from 10-ton manure treatment in 1944, and from 5-ton treatment in 1945.

Basin listing has been superior to open listing of sorghums every year since basin listing was initiated, except 1944. For the four-year average May 20 has been the best seeding date for grain yields, and June 20 for forage yields.

Potatoes were very poor in 1944 and only fair in 1945, but Irish Cobblers continue to yield best, with Warbas next, and Early Triumphs and Red River Ohios following in that order.

Fruits produced well in 1944, with Kaga plums and Opatá plums doing particularly well, and Early Richmond cherries making a good crop. There was little fruit in 1945 because of the late spring freeze. (T. B. STINSON, *in charge.*)

### STATION PUBLICATIONS

The results of investigations are reported by the Agricultural Experiment Station in four series of publications: biennial reports, technical bulletins, bulletins, and circulars; they are also reported in scientific journals.

**Biennial Reports.**— At the close of each biennium a report is made giving a brief survey of all the work of the station. It consists primarily of progress reports on the various projects actively pursued during the biennium.

**Technical Bulletins.**— Reports of detailed scientific investigations, too technical for the average reader but of value to the investigational and technically trained reader, are published as technical bulletins. Four such bulletins were issued during the biennium.

**General Bulletins.**— The reports of specific investigations for popular distribution are published as bulletins. The material is presented in such a manner as to be readily understood by the average reader. Six bulletins were printed during the biennium.

**Circulars.**— Brief popular reports of experimental results and popular discussions on various agricultural problems are published as circulars. Thirteen circulars were published during the biennium.

The following are the regular station publications issued during the biennium, listed by series and showing the title, size of edition, and the number of pages:

**AGRICULTURAL EXPERIMENT STATION**

**BIENNIAL REPORT**

No.	Title	Edition	Pages	Total pages
	Twelfth Biennial Report of the Director.....	1,200	99	118,800

**TECHNICAL BULLETINS**

57	A Study of the Morphological Nature and Physiological Functions of the Awns of Winter Wheat.....	1,500	82	123,000
58	Quality of Beef.....	2,250	86	193,000
59	Wheat-Seeding Dates and the Hessian Fly in Kansas.....	2,500	18	45,000
61	Chemical Composition of Some Sorghum Grains and the Properties of Their Starches.....	3,500	47	164,500

**GENERAL BULLETINS**

824	Transportation of Livestock by Motor Truck to the Kansas City Market.....	5,500	59	324,500
325	Kansas Corn Tests, 1944.....	5,500	35	122,500
326	Poultry Diseases, Their Prevention and Control.....	20,000	124	2,480,000
327	Farm Incomes and Living Costs for Certain Kansas Families.....	2,500	35	87,500
328	Alfalfa in Kansas.....	15,000	64	960,000
329	Kansas Corn Tests, 1945.....	6,000	40	240,000

**CIRCULARS**

225	Postwar Planning at the Community Level. . . . .	5,000	10	50,000
226	Buffalo Alfalfa . . . . .	3,500	7	24,500
227	List of Publications . . . . .	2,000	4	8,000
228	Trend of Real Estate Taxation in Kansas, 1910-'43.....	3,500	40	140,000
229	Inter-Relationships Among Farms in a Community.....	3,500	32	112,000
230	Preserving Food in Home Frozen Food Cabinets.....	20,000	28	560,000
231	Kansas Rural Institutions: I. The Fort Hays Branch Station.....	3,000	18	54,000
232	List of Publications, A. E. S.....	2,000	4	8,000
233	Bovine Mastitis . . . . .	5,000	12	60,000
234	The Elm Calligrapha.....	3,000	7	21,000
235	Combating Fruit Pests in Kansas. . . . .	10,000	52	520,000
236	Kansas Rural Institutions: II. A Pioneer in Rural Electrification.....	3,000	23	69,000
237	Brucellosis in Cattle.....	4,000	16	64,000

**ABSTRACTS**

5	Abstract of Publications.....	9,500	2	19,000
6	Abstract of Publications.....	9,000	2	18,000

**REPORTS**

2	Kernel Characteristics of Kansas Winter Wheat Varieties..	5,500	24	132,000
3	Proceedings of the First Annual Industrial-Agricultural Week .....	2,000	154	308,000

**PUBLICATIONS BY DEPARTMENTS**

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

**Department of Agricultural Economics**

Serial No.	Year of Issue	Title, author, and publication
122	1944	A Study of Farm Labor in Two Years of War. W. H. Pine. Jour. Farm Econ. 26(3):563-565.
123a	1944	The Trend of Real Estate Taxation in Kansas, 1910 to 1942. Harold Howe. Kan. Agr. Expt. Sta. Circ. 228:1-40.
124	1944	Postwar Planning at the Community Level. W. E. Grimes. Kan. Agr. Expt. Sta. Circ. 225:1-10.
126	1945	Transportation of Livestock by Motor Truck to the Kansas City Market. H. H. Haag (Missouri), F. L. Parsons, C. P. Wilson, J. H. McCoy (Kansas). Kan. Agr. Expt. Sta. Bul. 324:1-59.
127	1945	Inter-Relationships Among Farms in a Community. M. L. Otto. Kan. Agr. Expt. Sta. Circ. 229:1-32.
128	1945	State Market Agencies. W. E. Grimes. Kan. State Bd. Agr. Quart. Rpt. 54(26):66-92.



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<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
129	1945	Kansas Rural Institutions. I. The Fort Hays Branch Experiment Station. F. D. Farrell. Kan. Agr. Expt. Sta. Circ. 231:1-18.
132	1946	Is the Economic Climate Going to Be Favorable to Industry? W. E. Grimes. Proc. Indus. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:119-123.
133	1946	The Effect of the Tax Structure on Industrial Development. Harold Howe. Proc. Indus. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:143-147.
134	1946	Postwar Agricultural Problems in the Great Plains Area. W. E. Grimes. Jour. Farm Econ. 28(1):235-242.
135	1946	The Corn and Hog Industry and the Tariff. W. E. Grimes. Carnegie Endowment for International Peace. Agr. Series No. 5:1-17, April 10.
136	1946	Kansas Rural Institutions: II. A Pioneer in Rural Electrification. F. D. Farrell. Kan. Agr. Expt. Sta. Circ. 236:1-23.

Department of Agricultural Engineering

<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
75	1945	Pit Silos for the Storage of Atlas Sorgo Grain and Soft Corn. H. E. Bechtel, F. W. Atkeson, F. C. Fenton, and W. M. Carleton. Jour. Animal Sci. 4(4):488-452.

Department of Agronomy

352	1945	Alfalfa Seed Production as Affected by Organic Reserves, Air Temperature, Humidity, and Soil Moisture. C. O. Grandfield. Jour. Agr. Research. 70(4):123-132.
353	1943	The Inheritance of Reaction to Smut, Stem Rust, and Crown Rust in Several Oat Crosses. G. W. Cochran, C. O. Johnston, and E. G. Heyne. Jour. Agr. Research. 70(2):43-61.
358	1944	Reaction of F <sub>1</sub> Sorghum Plants to Milo Disease in the Greenhouse and Field. E. G. Heyne, L. E. Melchers, and A. E. Lowe. Jour. Amer. Soc. Agron. 36(7):628-630.
359	1944	Characteristics and Origin of Blackhull Wheats. E. G. Heyne and L. P. Reitz. Jour. Amer. Soc. Agron. 36(9):768-778.
360	1944	Response of Wheat Varieties to Applications of Superphosphate Fertilizer. L. P. Reitz and H. E. Myers. Jour. Amer. Soc. Agron. 36(11):936.
361	1944	Soil Aggregation as a Possible Factor in Yield Response Following Alfalfa. H. E. Myers and H. G. Myers. Soil Sci. 36(12):965-969.
362	1945	Buffalo Alfalfa. C. O. Grandfield. Kan. Agr. Expt. Sta. Circ. 226:1-7.
365	1945	Studies on Smut-Resistant Oats for Kansas. E. D. Hansing, E. G. Heyne, and L. E. Melchers. Jour. Amer. Soc. Agron. 37(6):499-508.
366	1945	Kernel Characteristics of Winter Wheat Varieties Grown in Kansas. L. P. Reitz. Kan. Agr. Expt. Sta. Rpt. No. 2:1-24.
367	1945	Kansas Corn Tests, 1944. A. L. Clapp, E. G. Heyne, C. D. Davis, and W. O. Scott. Kan. Agr. Expt. Sta. Bul. 325:1-35.
368	1945	Alfalfa in Kansas. C. O. Grandfield and R. I. Throckmorton. Kan. Agr. Expt. Sta. Bul. 328:1-64.
369	1945	New Combinations of Genes in Wheat and Wheatgrass Hybrids. L. P. Reitz, C. O. Johnston, and K. L. Anderson. Trans. Kan. Acad. Sci. 48:151-159.
370	1945	Hybrid Corn Comes to Kansas. E. G. Heyne, A. L. Clapp, and C. R. Porter. Pamphlet, Agr. Com. Kan. Bankers Assoc. pp. 1-12.
375	1946	Adaptation of Various Grasses for Turf Establishment in Kansas. K. L. Anderson. Proc. State Airport Conf. Kan. Eng. Expt. Sta. Bul. 49:50-54.
376	1946	Breeding Cron Plants for Industry. R. I. Throckmorton. Proc. Ind. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:37-38.
377	1946	Identification of Wheat Varieties in Kernel Analysis Schools. L. P. Reitz. Jour. Amer. Soc. Agron. 38(4):343-344.
378	1946	Kansas Corn Tests, 1945. E. G. Heyne, A. L. Clapp, C. R. Porter, W. O. Scott, and C. D. Davis. Kan. Agr. Expt. Sta. Bul. 329:1-40.

**Department of Animal Husbandry**

<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
147	1944	Horn and Scur Inheritance in Certain Breeds of Sheep. H. L. Ibsen. <i>Amer. Naturalist</i> , 78:506-516.
148	1945	Utilization of Industrial By-products by Livestock. A. D. Weber. <i>Proc. Ind. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:52-54.</i>
156	1944	Quality of Beef. J. L. Hall, D. L. Mackintosh, and Gladys E. Vail. <i>Kan. Agr. Expt. Sta. Tech. Bul. 58:1-86.</i>

**Department of Bacteriology**

217	1945	Growth Curves of Azotobacter at Different pH Levels. P. L. Ganey and Eric Fowler. <i>Jour. Agr. Res.</i> 70(7):219-236.
218	1944	The Production of Carotenoid Pigments from Mineral Oil by Bacteria. H. F. Haas and L. D. Bushnell. <i>Jour. Bact.</i> 48:219-231.
219	1944	Changes in Bacterial Counts of Stored Ice Cream Mix. F. E. Nelson. <i>Jour. Dairy Sci.</i> 27:459-462.
220	1944	Measuring the Growth of Azotobacter. P. L. Ganey. <i>Jour. Bact.</i> 48:285-294.
221	1944	Bacteriological Evaluation of Ice Cream. F. E. Nelson. <i>Jour. Dairy Sci.</i> 27:993-1005.
223	1944	Factors which Influence Growth of Heat-treated Bacteria F. E. Nelson. <i>Jour. Bact. Sci.</i> 48:473-477.
224	1944	Respiration of Resting Azotobacter Cells as Affected by the Respiratory Menstruum. John O. Harris and P. L. Ganey. <i>Jour. Bact.</i> 48:689-696.
225	1945	Pullorum Testing of Turkeys. L. D. Bushnell. <i>Poult. Sci.</i> 24:203-211.
226	1945	A Study of Methods for the Isolation of S. Pullorum. L. D. Bushnell and J. J. Porter. <i>Poult. Sci.</i> 24:212-215.
227	1944	Testing Turkeys for Pullorum Disease. L. D. Bushnell. <i>Turkey World.</i> 19:40-41.
228	1945	Poultry Diseases, Their Prevention and Control. L. D. Bushnell and M. J. Twiehaus. <i>Kan. Agr. Expt. Sta. Bul.</i> 326:1-124.
229	1945	Micro-organisms and the Struggle for Existence. L. D. Bushnell. <i>Trans. Kan. Acad. Sci.</i> 48(1):55-69.
230	1946	A Study of the Effect of Growth Substrate on the Respiration of Azotobacter. J. O. Harris. <i>Jour. Biol. Chem.</i> 162:11-20.

**Department of Botany**

370	1945	Inheritance of Reaction to Smut, Stem Rust, and Crown Rust in Four Oat Crosses. G. W. Cochran, C. O. Johnston, E. G. Heyne, and E. D. Hansing. <i>Jour. Agr. Research</i> 70:43-61.
371	1944	The Kansas Academy of Science. J. C. Frazier. <i>Amer. Assoc. Adv. Sci. Bul.</i> 3:78-80.
377	1944	A Study of the Morphological Nature and Physiological Functions of the Awns of Winter Wheat. E. C. Miller, H. G. Gauch, and G. A. Gries. <i>Kan. Agr. Expt. Sta. Tech. Bul.</i> 57:1-82.
378	1944	Standard and New Fungicides for the Control of Covered Kernel Smut of Sorghum and Their Effect on Stand. E. D. Hansing and L. E. Melchers. <i>Phytopath. (Note)</i> 34:1034-1036.
379	1945	Further Studies on the Occurrence and Distribution of Physiologic Races of Tilletia Foetida in Kansas. E. D. Hansing and L. E. Melchers. <i>Trans. Kan. Acad. Sci. Quart.</i> 48(1):71-75.
381	1945	Studies on Smut-Resistant Oats for Kansas. E. D. Hansing, E. G. Heyne, and L. E. Melchers. <i>Jour. Amer. Soc. Agron.</i> 37:499-508.
382	1945	Nature and Rate of Development of Root System of Gonolobus laevis. J. C. Frazier. <i>Bot. Gaz.</i> 106:324-332.
383	1945	Second-year Development of Root System of Apocynum cannabinum. J. C. Frazier. <i>Bot. Gaz.</i> 106:332.
384	1945	New Combinations of Genes in Wheat and Wheatgrass Hybrids. L. P. Reitz, C. O. Johnston, and K. L. Anderson. <i>Trans. Kan. Acad. Sci.</i> 48:151-159.
385	1946	Reaction of Oat Varieties and Selections to Four Races of Loose Smut. E. D. Hansing, E. G. Heyne, and T. R. Stanton. <i>Phytopath.</i> 36:433-445.

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Department of Chemistry

<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
271	1944	The Melanins. I. Studies of the Hair Pigments of the Guinea Pig. M. R. Baker and A. C. Andrews. Gen. 29:104-112.
279	1943	Brown Silage from Atlas Sorgo—Chemical Composition and Apparent Digestibility as Determined by Feeding to Dairy Cows. H. E. Betchel, F. W. Atkeson, J. S. Hughes. Jour. Animal Sci. 2(4):295-303.
282	1944	Phosphate Fixation by Soil Minerals. A. T. Perkins and H. H. King. Soil Sci. Soc. Amer. Proc. 8. 154-158.
284	1944	Quality of Beef. J. L. Hall, D. L. Mackintosh, and Gladys E. Vail. Kan. Agr. Expt. Sta. Tech. Bul. 58:1-86.
285	1944	Determination of Carotene in Dehydrated Alfalfa. A Simplified Method. R. E. Silker, W. G. Schrenk, and H. H. King. Ind. Eng. Chem. Anal. Ed. 16(8):513-515.
286	1944	Carotene Content of Alfalfa and Its Retention on Dehydration. R. E. Silker, W. G. Schrenk, H. H. King. Indus. Engr. Chem. 36(9):831-835.
289	1944	Phosphate Fixation by Soil Minerals. II. Fixation by Iron, Silicon, and Titanium Oxides. A. T. Perkins and H. H. King. Soil Sci. 58(3):243-250.
290	1944	Modified Knock-Pipette for Carr-Price Reagent Dispenser. D. B. Parrish and M. J. Caldwell. Jour. Clinical Med. 29:992-993.
291	1944	The Determination of Vitamin A in Dehydrated Eggs. W. G. Schrenk, Douglas Chapin, and R. M. Conrad. Indus. Engr. Chem. Anal. Ed. 16(10):632-634.
292	1945	The Stability of Vitamin A in an Experimental Poultry Feed. D. B. Parrish, M. J. Caldwell, and A. E. Schumacher. Trans. Kan. Acad. Sci. 47(3):375-379.
293	1945	Dough Development and Mechanical Gluten Dispersion in Relation to Amount of Mixing and to the Flour Water Ratio. C. O. Swanson and A. C. Andrews. Cereal Chemistry 22(1):60-74.
294	1945	The Effects of Papain, Yeast Water, Cysteine, and Glutathione on Gluten Dispersion or on Denaturation as Indicated by Gluten Recovery and by Mixogram Patterns. C. O. Swanson and A. C. Andrews. Cereal Chemistry 22(2):134-148.
295	1945	Phosphate Fixation by Soil Minerals. III. Particle Size. A. T. Perkins and H. H. King. Proc. Soil Sci. Soc. Amer. 9:61-65.
296	1945	A Suggested Explanation for the Action of Mineral Elements on Nerve Irritability. M. J. Caldwell and J. S. Hughes. Jour. Amer. Vet. Med. Assn. 818:298-300.
298	1945	The Effect of Light on the Stability of the Carr-Price Color in the Determination of Vitamin A. M. J. Caldwell and D. B. Parrish. Jour. Biol. Chemistry 158:181-186.
299	1945	Sorghum Feeds for Dairy Cattle. I. The Effects of Restricting Lactating Cows to Atlas Sorgo Rations. H. E. Betchel, F. W. Atkeson, Marvin Kroger, J. S. Hughes, W. J. Peterson, W. W. Thompson. Jour. Dairy Sci. 28(7):531-544.
300	1945	Phosphate Fixation by Soil Minerals. IV. General. A. T. Perkins. Trans. Kan. Acad. Sci. 48(2):209-217.
301	1946	Phosphate Fixation by Soil. A. T. Perkins. Proceedings Soil Sci. Soc. Amer. 10:102-106.
302	1946	The Vitamin A and Carotene Content of Kansas Market Butter. D. B. Parrish, W. H. Martin, F. W. Atkeson, and J. S. Hughes. Jour. Dairy Sci. 29(2):91-99.
303	1946	Growth and Food Preference of Rats Fed a Lactose-Dried Milk Ration Containing Butterfat or Corn Oil. J. S. Hughes, D. B. Parrish, E. Roberta Shimer. Jour. Nutr. 31:321.
304	1946	The Effect of the Parturient Diet of the Cow on the Vitamin A Reserves of Her New-Born Offspring. G. H. Wise, M. J. Caldwell, J. S. Hughes. Science 103(2681):616-618.
305	1946	Chemical Composition of Some Sorghum Grains and the Properties of Their Starches. H. N. Barham, John Wagoner, Carol Campbell, and E. H. Harclerode. Kan. Agr. Expt. Sta. Tech. Bul. 61:1-47.
307	1946	Industrial Utilization of Sorghum Grains. H. H. King. Proc. Indus. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:45-48.
308	1946	The Composition of Sorghum Grain Oil. F. A. Kummerow. Jour. Oil and Soap. 23:167-170.

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**Department of Dairy Husbandry**

<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
154	1944	Relative Effects of Several Base Oils and Toxic Ingredients Used in Livestock Sprays on the Skin of Cattle. F. W. Atkeson, A. R. Borgmann, R. C. Smith, and A. O. Shaw. Jour. Econ. Ent. 37(3):428-435.
155	1944	Comparative Toxicity Under Barn Conditions of Livestock-Type Flysprays Made from Various Combinations of Toxic Ingredients and Base Oils. F. W. Atkeson, R. C. Smith, A. R. Borgmann, and H. C. Fryer. Jour. Econ. Ent. 37(3):419-428.
156	1945	Brown Alfalfa Hay, Its Chemical Composition and Nutritive Value in Dairy Rations. H. E. Bechtel, A. O. Shaw, and F. W. Atkeson. Jour. Dairy Sci. 28(1):35-48.
157	1945	Latex in the Preparation of Corrosions of Mammary Glands. H. E. Bechtel and W. M. McLeod. Amer. Jour. Vet. Research. 6(18):17-20.
158	1945	Pit Silos for the Storage of Atlas Sorgo Grain and Soft Corn. H. E. Bechtel, F. W. Atkeson, F. C. Fenton, and W. M. Carleton. Jour. Animal Sci. 4(4):438-452.
159	1945	Determination of Improper Pasteurization by Applying the New York City Field Phosphatase Tests to Cheddar Cheese. W. J. Caulfield and W. H. Martin. Jour. Dairy Sci. 28(2):155-160.
160	1945	Sorghums Feeds for Dairy Cattle. I. The Effects of Restricting Lactating Cows to Atlas Sorgo Rations. H. E. Bechtel, F. W. Atkeson, Marvin Kroger, J. S. Hughes, W. J. Peterson, and W. W. Thompson. Jour. Dairy Sci. 28(7):531-544.
161	1946	The Vitamin A and Carotene Content of Kansas Market Butter. D. B. Parrish, W. H. Martin, F. W. Atkeson, and J. S. Hughes. Jour. Dairy Sci. 29(2):91-99.
162	1946	The Effect of the Parturition Diet of the Cow on the Vitamin A Reserves of Her New-Born Offspring. G. H. Wise, M. J. Caldwell, and J. S. Hughes. Science. 103(2681):616-618.
163	1946	Utilization of Dairy Products. F. W. Atkeson. Proc. Indus. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:40-41.

**Department of Entomology**

523	1944	Control of Three Red Cedar Scales. G. A. Dean. Bien. Rpt. Kan. State Hort. Soc. 47:80-82.
531	1944	Honeybee Pollination and Fruit Production. R. L. Parker. Bien. Rpt. Kan. State Hort. Soc. 47:56-59.
532	1944	Insects and Other Arthropods Collected in Pasture Grasses, Waste Lands, and Forage Crops, Manhattan, Kansas, 1937-1940, inclusive. H. H. Walkden and D. A. Wilbur. Jour. Kan. Ent. Soc. 17(4):128-143.
534	1944	The Importance of Honey Production During War Times. R. L. Parker. Trans. Kan. Acad. Sci. 47(3):191-193.
535	1945	The Hessian Fly Resistance of Pawnee Wheat. Reginald H. Painter and E. T. Jones. Jour. Kan. Ent. Soc. 18(4):130-149.
536	1944	Preliminary Report on the Biology and Control of the Strawberry Rootworms <i>Paria canella</i> (Fab.) and <i>Graphops pubescens</i> Mels. R. L. Parker and P. G. Lamerson. Bien. Rpt. Kan. State Hort. Soc. 47:114-116.
538	1945	Wheat-Seeding Dates and the Hessian Fly in Kansas. J. R. Horton, E. T. Jones, H. H. Walkden, and G. A. Dean. Kan. Agr. Expt. Sta. Tech. Bul. 59:1-18.
539	1945	Codling Moth Control by DDT, Fixed Nicotine, and Lead Arsenate Combinations. R. L. Parker and P. G. Lamerson. The Codling Moth Pool, Bureau of Entomology and Plant Quarantine (Mimeo. publication) 37-46.
540	1945	Corn Borers. D. A. Wilbur. Quart. Rpt. Kan. State Bd. Agr. 64:97-111.
542	1945	The Fourteenth of 1944 Annual Insect Population Summary of Kansas. R. C. Smith, G. A. Dean, and E. G. Kelly. Jour. Kan. Ent. Soc. 18(3):85-99.
543	1945	Beekeeping in Bermuda. R. L. Parker. Gleanings in Bee Culture. 73(9):371-373.
544	1946	The Elm Calligrapha. G. A. Dean. Kan. Agr. Expt. Sta. Circ. 234:1-7.
545	1946	Additional Host and Distribution Records of the Sweetpotato Leaf Beetle, <i>Typophorus viridicyaneus</i> (Crotch), (Coleoptera, Chrysomelidae). R. L. Parker. Jour. Kan. Ento. Soc. 19:11-12.

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<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
546	1946	Codling Moth Control with DDT, Lead Arsenate, and Fixed Nicotine Combinations during 1945. R. L. Parker and E. L. Eshbaugh. Codling Moth Pool. Bur. Ent. & Plt. Quart. (Mimeo) 44-51.
548	1946	The Fifteenth of 1945 Annual Insect Population Summary of Kansas. R. C. Smith, G. A. Dean, and E. G. Kelly. Jour. Kan. Ent. Soc. 19(2):37-52.
<b>Department of Home Economics</b>		
115	1944	Effectiveness and Permanence of Certain Moisture-Repellent and Stain-Resistant Finishes. Veola Crouch and Katharine Hess. Rayon Textile Monthly. 25(9):449-451.
118	1945	The Thiamine Content of Certain Varieties of Kansas Wheat and of Flour Milled from These Varieties. Doris E. Whitney, Helen Herren, and Beulah D. Westerman. Cereal Chem. 22(2):90-95.
120	1944	Quality of Beef. J. L. Hall, D. L. Mackintosh, and Gladys E. Vail. Kan. Agr. Expt. Sta. Tech. Bul. 58:1-86.
121	1945	The Nutritional Status of Midwestern College Women. M. S. Pittman, et al. Jour. Amer. Dietetic Assoc. 21(3):145-147.
122	1944	Hemoglobin Concentrations, Red Cell Counts, and Erythrocyte Volumes of College Women of the North Central States. M. S. Pittman, et al. Amer. Jour. Physiol. 142(5):727-732.
123	1945	Enriched, Morris Type, and Whole Wheat Flour as Sources of the B-Complex Vitamins. Beulah D. Westerman and E. G. Bayfield. Jour. Nutr. 29(1):27-33.
124	1945	Nutritive Value and Cost Distribution of Food of Army Students. Doris T. Odle and Martha M. Kramer. Jour. Amer. Dietetic Assoc. 21(5):285.
125	1945	Ascorbic Acid Content of Food Served to Army Students. Martha M. Kramer. Jour. Amer. Dietetic Assoc. 21(6):348.
126	1946	Variations in the Basal Metabolism of Mid-Western College Women. M. S. Pittman, et al. Jour. Amer. Dietetic Assn. 22:307-309.
127	1945	Farm Incomes and Living Costs for Certain Kansas Families. Myrtle A. Gunselman, Kan. Agr. Expt. Sta. Bul. 327:1-35.
128	1946	The Ascorbic Acid Content of Food Served in a Coöperative Residence Hall for Women. Mary L. Dunkerley and Martha M. Kramer. Jour. Amer. Dietetic Assoc. 22(1):15-19.
129	1946	Effect of Method of Combining the Ingredients upon the Quality of the Finished Cake. Gwendolyn L. Tinklin and Gladys E. Vail. Cereal Chemistry. 23(2):155-165.
130	1946	Effect of Fiber Content and Care on Resiliency, Thickness, and Thermal Conductivity of Blankets. Pearle A. Gilmore and Katharine P. Hess. Rayon Textile Monthly 27(5):78-82.
132	1946	The Use of Dried Whole Egg in Cakes Containing Fat. Gwendolyn L. Tinklin and Gladys E. Vail. U. S. Poultry and Egg Magazine. 52(2):76-78.
<b>Department of Horticulture</b>		
185	1942	New Commercial Varieties of Tree Fruits. W. F. Pickett. Proc. Amer. Assn. Nurserymen. 190-196.
189	1944	Lessons from the Atchison Experimental Orchard. R. J. Barnett. Proc. Kan. State Hort. Soc. 47:31-37.
191	1944	Some Notes on Apple Rootstocks. G. A. Filingier. Proc. Kan. State Hort. Soc. 47:83-84.
192	1944	Factors Influencing Successful Vegetable Gardening in Kansas. S. W. Decker. Proc. Kan. State Hort. Soc. 47:27-30.
194	1944	Our New Farm. W. F. Pickett. Proc. Kan. State Hort. Soc. 47:85-87.
200	1943	Preserving Small Fruits by Freezing. G. A. Filingier. Proc. Amer. Pomol. Soc. pp. 140-148. Trans. Ill. Hort. Soc. 77:219-227.
201	1943	Russeted Apples. W. F. Pickett. Proc. Amer. Pomol. Soc. pp. 226-233. Trans. Iowa Hort. Soc. 78:55-61. Trans. Ill. Hort. Soc. 77:336-343. Proc. Kan. State Hort. Soc. 47:102-107 (1944).
202	1944	Preserving Fruits and Vegetables in Frozen Food Lockers. G. A. Filingier. Bien. Proc. State Hort. Soc. 47:110-113.
203		Windbreaks, Woodlots, and Farm Forestry. W. F. Pickett. Quart. Rpt. Kan. State Bd. of Agr. 64(266):36-40.

<i>Serial No.</i>	<i>Year of Issue</i>	<i>Title, author, and publication</i>
204	1945	Preserving Food in Home Frozen Food Cabinets. G. A. Filinger. Kan. Agr. Expt. Sta. Circ. 230:1-28.
207	1946	Products for Frozen Food Lockers. G. A. Filinger. Proc. Indus. Agr. Conf. Agr. Expt. Sta. Rpt. No. 3:50-52.
208	1946	Combating Fruit Pests in Kansas. G. A. Filinger. Kan. Agr. Expt. Sta. Circ. 235:1-52.

**Department of Milling Industry**

91	1943	Effect of Moisture on the Physical and Other Properties of Wheat. III. Degree, Duration, and Number of Wetting Treatments. C. O. Swanson. Cereal Chemistry 20:286-299.
101	1945	Observations on the Thiamin Content of Stored Wheat. E. G. Bayfield and W. W. O'Donnell. Food Research 10:485-488.
104	1945	Methods of Estimating and the Effect of Variety and Protein Level on the Baking Absorption of Flour. K. F. Finney. Cereal Chemistry 22:149-158.
107	1945	The Effect of Mixing Speeds and Dry Milk Solids on Bread Volume. E. C. Swanson and E. G. Bayfield. Cereal Chemistry 22:214-224.
108	1945	Optimum Versus Fixed Mixing Time at Various Potassium Bromate Levels in Experimental Bread Making. K. F. Finney and M. A. Barmore. Cereal Chemistry 22:244-254.
109	1945	Varietal Responses to Certain Baking Ingredients Essential in Evaluating the Protein Quality of Hard Winter Wheats. K. F. Finney and M. A. Barmore. Cereal Chemistry 22:225-243.
110	1945	Enriched, Morris Type, and Whole Wheat Flour as Sources of the B-Complex Vitamins. Beulah D. Westerman and E. G. Bayfield. Jour. Nutr. 29(1):27-33.
111	1945	Effect of Fermentation, Rest Periods, and Formula Ingredients on Mixogram Patterns. John A. Johnson and C. O. Swanson. Cereal Chemistry 22:204-214.
112	1945	Dough Development and Mechanical Gluten Dispersion in Relation to Amount of Mixing and to the Flour Water Ratio. C. O. Swanson and A. C. Andrews. Cereal Chemistry 22:60-75.
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114	1945	The Industrial Utilization of Wheat. E. G. Bayfield. Bul. Assoc. Operative Millers, pp. 1420-1421.
115	1946	An Automatic Recording Device for Measurement of Gas Production and Gas Retention in Doughs. E. B. Working and E. C. Swanson. Cereal Chemistry 23:210-216.
116	1945	The Effect of Room Temperature in Experimental Baking. E. G. Bayfield, J. A. Johnson, and E. C. Swanson. Cereal Chemistry 22:547-553.
118	1946	Wheat Viability Loss Due to Fumigation and Its Relation to Baking Quality. R. T. Cotton, J. C. Frankenfeld, Bur. Ento. Plant Quarantine; E. G. Bayfield, J. A. Johnson. Northwestern Miller. 227(2) Sec. 2:4a-5a.
120	1946	The Effect of Yeast, Bromate, and Fermentation on Bread Containing Soy Flour. E. G. Bayfield and E. C. Swanson. Cereal Chemistry 23:104-113.
128	1946	Wheat Conditioning. R. O. Pence. Assn. Operative Millers' Bul. 1544-1548
129	1946	Research in Milling Industry. J. A. Shellenberger. Proc. Indus. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:43-45.
130	1946	Training Young Men for the Milling Industry. J. A. Shellenberger. The Miller (British Jour.) 72:160-162.

**Department of Poultry Husbandry**

160	1944	The Role of Carotenols in Growth and Reproduction of the Fowl. A. E. Schumacher, J. S. Hughes, W. J. Peterson, and H. M. Scott. Poul. Sci. 23:529-532.
161	1945	Inheritance of Ungual Osteodystrophy in the Fowl. D. C. Warren, C. D. Mueller, F. B. Hutt. Jour. Heredity 35:355-358.
162	1945	The Stability of Vitamin A in an Experimental Poultry Feed. D. B. Parrish, M. J. Caldwell, and A. E. Schumacher. Trans. Kan. Acad. Science, 47(3):375-379.

BIENNIAL REPORT OF DIRECTOR

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<i>Year of Issue</i>	<i>Title, author, and publication</i>
1945	The Value of DDT for the Control of the Common Chicken Louse. D. C. Warren. <i>Poult. Sci.</i> 24:473-476.
1945	A Note Regarding a Case of Lateral Asymmetry in the Fowl. D. C. Warren. <i>Jour. Heredity</i> 36:226-231.
<b>Department of Veterinary Medicine</b>	
1945	Outbreak of Haemonchosis in Feeder Lambs. J. H. Whitlock, et al. <i>Cornell Veterinarian</i> 35:273-275.
1945	Latex in the Preparation of Corrosions of Mammary Glands. H. E. Bechtel and W. M. McLeod. <i>Amer. Jour. Vet. Research</i> 6(18):17-20.
1945	Isolation of Actinomyces Bovis from Fistulous Withers and Poll Evil. Alice D. Kimball and E. R. Frank. <i>Amer. Jour. Vet. Research</i> 6(18):39-44.
1945	Sorghum Feeds for Dairy Cattle. I. The Effects of Restricting Lactating Cows to Atlas Sorgo Rations. H. E. Bechtel, F. W. Atkeson, Marvin Kroger, J. S. Hughes, W. J. Peterson, W. W. Thompson. <i>Jour. Dairy Science</i> 2:295-303. 28(7):531-544.
1945	Anthelmintic Bioassay of Simple Saturated Hydrocarbons. J. H. Whitlock. <i>Cornell Veterinarian</i> 35:214-220.
1946	Bovine Mastitis. R. P. Link. <i>Kan. Agr. Expt. Sta. Circ.</i> 233:1-12.
1946	Brucellosis of Cattle. V. K. McMahan. <i>Kan. Agr. Expt. Sta. Circ.</i> 237:1-16.
<b>Department of Zoölogy</b>	
1944	Reduced Pituitary Activity from the Influence of Sex Hormones. E. H. Herrick and Irene W. Hartman. <i>Trans. Kan. Acad. Sci.</i> 47:187-189.
1944	Effect of an All Plant Ration on the Resistance of an Omnivorous Animal to Parasitism. J. E. Aekert, Dorothy S. Branson, and D. J. Ameel. <i>Trans. Kan. Acad. Sci.</i> 47(2):215-218.
1945	Morphology of the Cysticercoid of the Fowl Tapeworm, <i>Raillietina cestiticillus</i> (Molin). Charles L. Wisseman, Jr. <i>Trans. Amer. Micros. Soc.</i> 64(2):145-150.
1945	Tensile Strength of Tissues as Influenced by Male Sex Hormones. E. H. Herrick. <i>Anat. Rec.</i> 93:145-149.
1945	The Derivation of Hymenoptera. R. K. Nabours. <i>Annals Ento. Soc. Amer.</i> 38(4):457-458.
<b>Director's Office</b>	
1944	The Crop Industries of Kansas. L. E. Call. <i>Trans. Kan. Acad. Sci.</i> 47(1):1-6.
1944	Twelfth Biennial Report of the Director of the Kan. Agr. Expt. Sta. L. E. Call. <i>Kan. Agr. Expt. Sta. 12th Bien. Rpt., 1942-1944.</i> pp. 1-99.
1946	The Agricultural Experiment Station. L. E. Call. <i>Proc. Indus. Agr. Conf. Kan. Agr. Expt. Sta. Rpt. No. 3:27-30.</i>
<b>Fort Hays Branch Experiment Station</b>	
1942	Varieties of Sorghum in Kansas. A. F. Swanson and H. H. Laude. <i>Kan. Agr. Expt. Sta. Bul.</i> 304:1-63.
1944	The Buffalo Grass Seed Drier. L. C. Aicher. <i>Jour. Agr. Engineering</i> 25:394.

**FINANCIAL STATEMENT, 1944-'45**

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

	<i>Federal appropriations</i>	<i>State appropriations and receipts</i>	<i>Totals</i>
Main station.....	\$140,050.96	\$55,820.12	\$195,871.08
Branch stations.....		84,945.91	84,945.91
Main and branch stations, fees.....		223,454.74	223,454.74
Balance, June 30, 1945, all sources less amount reverted.....		115,594.84	115,594.84
<b>Totals.....</b>	<b>\$140,050.96</b>	<b>\$479,815.61</b>	<b>\$619,866.57</b>
Personal services.....	\$129,298.37	\$189,762.02	\$319,060.39
Travel.....	764.08	4,326.28	5,090.36
Transportation of things.....	23.34	3,173.30	3,196.64
Communication service.....	96.53	2,591.40	2,687.93
Rents and utility services.....	17.50	7,219.95	7,237.45
Printing and binding.....	133.41	921.26	1,054.67
Other contractual services.....	802.34	6,939.35	7,741.69
(Repairs and alterations to equipment and buildings)			
Supplies and materials.....	6,259.28	53,773.38	60,032.66
Equipment.....	2,631.11	23,320.04	25,951.15
Lands and structures (contractual).....	25.00	1,178.50	1,203.50
Contributions to retirement.....			
Unexpended balances, June 30, 1945.....		186,610.13	186,610.13
<b>Totals.....</b>	<b>\$140,050.96</b>	<b>\$479,815.61</b>	<b>\$619,866.57</b>

**FINANCIAL STATEMENT, 1945-'46**

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

	<i>Federal appropriations</i>	<i>State appropriations and receipts</i>	<i>Totals</i>
Main station.....	\$143,614.76	\$207,874.29	\$351,489.05
Branch stations.....		68,500.00	68,500.00
Main and branch stations, fees.....		153,559.08	153,559.08
Balance, June 30, 1946, all sources less amount reverted.....		181,698.41	181,698.41
<b>Totals.....</b>	<b>\$143,614.76</b>	<b>\$561,631.78</b>	<b>\$705,246.54</b>
Personal services.....	\$133,425.87	\$187,410.02	\$320,835.89
Travel.....	1,194.07	6,660.63	7,854.70
Transportation of things.....	38.99	2,809.00	2,847.99
Communication service.....	107.70	1,699.81	1,807.51
Rents and utility services.....	32.99	6,993.10	6,926.09
Printing and binding.....	176.24	846.47	1,022.71
Other contractual services.....	603.34	10,702.29	11,305.63
(Repairs and alterations to equipment and buildings)			
Supplies and materials.....	6,629.84	68,279.69	74,909.53
Equipment.....	1,405.72	24,833.03	26,238.75
Lands and structures (contractual).....		887.74	887.74
Contributions to retirement.....			
Unexpended balances, June 30, 1946.....		250,610.00	250,610.00
<b>Totals.....</b>	<b>\$143,614.76</b>	<b>\$561,631.78</b>	<b>\$705,246.54</b>

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